THE EFFECT OF LAND USE ON THE COMMUNITY STRUCTURE DISTRIBUTION AND ABUNDANCE OF GROUND BEETLES (INSECTA: COLEOPTERA) IN A GUINEA SAVANNA IN NIGERIA

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ABSTRACT

A study was carried out to investigate the ground beetles of four habitats - cultivated farmland, Ifallow plot, a marshy plot and a secondary regrowth forest at the permanent site of Nnamdi Azikiwe University, Awka, Nigeria for a twelve-month period using the pitfall technique. Species of Coleoptera obtained from the four plots include Macrocheilus labrosus, Hyparpalus sp., Carpophilus fumatus (Boh.), Podagrica uniforma (Jac.), Tetragonothorax sp., Chlaenius sp., Pheropsophus parallus (Dej.), Silidus apicalis (Waterh), Tenebroides mauritanicus (L), Heteroderes sp., Heterorynchus licas (Klug.) and Mylabris sp., Analysis of Variance (ANOVA) indicate that the abundance of beetles wee significantly different in the cultivated farmland (F = 6.062). The result of Fisher's Least Significance Difference (F-LSD) test shows that the pitfall catches of beetles from the four sampling sites were also significantly different. The heterogeneity of the coleopteran species at the cultivated plot was traced to cultivation. The role of certain coleopteran families as faunal indicators was highlighted. Other factors, which influenced the Coleopteran species at the four plots, were also discussed.

Keywords: Insecta, Coleoptera, Agroecosystems, Distribution, Abundance, Guinea Savanna, Nigeria

INTRODUCTION

Insects are strategic in the welfare of man through their activities (Ewuim, 2004). Beetles, which constitute about two-thirds of all known insects, and about one-third of all known animal species, invariably participate in various activities, resulting in several changes in the ecosystems. The major important activity is the recycling of organic matter in the soil. They are phytophagous and can constitute a pest to crops. The litter feeders also enrich the various soils of the forests and savannas worldwide. The beetles like other insects, often evolve and exist as components of communities of plants and other animals. Most of the species are terrestrial but some are aquatic. In terms of food and feeding habits, since many coleopterans are plant eaters; some predacious, and others scavengers, or even wood-borers, their roles in various ecosystems are indeed significant. In terrestrial ecosystems many of these phytophagous forms, can cause significant damage either directly and transmit diseases, even though some are known to be beneficial herbivores. Many coleopterans have also been reported as epigeal beneficial (Honey et al. 1996).

With the elimination of their natural habitats due to the destruction of vast areas of natural forests for industrial, agricultural and urbanization purposes (Boorman, 1981), these coleopterans therefore constitute an interesting group to study in ecosystems. The study of the coleopteran species in the four study sites – a cultivated plot, a fallow farmland, a marshy plot and a tropical rainforest will no doubt provide invaluable information on their distribution and abundance.

MATERIALS AND METHODS

Study Area: The investigation was carried out in four contrasting study sites - a cultivated farmland, fallow farmland, marshy plot, a secondary regrowth forest, all of which are located at the permanent site of the Nnamdi Azikiwe University, Awka. Awka is the capital of Anambra State of Nigeria and located in the lowland rain forest zone of Southern Nigeria (Keay, 1965; Charter, 1970).

The cultivated plot measures 800m^2 in area and located between latitude $6^0 23^O$N and longitude $70^1 3^l$E. The plot has a variety of weeds which include *Sida acuta* Burm*, Aspilia africana* (CD), *Euphobia hirta* (L.), *Chromolaena odorata* (L.)*, Emilia sonchifolia* (L.), *Tridax procumbens (L.), Mariscus alternifolus* Vahl., *Commelina benghalensis* (L.), *and Axonopus compressus* (S.W.). It also has heaps of cassava *Manihot esculenta* Kranz. Also present was a shrub *Phyllanthus amarus* Schum and Thom. On the other hand, the fallow farmland measures 1000m2 and lies between latitude 6025IN and longitude 7013IE. It is separated from the cultivated farmland by a tarred road leading from the first gate of the permanent site of Nnamdi Azikiwe University, Awka. The plot had been fallow after the previous cultivation 12 year ago and therefore gone through an appreciable period of plan succession. Identified herbaceous plants in this plot included *Chromolaena odorata* (L.), *Aspilia africana* (C.D), *Tridax procumbens* (L.), *Axonopus compressus* (Sw.) Beauv, *Mariscus longibracteatus* Cherm., *Sida acuta* Burm. f., *Panicum maximum* Jacq. and *Veronia ambigua* Kotchsky and Peyr. Trees found in the plot included *Pentaclethra macrophyla* (Bentham), *Chlorophora excelsa* (Welw.) Benth., *Mangifera indica* L., *Combretum molle* R. Br., *Eleais*

Table 1: Collection of Beetles from Cultivated, Fallow Plot, Marshy and Forest Plots At Awka, Nigeria

Family	Species	Number of Beetles in Sampling Sites			
		A	B	C	D
Carabidae	***Macrocheilus labrosus***	1		3	-
	Pheropsophus parallus	1		1	-
	***Chlaenius* sp.**	2		-	-
	***Hyparpalus* sp.**	11	10	4	-
Nitudilidae	***Carpophilus fumatus***	1	-	-	-
Curculionidae	***Tetragonothorax* sp.**	1	-	-	-
Cantharidae	***Silidius apicalis***	1	-	-	-
Ostomatidae	***Tenebroides Mauritanicus***	2	-	-	-
Elatridae	***Heteroderes* sp.**	1	-	-	-
Scarabacidae	***Heterorynchus licas***	1	-	-	-
Staphylinidae	***Mylabris* sp.**	-	7	-	-
Unidentified Coleoptera		7	9	1	-

** Sampling sites: A – cultivated plot; B = Fallow plot; C -Marshy plot, D=Forest*

guineensis Jacq., *Newbouldia laevis* (P. Beauv.), *Terminalia ivorensis* A. Chev. nd., *Anthonata macrophylla* (P. Beauv.). The soil in the fallow farmland is sandy-loam.

The marshy habitat is located between latitude 6024′N and longitude 7013′E. The plot is over 600 m2 in area with sandy soil and subject to flooding annually. The dominant plant in the habitat was a sedge *Scirpus mucronatus* L. (Cyperaceae) of swamps and stream sides (Lowe and Stanfield, 1974). Other common plant species in the site include the grasses: *Setaria pallidefusca* Stapf and Hubb, *Panicum ribens* L. and *Cynodon dactylon,* Pegs and *Petotis* sp. The other herbaceous plants included *Chromolaena odorata, Imperata cylindrica* (L.), *Mariscus longibracteatus* Chem., *Axonopus compressus* (Sw.) Beauv., *Mimosa pudica* L., *Waltheria indica* (L.) in addition to the shrub *Mallotus oppositofolius* (Geisel). The trees included *Bauhinia rufescence* Lam., *Combretum mille* R. Br., *Elaeis guineensis* Jacq., *Daniela oliveri* (Benn.), *Pentaclethra macrophylla* (Bentham), *Acacia nilotica* Mill., and *Vitex doniana* Sweet.

The forest under investigation can be described as a secondary regrowth forest in an area of forest – agricultural mosaic (Lasebikan, (1974). The study area lies between latitude 6026′N and longitude $70^{1}1'$E. Alternatively it is located south east to east of the School of Postgraduate Studies and general south-east of Rufai Garba Square, with an approximate bearing of 125O and a distance of 200m from the center point of the Square. The size of the sampling plot is $200m^2$ in area. The herbaceous plants found at the fringe of the forest included Chromolaena odorata, Panicum maximum as well as shrubs like *Mallotus oppositofolius* (Giezel). The trees included *Newbouldia laevis* (P. Beauv.), *Alstolia bonier* de Wild, *Diallum guineensis* (L.), *Alchornea cordifolia* (Schum and Thonn.), *Alstonia bonei* (de Wild), *Ceiba pentandra* (Linn.), *Gaertn., Chlorophora exelsa* Welw. Benth.*, Harungana madagascariensis* Lam and Pols, *Newbouldia laevis* (P. Beauv.), *Morinda lucida* Benth., *Pterocarpus milbraedii* Harrns, *Ricinodendron heudelotti* (Baill.), *Rauvolfia vomitoria* Afyel *and Fagara macrophylla* Engl.

Sampling: Eight pitfall traps made of plastic containers of 9.80cm mouth diameter and 6.2 cm deep were, placed in the four study sites, on each sampling occasion (i.e. every month). The traps were filled to one-third with 5 % formalin. They were recovered after twenty-four hours, once every month and the insects caught were sorted, identified and counted under a dissecting microscope.

The insects and their larvae were identified using an appropriate key and also with reference to insects of Nigeria Check-List and Bibliography by Medler (1980). The identification of the specimens was verified in the Department of Crop Protection, Institute of Agricultural Research, Ahmadu Bello University, Zaria, Nigeria. The voucher specimens were also kept for reference purposes in the author's personal collections.

The analysis of variance (ANOVA) test was carried out to compare the beetle fauna obtained from the four sampling sites. The result of ANOVA shows that there is significant difference in the number of species collected from the cultivated plot. (F = 6.062) The Fisher's Probability Least Significant Difference (F-LSD) was used to test for the significance of pitfall catches of beetles at 5% probability level.

RESULTS

The results show that a total of 46 beetles were trapped during the twelve-month sampling period, from the study sites. No beetle was recorded from the forest. The 29 beetle species collected from the cultivated plot included *Macrocheilus labrosus* (Dej.)*, Pheropsophus parallus* (Dej.), *Chlaenius* sp., and *Hypapalus* sp., *Carpoplilus fumatus* (Boh.), *Tetragonothorax, Silidius appicalis* (Waterh.), *Tenebroides mauritanicus* (L), *Heteroderes* sp., *Heterorynchus licas* (Klug.) *and Mylabris* sp*.* Twenty-six beetles collected from the fallow plot were mainly *Hyparpalus* and *Mylabris* while 9 beetles collected from the marshy plot were *Macrocheilus labrosus* (Dej.), *Pteropsophus parallus* (Dej.) and *Hyparpalus* sp., (Table 1). The results the also indicate that the pitfall catches of beetles from the cultivated plot and

fallow farmland were significantly different at p-value of 0.0053 and mean difference of 2.500 while those of the cultivated plot and marshy plot showed significance at p-value of 0.0031 and mean difference of 20667. The pitfall catches of beetle from the cultivated plot and the forest were significant at 3.417 mean differences, at 0.0002 p-value.

DISCUSSION

Heterogeneity in the distribution of the beetle species in the fallow, cultivated and the marshy plot is related to the efficiency and capture rate of the wandering species. Out of eight families of Coleoptera trapped, Carabidae, Nitudilidae, Curculionidae, Cantharidae, Ostomatidae, Elatridae, Scarabaeidae and Staphylinidae were more abundant in the cultivated plot than in the fallow plot. The result suggested that land cultivation favoured the beetle community structure, relative abundance and distribution because of environmental disturbances arising from more current soil tillage, including the herbaceous and open nature of the vegetation, which provided ready food sources for the beetle species. In an earlier study, Ewuim (2007) associated the presence of members of Carabidae family with cultivation, while Spreight and Lawton (1976) established a complex relationship between wandering beetle, abundance and the frequency of vegetation cover (weed).

In earlier studies the relative abundance of the ground beetles was associated with nature of vegetation (Greenslade, 1964; Ewuim, 2004), while the curculionids have been associated with flower visiting and pollination (Sakai et al., 1998; Ewuim, 2007). Weevils are plant eaters and thus are serious agricultural pests. The lower catches of beetles at the fallow plot and marshy plot might also be related to dense vegetation associated with these plots which might have markedly impeded the movement of the beetles and invariably gave rise to their poor trapping. These observations are similar to those of Spreight and Lawton (1976), who observed that strip of vegetation offered resistance to movement of ground beetles.

It has been observed that adult beetles are herbivorous during their life on the soil surface and constitute the most influential grazers (Hinds and Rickard, 1973) hence their increased number in the cultivated farmland than the other three plots. This also explains the trend in which there are significant differences in the trapped coleopterans with more in the cultivated plot than the other three plots. The non-trapping of the beetles in the forest plot might also be associated with dense litter cover and the humid forest environment. These observations are similar to those of Adis (1979) who reported that in the forest, the depth of ground litter influenced pitfall-trapping success. Also species also respond differently to continuous variation in environmental quality (Bell *et al.,* 2000; Ewuim 2004) hence the differences in the pitfall catches at the four sites. The alteration of vegetation structure in the non-forested plots studied therefore possibly influenced the spatial and temporal variations in these species since in general; temporal dynamics of insect populations invariably take place within a spatial context.

In the long run evidence abound from this study that the least stable and perhaps the least efficient community is the highly diverse one as observed for the cultivated plot. The significant difference observation in the trapping of the coleopteran species with the highest population density for the cultivated plot is also a strong indication that the beetle families were particularly sensitive indicator taxa of land use (Rivers-Moore and Samsways, 1996) as confirmed by the increased density of the coleopteran species in the cultivated agro-ecosystem.

REFERENCES

ADIS, J. (1979). Problems of interpreting arthropod sampling with pitfall trap. *Zoological Analysis,* 202: 177-184

BELL, G., LECHOWICZ, M. J. and WATER, I. M. J. (2000). Environmental heterogeneity and species diversity of forest sedges. *Journal of Ecology,* 88: 67 – 87

BOORMAN, J. (1981). *West African Insects.* Longman Group Limited, Essex.

CHARTER, J. R. (1970). *Vegetation Ecological Zones.* Federal Department of Forest Research, Ibadan. Nigeria.

EWUIM, S. C. (2004). *A study of insect fauna of the Permanent Site of Nnamdi Azikiwe University, Awka.* Ph.D. Thesis, Nnamdi Azikiwe University, Awka.

EWUIM, S. C., EGWUATU, R. and NWANA, I. E. (2007). Coleopteran fauna of agro ecosystem in Awka, Nigeria. *Animal Research International,* 4(2): 647 – 649.

GREENSLADE, P. J. M. (1964). Pitfall trapping as a method for studying populations of Carabidae (Coleoptera). *Journal of Animal Ecology*, 33: 301 – 310.

HANEY, P. B., LEWIS, W. J. and PHATAK, S. (1996). Studies of insect population dynamics in crimson clover and refugia/cotton systems. Pages 1115 – 1119. *In:* Part II. Pitfall trap sampling. *Proceedings Beltwide Cotton Conferences,* Nashville, TN. USA. January 9 – 12, 1996.

HINDS, W. T. and RICHARD, W. A. (1973). Correlation between climatological fluctuations and a population of *Philolithus densicollis* (Horn). (Coleoptera: Tenebrionidae). *Journal of Animal Ecology,* 42: 341 – 351.

KEAY, R. W. J. (1965). *An outline of Nigerian vegetation.* Federal Ministry of Information, Lagos, Nigeria.

LASEBIKAN, B. A. (1974). Preliminary communication on microarthropods from a tropical rainforest in Nigeria. *Pedobiologia,* 14: 402 – 411.

LOWE, J. and STANFIELD, D. P. (1974). *The flora of Nigeria-Sedges (family Cyperaceae).* University Press, Ibadan.

MEDDLER, J. T. (1980). *Insect of Nigeria – Checklist and Bibliography*. Memoirs of the American Entomological Institute No. 30, American Entomological Institute, Michigan.

RIVERS-MOORE, W. A. and SAMSWAYS, M. J. (1996). Game and Cattle trapping and impacts on human dwelling on arthropods at a game park boundary. *Biodiversity and Conservation,* 5(12): 1545 – 1556.

SAKAI, K. M., TAKAKAZU, Y., MAKOTO, K and TAMIJI, I. (1998). Pollination of *Shorea parvifolia* (Section Mutika, Dipteraocarpae) in general flowering period in Sarawak, Malaysia. *Abstracts from forest canopies 1998. Global Perspectives, Sarasota, USA.*

SPREIGHT, M. R. and LAWTON, J. H. (1976). The efficiency of weed-cover on the mortality imposed on artificial prey by predatory ground beetles in cereal fields. *Oecologia,* 23: 211 – 223.