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BEETLES (COLEOPTERA) ABUNDANCE AND DIVERSITY IN TWO ZONES OF INTENSIVE RUBBER PRODUCTION IN CÔTED'IVOIRE (BONGO AND TOUPAH)

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ABSTRACT

In order to study the abundance and diversity of beetlesinrubberagro systems, a study was conducted in Bongo and Toupahrespectively in the south and south-east of Côted'Ivoire. Beetle were sampled by the combination off our types of traps in different plantations aged from1to 5,6 to10 years, overthan 15 years old, and a forest as control. A total of 10874 beetles distributed in 55 families were collected. The distribution of beetles families in different groups according to their size, shows that abundant Beetle have a higher abundance than the common and rare ones. However, the latter are richer in families. The forests in the two localities have higher numbers of beetles.However, the values of the Shannon (H) diversity index do not differ from one habitat to another in the two study areas. Yet, beetles are better distributed in the plantations in production with a high equitability index (E) in Toupah and Bongo. This study has shown that rubber cultivation, despite the strong anthropic activities related to latex production, does not affect the diversity of beetle's families.

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INTRODUCTION

Rubber cultivation (*Heveabrasiliensis*) was established in Côte d'Ivoire in 1955 (Keli *et al*., 2005). Following extensive crop diversification programs undertaken by the state between 1972 and 1980, this program has made Ivorian rubber growing, one of the most successful in the world (Ruf, 2008a). Rubber plantations, which were concentrated in the forested areas of the south-east, south and south-west, and with a marginal area of production in the center-west, are in marked progression with a significant evolution of the planted areas (Ruf, 2008b). This expansion of rubber plantations is due in part to the global demand for natural rubber, which is reflected in the rise in the price of a kilogram of rubber at the detriment of the coffee-cocoa pair (Assoko, 2014). Unfortunately, with this proliferation of culture surfaces, insect studies in rubber agrosystems in Côte d'Ivoire are few (Tahiri and Mangué, 2007 and Tahiri, 2010, Danon *et al.,* 2017).

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Yet insects including Coleoptera, play a very important role in their habitats. Some, such as Coprophagous, are good bioindicators, others are predators, so they can control and reduce plant pests as phytophagous. Hence, the need to know the composition, distribution and diversity of this very important insect order in rubber agrosystems is imperative. In fact, rubber farms are highly disturbed, especially those in production, because of the activities of the tree tap and harvesting of latex. Several studies report the impact of human activities on insect diversity. Thus, this comparative study whose purpose is to evaluate the diversity and abundance of Coleoptera in rubber plantations of different ages was conducted. The results of this work will make it possible to evaluate the impact of this crop on the biodiversity of Coleoptera associated with rubber production.

MATERIALS AND METHODS

Description of the study Environment: This study was conducted in two areas of high production of rubber in Cote d'Ivoire, in south and south-east regions. The sites of study are those of the African Society of Rubber Plantations (S.A.P.H)

located in the Integrated Agricultural Units (U.A.I) of Bongo and Toupah, respectively located in the departments of Grand-Bassam and Dabou (Figure 1). Toupah (5 ° 19' north latitude, 4 ° 34' west longitude) has a four equatorial season transition climate, two dry and two rainy seasons. About the locality of Bongo (5 ° 29' north latitude, 3 ° 35' west longitude), it has an equatorial climate, with two rainy and two dry seasons. The biggest rainy season starts from mid-May to the end of June and the smallest from early October to mid-December. (Abé, 2005). The two stud areas belong to the Guinean domain and is part of the ombrophilous sector. It is characterized by the variety of plant formations and the presence of large trees due to edaphic conditions with the rainforest (Guillaumet and Adjanohoun, 1971; Kangha *et al.,* 2016).

MATERIALS AND METHODOS

Four types of traps, namely Yellow Ground Trap (Pj), Yellow Height Trap (Pa), Screen Trap (Pe) and Pitfall Trap (Pf) were used to collecte beetles. Traps were used in rubber plantations of different ages. Then the choice of plantations was made according to the phenological stage of the plants. In each study area, plantations of 1 to 5 years, 6 to 10 years and more than 15 years were selected. A forest was taken as a control. Beetles were collected monthly from November 2015 to October 2016, in 1.5 ha sampling unit for both localities. Four transects of 200 m, spaced from 25 m, werelayed out. On each transect, five (5) yellow ground traps, five (5) pit trap, one (1) height trap and one (1) screen trap were set. The traps containing a mixture of soapy water and salt were placed on the sampler units the same day. The insects were collected 48 hours after the trapping. The contents of the traps were sieved and the beetles collected were stored in pillboxes with 70% alcohol. These containers were labeled according to the plantation type, the date of collection and sampling area. Insects were sent to laboratory for identification. Data from identification were analyzed by SATISTICA 7.1 and PAST 2.11 Software Inc. Thus, diversity indices such as the Shannon-Weiner index, the equitability index and the mean richness of families were assessed. One-way analysis of variance (ANOVA 1) and post-ANOVA were used to compare data on beetles abundance in different habitats and different indices of diversity. Before this, a logarithmic transformation was performed to normalize the data and stabilize the variables that were not. Fisher's LSD test at 5% threshold allowed the averages to be classified into different homogeneous groups. The two-by-two comparison of beetles family richness by study area was performed using Fisher's T-test. The Hierarchical Ascending Classification (HAC) was used to rally the two plantations according to the composition in beetles. The average abundance of families was used for the construction of different dendograms.

RESULTS

Abundance of beetles: A total of 10874 beetles distributed in 55 families was collected. The abundance in Toupah reveals that the forest with an average of 104 ± 5.25 insects, has the most individuals and was followed by the 6 -10 years old plot with 94.42 ± 14.05 insects. The lowest abundance was recorded in the plantation aged more than 15 years with 59. 66 ± 13.01 insects. ANOVA indicates that Beetlen abundance varies significantly from one habitat to another in this area ($p \leq 0.001$) (Figure 2). For the locality of Bongo, the results of the average abundance show that the forest has the more individuals, followed by the plantation aged over 15 years with an average abundance of 191.33 ± 5.12 and 131.75 ± 7.18 insects respectively. The lowest abundance was recorded in the plantation aged from 6 to 10 years with an average of 98.5 ± 9.16 insects. Statistical analyzes reveal highly significant difference between beetles abundances in different habitats ($p \leq 0.001$) (Figure 3).

Determination of beetles groups formed: Beetles were grouped according to their abundance in the different habitats. Beetles which number is between 1 and 10 individuals are considered be rare. Those that number 11 and 100 are considered common. Finally, those with more than 101 individuals are considered abundant. The Toupah site recorded 4144 beetles belonging to 44 families. As far as Bongo site, it recorded 6730 beetles belonging to 51 families (Table 1). On the whole collects, Toupah site recorded 3614 abundant beetles, representing 87.21% of the total population and belonging to 10 families. The most numerous of them were Staphylinidae (17.65 %) and Chrysomelidae (16.05 %), Platypodidae (13.58 %) and Scolytidae (13.43 %). The common beetles with a population of 459 individuals, represented 11.08% of the population, and it was divided into 16 families. The most numerous of them were Histeridae (20.92 %), Curculionidae (14.6 %) and Elateridae (11.11 %). The rare beetles group represented 1.71 % of the population and was divided into 18 families. The most numerous were Lycidae (11.28 %) and Bostrichidae (9.86 %) (Figure 4). Bongo site recorded 14 abundant beetles families representing 92.48 % of the total population. The most numerous of them were Staphylinidae (20.62 %), Scarabaeidae (14.73 %), Histeridae (10.94 %) and Carabidae (8.45 %). Common beetles represented 6.48 % of the population with 17 families, the most numerous being Cerambycidae (17.89 %), Endomychidae (10.55 %) and Silphidae (8.03 %). Finally, rare beetles divided into 20 families represented 1.04 % of the total population. The most numerous are Anthribidae and Lucanidae (10 %), Cantharidae and Brentidae (8.56 %) (Figure 5).

Beetles diversity

Comparison of beetles' diversity according to habitats: In the locality of Toupah, beetles Shannon index (H) varies from 1.909 ± 0.057 to 1.976 ± 0.123 in the different habitats. In Bongo, this index varies from 2.065 ± 0.07 to 2.157 ± 0.04. However, the one-way analysis of variance in the Shannon's diversity index of habitats in the different study areas gives no significant difference with respectively $p = 0.936$ at Toupah and $p = 0.852$ at Bongo. About the beetles distribution in Toupah habitats, the equitability index is higher in the plantation aged over 15 years with E = 0.699 ± 0.023 and lower in those from 1 to 5 year old age with E = 0.497 ± 0.016. Statistical analysis (ANOVA 1) reveals a highly significant difference between these indices in habitats ($p = 0.000$). In Bongo, equitability is higher in the 6 to 10 year old plantation with E = 0.6 ± 0.029 and lower in the forest with E = 0.51 ± 0.034. The one-way analysis of variance reveals a significant difference between these indices in habitats ($p = 0.002$). The average family wealth in Bongo is the same in all habitations ($p = 0.824$). In the Toupah area, the highest average was obtained in the 6 to 10 year old plantation with 14.83 ± 1.035 families on average. The lowest wealth is recorded in the plantation aged over 15 years with 11.083 ± 1.144 families on average. The statistical analysis reveals a significant difference ($p = 0.034$) between the family wealth of the different habitats in this area (Table II).

Table 1. Distribution of beetles groups formed in localities

Bongo		Abundant	Common	Rares	Total
	Aa	6226	436	70	6732
	S	14	17	20	51
Toupah	Aa	3614	459	71	4144
	S	10	16	18	44

Aa : absolute abundance et S : family richness

Table 2. Comparison of beetle's diversity indices according to habitats (1 to 5 years: rubber plantation aged 1 to 5 years; 6 to 10 years: rubber plantation aged 6 to 10 years; + 15 years: rubber plantation aged more than 15 years; H: Shannon indices; E: equitability indices and S: Family richness)

Localité	Indice	Habitats				
		1 à 5 ans	6 à 10 ans	+ 15 ans	Forêt	P
Toupah	H	1.909±0.057a	1.988±0.069a	1.976±0.113a	1.94±0.123a	0.936
	E	0.497±0.016b	0.519±0.033b	0.699±0.023a	0.549±0.05b	0.000
	S	13.83±0.726a	14.83±1.035a	11.083±1.14b	13.917±0.64a	0.034
Bongo	H	2.065±0.074a	2.157±0.046a	2.121±0,065a	2.099±0.104a	0.852
	E	0.534±0.041b	0.6±0.029a	0.559±0.036b	0.51±0.034b	0.002
	S	15.667±1.01a	14.917±0.68a	15.75±1.067a	16.167±0.99a	0.824

The values of the same line followed by the same letter do not differ significantly with P = 0.05 (ANOVA I and Test LSD of Fisher)

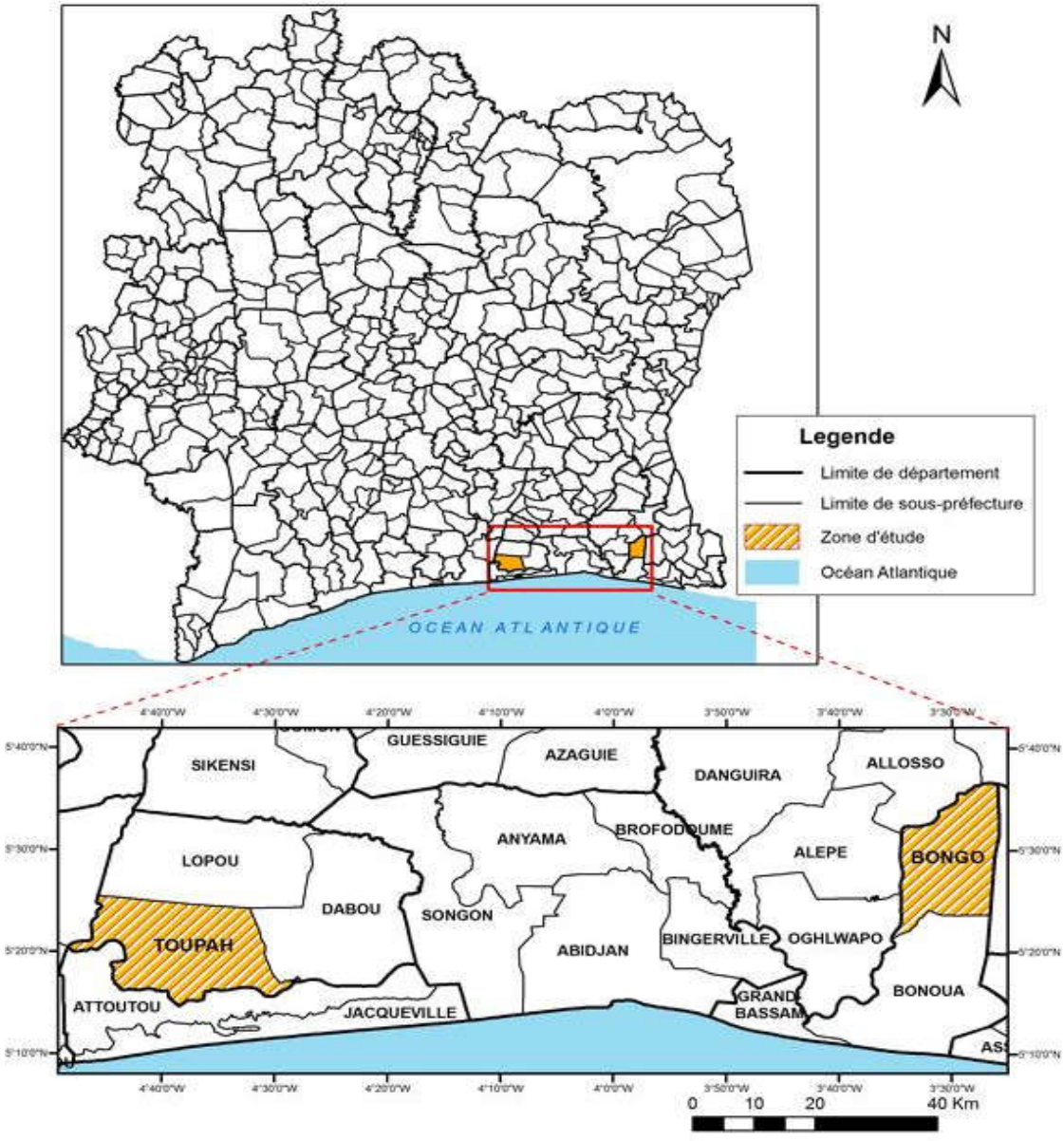

Figure 1. Geographical location of beetles studysites

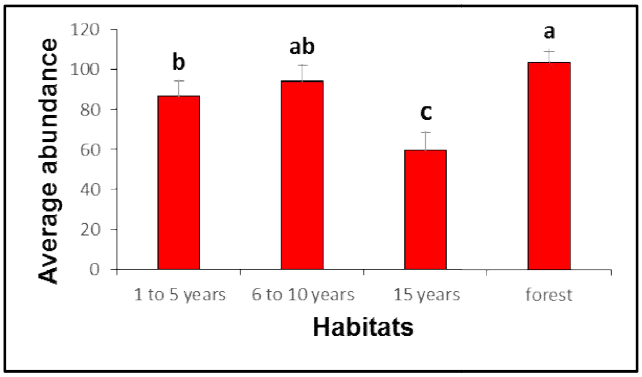

Figure 2. Abundance of Beetle in different habitats in Toupah

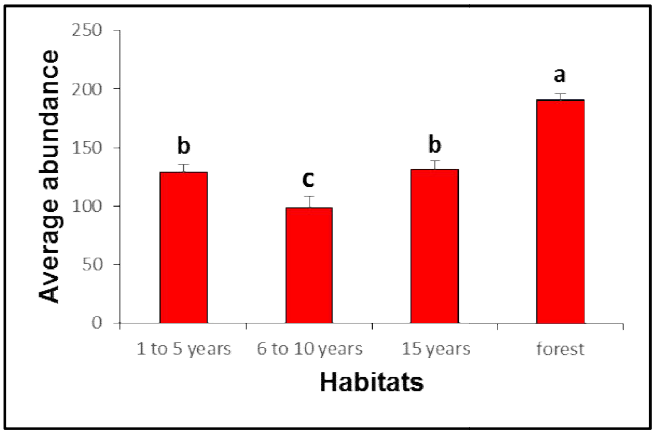

Figure 3. Abundance of Beetle in different habitats in Bongo

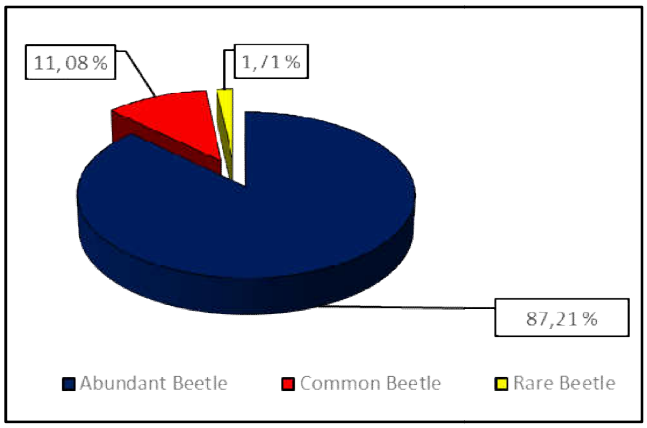

Figure 4. Proportions of Beetles groups in Toupah

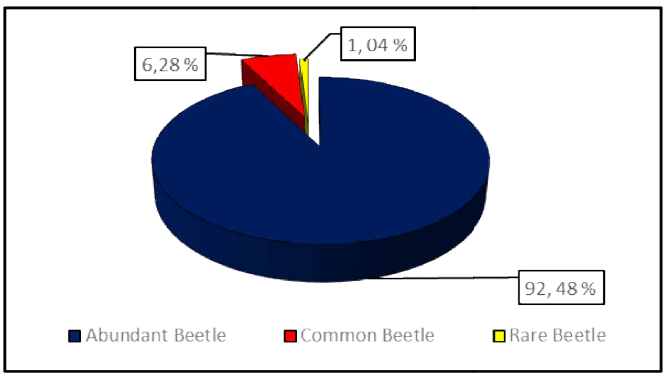

Figure 5. Proportions of Beetles groups in Bongo

Comparison of beetles family richness: The two-by-two comparison of the richness of the same age habitats of the two zones shows that there is no significant difference between the average family richness for plantations aged from 1 to 5 years ($p = 0.172$), 6 to 10 years ($p = 0.946$) and forests ($p = 0.07$). Morever, the statistical analysis showed a significant difference between the family richness for plantations older than 15 years ($p = 0.007$) (Figure 6).

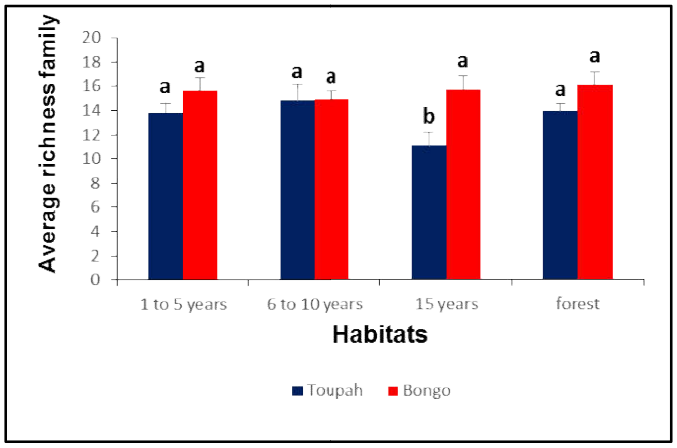

Figure 6. Comparison of beetles' family richness between Bongo and Toupah

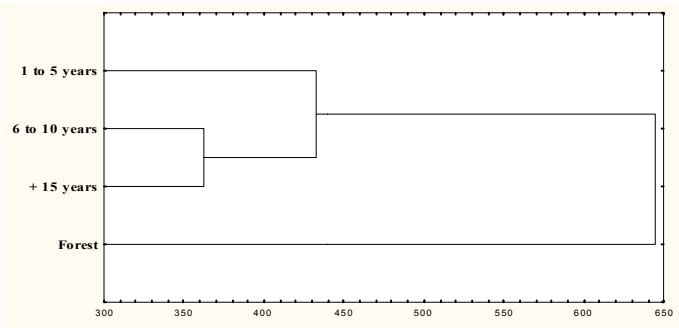

Figure 7. Hierarchical Ascending Classification (CAH) of habitat composition in beetles at Bongo (1 to 5 years: rubber plantation aged 1 to 5 years; 6 to 10 years: rubber plantation aged 6 to 10 years; + 15 years: rubber plantation aged more than 15 years)

Classification of habitats according to beetles composition: This classification was made from the average abundances of each family in the different plantations. In both study areas, the dendrograms obtained indicate 3 similar groups. In Toupah, the first group is formed by plantations aged from 1 to 5 years and 6 to 10 years. Plantation old more than 15 years old and the forest, form a group each. Regarding Bongo, the forest and the plantation aged from 1 to 5 years each form a group. The third group is formed by the plantation aged 6 to 10 years and that aged over than 15 years (Figure 7 and 8).

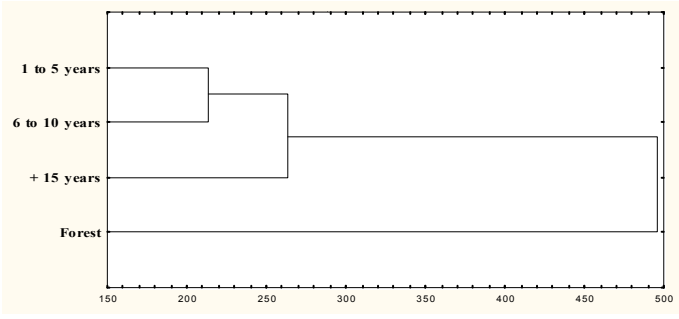

Figure 8. Hierarchical Ascending Classification (CAH) of habitat composition in beetles at Toupah(1 to 5 years: rubber plantation aged 1 to 5 years; 6 to 10 years: rubber plantation aged 6 to 10 years; + 15 years: rubber plantation aged more than 15 years)

DISCUSSION

In Toupah and Bongo, beetles are more numerous in forests than in rubber plantations. This abundance is due to the structure of forests that differentiates them from rubber plantations. (Lassau *et al.,* 2005), estimated that the abundance of beetles in forests is due to the complexity of the environment that facilitates passage and / or transit through these complex-structured habitats. In fact, the structure of forests characterized by the heterogeneity of the plant species would favor this abundance of beetles, because they find there place for reproduction and source of food. This statement is consistent with that of (Lamare *et al.,* 2011), which states that the density of beetles in the undergrowth is strongly correlated with the diversity of plant species. According to the same author, the more plant species there are, the more insects there are. Also, it should be noted that forests in which the sampling was carried out were less disturbed compared to plantations, which were for the most part in operation. The effect of anthropization on the abundance of insects (Rayassé *et al.,* 2009) and particularly on beetles has been the subject of numerous studies (Tamadouni *et al.,* 2017; Loukou *et al*., 2017). These authors found an abundance of insects in anthropized areas well below that of non-anthropized areas. In addition, the less disturbed forests compared to rubber plantations would be some sort of migratory islands of susceptible beetles. However, our results are contrary to those of (Mavoungou *et al.,* 2001) and (Kra, 2008) in which the highest abundances of beetles were obtained in cultivated areas compared to forests. This difference would be due to the study sites and habitat types that would affect the proportion of beetles. Indeed, our study was carried out in monoculture. The low beetles abundance in these plantations could be due to the homogeneity of these zones of culture made up only of rubber trees and to the upheaval created when establishing plantations. Abundant beetles have a higher proportion in both study areas and have a higher average size in all plantations. Abundances of this insect group do not vary from one habitat to another. However, this group is less rich in family which varies from 10 to 16 depending on the habitat. The different families in this group include Carabidae, Staphylinidae, Curculionidae, Chrysomelidae Scarabaeidae, Scolytidae, Tenebrionidae and Scydmaenidae, which represent the major insects of this group. Indeed, these beetles are the most diverse of the animal kingdom and their presence in all habitats directly imply the abundance of the group to which they belong. Indeed, some of them such as Carabidae and Staphylinidae have very varied habits, which allows them to occupy all types of terrestrial environments, as reported by (Kromp, 1989).

Common and rare beetles represent only 19.07% of the total number of individuals collected. Unlike abundance, rubber plantations are more diverse in beetles than forest. Diversity varies from one habitat to another but remains high in the plantations in production. Thus, latex production activities do not impact or at least do not significantly influence the diversity of beetles in these plantations. The disruption of habitats caused by the establishment of plantations has thus had no effect on the diversity of insects which tends to recover and to balance as the plantation ages (the upheaval is made when new plantations are created, old, unproductive plantations are destroyed for new fields). These rubber production activities would therefore have a direct effect or indirectly affect the diversity of beetles. Indeed, the micro climate created by the assembly and arrangement of the plants would favor the presence of typical insects which despite the disturbances find food source, but especially breeding place. In fact, the cuts on the trunk of the plants caused by the bleeding would be a shelter for the xylophagous beetles.

Dead leaves, forming a thick litter would be the place of spawning and breeding. When plantations become older, they are more rich in families, as mentioned by (Tra bi *et al.,* 2010), who assessed the richness and diversity of termites in mulches of cocoa pods of different ages. Plantations aged from 1 to 5 years old have high wealth and diversity, after plantations in productions. Indeed, these plantations, by their structure and sunshine due to a less dense canopy, would promote the activity of insects which for the most part, are thermophilic. This finding was made by (Barbalat, 1995) who also mentions that these places are the meeting place of different sexes. The similarities observed between habitats, describes the composition in abundance, diversity and family wealth of each habitat. Thus, forests formed a group on the one hand and on the other hand the rubber plantations of the groups. Indeed, plant formations and the structure of habitats such as vegetation cover and litter density would attract a specific group of beetles, hence these similarities. These remarks are in the same direction as (Chaudhuri *et al.,* 2013), which states that the densities and activities of the earth glasses are favored by the canopy and the litter biomass specific to each rubber plantation.

Conclusion

The results of this study show that beetles abundances in different habitats are significantly different, the greater abundance being observed in forests. Beetle's diversity is the same in all habitats in both areas. Although rubber plantations, and especially those in production are regularly disturbed by the activities of bleeding and harvesting latex. Also, the distribution of beetles within rubber plantations in production, is clearly good comparing to other habitats. Abundant beetles are represented in all habitats compared with rare and common ones. However, common and rare beetles are richer in families.

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REFERENCES

Abé J. 2005. Contribution à la connaissance de la morphologie et de la dynamique sédimentaire du littoral ivoirien (cas du littoral d'Abidjan) essais de modélisation en Vue d'une gestion rationnelle. Diplôme de doctorat d'Etat en sciences naturelles, 352 p Université de Cocody Abidjan (Côte d'Ivoire)

Barbalat S. 1995. Efficacité comparée de quelques méthodes de piégeage sur certains Coléoptères et influence de l'anthophilie sur le résultat des captures. Bulletin de la Société Neuchaleloise des Sciences Naturelles, 118, 39-52.

Chaudhuri PS, Bhattacharjee S, Animesh D, Chattopodhyay S, Bhattacharya D 2013. Impact of age of rubber (heveabrasiliensis) plantations of earthworm communities

of west Tripura (India). Journal of environmental biology, vol. 34, 59-65.

Danon ASD, Kra KD, Kwadjo KE, Douan BG, Loukou KKS, Doumbia M 2017. Abondance et distribution des Coléoptères coprophages selon l'âge des plantations d'hévéa dans la localité de Toupah, au sud de la Côte d'Ivoire, Afrique Science 13(1), 421-434.

Guillaumet JL, Adjanohoun E. 1971. La végétation de la Côte d'ivoire. In Le milieu naturel de la Côte d'ivoire. Mémoires ORSTOM, Paris, 50, 166 – 206.

Kangha A, Konan E, Alla AD, Ouattara MA 2016. Cartographie par télédétection et analyse de l'influence des activités agricoles dans le terroir villageois odjoukrou (à l'ouest d'Abidjan, Côte d'Ivoire). Institut de Géographie Tropicale (IGT), Université Félix Houphouët Boigny, Abidjan, Côte d'Ivoire, 15p

Keli ZJ, Omont H, Assiri AA, Boko CMAK, Obouayeba S, Dea BG, Doumbia A 2005. Associations culturales à base d'hévéa : bilan de 20 années d'expérimentations en Côte d'Ivoire. Agronomie Africaine 17 (1), 37-52.

Kra DK, Klimaszewski J, Doumbia M, Aidara D, Dagnogo M 2008. Comparing beetle abundance and diversity values along a land use gradient in tropical Africa (Oumé, Ivory Coast). Zoological Studies, 47 (4), 429-437.

Kromp B 1989. Carabid beetle communities (Carabidae: Beetle) in biologically and conventionally farmed agroecosystems. *Agriculture Ecosystems. Environment.* 27, 241-251.

Lamarre G. P.A and Paul V.A de Guyane 2011. Relations avec la structure et la diversité de la communauté de plantes ligneuses. ACOREP-France, 7p

Lassau SA, Hochuli DF, Cassis G, Reid C AM 2005. Effects of Habitat complexity on forest beetle diversity: do functional groups respond consistently? diversity and distributions, 11, 73-82.

Loukou KKS, Kwadjo KE, Kra KD, Douan BG, Danon ASD, Doumbia M 2017. Etude de la diversité et de la distribution des Coléoptères bousiers le long d'un gradient de dégradation du Parc National du Banco, Côte d'Ivoire. Afrique Science 13(3), 452-463.

Mavoungou JF, Mikissa JB, Basset Y. 2001. Rapport préliminaire de la mission d'évaluation des effets enthropiques sur l'entomofaune dans le complexe d'aires protégées de Gamba, pp1-29.

Rayaissé JB, Courtin F, Akoundjin M, Cesar J, Solano P 2009. Influence de l'anthropisation sur la végétation locale et l'abondance des Tsé-Tsé au sud du Burkina Faso. Parasite, 16, 21-28.

Ruf F 2008a. La fièvre caoutchouc. Jeune Afrique (2457) : 56 p

Ruf F 2008b. Côte d'Ivoire : la terre de plus en plus chère. Grain de Sel, 43, 5-6.

Tahiri A and Mangué J.J 2007. Stratégies d'attaques de jeunes plants d'Hévéa par les termites et effet comparés de deux insecticides utilisés pour leur protection en basse Côte-d'Ivoire. Sciences et Nature, 4 (1), 45 – 55.

Tahiri AY 2010. Termites ravageurs de l'hévéa Heveabrasilensis dans les départements de Daoukro et d'Agboville (Côte d'Ivoire). Lutte par utilisation des extraits de 6 plantes locales contre le termite champignonniste Macrotermesbellicosus, Thèse de Doctorat d'États es-sciences Naturelles, 223 p

Tamadouni I, Aradou M, Mouhajir K, Mataam A 2017. Biodiversité des Coléoptères Ripicoles de Sidi Moussa-Oualidia, zone humide de Maroc Atlantique. Revue d'Ecologie (Terre et vie) 72 (1), 94-101.

Tra Bi CS, Konaté S, Tano Y 2010. Diversité et abondance des termites (Insecta : Isoptera) dans un gradient d'âge de paillis de cabosses (Oumé-Côte d'Ivoire). *Journal of Animal &Plant Sciences* 6 (3), 685- 699.

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