Diversity of Soil Macro arthropods in the Arable Land of Cotton Zone, North Cameroon

Abstract

Arthropods constitute the most diverse and dominant species of biodiversity in terrestrial ecosystems. Despite this great abundance, our understanding of their ecological organization and diversity remains unknown in certain habitats. The present study aimed to evaluate the diversity of soil macro-arthropods in the arable land of six localities in the arable land of cotton zone of Cameroon. For this purpose, collections of soil macro-arthropods were carried out using Barber traps and subpots for two consecutive years 2018-2019. During the entire duration of the study, nearly 33.423 soil macro-arthropods were collected belonging to 67 species divided into 11 orders and 27 families. After classification, the most abundant insect groups were Coleoptera (36.9%), Hymenoptera (33.5%), and Orthoptera (22.9%), while the groups of Neuroptera, Hemiptera and Isoptera practically a low level of relative abundance. The proportions of the different families of soil macro-arthropods sampled varies from one locality to another and three large families were in the majority: Formicidae 32.4%, Acrididae 19.5% and Tenobrionidae 15.7%. Soil macro-arthropod samples collected in Kodek, Sanguere Njoï and Gashiga, respectively recorded the highest species richness as well as the Shanon-Weaver Diversity and Evenness index. In all the arable soils of the localities studied, the soil arthropods tend to have an Equidistribution of individuals and Equitability varies from 0.5 to 0.8. The soil macro-arthropods collected in the arable land of the cotton zone of North Cameroon were mainly phytophagous and saprophagous with a strong beneficial potential in these different ecosystems.

Keywords: Diversity, Soil Macro-arthropod, Arable land, Cotton zone, Cameroon.

1. Introduction

In North Cameroon, precisely in the northern part, nearly 53% of the land is intended for agriculture and the rest for protected areas and for mountains (Fok *et al.*, 2019). It is only in this part where cotton cultivation is the main driver of the economy (Levrat, 1984; Guibert *et al.*, 2003). This cotton zone occupies the administrative regions of North and Far North Cameroon and records an average density of 115 inhabitants / km^2 (Fok *et al.*, 2019). The soils of the cotton zone, like all arable soils in Cameroon, are a living environment for macrofauna where they spend a significant part of their biological cycle (Chotte *et al.* 2001).

The macro entomofauna of the soil play an important role in the biological life of a soil (Bachelier, 1963). They occupy an important place within the food chain. They are predators of phytophagous organisms (auxiliary role), but they are also prey for other arthropods (Viaux and Rameil, 2004). The macro entomofauna are also at the origin of the different processes of gallery formations (Gobat *et al.,* 2003), the fragmentation of litter and the formation of aggregates and the incorporation of organic matter into the soil (Freyssinel, 2007). However, land intended for agriculture in the cotton zone of Cameroon is subject to significant demographic pressure and the increased intensification of crops which leads to a systematic export of crop residues to the livestock profile, a work of repeated soil, a reduction in fallow times, a lack of crop rotations, a lack of organic matter, overgrazing and intensive use of pesticides (Fok *et al.,* 2019). The resulting disruptions in the biological activity of the soil undermine the life of insects in the soil by modifying diets, the availability of trophic resources and habitat (Bachelier, 1978; Boli *et al.,* 1991). This can result in a reduction in the diversity and abundance of insect populations in the soil (Bachelier, 1978). Several studies of soil fauna have already been carried out around the world (Amossé, 2014; El Alami, 2013; Bachelier, 1978), but none aiming to know the diversity and abundance of soil macro-arthropod in arable land has been carried out in the cotton-growing zone of Cameroon. The main objective of this study is to evaluate the abundance and diversity of soil macro-arthropods in arable land of cotton zone in order to better exploit and sustainably manage these soils.

2. Materials and methods

2.1. Location and biophysical characteristic of the cotton zone of Cameroon

Figure 1 shows the location of the cotton growing area and the six data collection sites for the study. The cotton zone covers approximately 85.000 km^2 (Liba'a and Havard, 2006). It is made up of two large groups (North and South), each equally suited to cotton cultivation, although different on a physical and human level.

The cotton zone belongs to the Sudanian Climate Zone, characterized by average precipitation between 700 and 1400 mm, and by the alternation of a dry season and a rainy season (Fok *et al.,* 2019). Temperatures are high there, and annual averages are between 24°C and 29°C. In this area we encounter a succession of phytogeographic landscapes characterized by progressive impoverishment and a reduction in the size of shrub formations (Liba'a and Havard, 2006). According to ORSTOM (1980), the soils of Kaele, Gaschiga, Sanguere, Home and Touboro are leached tropical ferruginous types while that of the Kodek area is of the vertisol type (table 1).

	Kaele	Kodeck	Gaschiga	Sanguere Njoï	Home	Touboro
GPS coordinates	N : 10 12 19.2	N : 10 39 57.2	N : 9 27 18.5	N : 9 13 55.5	N : 7 44 32.1	N : 7 43 37.3
	EO : 14 28 3.2	EO : 14 25 28.0	EO : 13 20 52.2	EO : 13 29 56.5	EO : 14 38 45.6	EO : 15 21 15.7
Administrative division	Far -North		North			
Climate	Sudano- sahelian					
Soils	Leached tropical ferruginous	vertisol	Leached tropical ferruginous			
Type of vegetation	Grassy and dotted with shrubs					

Table 1: Description of study areas.

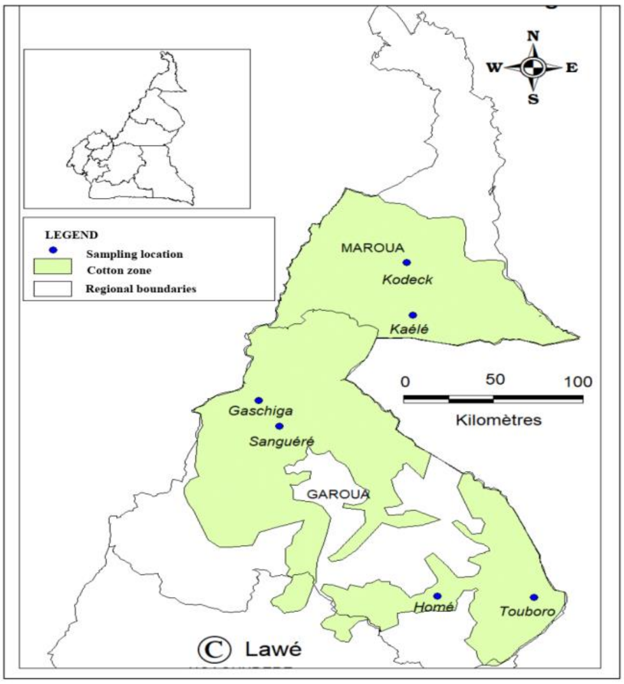

Figure 1: Location of study sites in the cotton zone of Cameroon.

2.2. Data collection methods

2.2.1. Choice of sites and study periods

Six (06) sites were selected for this study. These sites were selected because they had homogeneous plant cover, absence of bush fire, livestock and crop parking for at least one year. The experimentation were conducted in 2018 and 2019.

2.2.2. Sizing a plot

The system installed (Figure 2) in each locality consists of:

- Three sub-plots each measuring 30 meters wide and 50 meters long. The three sub-plots together form an elementary plot measuring 90 meters wide by 50 meters long. Each sub-plot is divided into two adjacent strips 15 meters wide and 50 meters long. The right-hand half of the strip contains the 9 traps for each sub-plot.

- The left half of the sub-plot contains 05 plots, each 1.0 meter wide and 10.0 meters long. So each elementary plot consists of 15 plots. Each plot was sprayed with Fipronil insecticide using a hand operated backpack sprayer.

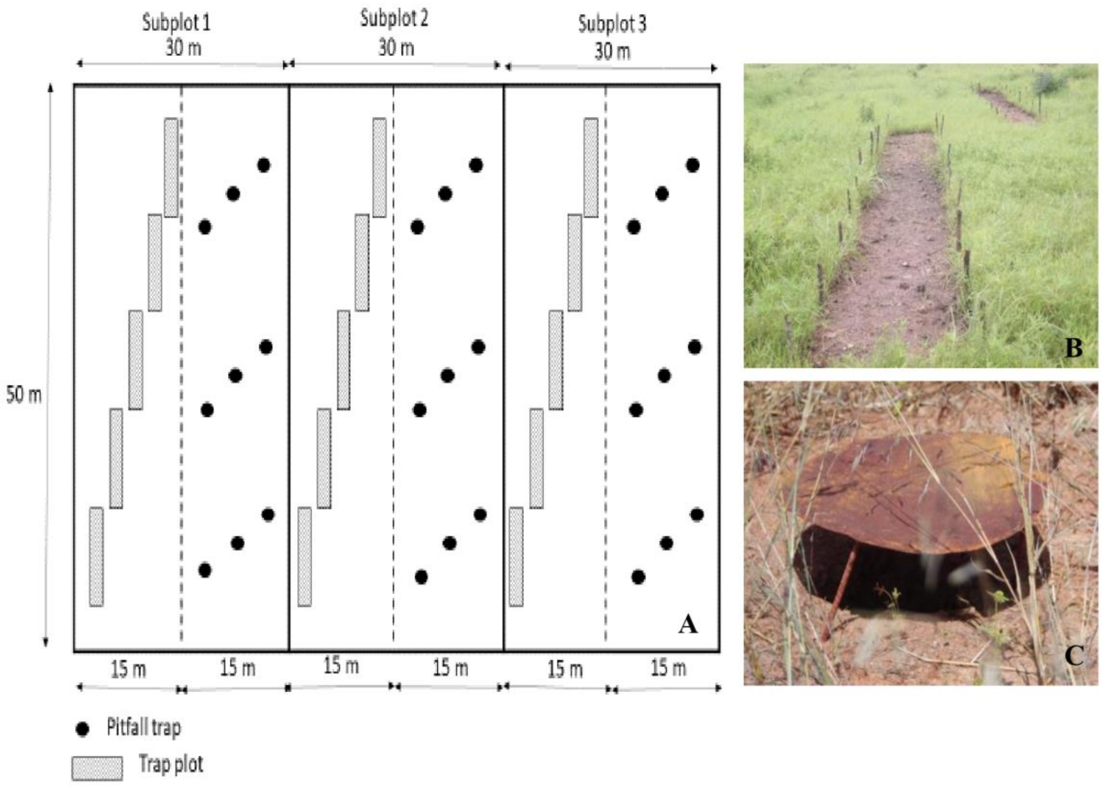

Figure 2: (A) Arrangement of traps in each study site, (B) Trap plot and (C) Pitfall trap.

2.2.3. Soil macro-arthropods sampling and data collection

The pitfall trap or "Barber Traps" was used for this study. This method is the most widely used as sampling technique, mainly used for ecology studies and ecologic pest control. It makes it possible to capture a large number of individuals and to access a group of arthropods that are very little observed and which have major trophic importance and whose biodiversity is very high (many different species each with sometimes strict requirements) (Bonneil *et al.*, 2009; Bouget *et al.*, 2009). The use of plots impregnated with insecticides is the most radical because it does not select the soil fauna. Any arthropods moving around the soil been exposed to the insecticide and are immediately poisoned and killed.

Trap readings or collections of trapped insects were carried out every other day, except when it rained, when they were carried out immediately the following day. These readings were carried out over five periods of 14 days. Arthropods found dead in the plots were collected every day for 14 days, in the same way as the traps. Between each of the 14 days period, a period of 21 days without collection was observed.

2.2.4. Identification of collected specimens

After classification of the specimens, only the one belonging to the insect class was retained for this study. The specimens collected were identified at least to the genus and for some to the species using different determination keys (Delvare and Aberlenc, 1989; Charrier, 2002, Aberlenc (ed), 2020), but also using reference specimens at The Laboratory of Cotton Entomology and Crops Protection Against Pests from the Institute of Agricultural Research for Development (IRAD) based in Garoua, North-Cameroon.

2.2.5. Calculation of diversity index

The data collected was used to calculate classic ecological index which make it possible to study the structure of populations and evaluate their biodiversity depending on space and harvest period. The calculated index were:

- **Species richness of insects,** determined by the total number of species recorded in each site (Magurran, 2004);
- **The diversity index of Shannon and Weaver** (1964), **H'** which expresses the diversity of the population is determined from the number of individuals per species and per study site it is determined by the formula :

  $$H' = - \Sigma ((qi/Q) \log (qi/Q))$$

  qi represents the number of individuals of taxon i and Q is the total number of individuals in the stand. Diversity is maximum when all taxa observed have the same abundance. H' max = log2S; S is the total number of taxa in the stand.
- **The PIELOU equitability index (J')** which evaluates the equidistribution of the population makes it possible to define the regularity which is the observed diversity compared to the maximum diversity and to compare very different ecosystems in

terms of their specific richness. It thus gives an idea of the quality of the structure of the population (Macron, 2015). It is calculated by the formula:

J' = H'/H' max.

- **Relative abundance (AR)**, centesimal frequency, or even relative abundance of a sampled species is the ratio between the numbers of individuals of a species (ni) to the total number of all inventoried species (N). It is calculated according to the following formula:

  RA% = (ni / Ni) x 100. Where, ni : the number of individuals of the species i taken into consideration, N is the number of individuals of all species combined (Hadjoudj, 2020).

2.2.6. Statistical analyzes

The descriptive analysis (percentages and averages presented) was carried out on Microsoft Excel 2016 edition.

3. Results and Discussion

Following the inventories and characterization of the soil macro-arthropod food web in the six localities of the cotton zone, the diversity, abundance of species and functional groups are known.

3.1. Identification and classification of collected specimens

Table 2 presents the identified taxonomic groups and their relative abundance (RA) in the cotton zone of Cameroon.

During the two years of trapped study, 34323 arthropods were collected, including 25294 collected in the Pit fall traps and 8113 collected in the plots. After classification, the arthropods collected are composed of 03 classes, 11 orders, 27 families and 67 genera among which 40 clearly identified species. However, 10 genera of insects are still being identified. The identification of soil invertebrates is a difficult task and requires the expertise of taxonomists who are becoming increasingly rare. Soil invertebrates are extremely diverse and can represent up to 23% of the total diversity of living organisms that have been described to date (Decaëns et *al.*, 2006).The number of arthropods captured by Pit fall traps is high compared to that of the plots because this method it allows the capture of a large number of individuals. It makes it possible to sample epigeic and mobile arthropods that are rarely observed and which have major trophic importance and whose biodiversity is very high such as Carabidae, Tenebrinidae, Acrididae, Formicidae, Sirphidae etc. (Bonneil *et al.,* 2009;

Bouget *et al.*, 2009). The figure 3 illustrates some species collected and clearly identified within the order of coleopteran belonging to 04 families (Carabidae, Cicindelidae, Scarabeidae and Tenebrionidae).

Table 2: Species composition of soil macro-arthropods collected on all the sites.

Class	Order	Family	Genus and species	Total number macro arthropods captured with		Total
				Trap	Plots	
Arachnida	Scorpiones	Buthidae	*Buthus prudenti* Lourenço & Leguin, 2012	77	0	77
			Butheoloides savanicola, Lourenço 2013	2	0	2
	Arachnidera	Scolopendridae	*Scolopendra* sp	67	1	68
		Solifudidae	*Galeodes* sp	1137	61	1198
Chilopoda	Scutigeromorpha	Scutigeridae	*Scutigera* sp	107	0	107
Insecta	Coleoptera	Carabidae	*Distichus gagatinus* Dejean, 1831	1084	97	1181
			Scarites tenebricosus Dejean, 1825	64	38	102
			not identified 1	91	2	93
			Graphipteurs lineatus Klug, 1829	237	5	242
			not identified 2	1105	15	1120
			Xenodochus senegalensis Dejean, 1831	116	16	132
			not identified 3	18	11	29
			Lissauchenius boisduvali Dejean, 1831	293	42	335
			Calosoma senegalense Dejean, 1831	17	2	19
			not identified 4	8	0	8
		Cetonidae	*Anoplochilus vuilleti* Bourg.	44	25	69
		Chrysomelidae	*Syagrus calcaratus* Fabricius, 1775	10	3	13
			Diacantha Kraatzi Jacoby, 1895	68	15	83
			Apisdimorpha sp	9	0	9
		Cicindelidae	*Lophyra senegalensis* (Dejean, 1825)	43	1	44
			Megacephala denticollis Chaudoir, 1843	114	15	129
		Cidnidae	*Pangaeus bilineatus* Say, 1825	156	32	188
		Coridae	*Anoplocnemis curvipes* Parker 1982	70	0	70
		Curculionidae	*Anaemerus* sp.	61	242	303
			Pycnodactylus tibialis Faust, 1904	6	37	43
			Cosmogaster lateralis Gyllenhal, 1834	29	92	121
		Meloidae	*Hycleus affinis* Olivier, 1795	25	6	31
		Myrmeleonidae	not identified 5	0	18	18
		Nitidulidae	not identified 6	28	0	28
		Paussidae	not identified 7	1	0	1
		Scarabeidae	*Onthophagus quiproquo* Moretto et Genier, 2010	0	45	45
			Catharsius peleus Olivier, 1789	295	1	296
			Onthophagus sp,	2002	22	2024
			Phalops sp	27	1	28
			not identified 8	52	0	52
			Anachalcos aurescens Hope, 1837	103	0	103
			not identified 9	7	0	7
			Scarabaeus sp	26	0	26
			Kheper subaeneus Harold, 1869	85	1	86
		Tenebrionidae	*Vieta dongolensis* Laporte de Castelnau, 1840	550	197	747
			Oncosoma hirsutum Solier, 1844	269	69	338

			Thalpophilodes schweinfurthi Haag-Rutenberg, 1875	580	141	721
			Adesmia sp	105	332	437
			Zophosis sp.	663	162	825
			Phrynocolus dentatus Solier, 1843	294	540	834
			Phallocentrion wanati Iwan D., 2001	44	261	305
			Crypsinous acutispina	231	33	264
			Trachymetus humerangulus Ardoin 1971	473	287	760
	Diptera	Tachinidae	*Cylindromia* sp	309	34	343
			Archytas sp	102	0	102
	Hemiptera	Pyrrhocoridae	*Dysdercus superstitiosus* Fabricius, 1775	7	16	23
	Heteroptera	Alydidae	*Mirperus jaculus* Thumberg	228	11	239
		Blattidae	*Blattela* sp	7	9	16
	Hymenoptera	Formicidae	*Messor* sp	6465	3785	10250
			Camponotus sp.	546	45	591
		Sphecidae	*Isodontia Mexicana* Saussure, 1867	267	40	307
			Ammophila sp	57	4	61
	Isoptera	Termitidae	*Macrotermes bellicosus* Smeathman, 1781	81	2	83
	Nevroptera	Myrmeleonidae	not identified 10	0	9	9
	Orthoptera	Acrididae	*Chrotogonus senegalensis* Krauss,1877	1981	363	2344
			Acrotylus blondeli Saussure (De), 1884	142	82	224
			Diabolocatantops axillaris Thunberg, 1815	1542	276	1818
			Morphacris fasciata	104	7	111
			Acrotylus patruelis Herrich-Schäffer, 1840	1324	398	1722
			Acrida sp	274	31	305
		Grillidae	*Gryllus asimillis* Fabricius, 1775	580	137	717
			Acheta domesticus Linneaeus, 1758	97	13	110
		Pyrgomorphidae	*Pyrgomorphidae vignaudi* Guérin-Méneville, 1849	291	5	296
Total						
03	**11**	**27**	**67**	**25294**	**8113**	**33423**

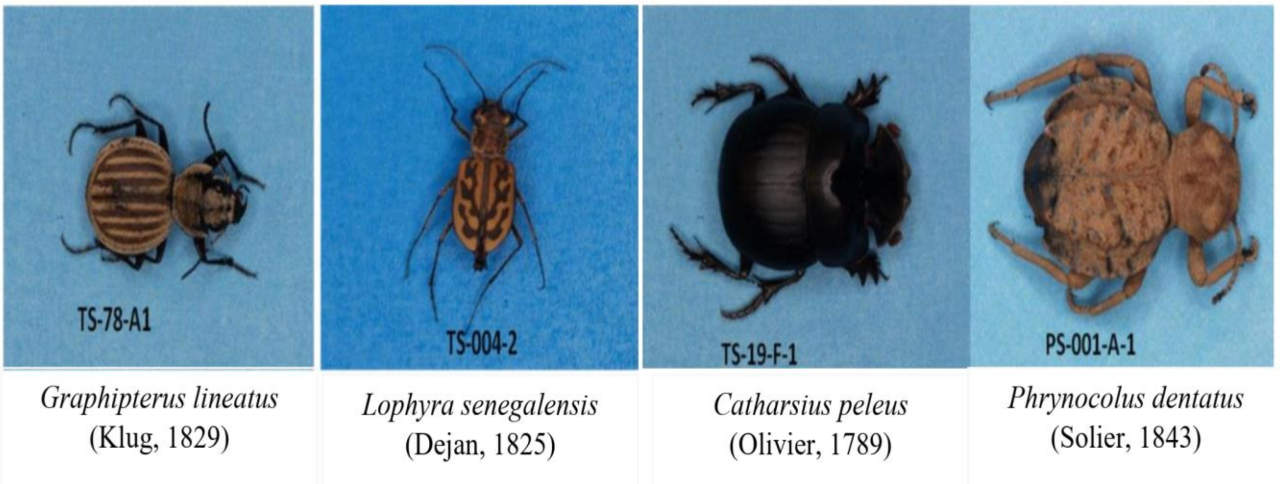

Figure 3: Some clearly identified species.

3.2. Ecological indices of composition and structure of the main soil macro-arthropod groups in the six localities of the cotton zone

3.2.1. Diversity and relative abundance (AR) soil macro-arthropods collected

Regardless of the locality studied (Table 3), Coleoptera, Hymenoptera and Orthoptera were the most abundant orders of arthropods in the Cameroon cotton zone with 36.9%, 33.5% and 22.9% of Relative Abundance respectively (Figure 4). While the orders Scorpion, Scutigermorpha, Hemiptera, Isoptera, Heteroptera and Diptera recorded abundances between 0 and 1% in all samples. The order Coleoptera and Hymenoptera alone includes 10 of the 23 families of arthropods recorded, which could explain the observed abundance. This result corroborates the results of the recent study by Samb *et al.*, 2017, which showed that Hymenoptera are the dominant insects of the soil macrofauna in the Sahelian ecosystem.

Table 3: Relative abundance of the macro-arthropod orders according to localities.

Ordre	Kodek		Kaele		Gaschiga		Touboro		Home		Sanguere Njoï	
	Ni	AR	Ni	AR	Ni	AR	Ni	AR	Ni	AR	Ni	AR
Scorpion	14	0.3	16	0.3	19	0.5	2	0.0	0	0.0	28	0.3
Arachinidera	50	1.2	73	1.5	165	4.0	192	3.2	122	2.1	664	8.1
Scutigermorpha	10	0.2	25	0.5	4	0.1	0	0.0	0	0.0	67	0.8
Coleotera	1643	39.1	1904	38.5	1868	46.0	1340	22.2	1205	20.3	4357	53.1
Diptera	15	0.4	29	0.6	34	1.0	2	0.0	54	0.9	311	3.8
Hemiptera	0	0.0	1	0.0	1	0.0	0	0.0	0	0.0	21	0.3
Heteroptera	0	0.0	174	3.5	20	0.0	25	0.4	20	0.3	16	0.2
Hymenoptera	2113	50.3	2009	40.6	726	18.0	2591	42.9	2607	43.9	1147	14.0
Isoptera	28	0.7	0	0.0	29	1.0	0	0.0	17	0.3	9	0.1
Orthoptera	327	7.8	717	14.5	1235	30.0	1887	31.2	1907	32.1	1582	19.3
Total	**4200**		**4948**		**4101**		**6039**		**5932**		**8202**	

Ni: Number of individuals collected; R.A. %: Relative Abundance

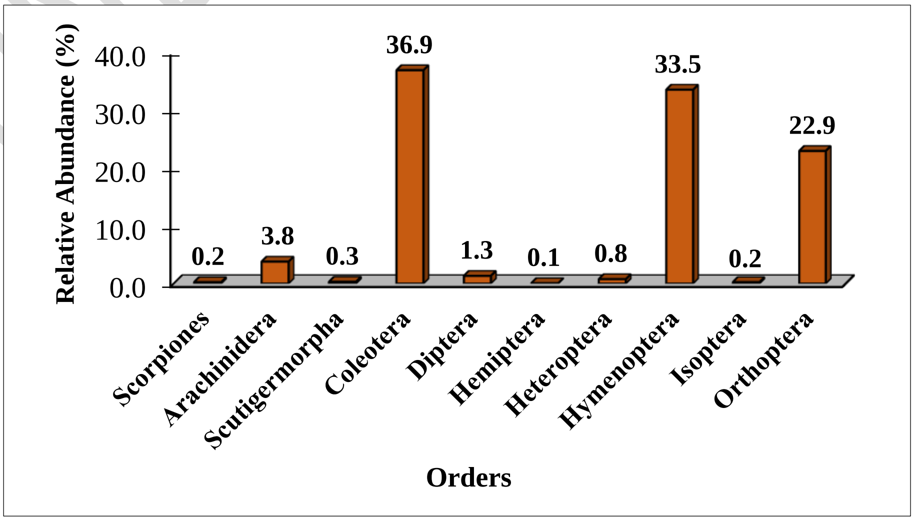

Figure 4: Relative abundance of different groups identified.

3.3.1. Relative abundance (RA) of main groups in different sites

Table 4 presents the Relative Abundance (RA) of arthropod entomofauna families by locality. The size of the populations of individuals of these families varies from one locality to another. In Kodek, the families Formicidae (50.0%), Scarabeidae (18.9%) and Carabidae (16.2%) recorded the highest Relative Abundance (RA) compared to other families. In Kaele, the families with the highest RA were Formicidae (40.4%), Carabidae (15.4%), Scarabeidae (14.0%), Acrididae (11.4%) and Tenebrionidae (8.5%). In Gaschiga, Acrididae (27.9%), Tenebrionidae (24.7%), Formicidae (16.9%) and Carabidae (14.5%) obtained the highest ARs, respectively. In Touboro, the families with the highest Relative Abundance (RA) were Formicidae (42.3%), Acrididae (22.2%) and Tenebrionidae (12.4%). In Home, the highest ARs were observed in Formicidae (42.5%), Acrididae (30.3%) and Scarabeidae (7.1%). In Sanguere Njoï, the families with the highest Relative Abundance (RA) were Tenebrionidae (32.1%), Acrididae (16.0%) and Formicidae (11.6%). Overall, the soil macro arthropods of studies zone belong mainly to the families of Formicidae (32.4%), Acrididae (19.5%) and Tenebrionidae (15.7%). When ecological requirements (light, humidity and food) are required in an environment, there can be an abundance of ants according to Bouget, 2009. This is the case in five of the six sites studied. According to Bolton, 2018; the Formicidae number 13.457 species and the weight of all the ants on the globe represents between 15% and 20% of all terrestrial animal biomass and exceeds that of humanity (Passera, 2016). These results are in agreement with those of Zodinpuii *et al.*, 2019 and Traore, 2012 who showed that in general this family of insects dominates in fallow environments or in cultivation systems without weeding.

Table 4: Relative abundance of the macro-arthropod families according to localities.

Family	Kodek		Kaele		Gaschiga		Touboro		Home		Sanguere NjoÏ		Total	
	Ni	AR	Ni	AR	Ni	AR	Ni	AR	Ni	AR	Ni	AR	Ni	AR
Buthidae	14	0.3	16	0.3	19	0.5	2	0.0	0	0.0	28	0.3	79	0.2
Scolopendridae	4	0.1	5	0.1	5	0.1	4	0.1	10	0.2	40	0.5	68	0.2
Scutigeridae	10	0.2	25	0.5	4	0.1	1	0.0	0	0.0	67	0.8	107	0.3
Solifudidae	46	1.1	68	1.4	160	3.9	188	3.1	112	1.9	624	7.6	1198	3.6
Carabidae	681	16.2	760	15.4	595	14.5	266	4.4	288	4.9	671	8.2	3261	9.8
Cetonidea	48	1.1	10	0.2	1	0.0	10	0.2	0	0.0	0	0.0	69	0.2
Chrysomelidae	7	0.2	1	0.0	1	0.0	39	0.6	4	0.1	53	0.6	105	0.3
Cicindelidae	19	0.5	2	0.0	11	0.3	96	1.6	3	0.1	42	0.5	173	0.5
Cidnidae	7	0.2	10	0.2	66	1.6	60	1.0	1	0.0	44	0.5	188	0.6

Coridae	2	0.0	0	0.0	0	0.0	5	0.1	5	0.1	58	0.7	70	0.2
Curculionidae	21	0.5	136	2.7	102	2.5	88	1.5	101	1.7	19	0.2	467	1.4
Meloidae	0	0.0	0	0.0	3	0.1	8	0.1	13	0.2	9	0.1	33	0.1
Myrmeleonidae	2	0.0	0	0.0	2	0.0	0	0.0	5	0.1	9	0.1	18	0.1
Nitidulidae	1	0.0	2	0.0	7	0.2	0	0.0	2	0.0	16	0.2	28	0.1
Paussidae	1	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.0	2	0.0
Scarabeidae	795	18.9	562	11.4	68	1.7	21	0.3	422	7.1	804	9.8	2672	8.0
Tenebrionidae	59	1.4	421	8.5	1012	24.7	747	12.4	361	6.1	2631	32.1	5231	15.7
Tachinidae	15	0.4	29	0.6	34	0.8	2	0.0	54	0.9	311	3.8	445	1.3
Pyrrhocoridae	0	0.0	1	0.0	1	0.0	0	0.0	0	0.0	21	0.3	23	0.1
Alydidae	0	0.0	174	3.5	20	0.5	22	0.4	15	0.3	8	0.1	239	0.7
Blattidae	0	0.0	0	0.0	0	0.0	3	0.0	5	0.1	8	0.1	16	0.0
Formicidae	2102	50.0	2001	40.4	692	16.9	2557	42.3	2521	42.5	952	11.6	10825	32.4
Sphecidae	11	0.3	8	0.2	34	0.8	34	0.6	86	1.4	195	2.4	368	1.1
Termitidae	28	0.7	0	0.0	29	0.7	0	0.0	17	0.3	9	0.1	83	0.2
Acrididae	246	5.9	691	14.0	1143	27.9	1340	22.2	1798	30.3	1314	16.0	6532	19.5
Grillidae	15	0.4	17	0.3	81	2.0	533	8.8	70	1.2	111	1.4	827	2.5
Pyrgomorphidae	66	1.6	9	0.2	11	0.3	14	0.2	39	0.7	157	1.9	296	0.9
Total	**4200**		**4948**		**4101**		**6040**		**5932**		**8202**		**33423**	

Ni: Number of individuals collected; R.A. %: Relative Abundance

3.3.2. Total richness of families (S), Shanon-Weaver (H') and distributional equitability index (J') of soil macro-arthropods collected in the six localities of study

The results presented in Figure 5 show that, the Shanon and Weaver (H') Index ranges from 1.9 to 3.1 depending on the different locations with an overall average of H=3. The samples of Sanguere Njoï and Gaschiga sites recorded respectively the highest indices H=3.1 and H=3. The Kodek site showed the lowest index H=1.9. The equitability (J') determining the distribution of individuals between species or the quality of the structure of the stand varies 0.5 to 0.8. It is high in the localities of Sanguere Njoï and Gaschiga with values of 0.8 and 0.7 respectively. Although these values are low in the other localities, they still show that in all the arable soils of the localities studied, the soil arthropod species tend to have an equidistribution of individuals. This result corroborates the one found by Brevault *et al.*, 2007 on plots of land under plant cover in northern Cameroon. These low levels of diversity indices recorded at Home could be linked to the action of bush fires caused by breeders in order to promote the regrowth of young grass intended for livestock feed in this area and as well as to farmers who practice slash-and-burn agriculture (Fok *et al.*, 2009). Ouédraogo *et al.*, 2014 showed that these low indices could also be attributed to poor agricultural practices such as repeated tilling of the soil. Likewise this observation would be linked to the poverty of the soil in matter organic. Soil arthropods live mainly in the litter of which they feed and their number is in perfect relationship with the organic matter available (Chotte *et al.*, 2001). Which could explain the great diversity and equitability observed on the Sanguere Njoï soil macro-arthropods sample compared to all the other samples.

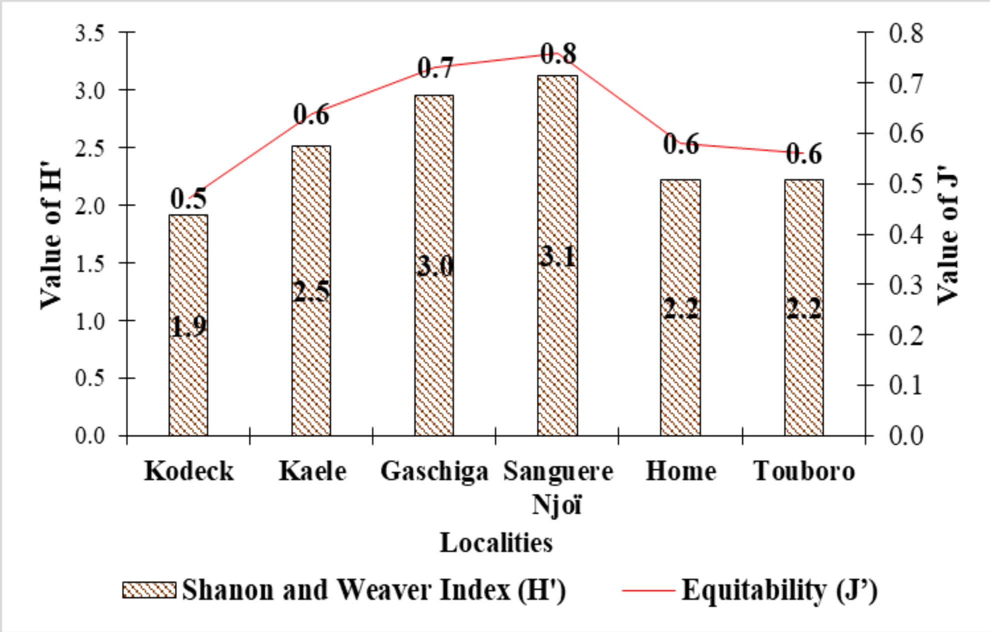

Figure 5: Species richness (S), Shannon – Weaver Index (H') and equitability (J') index in the soil macro-arthropods samples collected from the study sites.

3.4. Trophic functions of soil macro-arthropod collected in different studies sites

The abundance of different food groups varies from one locality to another (Figure 6). In the study area in general, the most widespread soil macroarthropods were saprophages and phytophages. Coprophagous and predators were the least common (relative abundance less than 30% in the samples collected). With the exception of Kaele and Kodek sites, a small percentage (1 to 12%) of coprophagous was found in the other localities. The majority of coprophagous insects are beetles. Among the most important beetles, *Catharsius peleus* and *Onthophagus sp* represented nearly 90% of the numbers collected. While the phytophagous group was the most important in Kodek, Sanguere Njoï and Home, mainly represented by locusts, bedbugs and weevils.

The group of saprophagous was abundant in the samples collected in Kaele, Gaschiga and Touboro with a relative abundance of 36%, 53% and 78% respectively. This group was mainly made up of mealworms, ants and crickets. Saprophages are organisms that mainly feed on dead organic matter (Triplet, 2020) and participate in the decomposition of litter. The strong presence of this group in our different study areas can be positively correlated by the organic matter content.

The predators represented here by: carabids, spiders, scorpions, solifuges and Tachinera, were present in almost all samples from all localities. However, there were more of them in Sanguere Njoï and Gaschiga with a relative abundance of 38% and 30%. The largest populations in this group were ground beetles, followed by tachinids, wasps and tiger beetles. The same observation was made in the work of Nadama (2006) in the region of Maroua and Garoua.

The group of phytophagous was the majority in the samples collected at Kodek 37%, Sanguere Njoï 86% and Home 79%. The individuals in each sample and were composed primarily of centipedes.

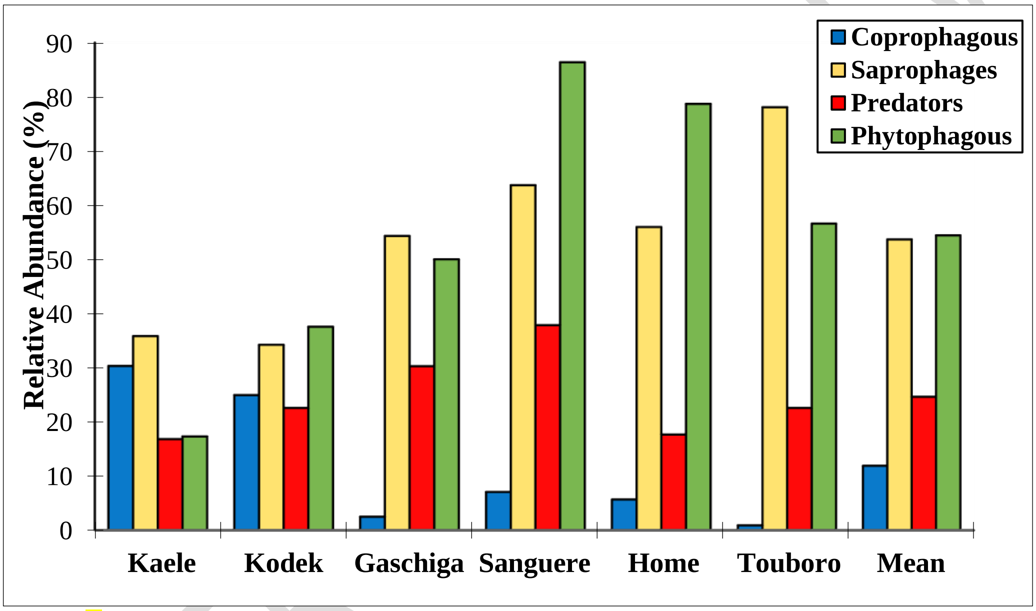

Figure 6: Relative abundance of different functional groups depending on locality.

3.5. Potential ecological role of the soil macro-arthropods collected in the study localities

Generally, all organisms found in an ecosystem have ecological niches, which include what they do in such a system (Lawrence *et al.*, 2019). In this study, the insects collected in the different sites were classified into two functional groups: beneficial and harmful. The proportions of these roles is shown in Figure 7. The kaele and kodek samples recorded respectively the highest rates of beneficial soil macro-arthropods (83% and 70%), while Sanguere and Home samples recorded respectively the lowest rates (57% and 51%). Overall, the soil macro-arthropods samples collected were mostly beneficial. Similar results were found by Lawrence *et al.*, 2019, who grouped beneficial macrofauna into: predators, soil fertility improvement and pollinators. According to Rusch and Sarthou 2013, insect pests are generally least abundant and diverse in diversified agrarian systems presenting a mosaic of cultivated fields and natural habitats or natural seeding. In the case of the locality of Home and Sanguere Njoï, the results could suggest that there is already an imbalance in soil fauna. This imbalance can be caused by a modification of the habitat through intense agricultural and livestock practices according to Ponde *et al.* (2013), Gobat (2013) and Bachelier (1978).

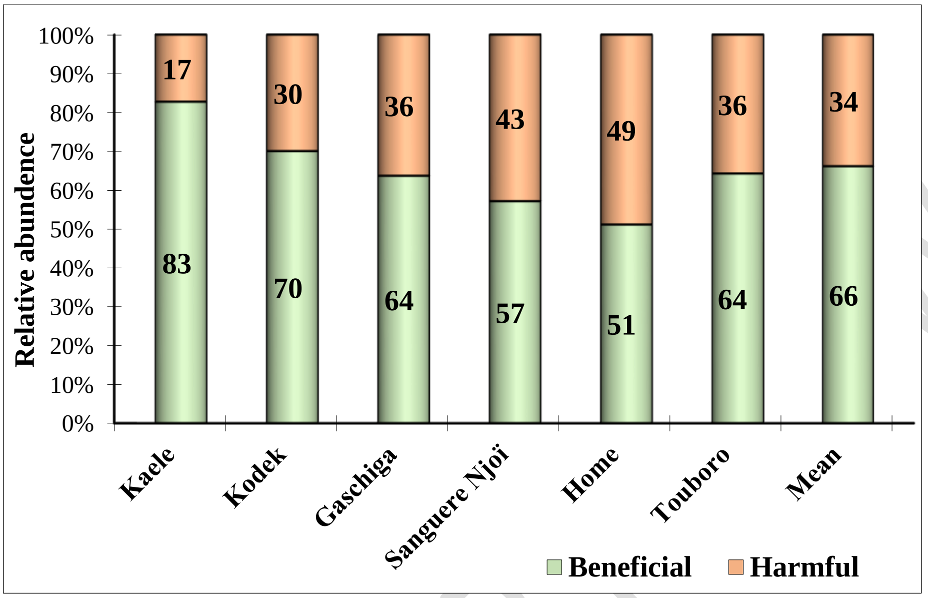

Figure 7: Proportion of potential ecological role of the soil macro-arthropods collected.

4. Conclusion

This study provided preliminary information on the abundance and diversity of soil macroarthropods in arable land in the cotton zone of Cameroon. The soil macro-arthropods collected were extremely abundant and diverse. The high abundance of soil macro-arthropods is an indicator of the proper functioning of soil biology. The order Coleoptera or beetles was dominant and the family Formicidea was the most represented. The Sanguere Njoï samples were distinguished from all other sites by a rich, diverse and balanced population of soil macro-arthropods. These were classified respectively as phytophagous, saprophagous, predators and coprophagous with a beneficial role for the most part in the different ecosystems studied. Our results suggest the continuation of studies on this soil macro-arthropod on cultivated or already exploited land in this area to compare their evolution in these two contexts.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

References

Aberlenc H.P. The insects of the world. Biodiversity, classification, keys to determining families. Plaissan : Museo; Ed.Quae. 2020; pp1848.

Amossé J. Soil fauna as an indicator of urban soil quality: Study of earthworm, enchytraeid and nematode communities and their relationships with soils of different ages. Thesis from the University of Neuchâtel. 2014; pp. 237.

Bachelier G. Animal life in soils. ORSTOM, Paris, Collection. Init. Doc. Tech, 3. 1963; pp. 279.

Bachelier G. Soil fauna, its ecology and its action. ORSTOM Paris. Init. Doc. Tech, 38, 1978; pp. 391

Bikay Bi Babiny S.B. Inventory of macrofauna in cotton cultivation under 4 methods of soil management: case of Windé-Pintchoumba and Zouana, Thesis presented with a view to obtaining the Diploma of Agricultural Engineer, PV, FASA, University of Dschang, 2005; p. 70.

Boli Baboule, Z., Bep Aziem, A., Roose, E. Investigation into erosion in the cotton-growing region of North Cameroon. Bull. Re. Erosion., n°11; 1991, pp. 127-138.

Brevault T., Bikay S., Maldès J.M., Naudin K.,2007. Impact of a no-till with mulch soil management strategy on soil macrofauna communities in a cotton cropping system. Soils and Tillage Research 97 (2007) pp. 140- 149.

Bolton, B. A Review of the Solenopsis Genus-Group and Revision of Afrotropical Monomorium Mayr (Hymenoptera : Formicidae). Bull.br. Mus.nat. Hist. Entomol, 1987; 54 (3) : 1-192. Antcat. An Online Catalog of the Ants of the World. http://antcat.org. (last consultation : 2 September 2018).

Bonneil, P., Nageleisen, L.M., Bouget, C. Catalog of entomological sampling methods (Chap. 2, part. II). The study of insects in forests: methods and techniques, essential elements for standardization. Summary of the reflections carried out by the working group. Inv.Ent.for, 2009; pp. 36-52.

Bouget, C., Nageleisen, L.M. The methods proposed by the “Entomological Inventories in Forest” group. Chap. 2, part III.1. The pit trap. The study of insects in the forest: methods and techniques, essential elements for standardization, ONF, pp.53-57, 2009, Forest files n° 19, 978-2-84207-343-5. 2009; ffhal-02593483f.

Charrier S. Key to determining Lucanid and Scarabeid beetles from Vendee and Western France. The Vendee naturalist N° 2, 2002 : 61 – 93

Chotte J. L., Duponnois R., Cadet P., Adiko A., Villenave C., Agbogba C., Brauman A. Fallow and soil biology in tropical Africa . In: Floret and Pontanier; eds. The fallow in Tropical Africa, 2, John Libbey Eurotext, Paris: 2001; 85-121.

Decaënsa T., Jiménezb II, Gioiac C., Measeyb GJ., Lavelleb P. The values of sail animals for conservation biology. European Journal of Soil Biology. 2006; 42 S23-838.

Delvare G., Aberleng P. Insects of Africa and tropical America. Key to family recognition. Fauna science laboratory, GERDAT department. Montpellier, France; 1989.

El Alami, I. Soil fauna: Recognition and biology of the main groups. Rev. Mar. Sci. Agron. 2013; Vet. No. 6, p. 60-66.

Fok, M., Balarabe, O., Calaque, R, Nicolay, G., Meier, M. Analysis of the cotton value chain in Cameroon. Report for the European Union, DG-DEVCO. Value Chain Analysis for Development Project (VCA4D CTR 2016/375-804), 2019; 145 p. + annexes.

Fryssinel G. Study of the diversity of soil fauna in agroforestry systems. Casdar Agroforestry Program 2006-2008 – Research and Development, 2007; 46p.

Gobat, J.M., Aragno, M., Matthey, W. The Living Soil. Basics of pedology, soil biology. Third revised and enlarged edition. French-speaking polytechnic and university presses.2013; 50(519).

Guibert H., M’biandoun M., Olina J.-P. Productivity and constraints of cropping systems in North Cameroon. Cirad - Prasac, 9 p. 2003; https://hal.archives-ouvertes.fr/hal-00131036/document.

Hadjoudj M. Richness and abundance of arthropods in the trophic diet of Muridae (Rodentia) of Touggourt. J.A.R.A., 2020; 14 (1): 55 - 65.

Lawrence TN, Justin NO, Valentine M, Jacques RT, Lewis DL, Jetro NN. Impact of Different Land-Use Systems on Soil Physicochemical Properties and Macrofauna Abundance in the Humid Tropics of Cameroon. Applied and Environmental Soil Science Volume 2019, Article ID 5701278, 9 pages https://doi.org/10.1155/2019/5701278.

Levrat R. The place of cotton in the lives of farmers in North Cameroon. In: Cahiers d’outre-mer. No. 145 - 37th year, January-March 1984; pp. 33-62; https://www.persee.fr/doc/caoum_0373-5834_1984_num_37_145_3089. PDF file generated on 04/23/2018.

Liba’a, N. K. Havard, M. Changes in the cotton sector in the northern provinces of Cameroon: perception and peasant strategies. Cah. Geographic. Quebec, 2006; 50 (139), 65–82. https://doi.org/10.7202/012935ar.

Magurran A.E. Measuring biological diversity. Oxford: Blackwell. 2004.

Nadama. Influence of three soil management methods on the profile of soil macrofauna in peasant cotton plots in Northern Cameroon. Agricultural Engineer Dissertation. University of Dschang, Cameroon. 2006.

ORSTOM. Soils in North Cameroon, Paris, France, 1980; 7 p.

Ouedraogo J, Ouedraogo E., Nacro HB. Effect of the interaction between fertility management methods and macrofauna on the productivity of cowpea and sorghum in the northern Sudanian zone of Burkina Faso / Int. J. Biol. Chem. Sci. 2014; 8(1): 104-114. http://ajol.info/index.php/ijbcs.

Passera, L. Formidables fourmis. Versailles : Éd. Quae. 2016.

Ponge JF, Per G, Guernion M. Impact of agricultural practices on soil biota: a regional study. SoilBiology and Biochemistry, 2013; vol. 67: 271–284.

Rusch A., Sarthou JP. Agroecological management of crop pests. Biofutur, Elsevier-Cachan: Lavoisier, 2013; pp.33-36. ⟨hal-02643340⟩.

Samb T, Cissé A, Ndiaye AB. Diversity of Soil Macrofauna in Reforestation Plots of the Great Green Wall in Senegal. European Scientific Journal, 2017; edition Vol.13, No.15 ISSN: 1857 – 7881 (Print) e - ISSN 1857- 7431.

Shannon C. E. and Weaver W. The mathematical theory of communication. U.I. Press, Urbana, 1949; pp.1-117.

Traoré M. Impact of agricultural practices (rotation, fertilization and plowing) on the dynamics of soil microfauna and macrofauna under sorghum and cowpea cultivation in West-Central Burkina Faso. Unique Doctoral Thesis, Soil Science, Polytechnic Rural Development Institute of Bobo Dioulasso University, Burkina Faso. 2012; 169p.

Triplet P. Dictionary of biological diversity and nature conservation, 6th edition, 2020; 1216p. ISBN 978-2-9552171-5-3.

Viaux P., Rameil V. Impact of agricultural practices on arthropod populations in field crops: Determine “bio-indicator” species. Mites and arthropods: regulators and bioindicators. Alter Agri., 2004; No. 66 p. 13-18.

Zodinpuii, B., Lalnuntluanga, Lalthanzara H.. Diversity of soil macro arthropods in shifting cultivation and forest ecosystem of Mizoram, Northeast India. Journal of Applied and Natural Science, 2019; 11 (3): 601- 611 https://doi.org/10.31018/jans.v11i3.2122.