Impact of habitat on the developmentof Coprophagous and XylophagousColeopteraninsectsin the park of Bamimgui-Bangoran

(Central African Republic)

ABSTRACT

Coprophagous and Xylophagous Coleopterans are equally impacted by the fragmentation of ecosystems and are recognized for their character as indicators of certain ecosystem functions, such as the recycling of organic matter and pollination. Thus, as part of the program to restore degraded ecosystems in protected areas and others sectors of the Bamingui-Bangoran Prefecture in the Central African Republic (CAR), an inventory of insectspecies according to their ecological profile is needed. Insects were collected over 8 hectares corresponding to 6 different habitats in the Bamingui-Bangoran park. Sixty different traps were installed in each habitatwith 100 meters of distance between the traps. The measured parameters are the number of individuals collected per week.As results, 8 coleopteran families (4 Coprophagousfamilies and 4 Xylophagous families)were identified. The Coprophagous and Xylophagous Coleopterans were much abounded in grassy savannahs with much mixing trees with *Imperatacylindrica* and in grassy and shrubby savannas with many flowering plants (Melliferous) and less abounded in grassy and shrubby savannahs domined by*Imperatacylindrica*. However, repartitions of individuals fit uniform distribution in all coleopteran families belonging to Xylophagous group whereas in coprophagous, uniform distribution fit was established only for one family.

Keywords: Habitat, ecology profile, insect development.

1.INTRODUCTION

Coleopteran insects are present throughout the terrestrial environment and they reveal a significant capacity for colonization and exploitation of their environment. They also occupy a large diversity of ecological niches (Ferrand et al, 2014) and are able to exploit a wide variety of food resources.

Coprophagous Coleopteran are insects that feed on the excrement of other animals. They play an essential role in the recycling of organic matter, because they are often the cause of the decomposition of excrement. Faeces are used as food for imagoes and larvae. Each Coprophagous Coleopteran generally has a relative trophic preference for a given type of excrement (Ailliet Mahdi, 2013). Indeed, the processes of aeration, mixing and burial of faecal matter by these insects directly stimulate fungi, bacteria, and microarthropods in the soil, whose combined actions are essential for the accomplishment of recycling of faecal matter (Lussenhop et al., 1980; Lumaret, 2000).

The XylophagousColeopteranare insects that consume woody material during their development cycle. They form a more or less deep gallery inside the wood from the start of the colonization process or after a subcortical phase. These are phytophagous insects that live mostly at the expense of plants (Haddar, 2007; Meziane, 2017). The Xylophagous Coleopteran contribute to diversifying forest ecological niches and they play a important role in forest biological diversity, either directly or via numerous predators. In tropical zones, the Xylophagous Coleopteran species are threatened by clear cutting,forest fires and deforestation.

The Coprophagousand XylophagousColeopteran are equally impacted by the fragmentation of ecosystems and are recognized for their character as indicators of certain ecosystem functions, such as the recycling of organic matter and pollination.

Thus, as part of the program to restore degraded ecosystems in protected areas and sectors of the Bamingui-Bangoran Prefecture in Central African Republic (CAR), it is important to make an inventory of insects according to their ecological profile.

2. Materials and Methods

2.1. Surveyed Site

Covering an area of approximately 86,000 km^2 (figure 1) a large part of the Bamingui-Bangoran park is covered by protected areas, classified as World Heritage (including approximately 90% in Bamingui-Bangoran and 60% in Vakaga) while the area occupied by family farming remains negligible. These are National Parks Bamingui-Bangoran and Manovo-Gounda St. Floris, an Integral Nature Reserve (VassakoBollo), a Wildlife Reserve

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(AoukAouakalé), Sport Hunting Sectors and Areas Village Hunting.The climate of Bamingui-Bangoranis characterized by two distinct seasons and a rainfall of between 800 and 1600 mm (the number of rainy days varying from 95 to 130). The climate is linked to the Sudano-Guinean domain of AUBREVILLE (1949).The Saharan influence of the dry season (North-East harmattan) is opposed to the Guinean influence of the rainy season (South-West monsoon).The study took place between April and June 2017, in the parks of Bamingui-Bangoran.

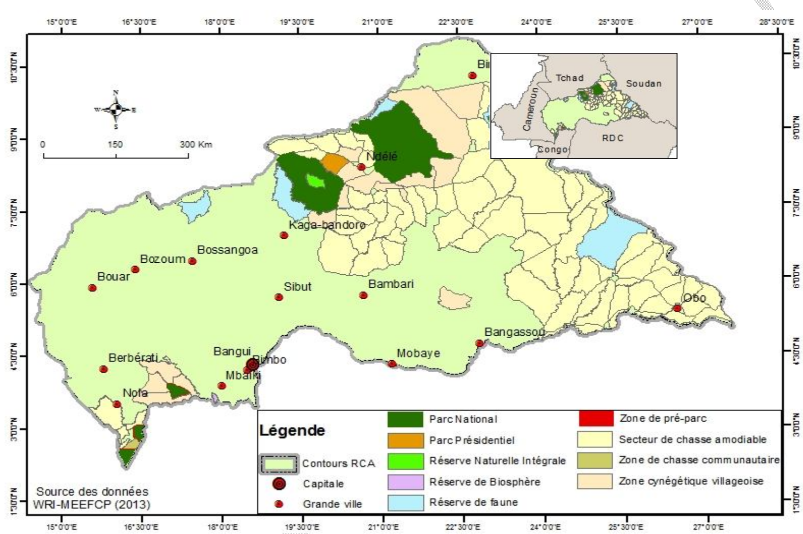

Figure1: Location of national northern park of Bamingui-Bangoran (ECOFAUNE, 2017)

A total of 8hectares are delimited and are located respectively at a distance of 10 km in the Bamingui-BangoranPark. In each hectare, sixty different traps are installed in the park with 100 meters of distance between the traps. Insects were collected from different habitats described in table 1.

Table 1. Descriptionof differentecological habitat

Codification	Descriptionof ecological habitat
H1	Dense to thorny thickets, very difficult to penetrate
H2	herbaceous stratumdomined by*Imperatacylindrica*
H3	Grassy and shrubby savannahs with a few Shea trees
H4	Grassy savannahs with much mixing trees with *Imperatacylindrica*
H5	Grassy and shrubby savannas with many flowering plants (melliferous)

H6	Grassy and shrubby savannahs domined by *Imperatacylindrica*

2.2. Insect trapping by theBarber Trap

The Barber trap (figure 2) is the most widely used and standardized method for trapping above ground soils (Pfiffner and Luka, 2003; Duelli and Obrist, 2003).It makes it possible to sample a variety of epigeal auxiliaries (Coleopteran, rove Coleopteran, spiders) and crop pests (slugs, wireworms, flea beetles Coleopteran, sitones). It is an easy to use and very effective method for obtaining specimens that would otherwise be difficult to obtain.To install the trap, simply dig a hole with a small hand shovel like those used for gardening and place the container in the hole.

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2.2.3 The yellow bin

Many insects are attracted to the color yellow.Simply push into the soil, flush with the surface, a flat container the yellowing color with adding a little water dish soap.

2.2.4The sweet liquid

According to the literature, a sweet liquid or honeydew is an effective method for capturing insects that are not attracted to light.This method consists of brushing a sweet liquid on a support (tree trunk…).

2.2.5 Collection and determination of the families of Coprophagous and Xylophagous Coleopteran

The assessment of the diversity and abundance of insects was carried out by collecting the insects captured in the traps weekly and for six months. Certain characteristics of the insects were determined on the sites using a magnifying glass. The samples were stored in alcohol 70%. In the laboratory, the samples were processed immediately. The samples were washed and cleared of various debris (leaves, twigs, buds, etc.). The insects were sorted in a water tank and distributed by family then repackaged by family. For the most part, identification was based on morphological criteria, the observation of which requires the use of a magnifying glass or a microscope and an identification key.

The Coleoptera are well characterized by their hardened forewings, which have become elytra. This criterion is found in other orders, but what characterizes the Coleoptera (Jeannel in Traite de Zoologie de P. GRASSE) is that the sutural edges of the elytra are juxtaposed without overlapping. The prothorax is often free from the meso and metathorax which join the abdomen quite tightly. If the coxa does not extend to the elytra, and the antennae are placed between the eyes and the mandibles, the insect is of the Carabid family (Carabidae). When the antennae end in lamellae, it is case of Coleoptera of the superfamily Scarabaeoidea. The

Bruchids are small insects, usually measuring around 4mm, with some larger species measuring just over 2cm. They are protected by an exoskeleton, and slightly shorter elytra that cover the abdomen, revealing the last abdominal segment (pygidium). They are generally brownish in color, some with more colorful patterns (JeanneletPaulian, 1944; Balfour-Browne, 1956; Delvare and Aberlenc, 1989; Dajoz, 2002; Ingerson-Mahar, 2002; Bartolozzie and Werner, 2004).

Figure 2.(a) the Barber's trap; (b) a yellow bin; (c) a jar containing sweet liquid et (d) conservation of insects in alcohol 70%.

2.3.Data Analysis

The measured parameters are the number of insects collected per week.The comparison of the number of insects according to the habitats was performed using One-Way Analysis of Variances (ANOVA) followed by Tukey'sHSD tests in the event of significant differences.Results are expressed as means ± standard deviation.To establish probable trends to equal repartitions over the 6 habitats within a family, uniform distribution fit was performed using Chi-square tests for given probabilities. R software was used for all analyses.The differences are considered significant for $P < 0.05$.

3. Results

3.1Family diversity and abundance of individuals

We identified 8 coleopteran families,4 of which belong to the Coprophagous group and the other 4 belong to the Xylophage group. A total of 20562 individuals were collected during the survey period. The most abundant Coprophagouscoleopterans belonged to the *Cicindelidae*family(3848 individuals) followed by the *Geotrupidae*family*(3497 individuals); Aphodiidea and Scarabaeidae*families totalized 3191 and 2782 individuals*,* respectively(Figure 3).In Xylophagous group, the *Tenebrionidae*family was the most abundant (2287 individuals) followed by the *Bruprestidae*family *(1729 individuals)*; *Scolytidae and Cerambycidae* families were represented by 1635 and 1593 individuals, respectively (Figure 3).

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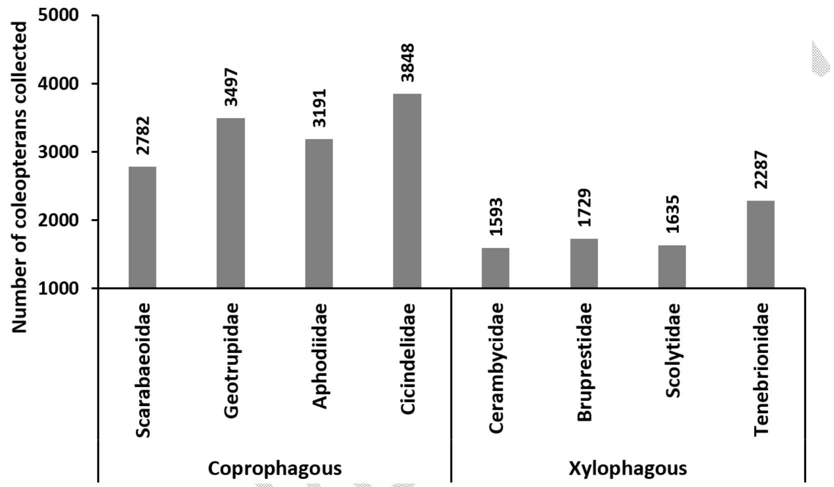

Figure 3. Abundance of Coprophagous and Xylophagous coleopterans collected over the 6 months of survey.

3.2. Repartition of CoprophagousColeopterans in the habitats

Globally in all Coprophagouscoleopteran families, H6 was the habitat where significantly lower numbers of individuals were recorded(Table 1). The average repartition of insects in the *Scarabaeidae*familyranged between 40 and 47 individuals in H1 to H5 with no statistical difference (P>0.05). The same pattern of the average repartition in the habitats H1 to H5 was recorded in *Geotrupidae*(47-59 individuals) and in *Cicindelidae*families (57-61 individuals) with no significant differences (P>0.05) within the family. The exception was observed in the*Aphodiidae*family where the number of individuals in the habitat H3 (Grassy and shrubby savannahs with a few Shea trees) dropped to 41.7±27but still significantly higher than that recorded in the habitat H6(Grassy and shrubby savannahs domined by *Imperatacylindrical)*. In spite of the difference in numbers observed for the habitat H6, only the repartition of individuals in the *Geotrupidae* family follow uniform distribution over the 6 habitats surveyed (X-square = 7.9, df = 5, P=0.16; Table 2). This means that even if the number of individuals in the habitat H6 is relatively low, the repartition tends to be the same over the 6 habitats surveyed for the *Geotrupidae* family.In the others Coprophagous families, the uniform distribution fit test failed ($P<0.05$; Table 2) showing no trend to equal repartition over the 6 habitats.

3.3. Repartition of Xylophagous Coleopterans in the habitats

The repartitionof Xylophagous Coleopteransin the habitats was different from that observed in Coprophagous in the way that numbers of individuals in the habitat H6 were not statistically different from all the others habitats. Indeed, statistical differences were established only in H5 and H6 (29.4±19.9and 15.7±2individuals, respectively; $P<0.05$) for the *Cerambycidae*Familyandonly in H4 and H6 (36.7±10.7and 25.6±16.2, respectively; $P<0.05$) for the *Tenebrionidae*family (Table 1). In the *Bruprestidae*family, the average numbers of individuals in the 6 habitats ranged from 21 to 28 and no significant differences was established($P>0.05$).The *Scolytidae*family was the only one where we recorded a higher number of individuals in the habitat H6 (30±10 individuals) compared to the other habitats (19.9-25.9 individuals).However, uniform distribution fit tests have established trends to equal repartition in all the Xylophagous families($P>0.05$; Table 2).

Table 2. Statistical comparisonof numbers (means ± SD) of Coprophagous and Xylophagous Coleopterans according to the habitatswithin each family

Differenteco logical habitat	**Coprophagous Coleopterans**				**Xylophagous Coleopterans**				**Total of individuals/habitat**
	Scarabaeid	***Geotrupidae***	***Aphodiidae***	***Cicindelida***	***Cerambycidae***	***Bruprestida***	***Scolytidae***	***Tenebrionida***	
H1	46±13.2[a]	47.4±34.2[a]	46.5±28.3[ab]	60.4±23.7[a]	19.7±17.9[b]	22.6±14.1[a]	21.6±13.4[b]	34.9±14.7[ab]	3590
H2	47.4±15.5[a]	51.9±33.1[a]	54.4±25.8[a]	60.1±17.8[a]	19.8±18.4[b]	21.9±12.6[a]	20.4±1[b]	31.2±9.1[ab]	3686
H3	47.2±15.6[a]	53.1±32.1[a]	41.7±27[b]	57.3±23[a]	24.5±19.3[ab]	**28.8±18.9[a]**	25.9±18.7[ab]	31.3±17.9[ab]	3717
H4	40±15.9[a]	**59.3±43.9[a]**	52±23.5[a]	**61.1±22[a]**	23.5±19.5[ab]	24.4±11.6[a]	19.9±13.1[b]	**36.7±10.7[a]**	3803
H5	**44.4±15.6[a]**	55±38.9[a]	**56.7±24.9[a]**	57.9±20.5[a]	**29.4±19.9[a]**	25.2±2[a]	22.3±17.3[ab]	30.9±15.4[ab]	3861
H6	6.85±2.7[b]	33.7±30[b]	21±14.7[c]	31±17.2[b]	15.7±2[b]	21.2±8.7[a]	**30±10[a]**	25.6±16.2[b]	1905

Means followed by different letters are statistically different (ANOVA followed by the Tukey's HSD test, P<0.05);in bold the biggest means.

Table 3. Uniform distribution fit test with the average repartition of individuals within each family over the 6 habitats

	CoprophagousColeopteran				**XylophagousColeopteran**			
Statistical	***Scarabaeidae***	***Geotrupidae***	***Aphodiidae***	***Cicindelidae***	***Cerambycidae***	***Bruprestidae***	***Scolytidae***	***Tenebrionidae***
Chi-square value	32.3	7.9	19	12.4	5	1.6	3.25	2.3
P-value	5.10^{-6}	***0.16***	0.002	0.03	***0.41***	***0.9***	***0.66***	***0.8***

P-values in bold are superior to 0.5 indicating a trend to an equal repartition of individuals over the 6 habitats within the family.

Discussion

The present work is the first step to the identification of coleopterans in different habitats existing in the CAR. The National Park of Bamingui-Bangoran is by excellence an ecosystem that bring together all types of biotopes that can be found across the country. Thus, we retained 6 pilot habitats where this study was performed.

Trapping tools employed allowed to collected several coleopteransdivided into 2 groups (Coprophagous and Xylophagous) over the 6 habitats surveyed. The Coprophagous group was represented by 4 families (*Scarabeidae*, *Geotrupidae*, *Aphodiidae*and *Cicindelidae)* totalizing 13318 individuals (64.76%). Each of these families are a higher number of individuals compared to families in the Xylophagous group.This tend to confirm the fact that none of Coprophagous beetles is considered rare species (Miessen et *al*, 2005).

The Xylophagous group was represented also by 4 families with an abundance of 7244 individuals (35.23%). Such a result is in accordance with that ofTalbi and Bouhraoua (2015) who found also 4 xylophagous families with an abundance representing 32,14% of the total of collected individuals in the Algerian Atlas.The low abundance of individuals in the xylophagous group may be explained by the fact that wood is extensively used as source of energy in households and field burns for cropping, thus directly impacts the density vegetal covert. Indeed, coprophagous and xylophagous coleopteranspooled together were much abounded in the habitats H1 – H5(3590 – 3861 individuals) than in the habitat H6 (1905 individuals) characterized by grassy and shrubby savannahs domined by *Imperatacylindrica*. The plant cover strongly modifies the parameters near the ground, thus influencing the distribution of beetles(Mecherihadjer et *al*, 2014).

The burrowersbringtogetherseveralspecies of the *Scarabeidae*family and the *Geotrupidae*.The individualsdig a burrowunder the excrement and laytheireggs in cellsfilledwithfeces and laid out below the surface.They mix the excrementwith the surface layer of the soil.Suchbehavior, highly adaptive, allows the larvae to have enoughreserves to accomplish all theirdevelopment, the adultscompete in order to accumulate the reserves (Lumaret 1989).

The family of *Cicindelidae*is most abundant H1 in (Dense to thorny thickets, very difficult to penetrate), H2 (herbaceous stratumdomined by *Imperatacylindrica*), H3 (Grassy and shrubby savannahs with a few Shea trees) and H4 (Grassy savannahs with much mixing trees with *Imperatacylindrica*).

The Cerambycidae, commonlycalledbeetles or capricornsbecause of the length of theirantennaeoftenexceedingthat of the body, are a family of insects of the orderColeoptera.Cerambycidaebeetlesbelong to the phytophagoideasuperfamily(sensu

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Jeanne and Paulian, entomologists).Most of the insects of thisfamily are sylvicultural living in deadwoodswith the exception of a few species living in hot and dry places or evendeserts.

The ScolytidaefamilyAccording to Benhalima (2006), thisfamilyiscomposed of xylophagousspecies and isplacedat the forefront of the naturalenemies of coniferousforests, and isresponsible for 90% of the damage caused. Balachowskyin 1962, indicatedthatmostspecies of the genusScolytuscolonizeveryweakened, fallen or felledtrees. SomeScolytidaecan change theirbehaviortowardstheir host. In fact, they have apolyphagythatallowsthem to live on bothConifers and Hardwoods. Barkbeetles practice gallerysystemscomposed of a corridor that the female practices duringspawning, this corridor isdotted on bothsides by larvalgallerieswhichstartfromnotchwhoseeggs are deposited by the female. Adults are small, cylindrical, fairly good fliers. The larvae of mostspecies are xylophagous, diggingtheirgalleriesfrom the one made by the adults (ovipositiongallery or maternalgallery) in the bark or betweenwood and bark. Somebarkbeetles are dependent on symbiotic "Ambrosia" fungiwhichtheysow in theirgalleries and whichthey consume once they have digested the wood.

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Conclusion

The cluster analysis showed that the herbaceous stratumdomined by *Imperatacylindrica*and the grassy and shrubby savannahs with a few Shea treesare the most similar in relation to species composition and abundance, yet different from the Dense to thorny thickets, very difficult to penetrate with herbaceous stratumdomined by *Imperatacylindrica* and the Grassy and shrubby savannahs with a few Shea trees.

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