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Ant diversity in humid savannah at Koutaba (West Region, Cameroon)

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Abstract

Human activities caused a several threat to the biodiversity in the forest zone in Cameroon. Nevertheless, the situation in some ecoregion like dry and humid savannah remains less study. Our study was conducted at Koutaba in the West Region of Cameroon. Four land use system were selected in order to study their influence on ant diversity, composition and distribution. Ant were sample in a linear transect using pitfalls, baits and handling capture. Data was analyses using species richness, Shannon and Pielou indexes for diversity and Sorensen index for species composition. Venn diagram was used for species richness distribution between land use system. Clam test and Individual value were used to found relationship between ant species and land use system. A total of 90 ant species belonged to 30 genera and six subfamilies were collected. Myrmicinae was the richest subfamily with 10 genera and 44 species collected. Palm grove with 63 species was rich and diverse (S=63; H'=2.69; J= 0.65) than other land use system. Ant composition was similar between palm grove and savannah while orchard differ to all other land use system. Ant community was numerically dominated by *Myrmicaria opaciventris* (53.31 %) and *Camponotus acvapimensis* (11.08 %). Ant diversity and distribution was influence by land use structure and human disturbance like mechanization of agriculture in coffee farm and orchard and pasture activity in savannah.

Keywords: Biodiversity, Myrmecofauna, Environment, Diversity, Koutaba, Cameroon

Introduction

The last decades of the 20th century was characterized by a significant loss of biological diversity. This decline is more worrying in tropical ecosystems where more than 90 % of the world's species live. This habitat is threatened by human activities such as logging, agriculture and urbanization (Suspense *et al.,* 2017) [1]. Many research program aim to assess the state of biodiversity and it role in the functioning of tropical ecosystems; however, most of them focuses on the visible part of biodiversity above the soil surface to the detriment to that located below (David, 2002) [2]. Several study in tropical ecosystem highlight the fundamental role of soil fauna in the functioning of tropical ecosystems (Lavelle,1996 [3]; Konaté *et al.,* 2003 [4]).

Ants are the most important components of the macrofauna of soil in tropical region, where their ecological roles make them a true engineers of the ecosystem. These organisms are able to control food and space resources available for other organisms (Lavelle, 1996 [3]; Konaté *et al.,* 1999 [5]). The ecological importance of ants can be observed at two levels: they are ecologically dominant in most terrestrial ecosystem (Hölldobler and Wilson, 1990) [6] and they act as predators and therefore may protect plant against pest (Dejean *et al.,* 2008) [7], soils aeration by excavation activities, disseminators of the seeds of some plants (Kaspari, 1993) [8]. The importance of ants is also linked to their high sensitivity to the environmental change, making them potential biological indicators for sustainable biodiversity management (Andersen *et al.,* 2002) [9]. The functional guilds in ant community is amongst the reasons making them so successful in ecosystems. Several functional groups were identify in Australian ant community by Andersen (1995) [10] base on their ecology, alimentary diet, behavioral habits and nesting behavior: dominant Dolichoderinae, subordinate Camponotus, climate specialists, cryptic species, opportunists, generalized Myrmicinae and specialist predators. Nevertheless, the composition of the functional guild may change through time with different habitat management practices (Assis *et al.,* 2018) [11].

During the last decade, ant community in Cameroon was investigate principally in the Centre and South Regions in regard with natural environmental change, land use system and human activities. All these studies provide information to documented progressively ant diversity in Cameroon. Nevertheless, ant fauna remain unstudied in some ecoregion like humid savannah in the western region. It is in this context that the present study was carried out with the objective to study ant diversity and distribution in regard of land use system and human disturbance in a humid savannah.

Material and Methods

Study site

The study was conducted at Koutaba (5°42'0" N, 10°49"0" E) a rural agglomeration in the Foumban Subdivision, near the Foumbot city in the West Region of Cameroon (Figure 1). The climate is tropical climate of mountain (Olivry, 1986) [12] with a bimodal rainfall regime with three month of dry season and nine month of rainy season. The precipitations are abundant and vary between 2000 mm/year to 10000 mm/year. The mean annual temperature is 26 °C in a lower altitude and 21°C for a high altitude (Sighomnou, 2004) [13]. Vegetation is dominated by a mosaic of food crop farms, orchards, coffee farms, palm groves, and savannah sprinkle with shrub.

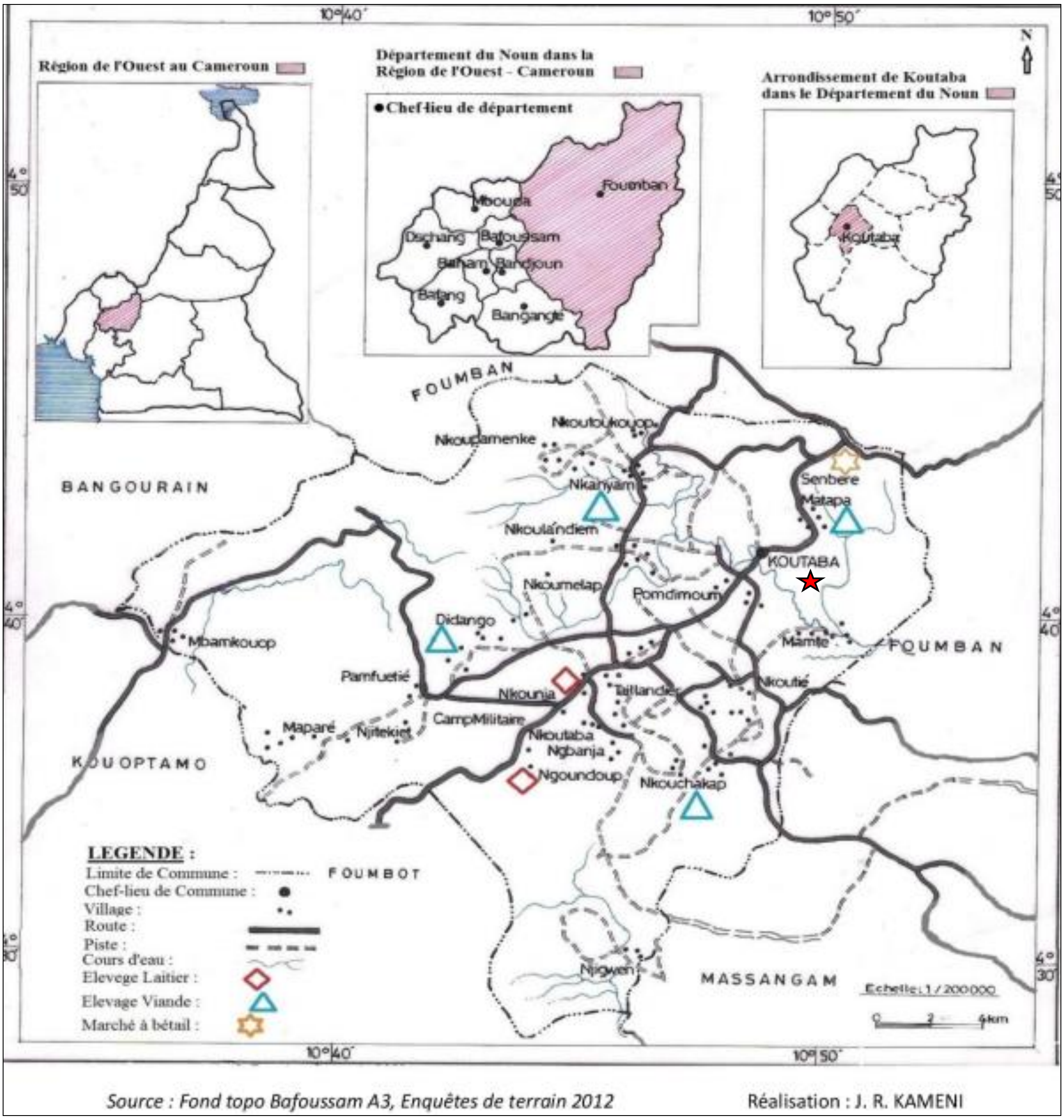

Fig 1: Map of the Foumban Subdivision

Description of the sampling land use system

Study was conducted in coffee farm, orchard, palm grove and savannah. Coffee plantations have more than 60 years old and are bordered by eucalyptus trees and food crops plantations. Coffee plantation is regularly cleared by the monks for maintenance using tractor and no chemical treatment was use since at least 30 years. Palm grove was regularly weeding using a tractor, soils are covered with dead leaves and food crop plantations is dominant around. Orchards are surrounded by gallery forest and savannah.

Ant sampling

Ants were sampling once every two months on January 2017 to March 2018 using pitfall traps, handling capture and baits. We combine the tree method to optimize the success of capture (Delabie *et al.*, 2021) [14]. Eight plots were selected in which two for each land use system including coffee farms, orchards, palm groves and savannahs. In each land use system, a plot of 100 m x 5 m (500m^2) were delimited in a center of each land use system to reduce edge effect. In each section, tree lines of transect of 100 m in length was materialize. In the first transect, 11 pitfall traps (9 cm Ø and 12 cm of depth cups) were put in the ground at 10 m interval beginning at the origin. Each pitfall cup was filled at 1/3 volume with a solution of detergent and salt. Pitfalls were removed after three consecutive days. A mixture of sardine and honey baits were deposited directly on a death leaves in the second transect and controlled five minutes later and ant were capture using mouth aspirator and forceps; so, 11 baits distant to 10 m were deposited. In the third transect, a litter was collected in 10 section of 1x1 m distant to 10 m and ants were sorted during 30 minutes. The distance between two consecutive transect line was 2.5 m. All the sample were preserved in hemolysis tube filed with 70 % alcohol and carried to the laboratory of Zoology at the University of Yaoundé I for identification. Ants were identified using keys of Fisher & Bolton (2016) [15] at genera levels, and Taylor (2010) [16] at species level when possible. Voucher specimens were deposited in the reference collection at the laboratory of Zoology of the University of Yaoundé 1.

Data analysis

Ant diversity

To provide some basics information on diversification of ant, genera and species richness per subfamily were analyze base on their presence or absence in each land use system (Tadu *et al.,* 2021) [17]. We characterize diversity of each community based on species richness (S), Shannon diversity index (H') and the Pielou index (J) using the Vegan package (Oksanen *et al.,* 2011) [18]. Variation of species richness, Shannon diversity and equitability between land use system were tested with Kruskal Wallis test associated with the Wilcoxon pairwise test when necessary. For pairwise comparison, p-value was adjusted with a sequential Bonferroni procedure and the results were appreciated at 5 % confidence level.

Ant composition and relation between ant and land use system

We evaluated ant community composition between different land use system using Sorensen index and Venn diagram to showed the number of proper and common species. Relationship between ant species and land use system was study using Clamtest (Chazdon *et al.,* 2011) [19] and Indval (Dufrêne and Legendre, 1997) [20]. We used both approach as complementary to found whether ant species are generalist or specialist in two distinct habitats with Clamtest and whose species are potentially bioindicator for each land use system with Indval.

Clam test analysis use a multinomial model based on estimated species relative abundance in two habitats (A, B). It minimizes bias due to differences in sampling intensities between two habitat types as well as bias due to insufficient sampling within habitat. The method provides a robust statistical classification of habitat specialists and generalists, without excluding rare species a priori (Chazdonet *al.,* 2011) [19]. According to CLAM, a species is considered as specialist when at least two-thirds of its abundance are concentrated in a single habitat. Based on a user-defined specialization threshold, the model classifies species in four groups: (1) generalists; (2) habitat A specialist; (3) habitat B specialists; and (4) too rare to classify with confidence.

We used indicator value of Dufrêne and Legendre (1997) [20] to find indicator species. The indicator value "$d_{i,c}$" of species is a product of the relative frequency and relative average abundance in cluster. It is given by the following formula:

$$d_{i,c} = f_{i,c} \times a_{i,c};$$

Where $f_{i,c} = \frac{\sum_{j \varepsilon c} p_{i,j}}{n_c}$ and $a_{i,c} = \frac{\sum_{j \varepsilon c} p_{i,j}/n_c}{\sum_{k=1}^{K}((\sum_{j \varepsilon k} x_{i,j})/n_k}$; $p_{i,j}$ is the presence/absence (1/0) of species i in sample j; $x_{i,j}$: abundance of species i in sample j; n_c: number of sample in a cluster c; for cluster c in set k. The analysis was done with labdsv package (Roberts. 2016) for R software (version 3.2.2) and the result was appreciated at 5 % confidence interval.

Variation of species abundance between land use system

We evaluated the abundance of different ant species in each land-use system and the continuation of the analysis concerned only the species with a cumulative abundance per sample in the whole land use system superior or equal to 5 %. We tested the main effect of land use system on the variation of the abundance of numerical dominant ant species with ANOVA (GLM proc) associated with Tukey pairwise test when necessary. For pairwise, the p-value was adjusted with a sequential Bonferroni procedure and the results were appreciated at 5 % confidence level.

Ant community structure between land use system

We used the rank-frequency diagram to study ant communities structure through an assessment of the relationship between species richness and their abundance. The observed distribution models were fitted with theoretical models using the Vegan package (Oksanen *et al*., 2011) [18]. The proposed theoretical adjustment models are: Log normal model or Preston model, Zipf-Mandelbrot model and Preemption model. The Bayesian Information (BCI) and the Akaike's (AIC) Criterias were used to determine the best theoretical adjustment model, which is the one with the lowest BIC and AIC values. The adjustment in the BIC estimate is given as k= log (S), where S represents species richness, while in the AIC estimate, the value k= 2.

Result

Genera and species richness per subfamilies between land use system

At Koutaba, a total of 90 ant species belonged to 30 genera and five subfamilies were collected in savannah, coffee farm, orchard and palm grove. Looking the distribution between subfamily Myrmicinae with 10 genera and 44 species was the richest subfamily follow by Formicinae with six genera and 22 species. Pseudomyrmicinae was the less rich subfamily. Myrmicinae appear most diverse in palm grove with eight (32.0 %) genera and 32 (57.14 %) species follow by coffee farm with eight (34.78 %) genera and 27 (52.94 %) species. The Formicinae subfamily was rich in savannah with three (15.79 %) genera and 12 (21.43) species and in orchard with 5 (31.25 %) genera and six (22.22 %) species (Table 1).

Table 1: Variation of ant genera and species richness per subfamily in different land-use system at Koutaba

Subfamily	Land use system								Total	
	Coffee farm		Savannah		Palm grove		Orchard			
	Genera	Species	Genera	Species	Genera	Species	Genera	Species	Genera	Species
Dolichoderinae	3(13.0)	6(11.76)	2(10.53)	4(7.14)	3(12.0)	6(10.71)	0(0.00)	0(0.0)	3(10.0)	6(6.67)
Dorylinae	2(8.70)	3(5.88)	1(5.26)	2(3.57)	2(8.0)	2(3.57)	1(6.25)	2(7.41)	2(6.67)	3(333)
Formicinae	4(17.39)	7(13.73)	3(15.79)	12(21.43)	4(16.0)	6(10.71)	5(31.25)	6(22.22)	6(20.0)	22(24.44)
Myrmicinae	8(34.78)	27(52.94)	6(31.58)	27(48.21)	8(32.0)	32(57.14)	8(50.0)	16(59.26)	10(33.33)	44(48.89)
Ponerinae	5(21.74)	7(1373)	6(31.58)	10(17.86)	7(28.0)	9(16.07)	2(12.50)	3(11.11)	8(26.67)	14(15.56)
Pseudomyrmicinae	1(4.35)	1(1.96)	1(5.26)	1(1.79)	1(4.0)	1(1.79)	0(0.0)	0(0.0)	1(3.33)	1(1.11)
Total	23	51	19	56	25	56	16	27	30	90

Relative proportion of genera and species richness per land use system was given in a bracket

Ant diversity and variation between land use system

Among the 90 ant species collected, 63 species were collected in palm grove and 27 in orchard. The mean of species richness in orchard is low with 1±2 ant species compared to palm grove where the mean species richness found was 4±6 ant species per sampling unit. Shannon diversity index showed that palm grove (H'= 2.69; J= 0.65) and savannah (H'= 2.65; J= 0.66) were most diverse than coffee farm (H'= 0.77; J = 0.20), and orchard (H'= 0.48; J= 0.15). The mean species richness (χ^2= 92.39; df= 3; p< 0,0001), Shannon (χ^2= 100.07; df= 3; p< 0,0001) and Pielou (χ^2= 115.66; df= 3; p< 0,0001) indexes varies significantly between land use system (Table 2).

Table 2: Variation of ant diversity in different land-use system at Koutaba

Parameter	Land use system				Kruskall-Wallis (χ^2)
	Coffee farm	**Palm grove**	**Savannah**	**Orchard**	
Specific richness (S)	51(2 ± 4)^{a}	63(4 ± 6)^{ab}	56 (4 ± 4)^{bcd}	27(1 ± 2)^{abe}	χ^2 = 92.39 ***
Shannon index (H')	0.77(0.14 ±0.30)^{a}	2.69 (0.59 ± 0.81)^{bc}	2.65 (0.87 ± 0.71)^{bde}	0.48 (0.09 ±0.23)^{adf}	χ^2 = 100.07 ***
Maximal diversity (Hmax)	3.93(1.26± 0.90)^{a}	4.14 (1.94 ± 0.89)^{bc}	4.03 (1.51± 0.71)^{ade}	3.30 (0.81 ± 0.59)^{adf}	χ^2 = 46.240 ***
Pielou index (J)	0.20 (0.11 ± 0.22)^{a}	0.65 (0.28 ± 0.36)^{bc}	0.66 (0.55± 1)^{bde}	0.19 (0.08 ± 0.17)^{adf}	χ^2 = 115.66 ***

df= 3; ***: p< 0.0001 for significant p-value at 5 % level, df= 3; different letters translate the significant difference between the group, the mean of each parameter are into the bracket. We use standard deviation for frame of the mean

Variation of ant composition between land use system

Sorensen index showed a high percentage of similarity between different land use system. Coffee farm and palm grove, and savannah and palm grove appear more similar (67.0 %) than other land-use system. The less similar system was orchard and savannah (41.0 %) (Table 3).

Table 3: Matrice of similarity showing the level of similarity between land use systems at Koutaba

	Coffe farm			
Coffe farm	1	Palm grove		
Palm grove	0.67	1	Savannah	
Savannah	0.64	0.67	1	Orchard
Orchard	0.49	0.42	0.41	1

Venn diagram showed that, the four land use system share in common 13 species (14.14 %). The number of proper species found in each land use system is relatively low. Palm grove with 12 (13.13 %) proper species was the richest while the Orchard appears the less rich with 4 (4.44%) species. Coffee farm, palm grove and savannah share 16 (17.78 %) species while palm grove, savannah and orchard share just 1 (1.11 %) species (Figure 3).

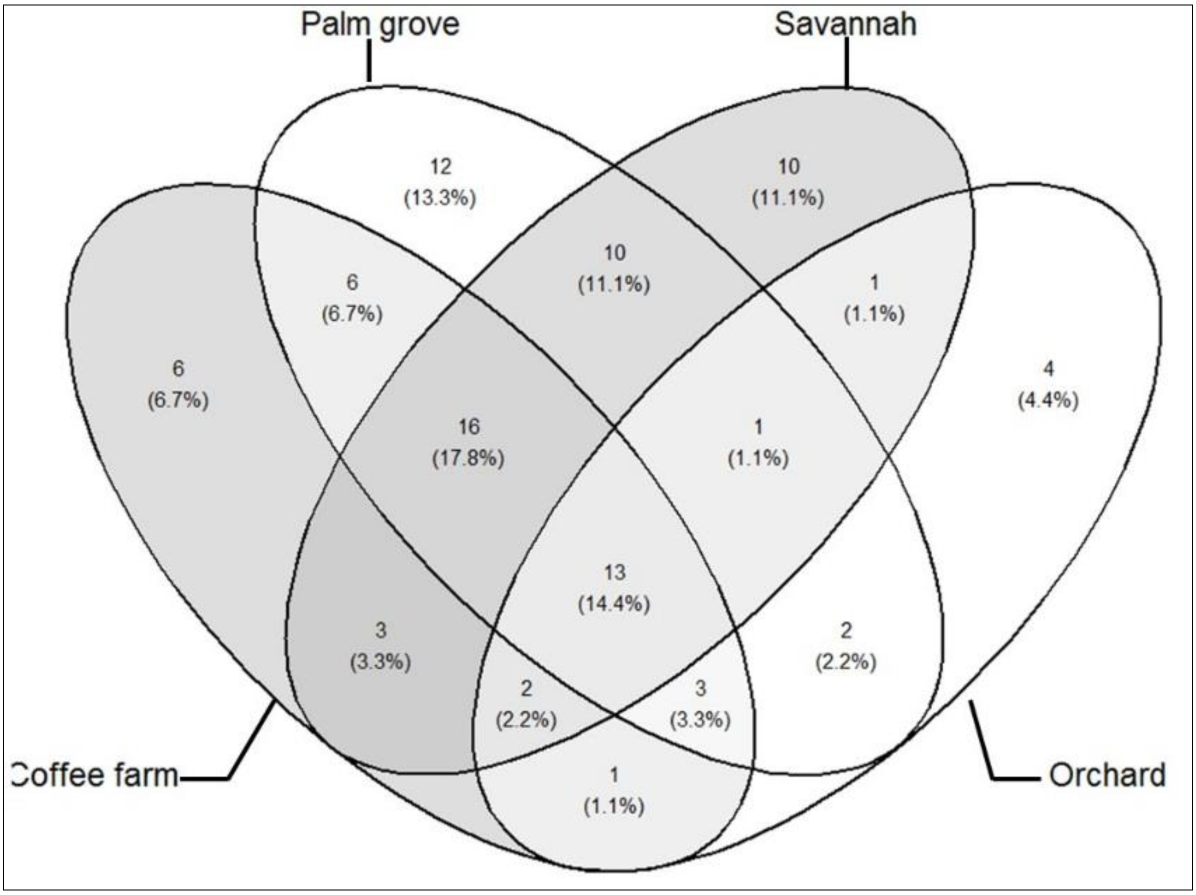

Fig 3: Venn diagram showing the number and percentage of shared and exclusive species between land use systems at Koutaba

Relationship between ant species and land use system

Clamtest showed that coffee farm and savannah, and Palm grove and savannah were the richest combine land use system with 72 species for each pair. Percentage of too rare species to be classified is high compared to generalist and specialist species. The high number of generalist ant species was found between palm grove and orchard (28.20%) and palm grove and savannah (26.40 %) species. The number of specialist species in coffee farm (27.0 %) was inferior to that found in the palm grove (32.0 %). The same trend was observed between coffee and savannah, and coffee and orchard. Comparison between palm grove and orchard showed that 20 (28.20 %) ant species collected was specialize in palm grove while 4 (4.20 %) was specialize in orchard (Table 3). Individual value showed that at Koutaba, *Od. troglodytes* ($d_{i,c}$= 0.05; p= 0.05), *Ph. rohani* ($d_{i,c}$= 0.08; p= 0.04) and *Rhoptromyrmex opacus* ($d_{i,c}$= 0.08; p= 0.04) were the indicator species of coffee farm. In the savannah, the indicator species were *C. acvapimensis* ($d_{i,c}$= 0.21; p= 0.03) and *Od. troglodytes* ($d_{i,c}$= 0.10; p= 0.03). No indicator species was found in the palm grove and orchard.

Table 3: Distribution of species richness in relation with habitat statute of ant species between land use system

Habitat statut	Land use system					
	Coffee-Palm	Coffee-Savannah	Coffee-Orchard	Palm-Savannah	Palm-Orchard	Savannah-Orchard
Generalist	9(12.0)	9(12.5)	9(15.5)	19(26.4)	20(28.2)	3(4.5)
Specialist A	2(27.0)	4(5.60)	8(13.8)	14(19.4)	20(28.2)	25(37.9)
Specialist B	24(32.0)	20(27.8)	1(17.0)	12(16.7)	3(4.20)	4(6.1)
Too-rare	40(53.3)	39(54.2)	40(69.0)	27(37.5)	28(39.4)	34(51.5)
Species richness (S)	75	72	58	72	71	66

S: species richness found in land use system A and B, relative proportion of species in each habitat statute are given into a bracket. Specialist to habitat A and B represent in the same order like in the table first and second land use system.

Variation of ant species abundance between land use system at Koutaba

We have identified 90 species from a set of 31483 individual collected. Eight species were numerically dominant. Among them, *M. opaciventris* (53.31 %) was the most dominant species following by *C. avacpimensis* (11.08 %). In regard of their distribution among land use system, *M. opaciventris* was numerically dominant in orchard and coffee farm with respectively 89.66 % and 85 % of workers collected. *Camponotus avacpimensis* was dominant in palm grove (36.17%) while *Crematogaster (Crematogaster)* sp.1 (28.23%) was dominant in the savannah. Land use system affect significantly the distribution of *M. opaciventris* (F= 65.36; df=3; p< 0.0001), *C. avacpimensis* (F= 50.88; df=3; p< 0.0001), *Pa. tarsatus* (F=45.4; df=3; p< 0.0001) and *Crematogaster (Crematogaster)* sp.1 (F= 26.01; df=3; p< 0.0001). Pairwise comparisons were consigned in a table 4.

Table 4: Variation on species abundance between land use system

Ant species	Land use system					Test F (GML Proc)
	Coffee farm	Palm grove	Savannah	Orchard	Total	
*Botroponera*sp.1	103(1.05%)	120(1.96%)	190(2.69%)	0(0.00%)	413(1.31%)	F= 2.53 ns
Camponotus (Tanaemyrmex) acvapimensis(Mayr, 1862)	49(0.50%)^{a}	2209(36.17%)^{bc}	1211(17.17%)^{bde}	18(0.21%)^{adf}	3487(11.08%)	F= 50.88***
Crematogaster (Crematogaster) sp.1	48(0.49%)^{a}	217(3.55%)^{ab}	1991(28.23%)^{bcd}	22(0.26%)^{bce}	2278(7.24%)	F= 26.01***
Dolyrus (Anoma) nigricans(Emery,1895)	470(4.18%)	17(0.28%)	99(1.40%)	593(6.93%)	1179(3.74%)	F= 1.12ns
Hypoponera cognate (Santschi, 1912)	8(0.08%)^{a}	181(2.96%)^{ab}	262(3.71%)^{bbc}	0(0.00%)^{abd}	451(1.43%)	F= 6.28 ***
Myrmicaria opaciventris(Emery, 1893)	8391(85%)^{a}	423(6.93%)^{bc}	301(4.27%)^{bcd}	7668(89.66%)^{ade}	16783(53.31%)	F= 65.36 ***
Oecophylla longinoda(Latreille, 1802)	44(0.45%)^{a}	327(5.35%)^{bc}	0(0.00%)^{acd}	59(0.69%)^{acd}	430(1.37%)	F= 12.07 ***
Paltothyreus tarsatus(Fabricus, 1798)	17(0.17%)^{a}	346(5.67%)^{bc}	532(7.54%)^{bde}	9(0.11%)^{adf}	904(2.87%)	F= 45.4***
Tetramorium aculeatum(Mayr, 1866)	111(1.14%)^{a}	258(4.22%)^{ab}	487(6.90%)^{abc}	12(0.14%)^{abd}	868(2.76%)	F= 3.4 **
Tetramorium guineense(Bernard, 1877)	94(0.96%)^{a}	273(4.47%)^{bc}	128(1.81%)^{ace}	38(0.44%)^{adf}	533(1.69%)	F= 4.23***
Other ant species	435(4.45%)	1736(28.43%)	1853(26.27%)	133(1.56%)	4157(13.20%)	
Total	9770	6107	7054	8552	31483	

df= 3; *: p= 0.05, **: p< 0.001 and ***: p< 0.0001 for significant p-value at 5 % level, ns for non-significant p-value, different letters translate the significant difference between the group, relative abundance are into the bracket.

Ant distribution models between land use system

Ant community in coffee farm, palm grove and orchard was numerically dominate by one ant species while two ant species were dominant in savannah with an abundance superior to 1000 workers. This species were *M. opaciventris* in coffee farm and orchard, *C. acvapimensis* in palm grove, *Crematogaster (Crematogaster)* sp.1 and *C. acvapimensis* in savannah. Approximately 10 species were represented by less than 500 workers and more than 100 workers in palm grove and savannah. More than 50 ant species was represented by less than 100 workers (Figure 4).

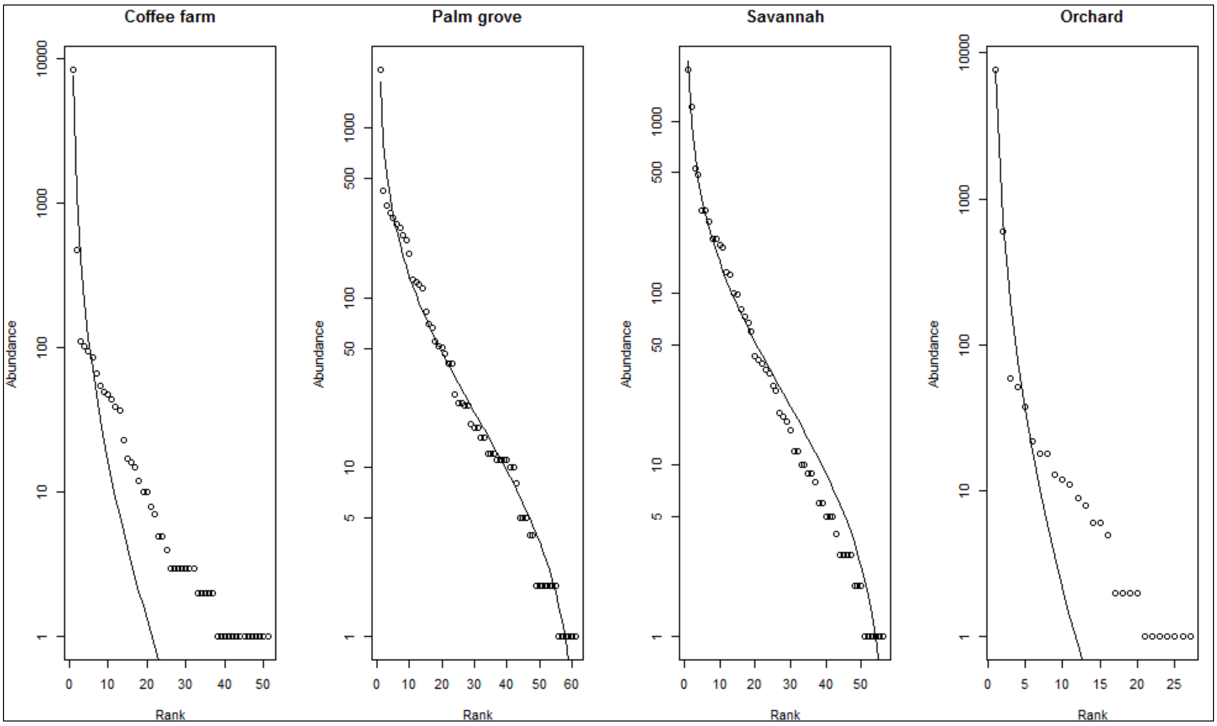

Fig 4: Rank-frequency diagrams showed the relation between species richness and ant abundance in different land use system at Koutaba.

The adjusted distribution of rank-frequency diagram with theoretical models showed that distribution of ant community follow Zipf model in the coffee farms (AIC=1630.9; BIC=1634.8) and orchard (AIC=415.20; BIC=417.79), log-normal distribution model was found in palm grove (AIC= 790.86; BIC=795.14) and savannah (AIC= 473.24; BIC= 795.14) (Table 5).

Table 5: Adjustment with theoretical model of rank-frequency diagram of ant community in four land-use system at Koutaba

Theoretical model	Land use system											
	Coffee farms			Palm grove			Savannah			Orchard		
	Deviance	AIC	BIC	Deviance	AIC	BIC	Deviance	AIC	BIC	Deviance	AIC	BIC
Null	34152.0	34348.0	34348.0	5466.15	5764.43	5764.43	5429.17	5703.92	5703.92	25785.11	25891.94	25891.94
Preemption	10081.7	10279.7	10281.6	2358.41	2658.69	2660.84	1334.55	1611.30	1613.32	3279.98	3388.81	3390.11
Lognormal	1755.5	1955.4	1959.3	488.57	790.85	795.14	194.49	473.24	477.29	514.27	625.11	627.70
Zipf	1431.0	1630.9	1634.8	951.83	1254.11	1258.40	808.92	1087.76	1091.72	304.36	415.20	417.79
Mandelbrot	1431.0	1632.9	1638.7	951.83	1256.11	1262.54	338.97	619.71	625.79	304.36	417.20	421.08

Bold values represent the best theoretical Adjustment model. AIC and BIC respectively represent the Akaike Criteria and the Bayesian Information Criteria.

Discussion

Variation of genera and species richness per subfamilies between land use system

The Myrmicinae was the most diverse subfamily follow by Ponerinae and Formicinae. The diversification of Formicinae is related to the environmental condition due the low shade coverage who favor the expansion of their colonies (Tadu *et al.*, 2014) [21]. In fact, landscape of Koutaba is dominated by savannah which offer ideal condition for the proliferation of ant species like *C. acvapimensis* (Levieux, 1972) [22]. Nevertheless, the nectar offered by the flower of coffee and other fruits trees in the orchard, and dead arthropod result from human activities may contributed to the diversification of these groups.

Ant diversity and variation between land use system

A total of 90 ant species belonged to 30 genera and five subfamilies were collected in savannah, coffee farm, orchard and palm grove. The palm grove and savannah were richest and diverse than coffee farm and orchard. This variation may be explaining by the habitat heterogeneity and human disturbance who induce change in ant diversity and composition as suggest by Tadu *et al.* (2021) [17] and Assis *et al.* (2018) [11]. Despite the pruning and the weeding using tractor, palm groove remains rich than coffee farm intensely manage without chemical product. The high species richness in palm grove was influence by the edge effect due to his proximity with savannah who favor his rapid recolonization after disturbance. A similar result was also found in cocoa farm after insecticide treatment (Tadu *et al.* 2013 [23]). Some biotic factor like interspecific competition and ecological traits of dominant ant species may explain the low species richness and diversity in some ecological situation. So, by their aggressiveness and large size of their colony, a species like *D. nigricans* invade periodically cocoa farm and reduce species richness and diversity (Majer, 1972 [24], Bizumungu and Majer, 2019 [25]). In regard of climate, seasonal variation caused the shift in species diversity and composition as demonstrate in Bornean tropical peat swamp forest (Stijn, 2013) [26]; nevertheless, a different result was obtained in Cameroon where season was not affected significantly ant species richness and diversity in different type of habitat around Dja forest reserve (Tchoudjin *et al.*, 2020a) [27].

Ant composition between land use system

The composition of ant species between the different land use system was similar between palm grove and coffee farm, palm grove and savannah and coffee farm and savannah. Orchard was different in species composition compared to other land use system. This variation may explain by heterogeneity result in each habitat by human management and influence of surrounding environment as demonstrate between different type of habitat around Dja forest reserve by Tchoudjin *et al.* (2020a) [27]. The number of common and exclusive species between land use system was very low. It can explain by mechanized agriculture by the monks of Koutaba, agriculture practices by local population and pasture by a shepherd Peulh a local ethnic population in Cameroon. Economic interest of human influence the intensity of disturbance in some type of habitat (Tadu *et al.*, 2021) [28] and may explain why coffee farm was intensively manage by the monk, who produce syrup, jams and even ground coffee for selling.

Relation between ant and land use system

The number of specialist species was low in the coffee farm compared to palm grove and savannah. The high number of specialize ant species in savannah, suggest that savannah by their composition influence ant species richness and composition in palm grove, coffee farm and orchard at Koutaba. Nevertheless, the specificity of each land use system was at the base of the contrast between the ant community. By their structural characteristic and edge effect due to the proximity with savannah and crop plantation, palm grove and orchard provide similar ecological condition and may explain the high number of generalist ant species when comparing to the savannah. The variation of indicator species found in different land use system was related to the influence of environmental changes due to the various disturbances levels of the habitats by anthropic activities. However, the presence of these species allows us to observe changes in the population dynamics of other species with which they share a natural habitat and with which they maintain a complex biological interaction, such as predation and symbioses.

Variation of species abundance and distribution between land use system

Ant community was numerically dominated by *M. opaciventris* and *C. acvapimensis*. Both species were ground-dwelling ant species with arboreal habit, generally found in and open and disturbed habitat for *M. opacientris* (Tchoudjin *et al.*, 2020 b) [29] and savannah for *C. acvapimensis* (Levieux, 1965) [30]. In agroforestry systems such as orchard (Kenne *et al.*, 2003) [31] and cocoa farm (Leston, 1971) [32], *M. opaciventris* and *C. acvapimensis* were generally associated to hemipteran and cause damage to the plants. Their numerical dominance in Koutaba may also related to the natural landscape dominated by savannah and low shade covered in wooded habitat. Ant community in palm grove and savannah was in competition for food and nesting site while in coffee farm and orchard ant community was still in reconstruction due to disturbance generate by human activities. A similar result was obtained in different land use system around Dja reserve forest by Tchoudjin *et al.* (2020 a) [29].

Conclusion

We have collected 90 ant species belonged to 30 genera and six subfamilies in coffee farm, palm grove, orchard and savannah at Koutaba. The subfamily Myrmicinae with 10 genera and 44 species was the richest subfamily. Palm grove was the richest land use system with 63 ant species while orchard was the less rich with 27 ant species. Ant community was dominated by *M. opaciventris*. Due to the disturbance and natural heterogeneity, ant community was permanently in recolonization process in the coffee farms and orchard and interspecific competition characterize ant community in the palm groove and savannah. Ant diversity and distribution at Koutaba change with land use system and the human activities related to agricultural practices and pasture.

References

1. Suspense IA, Binsangou S, Nzingoula S, Lisa L. Cartographie des Sites Forestiers de la Ville de Brazzaville dans la Période de 1946 à 2016 et Etude des Causes de la Déforestation. Revue Ivoirienne de Géographie des Savanes,2017:3:1-72.
2. David AW. Communities and Ecosystems. Linking the above ground and below ground components in Monograph in population Biology. 34. Princetown University Press, New Jersey, USA, 2002, 392.
3. Lavelle P. Diversity of soil fauna and ecosystem function. Biology International,1996:33:3-16.
4. Konaté S, LE Roux X, Verdier B, Lepage M. Effect of underground fungus-growing termites on carbon dioxide emission at the point-and landscape-scales in an African savanna. Functional Ecology,2003:17:305-314.
5. Konaté S, Le Roux X, Lepage M. Influence of the large termitaria on soil characteristics, soil water regime, and tree leaf shedding pattern in a West Africa. Plant and Soil,1999:206:47-60.
6. Hölldobler B, Wilson EO. *the Ants. Massachusetts The Belknap Press of Haward* University Press Cambridge, 1990, 732.
7. Dejean A, Djiéto-Lordon C, Orivel J. The plant ant Tetraponeraaethiops (Pseudomyrmecinae) protects its host myrmecophyteBarteriafistulosa (Passifloraceae) through aggressiveness and predation. Biological Journal of the Linnean Society,2008:93:63-69.
8. Kaspari M. Body size and microclimate use in Neotropical granivorous ants. *Oecologia*,1993:96:500-507. doi.org/10.1007/BF00320507
9. Andersen NA, Hoffman BD, Muller WJ, Griffiths AD. Using ants as bioindicators in land management: simplifying assessment of ant community responses. Journal of Apply Ecology,2002:39:8-17.
10. Andersen AN. A classification of Australian ant communities, based on functional groups which parallel plant life-forms in relation to stress and disturbance. Journal of Biogeography,1995:22:15-29.
11. Assis DS, Dos Santos IA, Ramos FN, Elena KBR, Majer JD, Vilela EF. Agricultural matrices affect ground ant assemblage composition inside forest fragments. PLoS ONE,2018:13:e0197697. https://doi.org/0197610.0191371/journal.pone.0197697.
12. Olivry JC. Fleuves et rivières du Cameroun. Office de la recherche scientifique et technique outre-mer. Paris, France, 1986, 745.

13. Sighomnou D. Analyse et redéfinition des régimes climatiques et hydrologiques du cameroun: perspectives d'évolution des ressources en eau. Thèse de Doctorat, Université de Yaoundé I, Cameroun, 2004, 291.
14. Delabie JHC, Koch E, Dodonov P, Caitano B, DaRocha W, Jahyny B, *et al*. Sampling and analysis methods for ant diversity assessment, 2021, 13–54 *in* J. C. Santos and G. W. Fernandes, editors. Measuring Arthropod Biodiversity - A Handbook of Sampling Methods. Springer, Cham.
15. Fisher BL, Bolton B. Ants of Africa and Madagascar. A guide of genera. University of California Press, 2016, 512.
16. Taylor B. *The ants of (Sub- Saharan African) Hymenoptera: Formicidae.in* W. Grazingfield, Nottingham, 11, NG11 7FN, U.K. Visiting Academic in the Department of Life Science, University of Nottingham., editor, 2010.
17. Tadu Z, Edoa S, Messop-Youbi EB, Guibaï JP, Fomekong Lontchi J, Aléné DC, *et al*. A comparative assessment on ant communities in three vegetation types located at Mfou suburban locality of Yaoundé (Cameroon). Journal of insect biodiversity,2021:026:015-030.
18. Oksanen J, Blanchet FG, Kindt R, Legendre P, Minchin PR, O'Hara RB, *et al*. vegan: Community Ecology Package. R package version 2.0-2, 2011. http://CRAN.R-project.org/package=vegan.
19. Chazdon RL, Chao A, Colwell RK, Lin SY, Norden N, Letcher SG, *et al*. A novel statistical method for classifying habitat generalists and specialists. Ecology,2011:92(6):1332-1343.
20. Dufrêne M, Legendre P. Specie assemblages and indicator species: the need for a flexible asymetrical approach. Ecological Monographs,1997:67:345-366.
21. Tadu Z, Djiéto-Lordon C, Yede, Messop-Youbi EB, Fomena A, Babin R. Ant diversity in different cocoa agroforest habitats in the Centre Region of Cameroon. African Entomology,2014:22:388–404.
22. Levieux J. Le rôle des fourmis dans les réseaux trophiques d'une savane préforestière de Côte-d'Ivoire. Annales Université d'Abidjan Serie E (Ecologie), T. V, fasc,1972:1:146-239.
23. Tadu Z, Djieto-Lordon C, Babin R, Yede, Messop-Youbi EB, Fomena A. Influence of insecticide treatment on ant diversity in tropical agroforestry system: some aspect of the recolonization process. International Journal of Biodiversity and Conservation,2013:5(12):832-844.
24. Majer JD. The ant mosaic in Ghana cocoa farm. Bullethin of Entomological Research,1972:62:151-160.
25. Bizumungu G, Majer JD. The distribution of ants in a Rwandan coffee plantation and their potential to control pests. African Entomology,2019 27:159-166.
26. Stijn S. Ant community composition in relation to forest disturbance in a Bornean tropical peat swamp forest. MSc Thesis, Wageningen University, 2013, 34.
27. Tchoudjin GL, Tadu Z, Fomekong-Lontchi J, Kakam S, Aymélé-Choungmo SR, Kenfack-Fongang P, Massussi JA, Niba AS, Djiéto-Lordon C. Leaf litter-dwelling ant (formicidae) diversity in a tropical rainforest and agro-forestry system, south region of Cameroon: implications for conservation management. International journal of zoology studies,2020 a:5:1-9.
28. Tadu Z, Edoa S, Messop-Youbi EB, Guibaï JP, Fomekong Lontchi J, Aléné DS, *et al*. A comparative assessment on ant communities in three vegetation types located at Mfou Suburban locality of Yaoundé (Cameroon). Journal of Insect Biodiversity,2021:026:015-030.
29. Tchoudjin GL, Tadu Z, Fomekong-Lontchi J, Kakam S, Aymélé-Choungmo SR, Kenfack-Fongang P, *et al*. Influence of season on leaf litter ant (Hymenoptera: Formicidae) diversity in the locality of Minko'o (Southern, Cameroon). African journal of ecology,2020b:58(4):796-814.
30. Levieux J. Description de quelques nids de fourmis de Côte d'Ivoire. Bulletin de la Société Entomologique de France,1965:70:259-265.
31. Kenne M, Djieto-Lordon C, Orivel J, Mony R, Fabre A, Dejean A. Influence of Insecticide Treatments on Ant-Hemiptera Associations in Tropical Plantations. Journal of Economic Entomology,2003:96(2):251-258.
32. Leston D. Ants, capsids and swollen shoot in Ghana: Interactions and the implication for pest control. Proceeding of the 3rd International Cocoa Research Conference Ghana, 1971, 205-221.