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Diversity of butterflies visitors of cashew (*Anacardium occidentale* L.) flowers in Korhogo (Northern Côte d'Ivoire)

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Abstract
A study was conducted in three farms in Northern Region of Côte d'Ivoire, near Korhogo from December 2017 to February 2018 to collect butterflies distributed on the cashew farms during it flowering period. In each farm, one plot of an area measuring 25 m x 50 m was established in all the three cashew farms with approximately 30 to 32 trees per plot. The butterflies found on the cashew plants during the flowering period were identified and counted. A total of 37 species of butterflies distributed under 4 families viz., Lycaenidae, Nymphalidae, Papilionidae and Pieridae of 19 genera have been reported. Family Pieridae recorded the highest richness with 15 species and 5 genera. A total of 204 individuals was collected in this study. *Eurema brigitta brigitta* and *Danaus chrysippus chrysippus* was found to be the most abundant species.

Keywords: cashew, flowering period, butterflies, diversity, korhogo, Côte d'Ivoire

1. Introduction
Order Lepidoptera is the second largest order in the class Insecta and constitutes an important
component of terrestrial biodiversity [1]. The extent of species diversity in an ecosystem depends upon their adaptability to particular micro-habitats present in that area[2]. Butterflies constitute sensitive biota since they are severely affected by the environmental variations and changes in the plant community structure due to their close dependence on plants[3]. The diverse ecological role performed by butterflies are pollinator, herbivores, and bio indicators of ecosystem [4]. Their role as pollinators helps in production of food crops, seeds, fruits, sexual reproduction and genetic variation of the vascular plants, therefore, they are essential for the survival of man and animals [5]. Cashew (*Anacardium occidentale* L.) is a tree belonging to the Anacardiaceae. It is a hardy drought-resistant tropical and subtropical tree. It is distributed in tropical america, from Mexico and West Indies to Brazil and Peru[6]. It is presently cultivated in many tropical countries. In Côte d'Ivoire, the introduction of cashew trees dates back to independence. It took place in two essential phases: a reforestation phase (1959-1960) and a fruit production phase (from 1960 to today). The first phase was part of the government's policy to combat soil degradation in the North and Center part of the country. Côte d'Ivoire, with over 200 000 tonnes is the first Cashew producer in Africa.
[7] suggest that biodiversity in agro-ecosystems depends on both landscape heterogeneity and farm management, the studies that take landscape variables into account are rare. The few studies performed at a large enough scale found that the landscape context can modify the influence of organic farming on plants [8] or may be even more important for the diversity of bees, butterflies, carabids and spiders than the local farming system [9, 10, 11, 12]. Many recent studies have demonstrated that most of the plant species are visited by a diverse assemblage of insect[13, 14, 15, 16]. Literature on cashew insects is lacking in West Africa during the flowers and fruits seasons [15, 16], but there has not been much information on insect species associated with cashew in Côte d'Ivoire, regarding to either the flowers or the fruits. Likewise, there no literature on butterflies associated with cashew flowers. Insects, in particular the butterflies are real visitors of cashew flowers[15, 16, 17]. It would be important to know their diversity. It is therefore, necessary to investigate into butterflies that visit cashew plant during the flowering sesason, the butterflies diversity and species composition of butterflies that visits cashew plant during the flowering season in different locations.

2. Material and Methods
The study was carried out in three farms in Korhogo (9°27′28″N ; 5°37′46″W) northen of Côte d'Ivoire (Fig. 1). Equipment used for the execution of the research are: G.P.S, Sweep net, Field note book, pencil, and Paper envelopes. The study follows the methodology proposed by [18]. In each farm, one plot of an area measusring 25 m x 50 m (1,250 m^2) was established in all the three cashew farms with approximately 30 to 32 trees per plot. The enumeration team was made up of two members: one person served as a recorder and the other one scanned through the cashew trees, caught insects and gave them to the recorder. This procedure was carried out on all the trees in the plot. Insects captured were identified according to [19, 20, 21]. This procedure was carried out in the flowering season (mid December 2017 to mid February 2018). For community structure analysis, abundance, relative abundance, Shannon-Wiener diversity index (bits), Pielou Evenness,

Berger-Parker index were calculated and frequency of occurrence was determined.

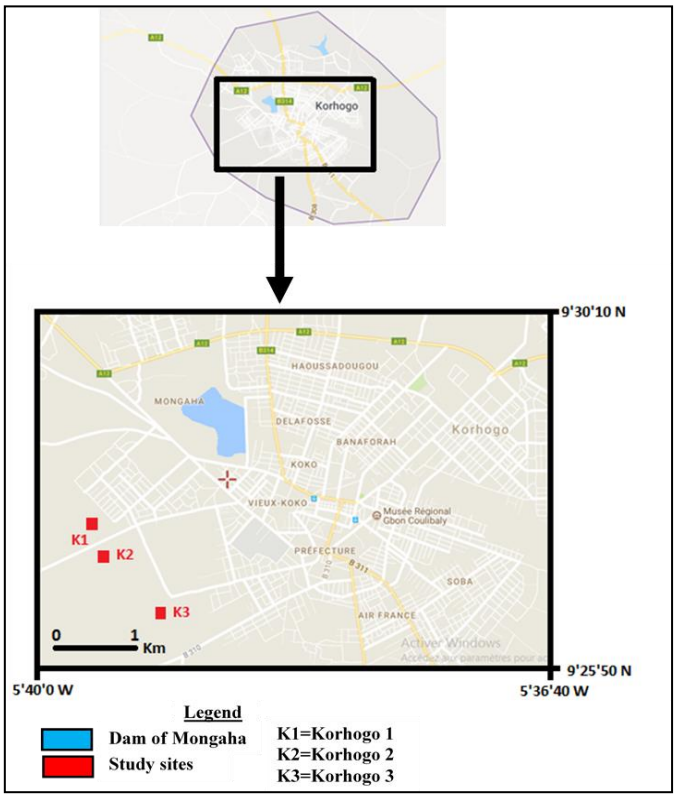

Fig 1 : Map of Korhogo locality showing the différents study sites (Source: Map data 2018 Google).

3. Results and discussion

During the course of present field investigations, 37 species of butterflies distributed under 4 families viz., Lycaenidae, Nymphalidae, Papilionidae and Pieridae of 19 genera have been reported. The detail list of family, name of species and their abundance, frequency of occurrence is provided (Table 1). The flowering of *A. occidentale* gets synchronized in December-February when it attracts abundant butterflies visitors. In previous study Lepidoptera were found to be rare visiting cashew flowers [22]. Four families of butterflies were collected in this investigation. These families were Nymphalidae, Pieridae, Lycaenidae and Papilionidae. Globally, the composition of the settlement corresponds to that generally visit the cashew plant during the flowing stage [16]. Pieridae was found to be the most dominant (41%) family represented by (5 genera, 15 species), followed by Nymphalidae (32%) (7 genera, 12 species), Lycaenidae (22%) (5 genera, 8 species), and Papilionidae (5 %) (2 genus, 2 species), (Fig. 2). Apparently, cashew flowers are attractive to Pieridae and Nymphalidae because 72.97% of these two families were recorded as floral visitors, but also in low numbers, like Papilionidae. The highest butterfly diversity was in January (Table 2). Korhogo 1 recorded the highest richness of butterflies. A total of 204 individuals was collected in this study. The specie richness recorded in the present study is high but abundance is low. This constat could be attributed to the farm landscape. Other recent works have shown that the landscape around and within farms can affect the richness of species and abundance [23, 24, 25]. Indeed, the cashew farms visited as part of our study are near the town of Korhogo. The vegetation was degraded, this could be a factor against the great wealth and abundance of species. Species abundance was found highest in Korhogo 3 (Table 3). During this study, only two species had remarkable abundance. These are *Eurema brigitta brigitta* and *Danaus chrysippus chrysippus*. These species make up 27.45% of the total abundance. *Eurema brigitta brigitta* recorded the highest abundance in Korhogo 2 while *Danaus chrysippus chrysippus* was the most abundant specie in Korhogo 3 and Korhogo 1. Species abundance was high at Korhogo 3 in December and February. In January, abundance was high at Korhogo 1. Family Pieridae recorded the highest abundance. This family was the most abundant in Korhogo 1 and in Korhogo 2 with 47.22% and 56.14% of total abundance respectively. In Korhogo 3 family Nymphalidae dominated the abundance with 41.33%. It was followed by Pieridae with 40% of total abundance. Shannon-Wiener index was higher in Korhogo 1 and lower in Korhogo 2. The highest value of evenness was recorded in Korhogo 3. Berger-Parker index was lower in Korhogo 1 (Table 3).

Table 1: Butterflies enumerated during cashew flowering phase. Ab=abundance, FO=Frequency of Occurrence (%).

Families	Taxa	Sites					
		Korhogo 1		Korhogo 2		Korhogo 3	
		Ab	FO	Ab	FO	Ab	FO
Nymphalidae	*Neptis morosa*	3	100	1	33.33	1	33.33
	Acraea serena	1	33.33	0	0.00	2	66.66
	Acraea pseudegina	1	33.33	0	0.00	1	33.33
	Acraea abdera abdera	2	66.66	0	0.00	1	33.33
	Acraea caecilia caecilia	0	0.00	1	33.33	0	0.00
	Danaus chrysippus chrysippus	12	66.66	5	100	14	100
	Junonia chorimene	4	66.66	1	33.33	3	66.66
	Junonia hierta cebrene	0	0.00	1	33.33	0	0.00
	Precis sinuata	0	0.00	1	33.33	0	0.00
	Precis antilope	0	0.00	4	66.66	3	100
	Phalanta phalanta aethiopica	0	0.00	2	33.33	1	33.33
	Eurytela alinda	0	0.00	1	3.33	5	100
Pieridae	*Eurema hecabe solifera*	7	33.33	0	0.00	6	66.66

	Eurema brigitta brigitta	7	33.33	15	100	3	33.33
	Eurema desjardensii regularis	1	33.33	8	66.66	3	66.66
	Eurema senegalensis	0	0.00	1	33.33	1	33.33
	Colotis ione	1	33.33	1	33.33	2	66.66
	Colotis euippe euippe	6	66.66	0	0.00	1	33.33
	Colotis daira stygia	1	33.33	0	0.00	1	33.33
	Belenois subeida frobeniusi	3	66.66	0	0.00	2	33.33
	Belenois creona creona	1	33.33	0	0.00	0	0.00
	Belenois gidica gidica	1	33.33	0	0.00	1	33.33
	Belenois calypso calypso	1	33.33	0	0.00	4	66.66
	Belenois zochalia connexiva	1	33.33	0	0.00	0	0.00
	Belenois aurota	1	33.33	1	33.33	3	100
	Mylothris chloris chloris	1	33.33	1	33.33	2	66.66
	Catopsilia florella	2	33.33	5	66.66	1	33.33
Lycaenidae	*Cupidesthes salvatoris*	1	33.33	0	0.00	0	0.00
	Lampides boeticus	2	66.66	0	0.00	0	0.00
	Anthene amarah	1	33.33	0	0.00	0	0.00
	Anthene starki	6	66.66	5	66.66	6	100
	Anthene kikuyu	1	33.33	0	0.00	0	0.00
	Anthene lunulata	0	0.00	1	33.33	0	0.00
	Leptotes babaulti	1	33.33	0	0.00	1	33.33
	Hypolycaena liara liara	0	0.00	1	33.33	0	0.00
Papilionidae	*Papilio demodocus demodocus*	2	66.66	1	33.33	5	100
	Graphium angolanus baronis	1	33.33	0	0.00	2	66.66
Total=4	37	72		57		75	

Table 2: Month wise distribution of families/genera/species

Months	Families	Genera	Species
December	4	15	25
January	4	17	26
February	4	15	25

Table 3: Richness, abundance, Shannon-Wiener index evenness and Berger-Parker index of Butterflies recorded in the different stations.

Parameters	Sites		
	Korhogo 1	Korhogo 2	Korhogo 3
Richness	28	20	26
Abundance	72	57	75
Shannon Wiener index (bits)	2.94	2.49	2.93
Pielou Evennes	0.88	0.83	0.90
Berger-Parker index	0.16	0.26	0.18

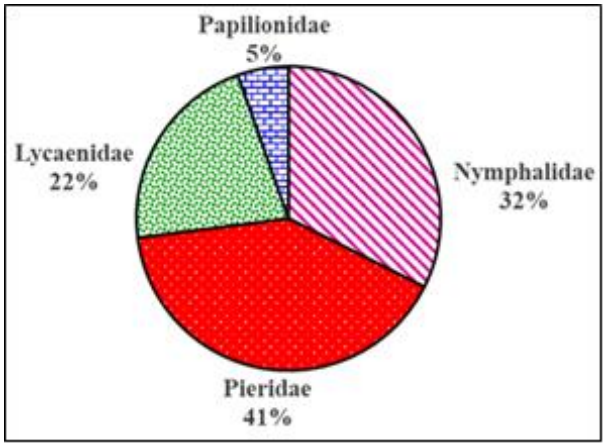

Fig 2: Percentage of species in each family.

4. Conclusion

The study revealed a number of butterflies that visit cashew during the flowering season. They were from the families Pieridae, Nymphalidae, Lycaenidae and Papilionidae. Family Pieridae and Nymphalidae recorded the highset number of species. During this study, butterflies encountered were 204 individual. Families Pieridae and Nymphalidae were the most abundant. Further studies should be conducted throughout the fruiting season in order to identify butterflies that visit cashew plant during the flowering and the fruiset periods.

5. References

1. New TR, Collins NM (and the IUCN/SSC Lepidoptera Specialist Group). Swallowtail butterflies. An action plan for their conservation (Gland, Switzerland: IUCN), 1991.
2. Kumar A. Butterfly (Lepidoptera: insecta) diversity from different sites of Jhagadia, Ankleshwar, district-Bharuch, Gujarat. Octa Journal of Environmental Research. 2013; 1(1):9-18.
3. Blair RB. Birds and butterflies along an urban gradient: surrogate taxa for assessing biodiversity? Ecological Applications. 1999; 9(1):164-170.
4. Tiple A, Deshmukh DVP, Dennis RLH. Factors influencing nectar plant resource visits by butterflies on a university campus: implications for conservation. Nota Lepidopteralogica. 2006 ; 28: 213-224.
5. Maheshwari JK. Endangered pollinators. Environmental News Archives. 2003; 9: 32-45.
6. Johnson D. Cashew cultivation in Brazil. Agron Mocamb. Laurenco Marques. 1973; 7:119-129.
7. Krebs JR, Wilson JD, Bradbury RB, Siriwardena GM. The second silent spring. Nature. 1999; 400 :611-612.

8. Roschewitz I, Gabriel D, Tscharntke T, Thies C. The effects of landscape complexity on arable weed species diversity in organic and conventional farming. Journal of Applied Ecology, 2005; 42: 873-882.
9. Weibull AC, Bengtsson J, Nohlgren E. Diversity of butterflies in the agricultural landscape: the ole of farming system and landscape heterogeneity. Ecography. 2000; 23:743-750.
10. Kremen C, Williams NM, Thorp RW. Crop pollination from native bees at risk from agricultural intensification. Proceedings of the National Academy of Sciences of the USA. 2002; 99:16812-16816.
11. Weibull A-C, Östman Ö, Granquist Å. Species richness in agroecosystems: the effect of landscape, habitat and farm management. Biodiversity and Conservation. 2003; 12 : 1335-1355.
12. Schmidt MH, Roschewitz I, Thies C, Tscharntke T. Differential effects of landscape and management on diversity and density of ground-dwelling farmland spiders. Journal of Applied Ecology. 2005; 42:281-287.
13. Mishra RM, Gupta P, Yadav GP. Intensity and diversity of flower-visiting insects in relation to plant density of Zizyphus mauritiana Lamk. Tropical Ecology. 2004; 45(2):263-270.
14. Sundararaju D. Diversity of bee pollinators and flora in cashew. J. Hortl. Sci., 2011; 6(1):52-55.
15. Abid A, Addressed N, Standards CC, Arts E L, Adjaloo M, Oduro W, Gemmill-Herren B. Flower visitors and fruitset of *Anacardium occidentale*. Oecologia. 2013; 2(1):1-5. http://doi.org/10.1086/282813.
16. Kuukyi FS, Wiafe ED. Density and Diversity of Insects That Visit Cashew (*Anacardium occidentale* L.) Plants in the Flowering and Fruiting Periods in Northern Ghana. International Journal of Natural Resource Ecology and Management. 2016; 1(4):171-178.
17. Bhattacharya A. Flower visitors and fruitset of Anacardium occidentale. Annales Botanici Fennici, 2004; 41:385-392.
18. Vaissière B, Freitas B, Gemmill-Herren B. Protocol to detect and assess pollination deficits in crops: a handbook for its use of Pollination, 70. Retrieved from http://www.internationalpollinatorsinitiative.org/uploads/ Proto col_PolDef_FINAL.pdf. 2011.
19. Larsen TB. Butterflies of West Africa. Plate volume, Apollo books, Stenstrup, Denmark. 2005, 270.
20. Woodhall S. Field guide to Butterflies of South Africa, Struik Nture, Cape Town, South Africa. 2005, 439.
21. Penney D. Field guide to Butterflies of the Gambia, West Africa, Siri Scientific Press, Manchester, 2009, 80.
22. Freitas Breno M, Pacheco Filho Alípio JS, Andrade Patrícia B, Lemos Camila Q, Rocha Epifânia EM, Pereira Natália O, *et al*. Forest remnants enhance wild pollinator visits to cashew flowers and mitigate pollination deficit in Brazil. Journal of Pollination Ecology. 2014; 12(4):22-30.
23. Kremen C, Williams NM, Bugg RL, Fay JP, Thorp RW. The area requirements of an ecosystem service: crop pollination by native bee communities in California. Ecology Letters. 2004; 7:1109-1119.
24. Viana BF, Boscolo D, Mariano-Neto E, Lopes LE, Lopes, AV, Ferreira PA, *et al*. How well do we understand landscape effects on pollinators and pollination services?. Journal of Pollination Ecology. 2012; 7:31-41.
25. Kennedy CM, Lonsdorf E, Neel MC, Williams NM, Ricketts TH, Winfree R, Bommarco R, *et al*. A global quantitative synthesis of local and landscape effect on wild bee pollinators in agroecosystems. Ecology Letters, 2013. doi: 10.1111/ele.12082.