SURVEY OF SOIL MICRO-ARTHROPODS IN SELECTED SITES IN OGUN STATE

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ABSTRACT
A survey of the soil fauna of selected farm locations in Ogun State was conducted. The study was carried out at the school farm of the University of Agriculture, Alabata, Abeokuta; the School garden of the Baptist Girls` College, Idi-Aba, Abeokuta; a Farmland at Ewekoro, the Rubber plantation, Ikenne. All sites are in Ogun State. Microarthropods encountered during the survey of the sites considered belong to Class Arachnida, order Acarina, Suborders Oribatida, x = 36.50; Actinedida x = 1.00 and Gamasida; x = 2.25 and class insecta, order Collembola, x = 0.75. The rubber plantation was found to have the highest population of all these Microarthropods x = 24.75 while the school farm of the University of Agriculture, Abeokuta recorded the least population containing species of Suborder Oribatida x = 1.75 only. The school garden of Baptist Girls` College, Idi-Aba, Abeokuta x = 11.75 and the Farmland at the Cement Factory area, Ewekoro x = 3.75. The result of the physico-chemical analysis of the soil conducted indicated the influence of soil properties on the distribution of these microarthropods, also, different farm practices.

Keywords: Microarthropods, arachnida, acarina, soil physico-chemical properties

INTRODUCTION
Soil fauna communities include soil inhabiting invertebrates. They are known to improve soil structure by decreasing bulk density, increasing soil pore space, soil horizon mixing, increase aeration and drainage, increase water holding capacity, liter decomposition and soil aggregate structure (Abbott, 1989). The soil organisms range from macroscopic forms to the microscopic forms (Franke, 2003). There are two size classes of invertebrates that live in the soil. They include microfauna such as protozoa, mesofauna (which include nematodes, microarthropods and diptera larvae), and macro fauna, which include macro arthropods and earthworm (Abbott,1989). Population density and composition of the fauna in soils are indicators of soil condition (Lussonhop, 1992); (Stork and Eggleton, 1992) and rehabilitation of ecosystem quality because they can integrate information about other values as well as soil quality (Curry, 1979). Adejuyigbe *et al*., (1999), observed that soil degradation due to physical disturbance associated with cultivation, depletion of soil organic matter, reduced floral diversity and absence of plant cover for part of the year leads to depletion in the population of soil microarthropods. For an area with degraded soil such as mined or intensely cultivated sites, the re-establishment of invertebrates can simply be a matter of removing the cause of degradation or may involve more extensive site preparation techniques and re- introduction (Bonnie, 2003). Killham (1995) stated that the abundance and diversity of soil animals is greatest in soil of little or no disturbance such as those of permanent grassland and woodland, where they play a vital role in nutrient cycling. Tropical savannahs and forest have a lower fauna biomass than their temperate counterpart David *et al*., (1989). It further explained that for forest ecosystems, the fauna biomass is often inversely related to the accumulated weight of organic matter in the soil surface.

Climate also influences the composition of soil fauna. Brussaard *et al*. (1997) observed that physical and chemical characteristics of the soil are prominent soil are prominent soil characteristics determining the occurrence and functioning of the microarthropods. The abundance of microarthropods is determined by resource availability (i.e. organic matter), macro and micro climate, pH and disturbance (Petersen, 1982; Curry, 1994). The objectives of this study are therefore to survey the soil fauna – microarthropods in different soil type and land use and to assess the influence of both physical and chemical factors of the soil on microarthropod population and distribution.

MATERIALS AND METHODS
The sampling sites where soil samples were collected were School farm, University of Agriculture Alabata Abeokuta; School garden of Baptist Girls` College, Idi-Aba, Abeokuta; Farmland at Cement factory area, Ewekoro and Rubber plantation farm settlement, Ikenne, all in Ogun State, Nigeria. Samples of each soil were collected to 10.cm depth with sampling core. Growing vegetation was gently removed using cutlass,

root and leaf debris were also removed. The samples were air dried for laboratory analysis. Similar core samples were taken at each sites for microarthropods extraction. Microarthropods in the sample were collected using core of size 50cm^2 from 0-10cm soil depth. Without removing the liter layer, microarthropods were extracted using a modified Tullgreen – type extractor with a 25-watt bulb suspended over each sample for three days. Soil microarthropods were collected in formalin solution, their abundance were sorted and counted using a stereomicroscope and were grouped into taxonomic groups. Photographs of microathropods were taken using photomicrogramm. Particle size analysis introduced the dispersion and segmentation rate and the use of hydrometer. The sand fractions were obtained by deducting the values obtained for silt and clay fractions from 100%. The classes of the soil were traced out on a textural class triangle. Organic matter was derived from organic carbon using Walkey – Black method. Soil pH was determined using digital pH meter. Fifty grammes portion of fresh soil samples were weighed from each samples into a can of known weight. The soil samples in the cans were oven dried at 105^{o}C for 24 hours. The final weight of the cans and the content were weighed after drying. Moisture content is given by

$$= \frac{\text{Moisture loss after heating}}{\text{Weight of dry soil}} \times 100$$

Temperature of each sample taken was determined by inserting a mercury glass bulb thermometer into the tied polythene bag containing the soil samples. Temperature readings were taken at a point at which the reading is stable. Temperature readings of the four samples taken from each sites surveyed were recorded. ANOVA, Multiple Regression and Pearson Coefficient Correlation were used for the Statistical Analysis.

RESULTS

Population of microarthropods in the different soil samples

Microarthropods population found were of class Arachnida, order Acarina, suborders Oribatida (Cryptostigmata); Microarthropods population was found to be highest in rubber plantation and lowest in UNAAB farm. For the entire soil sample, the microarthropods population was not significantly different (P > 0.05) from each other with the exception of gamasids population. Soil of rubber plantation was observed to have highest species biodiversity or richness while the University of Agriculture Abeokuta farm was found to be least in species abundance. Table 1 shows the mean population of microarthropods in the different soils.

Particle size distribution

School garden of Baptist Girls` College, Idi-Aba has the highest percentage of 92.79% sand while farmland at Ewekoro has the lowest value of sand (80.20%). The percentage of clay and silt in the soil were generally low. The percentage of clay was found to be high in soil with low percentage of sand and low in soil with high percent.sand. The highest percentage of clay was observed in soil from farm land at Ewekoro. The soils fall into two textural classes that is sand and loamy sand. Table 2 shows the particle size distribution

Table 1: Mean population of microarthropods taxonomic taxa in the different soil samples.

SAMPLING SITE	CLASS ARACHINDA ORDER ACARINA SUB ORDERS			CLASS INSECTA	
	ORIBATIDA	ACTINEDIDA	GAMASIDA	ORDER COLLEMBOLA	TOTAL
UNAAB Farm	1.75a	0.00a	0.00b	0.00a	1.75a
School Garden Idi-Aba	11.00a	0.75a	0.00b	0.00a	11.75a
Farm Land at Ewekoro	3.25a	0.00a	0.50b	0.00a	3.75a
Rubber Plantation	20.50a	0.25a	1.75a	0.75a	24.75a
	36.50	1.00	2.25	0.75	42.00

NOTE: Values in each column with the same letter are not significantly different (P > 0.05).

Table 2: Particle size distribution

SITE	CLAY%	SILT%	SAND%	TECTURAL CLASS
UNAAB Farm	4.95a	5.05a	89.97a	Sand.
School Garden Idi-Aba	3.63a	3.57a	92.79a	Sand.
Farm Land at Ewekoro	11.48a	8.32a	80.20a	Loamy sand
Rubber Plantation	10.45a	3.87a	85.65a	Loamy sand

NOTE: Values in each column with the same letter are not significantly different (P > 0.05).

Distribution of soil organic matter

The organic matter at the School garden in Idi-Aba was observed to be the least. It was observed that organic matter of the University of Agriculture Abeokuta farm and the Rubber plantation at Ikenne are not significantly different (P > 0.05) from each other but significantly different (P < 0.05) from organic matter of the School garden at Idi-Aba and the Farmland at Ewekoro. Organic matter of the School garden of Baptist Girls' College Idi-Aba and the Farmland at Ewekoro are significantly different (P < 0.05) from each other. The result in Table 3 showed that organic matter of the Farmland at Ewekoro was the highest followed by the Rubber plantation at Ikenne.

pH

It was observed from the result that the University of Agriculture, Abeokuta farm, the School garden of Baptist Girls' College, Idi-Aba and the Rubber plantation at Ikenne soils were acid soils but pH of University of Agriculture, Abeokuta farm and the School garden Idi-Aba is significantly different (P < 0.05) from pH of the Rubber plantation Ikenne. Soil of farmland at Ewekoro was observed to be alkaline (Table 4).

Moisture content

The moisture content of the University of Agriculture, Abeokuta farm soil was extremely low while that of the Farmland at Ewekoro and the Rubber plantation, Ikenne were the highest. With the School garden Idi-Aba however, the moisture content was found to be lower (Table 5).

Table 3: Distribution of soil organic matter

	ORGANIC MATTER (%)				
SITE	1	2	3	4	Mean O. M
UNAAB Farm	2.26	2.29	2.41	1.24	2.18a
School Garden Idi-Aba	1.31	1.81	2.59	2.02	1.93b
Farm Land at Ewekoro	2.55	3.86	3.66	3.04	3.27a
Rubber Plantation	4.83	1.86	2.83	3.10	3.15ab

NOTE: values in each column with the same letter are not significantly different (P > 0.05).

Table 4: pH of the different soil

SITE	1	2	3	4	MEAN SOIL pH
UNAAB Farm	5.92	6.40	5.87	5.95	6.04ab
School Garden Idi-Aba	7.81	5.86	5.88	7.36	6.73ab
Farm Land at Ewekoro	6.16	7.20	7.34	9.13	7.46ab
Rubber Plantation	5.36	6.97	5.17	5.70	5.80b

NOTE: values in each column with the same letter are not significantly different (P > 0.05).

Table 5: Soil Moisture content

SAMPLING SITE	% MOISTURE CONTENT 1	2	3	4	MEAN MOISTURE CONTENT
UNAAB Farm	0.89	0.83	0.81	0.60	0.78b
School Garden Idi-Aba	1.21	1.0	1.42	2.04	1.42b
Farm Land at Ewekoro	4.36	5.62	14.97	4.04	7.23a
Rubber Plantation	14.81	2.31	7.33	7.25	7.90a

NOTE: values in each column with the same letter are not significantly different (P > 0.05).

Soil temperature

It was observed from the result that the University of Agriculture, Abeokuta farm has the highest temperature while temperature of rubber plantation was the lowest. The range temperature between farmland at Ewekoro and school garden is 1^0C (Table 6).

Table 6: Soil temperature

SAMPLING SITE	1	2	3	4	Mean Temperature (^{0}C)
UNAAB Farm	33.8	34.3	34.0	34	34.05a
School Garden Idi-Aba	33.20	33.50	33.50	33	33.43a
Farm Land at Ewekoro	32	31	31	35	32.25a
Rubber Plantation	26	26	30	29	27.75b

NOTE: Values in each column with the same letter are not significantly different (P > 0.05).

Correlation between particle size, moisture content, organic matter, temperature and soil pH

Organic matter correlated negatively with temperature, this is significant at 5%, so also temperature correlated negatively with moisture, which is significant at 5%. Table 7 showed how the parameters correlated with each other either negatively or positively which can also be significant or non-significant at 1% and 5% significant levels.

Correlation between microarthropod populations, particle size, temperature, moisture content, ph and organic matter

The total microarthropods population correlates significantly with moisture. Oribatids population correlates negatively with temperature, this was significant at 1%. It also correlates significantly with moisture. Table 8 shows the coefficient correlation between microarhtropod populations, physical and chemical properties of the soil considered.

Table 7: Correlation between particle size, moisture content, organic matter, temperature and soil pH

	Organic matter	Temperature	pH	Clay	Silt	Sand
Clay	0.479	-0.338	0.109	1.000	0.559*	-0.951**
Silt	0.650**	-0.071	0.124	0.559*	1.000	-0.787**
Sand	-0.596*	0.274	-0.129	-0.951**	-0.788**	1.000
Moisture	0.8135	-0.614*	-0.075	0.785**	0.569*	-0.792**

NOTE: *5% significant level
**1% significance level.

Table 8: Correlation between microarthropod populations, particle size, temperature, moisture, ph and organic matter

	Clay	Slit	Sand	Temp.	Organic matter	Moisture	pH	Oribatid	Total
Oribatids	0.155	0.066	-0.134	-0.626**	0.486	0.529	-0.168	1.000**	0.996**
Total	0.186	0.073	-0.159	-0.654**	0.511*	0.564*	-0.198	0.995**	1.000

NOTE: *5% significant level; **1% significance level.

Dependent variables (physical and chemical properties of soil) for microarthropods population

For total microarthropods population, all the variables are non-significant except temperature which is significant at 1%. Using multiple regression analysis, all the variables are non-significant together in functioning of total microarthropods population. Through backward elimination however pH was the first variable eliminated yet the remaining variables are non significant. pH elimination was followed by organic matter removal with the remaining variables close to significant level. Elimination of moisture made temperature only to be significant in functioning of microarthropods. Hence order of dependence for total microarthropods is temperature → moisture → organic matter → pH. This is also the case for Oribatids population with slight change in order of dependence of variables. The order of dependence for Oribatids is temp → organic matter→ pH. Table 9 is a result of multiple regression analysis for total microarthropods population showing order of variable dependence of microarthropods.

Table 9: Dependent variables (soil properties) for microarthropods population

Dependent variable	Oribatids	Total
pH	0.931	0.832
Organic matter	0.374	0.712
Moisture	0.777	0.327
Temperature	0.009**	0.006**

NOTE: *5% significant level; **1% significance level.

DISCUSSION

This work was carried out with the aim of surveying the varying land farm practices sites chosen for their microarthropod distribution and the influence of the soil properties considered on the microarthropod abundance. This is attributed to the land use and the physicochemical properties of the soil supporting the evidence that environment, physical and chemical properties of the soil affect the distribution and abundance of invertebrates (microarthropods) directly by influencing their biology and life processes and indirectly by determining the nature of the habitats they occupy and their food supply (Curry, 1994).

It was found that the soil properties considered differed from one site to another. The result showed that the variation in sand, silt and clay content was not very high and the soil of the four sites considered fall into the textural classes' i.e. loamy sand soil and sand soil. The Rubber plantation had high organic matter. This could be attributed to its continuous supply of organic material for decomposition. The UNAAB farm organic matter is statistically similar to the rubber plantation's organic matter due to its fertilizer inputs. Considering the soil pH, soil of the farm land at Ewekoro was slightly alkaline due to the effect of calcium from lime stone found in the dust of the environment. Other sites were acidic soil though the rubber plantation soil was statistically different from the rest.

Temperature of the soil range from 27.75 -- 34.05 with the rubber plantation having the least because rubber trees produced a cover (shade) to the soil while the UNAAB farm had the highest temperature value because the soil was exposed to direct sunlight (crop had been harvested). It was observed that the presence of rubber trees and arable crops such as sugarcane and cassava in rubber plantation and the farm land at Ewekoro respectively shield the sun from direct penetration or sunlight hence high moisture content while the reverse was the case for the UNAAB farm and the school garden of the Baptist Girls' College, Idi-Aba.

Results also showed that properties considered correlates significantly with each other with few exceptions. This is in substantial agreement with those of Curry (1994) that all the physical and chemical properties of soil operate strongly interconnected. Soil microarthropods bear greater relationship with temperature. As temperature increases, soil microarthropod population decreases. This is due to the fact that temperature directly affects the rate of physiological reactions and indirectly has effect on the soil biological activities; also soil animals migrate to avoid high temperature. This observation supports the view of Swift *et al.,* (1979) that soil temperature is a factor of paramount importance in terms of distribution and activities of the soil animals.

The population of total microarthropods was found to increase as organic matter increase. Moisture also correlates significantly with soil microarthropods mainly because it influences soil water content and relative humidity of the soil pores. Result has shown that moisture correlated significantly with organic matter. Both moisture content and organic matter correlated significantly with soil microarthropods. This signifies that apart from microarthropods feeding on organic matter, it also aids microbial growth providing food for the microarthropods, hence influencing microarthropod population. This observation positively support the view that moisture increases the surface area of organic matter particles available for microbial attack thus increasing the growth rate of bacteria and fungi use as food by microarthropods (Visser, 1985). The rubber plantation has the highest population density of soil fauna and species biodiversity. This could be attributed to land use. This supports the view that perennial crops offer the most suitable conditions to microarthropods compared with arable fields. In the rubber plantation, the soil micro flora, the main primary food source of the microarthropods is stimulated by continuous inputs of organic matter from the liter, roots and often manure all year round. Also the absence of soil tillage constitutes the main difference between annual and perennial crops. Favorable soil characteristics also influence the high population density. The School garden soil, which was less degraded, had high population density of soil fauna with its major population belonging to suborder Oribatida. Although the soil is acidic with low organic matter, high temperature and low moisture content the soil still support soil fauna because it was less disturbed. Despite the favorable soil characteristics of soil characteristics of farm land at Ewekoro, the soil could not support large number of soil fauna as found in the school garden at Idi-Aba because it is subjected to continuous cultivation. This is in agreement with those of Adejuyigbe *et al.,* (1999) that soil degradation due to physical disturbance associated with cultivation, reduced flora diversity. Also, absence of plant cover for a part of the year leads to depletion in the population of soil microarthropods. Its high organic matter was signified by the number of soil millipedes obtained. Oribatid mites or beetles mites was the only soil fauna observed in the soil from the UNAAB farm. This could be attributed to the fact that crop on the land had been harvested, exposing the soil to direct effect of sunlight. Oribatid mites were found to be common to the four sites. For the total microarthropods population, results from this study has shown that soil temperature contributed significantly to its abundance, organic matters mainly because some of the microarthropods live and feed in liter layer. Influence of moisture content on the total Oribatids abundance was not significant while effect of pH contribution was the least and of no significance.

REFERENCES

Abbott, I. (1989). The influence of fauna on soil structure. In majer, J.D. (ed) Animals in Primary Succession: the role of fauna in reclaimed lands. Cambridge University Press. Pp 39-50

Adejuyigbe, C.O., Tian, G. And Adeoye, G.O. (1999). Soil microarthropods populations under natural and planted flowers in Southwestern Nigeria. Agroforestry system 47: 263-272.

Bonnie, W. (2003). Using Soil Fauna to improve Soil Healths. //www.nhm.ac.uk/science/entom/project3.

Brussaard, L., Hassink, J. and Vreeken-Buijs, M. J. (1997). Relationship of Soil Microarthropod Biomass with Organic matter and pore size Distribution in soils under Different Land Use. *Soil Biol. Biochem.* 30. No 1. pp 97.

Curry, J.P. (1979). The Arthropods Fauna Associated with Cattle Manure Applied as Slurry to Grassland. Proceedings of the Royal Irish Academy, 76B, 49-71.

Curry, J.P. (1994). Grassland Invertebrates. Chapman and Hall. London.

David, C.C., Malcolm, J.O. and Gorouehara, B. (1989). Dynamics of Soil Organic Matter in Tropical Ecosystem. Mc Graw Hill. London. Pp 1-19, 62-64.

Franke, B. (2003). Arthropod fauna of soils. News letter of the Biological survey of Canada (Terrestrial Arthropods) 20, No.2.
Killham, K. (1995). Soil Ecology. Cambridge. University press. London.
Lussenhop, J. (1992). Mechanisms of microarthropod-microbial interactions in soil. Adv Ecol. Res.23, 1-33.
Peterson, H. (1982). The soil fauna biomass and its composition. Oikos 39: 330-339.
Robert, L. T. (1995). Soil Microbilogy. John Willey and Sons Inc. USA. Pg 38-42.
Seastedt, T.R. (1984). The Role of Microarthropods in Decomposition and MineralizationProcesses, Ann. Rew. Entomol. 29: 25-46.
Stork, N.E. and Eggleton, P. (1992). Invertebrates as determinants and indicators of soil quality. American Journal of Alternative Agriculture. 7; 38-45.
Swift, M. J., Heal, O.W. and Anderson, J.M. (1979). Decomposition in Terrestrial Ecosystems. Blackwell. London.
Visser, S. (1985). Role of soil invertebrates in determining the composition of soil microbial communities. In: Fitter A.H., and Atkinson, O. (ed). Biological interaction in soil. Blackwell, Oxford. 297-317.