Comparative study of diversity and termite damage in the selected variety of cocoa "Mercedes or CNRA" and unselected "Tout venant" grown in Abengourou in eastern Côte d'Ivoire

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Abstract
This work was done in the East of Côte d'Ivoire in Abengourou, in order to compare the termite diversity and their impact on two cultivated cocoa varieties « Mercedes » and « Tout venant ». One hundred (100) of 2-year-old cocoa plants were delineated on three plots by variety of cocoa. The results obtained show a comparatively identical specific richness in the two varieties. The unselected variety "Tout venant" records 18 species against 17 species for the selected variety "Mercedes". The comparison of the specific richness, the Shannon diversity index (H'), the Simpson index (SI) and the Equitability index (E) do not vary significantly between the two varieties of cacao. The density of termites varies significantly depending on the variety in the soil. The densities of the varieties "Mercedes" and "Tout venant" were respectively 2755.50 ± 397.43 ind/ m^2 and 1612.37 ± 208.74 ind/ m^2. Densities at the depth level were also compared for both varieties. Statistical analyzes show that the "Mercedes or CNRA" variety has the highest density at all depths. This density decreases with the depth of the two varieties. Eleven (11) species of termites have been identified, 8 of which are common to both varieties. The calculated Jaccard coefficient was 0.74. This value does not reflect any difference in the diversity of termites pests in both varieties. The attack rates of the "Mercedes" and "Tout venant" varieties were respectively $25.00 \pm 1.15\%$ and $26.33 \pm 1.20\%$. These rates do not vary significantly between the two varieties. The species *Ancistrotermes guineensis* and *Microtermes sp1* are the most aggressive. *A. guineensis*, with an attack rate of 34.68 ± 1.70 %, is more aggressive on the variety "Mercedes" and *Microtermes sp1* on the variety "Tout venant" with an attack rate of $28.74 \pm 1.97\%$. This work shows that the new cocoa variety "Mercedes" does not influence the biodiversity and the attacks of the cocoa pest termites but shows a difference of the termite population in the soil depending on the variety and specificity of the termites pests depending on the species.

Keywords: diversity, mercedes, varieties, tout-venant, damages

1. Introduction
The Cocoa is an export product of major interest worldwide. It is one of the main export crops of some producing countries such as Brazil, Ecuador, India, Nigeria, Ghana and Côte d'Ivoire. World cocoa production is estimated at more than 3.5 million tonnes per year according to [1] statistics. This crop supports nearly 3.5 million people around the world. Eight (8) to ten (10) million hectares are devoted to cocoa cultivation worldwide. In Africa, cocoa is the main product exported by states. West Africa alone contributes over 70% of world cocoa bean production [2]. In Côte d'Ivoire, cocoa is the mainstay of the agricultural sub-sector and, thereby, is of strategic importance for macroeconomic balance and social stability. It provides 40% of export earnings, 70% of agricultural income and about 30% of tax revenue [3]. It contributes more than 15% to the Gross Domestic Product. In Côte d'Ivoire, three varieties of cocoa are grown [4]. It's about the variety selected by the CNRA "Mercedes", the unselected variety "Tout venant" and the Amelonado. "Tout Venant" represents on average 52% of the areas, against respectively 8 to 10% for the selected variety and Amelonado [4]. This crop is today

confronted with many pests and diseases. The most damaging in Côte d'Ivoire are mirids, stem borers and termites [5, 6]. The variety "Mercedes" has characteristics of resistance to certain insect pests (mirids) and diseases (swollen shoot). Few data exist regarding termite attacks on this variety. Termite being one of the formidable pests of cocoa farming in Côte d'Ivoire [6], we set ourselves the goal of comparing termite damage in two varieties of cocoa commonly grown in the department of Abengourou, the variety selected " Mercedes or CNRA "and the variety unselected "Tout venant". To achieve our goal, we have: 1) make an inventory of termites in the different plots of the two varieties, 2) determine the density of the species according to the variety, 3) Evaluate the attack rates of termites according to the variety.

2. Material and methods
2.1. Study site
The department of Abengourou is located in the East of Côte-d'Ivoire, in the region of Indénié-Djuablin. The climate of this department is of the subequatorial type [7]. It is marked by two rainy seasons in June and October and two dry seasons from

November to March and around August. The relative humidity varies between 40% and 85%. The soils are essentially ferralitic. The vegetation is essentially mesophilic dense forest in the northern part.

2.2. Material vegetal
The vegetal material consists of cocoa trees (*Theobroma cocoa*). This species is cultivated in Côte d'Ivoire with several varieties, two of which are the subject of our study. It is the selected variety "Mercedes or CNRA" (Figure 1A) and the unselected variety "Tout venant" (Figure 1B). The selected variety "Mercedes" is characterized by the unselected variety "Tout venant" by its precocity, its yield, its quality and the size of the beans, the large number of pods and the size of the cocoa tree. At the level of root depth, trunk shape no difference exists between the two varieties.
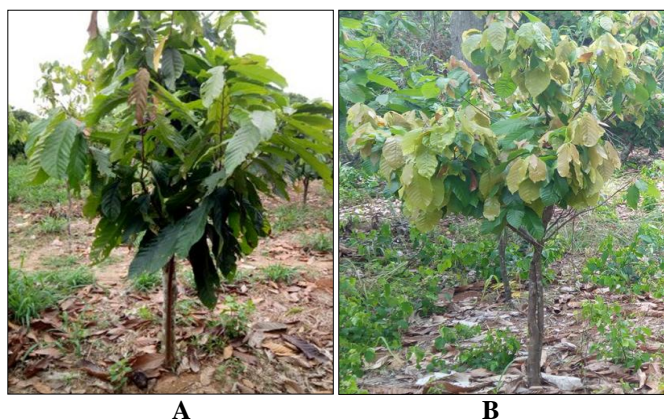

Fig 1: Young cocoa trunk of two varieties grown in the department of Abengourou A) Young trunk of the Variety "Mercedes"; B) Young trunk of the variety "Tout venant"

2.3. Methods
2.3.1. Study of the diversity of termites according to the variety of cocoa
To compare the diversity of termites in the selected variety or "Mercedes" and the unselected or "Tout venant" variety, three cocoa orchards of the same age (2 years) per variety have been sampled. A plot of one hectare has been defined. Twenty (20) sections of 10 m² (5 m × 2 m) in area along a transect 100 m long and 2 m wide were delineated according to the method of [8]. The search was done in two stages. The first consisted of digging in the litter, all the micro-habitats likely to house the termites, the superficial soil horizons, under the dead woods, in the accumulations of litter at the bas of the tree trunks. The second step was to randomly collect and search 12 clods of soil equal to 12 cm x 12 cm and 10 cm thick [8].

2.3.2. Sampling of hypogeous termites
The hypogeous termites were collected in the cocoa plots of both varieties by the TSBF monoliths method [9]. A metal quadrat 25 x 25 cm and 30 cm thick was sunk into the ground. A pit is then dug around to clear the soil monolith. The monolith is cut into successive slices (0-10 cm, 10-20 cm, 20-30 cm). Each layer of soil is searched minutely. All termites harvested in each stratum are kept in bottles containing 70° alcohol. Three monoliths are dug per plot along the transect at the level of sections 1, 10 and 20 according to the method used by [6]. The TSBF monoliths are located 10 m from transect.

2.3.3. Evaluation of termite damage according to variety
To evaluate termite damage in both varieties, 3 cocoa orchards of the same age (2 years) of one hectare were sampled by variety. In each orchard, 100 cocoa trees were delineated in the middle of each plot to avoid the border effect. The trunks of is examined at a height of 1.5 m from the ground in search of termites and signs of their presence (biogenic structures). The number of cocoa trunks attacked and those killed as a result of the attacks are counted and the type of attack is identified. The termites responsible for the attack are harvested and kept in 70 ° alcohol.

2.3.4. Estimation of damage caused by termite attacks on cocoa trees
The index of intensification or infestation of termites was calculated using the following formula : ID = [(Ps x 0%) + (P1 x 25%) + (P2 x 50%) + (P3 x 75%) + (P4 x 100%)] / [Ps + P1 + P2 + P3 + P4].

ID = the index of intensification of damage per plot
Ps = the number of healthy trunks
P1 = the number of truncks with type 1 damage
P2 = the number of truncks with type 2 damage
P3 = the number of truncks with type 3 damage
P4 = the number of truncks with type 4 damage

Table 1: Qualification of termite infestation indices

Group	Index (%)	Qualification
I	$0 \leq ID \geq 20$	Low
II	$20 \leq ID \geq 40$	Middling
III	$40 \leq ID \geq 50$	Bred
IV	$50 \leq ID \geq 100$	Very high

ID: Infestation index

2.3.5. Estimation of termite attack rates
The rate of attack of termites is calculated according to the following formula:

F = Npa x 100 / Ntp
F = termite attack rate
Npa = Number of truncks with termite attacks
Ntp = Total number of truncks observed

2.3.6. Sorting and identification of termite species
Harvested individuals are sorted and kept in bottles containing 70 ethyl alcohol. They are identified using a determination key of [10, 11, 12, 13]. The identification was based on the caste of the soldiers according to the identification keys mentioned above. For those without soldiers, they were identified using the key of [13]. After identification, each species is classified in the trophic groups (Champignonnist, humivorus, xylophageous).

2.3.7. Data analysis
The statistical analysis of the data was carried out with graphpad and statistica software. The non parametric test of

student at the threshold of 5%, made it possible to look for differences between the rates of attacks and the densities of termites within the plots of the 2 varieties "Mercedes or CNRA" and "Tout venant". Both software also helped build the graphics. To analyze the diversity of termite populations, we calculated the indices of diversity (Shannon index, Simpson) and equitability. An analysis with the t-test of Student allowed us to compare mean diversity indices.

Subsequently, we calculated the similarity index according to the formula of Jaccard:

$$S_{TA}(i, j) = \frac{a}{a + b + c}$$

a. Number of species common to variety i and variety j
b. Number of species present only at variety level i
c. Number of species present only at the variety level j

3. Results
3.1. Inventory of termite species according to the varieties Mercedes and Tout venant
Of the two varieties, 19 termites species were collected in transects and monoliths. They belong to 3 families (Kalotermitidae, Rhinotermitidae and Termitidae). They are grouped into 7 sub-families and 15 genera. The sub-family Macrotermitinae is the most represented with 7 species. It is followed by the sub-family Termitinae and that of cubitermitinae with 5 and 2 species respectively. The least diversified sub-families were Coptotermitinae, Rhinotermitinae, Nasutitermitinae and Kalotermitinae with one species each. (Table 2).

Sixteen (16) species are common to both varieties, the varieties selected "Mercedes or CNRA" and unselected "Tout venant". These are *Coptotermes intermedius, Schedorhinotermes lamanianus, Postelectrotermes sordwanae, Ancistrotermes guineensis, A.cavithorax, A. crucifer, Acanthotermes acanthothorax, Microtermes sp1, M. sp2, Cubitermes sp, C. fungifaber, Nasutitermes sp, Amitermes evuncifer, Pericapritermes urgens and Microcerotermes sp1.*

The specific richness was 17 species in the plots of the selected variety "Mercedes or CNRA". That of the unselected variety "Tout venant" was 18 species. The Shannon index (H') calculated for the varieties "Mercedes or CNRA" and "Tout venant" were respectively 2.94±0.32 and 2.42±0.27. The values of equitability (E) of the varieties "CNRA" and "Tout venant" were respectively 0.76±0.083 and 0.68±0.081. The Simpson index (IS) calculated for the varieties "Mercedes or CNRA" and "Tout venant" were respectively 0.80±0.03 and 0.76±0.02. With regard to average diversity, the statistical analyzes show no significant difference between the termite populating of the "Mercedes or CNRA" and "Tout venant" plots (P> 0.05) (Table 3). The Jaccard coefficient that reflects the specific composition at the level of the two varieties was 0.84, well above 0.5. This value shows a similarity in the specific composition of the two varieties.

Table 2: List of termites harvested in the plots according to the two varieties of cocoa

Families	Sub-families	species	GT	Mercedes	Tout venant
Kalotermitidae	Kalotermitinae	*Postelectrotermes sordwanae*	X	*	*
Rhinotermitidae	Coptotermitinae	*Coptotermes intermedius*	X	*	*
	Rhinotermitinae				
		Schedorhinitermes lamanianus	X	*	*
Termitidae	Macrotermitinae				
		Ancistrotermes guineensis	C	*	*
		Ancistrotermes cavithorax	C	*	*
		Ancistrotermes crucifer	C	*	*
		Odontotermes pauperans	C	*	
		Acanthotermes acanthothorax	C	*	*
		Microtermes sp1	C	*	*
		Microtermes sp2	C	*	*
		Macrotermes bellicosus	C	*	*
	Cubitermitinae				
		Cubitermes sp	H	*	*
		Cubitermes fungifaber	H	*	*
	Nasutitermitidae	*Nasutitermes sp*	X	*	*
	Termitinae	*Amitermes evuncifer*	X	*	*
		Pericapritermes urgens	H	*	*
		Termes sp	X		*
		Microcerotermes sp1	X	*	*
		Microcerotermes sp2	X		*
Total		19		17	18

(C= Champignonnist, H= Humivorus, X= Xylophageous, GT : Trophic Groupe)

Table 3: Indices of diversity of cultivated plot with "Mercedes or CNRA" and "Tout venant"

Variety	Specific richness (S)	Shannon (H')	Equitability (E)	Simpson (IS)
Mercedes	17	2.94± 0.32 a	0.756±0.08 a	0.80±0.03 a
Tout enant	18	2.42±0.27 a	0.676± 0.08 a	0.76 ± 0.02 a
Tcal	-	2.14	1.19	1.30
p-value	-	0.099	0.300	0.26

In each column, means with the same letters are not statistically different at the 5% threshold according the t-test of Student. Tcal: Student t-value

3.2. Diversity of hypogeous termites according to the variety "Mercedes or CNRA" and "Tout venant"

A total of 12 termite species grouped into two families, five (5) sub-families and 9 genera were collected in the monoliths (TSBF) at both varieties. The champignonnists are the most represented with 5 species (*A. guinneensis, A. crucifer, A. cavithorax, A. acanthothorax and Microterms sp1*). They are followed by humivorus with 4 species (*Cubitermes sp, C. fungifaber, Promirotermes sp and Pericapritermes urgens*). Finally, the group of Xylophageous are the least represented with 3 species (*P. sordwanae, Nasutitermes sp* and *A.*

evuncifer). Five species were common to both varieties. There are *A. guineensis, A. cavithorax, Microterms sp1, Cubitermes sp* and *A. evuncifer*. Three species were harvested only in the monoliths of the parcels of the variety "Mercedes or CNRA". These are *P. sordwanae, Nasutitermes sp* and *P. urgens*. Three species were also specific to the parcels of the variety "Tout venant". These are *Promirotermes sp, C. fungifaber* and *A. acanthothorax*. The calculated Jaccard coefficient was 0.42. This value shows no similarity in the monoliths in the plots of both.

Table 4: List of hypogeous termites in the plots according to the two varieties of cocoa

Families	Sub-families	spècies	GT	Mercedes	Tout venant
Kalotermitidae	Kaloterminae				
		Postelectrotermes sordwanae	X	*	
Termitidae					
	Macrotermitidae				
		Ancistrotermes guineensis	C	*	*
		Ancistrotermes crucifer	C	*	
		Ancistrotermes cavithorax	C	*	*
		Acanthotermes acanthothorax	C		*
		Microtermes sp1	C	*	*
	Cubitermitinae				
		Cubitermes sp	H	*	*
		Cubitermes fungifaber	H		*
	Nasutitermitinae				
		Nasutitermes sp	X	*	
	Termitinae				
		Amitermes evuncifer	X	*	*
		Pericapritermes urgens	H	*	
		Promirotermes sp	H		*
Total		12		9	8

C= Champignonnist, H= Humivorus, X= Xylophageous, GT : trophic groupe)

3.3. Termite density according to cocoa variety

Termites have been present in all plots whatever the variety. Termite densities in the varieties selected "Mercedes" and unselected "Tout venant" are respectively 2755.50±397.43 ind/m^2 and 1612.37±208.74 ind /m^2. Statistical analysis shows that the density of termites at the level of the TSBF monoliths is significantly higher in the Mercedes variety (t = 4.41, p = 0.011) (Figure 2). Densities at the depth level were also compared for both varieties. Thus, the statistical analyzes show that the variety "Mercedes or CNRA" records the highest density at all depths. This density decreases with depth in both varieties (Figure 3).
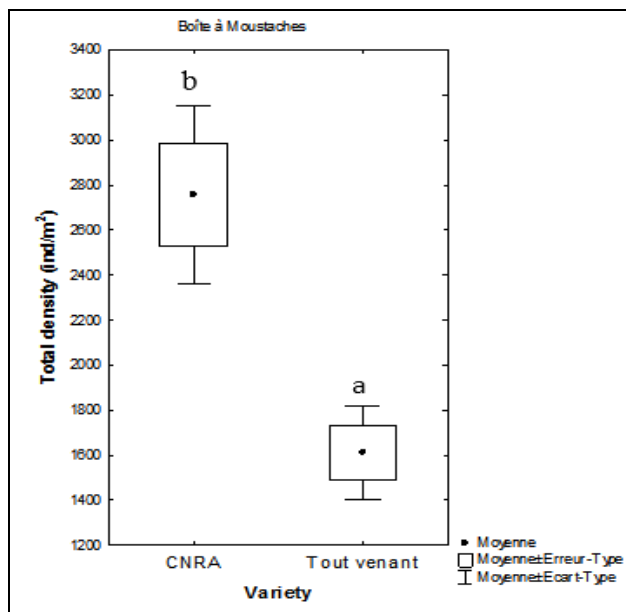
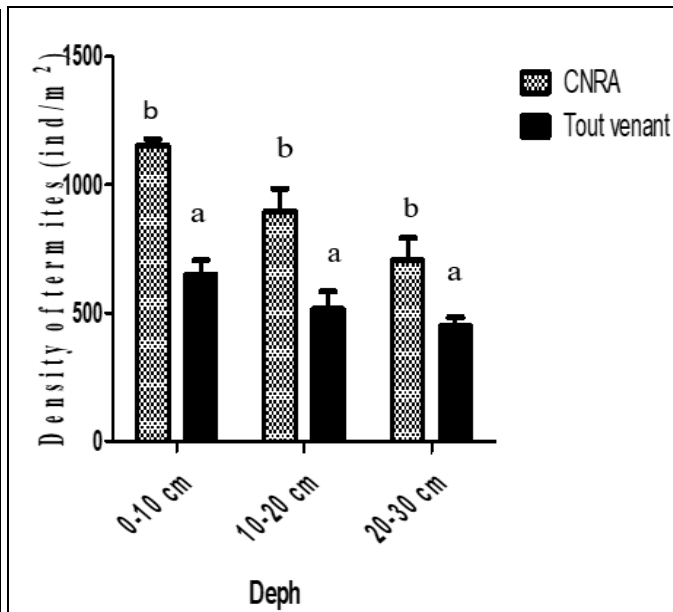**Fig 2:** Variation of termite density in TSBF monoliths between the variety

Fig 3: V ariation in termite density by Type of damage and variety

3.4. Attacks and damage of termite pests in cocoa orchards according to both varieties

3.4.1 Termites pests of cacoa according to both varieties

A total of 11 termite species grouped into 3 families, 5 sub-families and 8 genera were collected in the cocoa plots of both varieties. The variety selected "Mercedes or CNRA" has the highest number of species (10 species), against 9 species for the unselected variety "Tout venant" (Table 5). All species harvested on cocoa trees are present in orchards. They were harvested in transects and in monoliths. Eight (8) were common to both varieties. Two species are harvested only in the cocoa trees of the selected variety "Mercedes". These are *Microcerotermes sp1* and *Microtermes sp2* against a single species (*A. evuncifer*) specific to the unselected variety "Tout venant". The calculated Jaccard coefficient was 0.74. This value shows no difference of the pests termite diversity in the two varieties.

The plate 1 shows illustrative photos of the different species of termites pests of cocoa trees.

Table 5: Distribution of cocoa termites pests according to the two varieties

Families	Sub-familles	Species	GT	Mercedes	Tout venant
Kalotermitidae	Kalotermitinae				
		Postelesctrotermes sordwanae	X	*	*
Rhinotermitidae	Coptotermitinae				
		Coptotermes intermedius	X	*	*
Termitidae					
	Macrotermitinae				
		Ancistrotermes guineensis	C	*	*
		Ancistrotermes crucifer	C	*	*
		Ancistrotermes cavithorax	C	*	*
		Acanthotermes acanthothorax	C	*	*
		Microtermes sp1	C	*	*
		Microtermes sp2	C	*	
	Nasutitermitinae				
		Nasutitermes sp	X	*	*
	Termitinae				
		Amitermes evuncifer	X		*
		Microcerotermes sp1	X	*	
Total		11		10	9

GT = Trophic Groupe : C= Champignonnist, X= Xylophageous

3.4.2. Average rates of termite pest attacks by variety

The average rate of termite attacks per hectare of the varieties selected "Mercedes or CNRA" and unselected "Tout venant" are respectively 25.00 ±1.15% and 26.33±1.20%. These rates do not differ significantly between the two varieties (p> 0.05, T = 0.8, df = 4) (Figure 4). The different types of termite attacks have been observed in both varieties. In the plots of the variety "Mercedes or CNRA", the trunks were infested

with 14.33±1.76% type 1 damage (P1), 5.00± 1.00% type 2 damage (P2), 3.33±0.88% type 3 damage (P3) and 2.34±1. 20% type 4 damage (P4). For plots of the "Tout venant" variety, 15.67±0.88% of the attacks are of type 1 (P1), 4.00±0.57% of type 2 (P2), 3.66±1.76% of type 3 (P3) and 3.00±0.33% of type 4 (P4). The analysis of the results shows no significant difference of the types of damage at the level of the two varieties (Figure 5). Plate 2 shows illustrative photos of different termite attacks on cocoa trees.
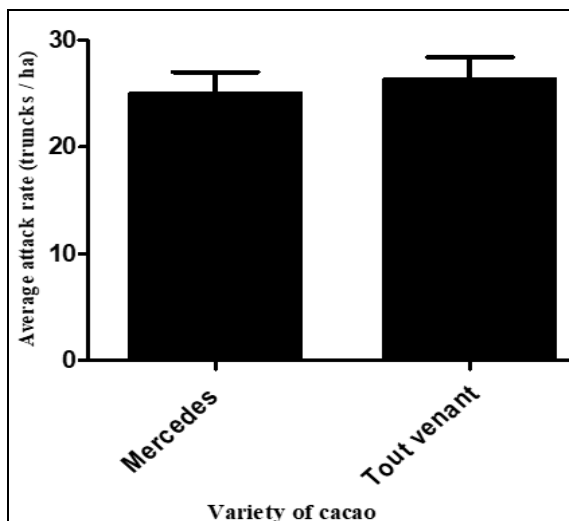
3.4.3 Qualification of termite infestation indices in cocoa orchards
The termite damage in cocoa orchards of the variety "Mercedes or CNRA" and "Tout venant" are belew. Infestation indices for both varieties, "Mercedes" and "Tout venant", have been 10.92±0.51 and 10.33±1.94, respectively. The statistical analysis shows no significant difference at level of index of infestation between cocoa varieties (P = 0.78, t = 0.2912, df = 4).
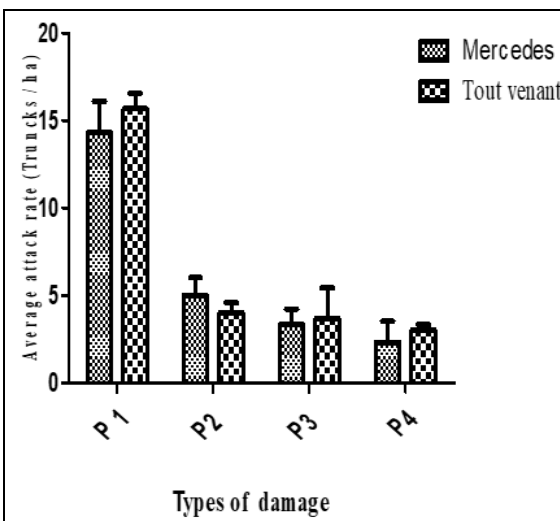

Fig 4: Termite attack rates in different cocoa varieties

Fig 5: Termite attack rates by type of damage and variety

4.4. Most aggressive species according to cocoa varieties
For the variety "Mercedes" the species *A. guineensis* have been the most aggressive with a rate of 34.68±1.7% attack. The least aggressive species for this variety have been *C. intermedius* and *A. acanthothorax* with an attack rate of 1.58±0.24% and 1.58±0.22%, respectively. With regard to the unselected variety 'Tout venant', the species *Microtermes sp1* and *A. guineensis* have been the most aggressive with an attack rate of 28.74±1.97% and 24.75±1,33 % respectively. The least aggressive species are *C. intermedius* and *P. sordwanae* with attack rates of 1.24 ± 0.14% and 1.53 ± 0.57%, respectively.

Based on the coding of the frequency indices presented in the following table, the termite species harvested on the cocoa

trees for both varieties can be classified into three groups. Thus, for the variety "Mercedes", the species *A. guineensis* was classified aggressive. The species *A. crucifer, A. cavithorax* were classified moderately aggressive. The species *Nasutitermes sp*, *Microtermes* sp1 and *P. sordwanae* are classified not very aggressive. Finally, *C. intermedius* and *A. acanthothorax* are classified rarely aggressive. With regard to the variety "Tout venant", the species *A.guineensis* and *Microtermes sp1* are classified aggressive. *A. crucifer*, *C. intermedius* and *P.sordwanae* are the three species ranked rarely aggressive for the variety "Tout venant". Finally, the species *A. acanthothorax, Nasututermes sp* and *A. cavithorax* are classified mildly aggressive (Table 6).

Table 6: Rate of attack and degree of infestation of termite species according to cocoa varieties.

Spècies	A. R. Mercedes	D. infestation	A. R. Tout venant	D. infestation
A. guineensis	34.68 ± 1.70 e	Agressive	24.74 ± 1.33 d	Agressive
A. crucifer	11.93 ± 0.80 d	M. Agressive	2.12 ± 0.11 a	R. Agressive
A. cavithorax	11.57 ± 4.03 d	M. Agressive	8.77 ± 0.77 c	L. agressive
C. intermedius	1.58 ± 0.24 a	R. Agressive	1.24 ± 0.14 a	R. Agressive
A. acanthothorax	1.58 ± 0.22 a	R. Agressive	6.47 ± 0.56 b	L. agressive
Nasututermes sp	9.52 ± 0.41 c	L. Agressive	5.40 ± 0.36 b	L. agressive
Microtermes sp 1	9.13 ± 0.80 c	L. Agressive	28.74 ± 1.97 e	Agressive
P. sordwanae	5.99 ± 0.71 b	L. Agressive	1.53 ± 0.057 a	R. agressive

A. R. Mercedes = Attacks Rate Mercedes, A. R. Tout venant = Attacks Rate Mercedes; M. Agressive: Moderately aggressive; R. Aggressive: Rarely aggressive; L. aggressive: Little aggressive.

In each column, means with the same letters are not statistically different at the 5% threshold according the t-test of Student.

3.4.5. Attack rate of termites common to both cocoa varieties
The Comparison of attack rates of cocoa termite pest species

with the t test of Student showed that attack rates of *A. guineensis, A. cavithorax, A. crucifer, Nasutitermes sp, Microtermes sp, P sordwanae* and *A. Acanthothorax* vary significantly by both varieties (Table 7). On the other hand, for the *C. intermedius* species, the attack rate is not significantly different between the two varieties (Table 7).

Table 7: Attack rate of termite species according to the varieties "Mercedes or CNRA" and "Tout venant "

Species	A. R. Mercedes	A. R. Tout venant	T. calculated	p-value
A. guineensis	34.68 ± 1.70 a	24.74 ± 1.33 b	9.714	0.0006
A. crucifer	11.93 ± 0.80 a	2.12 ± 0.11 b	20.98	0.0001
A. cavithorax	11.57 ± 4.03 a	8.77 ± 0.77 b	6.143	0.0036
C. intermedius	1.58 ± 0.24 a	1.24 ± 0.14 a	1.888	0.132
A. acanthothorax	1.58 ± 0.22 b	6.47 ± 0.56 a	13.96	0.0002
Nasututermes sp	9.52 ± 0.41 a	5.40 ± 0.36 b	10.48	0.0005
Microtermes sp 1	9.13 ± 0.80 b	28.74 ± 1.97 a	15.95	0.0001
P. sordwanae	5.99 ± 0.71 a	1.53 ± 0.05 b	10.77	0.0004

A. R. Mercedes = Attacks Rate Mercedes; A. R. Tout venant = attack Rate Tout venant; Calculated T. = Student t-value

On the same line, the averages bearing the same letters are not statistically different at the 5% threshold according the t-test of Student.

4. Discussion
Total of 19 termite species grouped into three (3) families (Kalotermitidae, Rhinotermitidae and Termitidae) have been collected during this study. These collected species are common to termite species of perennial crops, including mangoes trees [14], rubber [15] and cocoa [6] in Côte d'Ivoire. The study showed no difference of the populating of termites between the plots of the selected variety 'Mercedes' and those of the unselected variety 'tout venant'. The mean diversity indices (Shannon, Simpson and Equitality) of the "Mercedes" variety were 2.94±0.32, 0.80±0.03 and 0.756 ± 0.08, respectively. Those of the "Tout venant" variety were respectively 2.42±0.27, 0.76±0.02 and 0.676±0.08. The comparison of the indices showed no difference between the two varieties. This result shows that the variety "Mercedes" like the variety "Tout venant" does not exert any attraction, in particular, on the species of termites. At the level of monoliths, termite density is lower with the variety "Tout venant" than the variety "Mercedes or CNRA". The density at the level of the variety "Mercedes or CNRA" is 2755.50±397.43 ind / m². That at the variety "Tout venant" is 1612.37±208.74 ind / m². This variation could be due to agricultural practices. Indeed, plots with the variety "Mercedes" were made undergrowth unlike the variety "Tout venant" where the plots were previously burned before the establishment of orchards. According to several authors including [16, 17], the canopy has a considerable effect on the density, diversity and the specific richness of termites. Also, it should be noted that the frequent cultural practices on brulis that the soils undergo in season of the cultures acidify them and deteriorate their properties making difficult the survival of termites [18]. This density, at the level of both varieties,

decreases with depth. Our results are identical to those of [19]. Indeed, this author has also shown, in cocoa plantations in departement of Oumé, western Côte d'Ivoire, a high density of termites in the 0-10 cm layer and a decrease as a function of depth. This high density in the 0-10 cm layer in the present study could be explained by the high concentration of organic matter (OM) on the soil surface in cocoa farms. The decrease in the density as a function of the depth could be explained by the variation of the chemical composition of the soil [20] and the presence of impenetrable structures (layer of gravel) [21]. In fact, [22] showed that the texture of the soils of Abengourou department is clay with ferruginous gravel on the surface.

A total of 11 termite species were harvested on cocoa trees in the both varieties. These species belong to the groups of champignonnists and xylophageous. The Observations of [14] showed that the termite species responsibles for the damage caused to mango trees in northern Côte d'Ivoire belong to the group of xylophageous and champignonnists.

Also, the work of [15] showed the presence of champignonnists, in particular the two underground species *Ancistrotermes guineensis* (Sjöstedt) and *Microtermes subhyalinus* (Smeathman) on rubber trees. These authors claimed that these two species are responsible for the attacks and losses of rubber trees on the plot studied in the department of Agboville. These trophic groups are not only pests of perennial crops but also attack cereals (maize, rice, millet, sorghum) [23, 24] and annual crops (cotton) [26].

Termite attack rates for the varieties "Mercedes or CNRA" and "Tout venant" are respectively 25.00±1.15% and 26.33±1.20%. These attack rates do not vary from one variety to another. These results confirm that termites do not have a variety preference. No humivorous species were harvested from cocoa trees. The results are similar to the results of [19].

Indeed, this author has not found any humivorus species on cocoa trees in western Côte d'Ivoire. The species *A. guineensis* and *Microtermes sp1* are the most aggressive respectively on cocoa trees of the variety "Mercedes or CNRA" and "Tout venant". The two genera Ancistrotermes and Microtermes have been identified as the main pests of rubber trees [15], cocoa trees [19] and plants of mango [14] in Côte d'Ivoire.

The selected variety "Mercedes" is characterized by the unselected variety "Tout venant" by its precocity, its yield, its quality and the size of the beans, the large number of pods and the size of the cocoa tree. All these characteristics that distinguish it from the variety "Tout venant" does not influence the attacks of the pests.

5. Conclusion
This study made it possible to highlight the impact of the cocoa variety on the diversity and the damage in two cocoa varieties cultivated in Côte d'Ivoire. Specific richness and the diversity indices do not vary according to the two varieties. The results obtained show that the termite attack rate does not vary between the new selected "Mercedes" cocoa variety and the unselected old "Tout venant" cocoa variety. This damages are importants. Termites do not have preferences. They attack both varieties and cause mortality.

Plate 1: Photos of some termites cocoa pests reported in the department of Abengourou
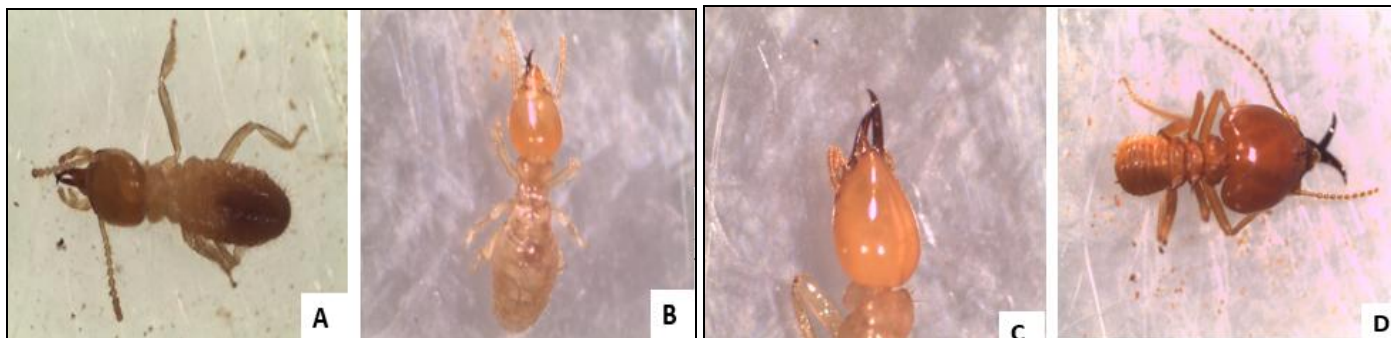

Fig 6: Photos of some termites cocoa pests reported in the department of Abengourou A*: A. guineensis*; B: *Microtermes sp*; C: *C. intermedius*; D: *A. acanthothorax*

Plate 2: The different termite damage observed on cocoa trees in two varieties

Fig 7: Damage of *A. guineensis* on cocoa base of the unselected variety « Tout venant »

Fig 8: Damage of *Microtermes sp1* on cocoa base of the unselected variety « Tout venant »

Fig 9: Damage of *A. guineensis* on cocoa base of the selected variety 'Mercedes'

Fig 10: Damage of *Microterms sp1* on cocoa base of the selected variety "Mercedes"

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