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Abstract

A study on the species diversity and distribution of soil macroarthropod fauna in irrigated vegetable plots in Jos was carried out. Five sampling sites were selected based on the mass cultivation of four staple food crops: cabbage, maize, potatoes and carrots. A total of 981 soil macroarthropod were collected. Out of which 539(54.94%) were collected by pitfall traps and 442 (45.60%) were collected by hand capture technique 953 (97.12%) were adults while 28(2.85%) were juveniles. 11 orders and 19 families were identified. Unidentified families were termed, "others". The Hymenoptera (37.3%), Coleoptera (24.5%) and Diplopoda (8.8%) were the dominant macroarthropod group, but the least dominant groups are Hemiptera (1.0%) and Chilopoda (2.0%). There was no significant difference ($P>0.05$) between macroarthropod collected by pitfall trap and those collected by hand capture technique. A significant difference ($P<0.05$) was observed between the juvenile and adult populations collected. Factors such as pH, soil temperature, fertilizer application, crop type, control methods influence the abundance and distribution of soil macroarthropod fauna. Data across sites showed that maize had highest abundance of 408 macroarthropod at 26.5^{O}C while there was decline in cabbage with 183 at 27^{O}C. However, a decrease to 187 at 26.7^{O}C for carrot and increase to 203 macroarthropod at soil temperature of 27.8^{O}C for potatoes was noted.

Keywords: Species Diversity, Macroarthropod, Vegetable Plots, Jos, Nigeria.

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Introduction

Soil fauna represents one of the most complex and yet rewarding areas of current biological exploration. It perhaps remains one of the least known biological frontiers, particularly in terms of soil zoological systematic and taxonomy (Henri *et al.*, 2002; Alfred *et al.*, 1991). Soil plays an important role in agro-ecosystem and management and also in the abundance of soil fauna. Through, their activities, macrofauna influence the physical, chemical and biological status of the soil. They also communite organic resources, determine diversity and abundance of other organism through availability of nutrients (Icarina *et al.*, 2006).Macroarthropod diversity is related at least in part to different preferences for microclimatic conditions, some species selecting shaded sites, other more exposed areas. Vertical gradients of microclimate in the soil contribute to microhabit diversity, likewise structural and biochemical gradients also make their contribution to these diversity (Wallwork, 1976).

The most important groups of soil fauna in most sites are the protozoa, Annelida, Mollusca and Arthropoda. Other groups of soil fauna also include a number of groups which are rare or much more localized in their distribution such as Rotifers, Gastrotichs and Tordigrades (Wallwork, 1976).Macroarthropods in the soil participate in numerous processes of soil formation and affect the usefulness of soil. The classical role of soil fauna is in the breakdown of dead plants and animals, which are returned to the soil. Accompanying this decaying process is the release of nutrients from the organic body of plants and animals into the soil. Effects of macroarthropods in and on soil results in changes of soil fabrics as size, shape, arrangement of soil componenets and changes in soil composition (Timo *et al.*, 2006, Stephen *et al.*, 2006, Takafumi *et al.*, 2006). This work is aim at establishing the species diversity and distribution of soil macroarthropod fauna in irrigated vegetable plots.

There are at least twelve kinds of activities by which soil dwellers affect the soil, these activities include mounding, mixing, forming voids, back filling voids, forming and destroying peds, regulating soil erosion, regulating movement of water and air in soil, regulating plant litter, regulating animal litter, regulating nutrients cycling, regulating biota and producing special constituents through the processes of regurgitation, mixing of saliva or excreta with soil materials (Hole 1981, Darlong *et al.*, 1991).

Materials and Methods

The study area was divided into five sampling sites, each site from the corresponding districts of Jos south L.G.A of Plateau state. Each site was subdivided into four plots, with four crops from each plot as cabbage, maize, potatoes and carrots due to their mass cultivation in these areas. Each plot was measured into 10x10m and five pitfall traps measuring 7cm was set in ground level to the soil surface 2m apart from each trap. 20 pitfall traps were set in each sampling site giving rise to a total of 100 pitfall traps set at five sampling sites. The traps were checked after 24hours according to Bater, 1996 and trapped macroarthropod were collected. Soil macroarthropod were also collected by hand-capture technique for 10 minutes in each plot. They were placed in collecting jars containing chloroform. A soil temperature was taken for each plot and soil samples were collected from each sampling site(s) at the top 0-7.5cm of the soil. 10g of soil was weighed and placed in a 500ml flask and 25ml of distill water was added and stirred gently for 1 minute, left to stand for 30 minutes. After which the solution was decanted in beaker and placed on a retort stand. The pH was determined using pH meter with glass electrode for each soil sample from the twenty-four (24) sampling sites.

Results and Discussion

A total of 981 soil macroarthropod were collected (table 1) out of which 2.85% were juveniles while 97.12% are adults (table 2). Macroarthropod diversity obtained from four different classes (major taxa) include myriapoda, Insecta, Crustacea and Arachnida. 11 orders were established from major taxa as Hymenoptera, Coleoptera, Diplopoda, Thysanoptera, Homoptera, Orthoptera, Odonata, Lepidoptera, Hemiptera, Araneida and Chilopoda (table 1). The dominant macroarthropod group in studied plots was Hymenoptera with total of 607 macroarthropod. 18.86% were macroarthropod obtained from cabbage plot, 34.46% were collected from maize plot, 27.63% from potatoe plot while 19.06% were from carrot plots. The data across sites (table 3) indicates that maize had highest abundance of 408 macroarthropod at 26.5^{0}C while a decline was noted in cabbage plot with 183 at 27^{0}C. However, there was decrease to 187 at 26.7^{0}C for carrot and increase to 203 macrotharthropods at soil temperature of 27.8^{0}C for potatoes. It was also noted across sites that vegetable plots showed pH value (less acidic) with marked increase of 408 and 203 soil macroarthropod in both maize and potatoe plots at 5:75 and 5.56 pH values. There were fluctuations in cabbage and carrots plots respectively.

The most dominant group of macroarthropod were Hymenoptera (61.88%), coleoptera (22.32%), Diploda (3.26%) and Homoptera (2.35%). The result is similar with the work by Liao *et al.*, 2002 and Liu *et al.*, where hymenoptera and coleoptera are the dominant in the tropical rainforest of china.

The abundance of hymenoptera (mostly formicidae) is similar to the work of Frouz and Ali (2004) where formicidae were the dominant soil macroarthropods found in florida upland habitats. This could be due to their habitual nature of constant burrowing in the soil strata which improves soil fertility by aeration at the surface of soil. Out of 981 soil macroarthropod 97.12% were adults while 2.28% were juveniles, the juveniles are less abundant because their developmental stages occur in the soil strata. Those collected by pitfall traps was 539 and those collected by handcapture technique was 442.

The pitfall traps collected more macroarthropods than handcapture, therefore it is more effective in this work. There was no significant difference (P>0.05) observed in the soil macroarthropod abundance the five sampling sites. Likewise, there was no significant difference (P>0.05) between macroarthropod collected by pitfall trap and those collected by handcapture technique.

Themacroarthropod abundance decrease at high temperature and increase at low temperature. At such soil temperature has relative influence on their distribution across the study sites. Low pH values had less abundance of soil macroarthropod whereas increase pH values showed more abundance of macroarthropod across study sites. This is similar with Enami *et al. (*2009) whose work shows positive correlation of pH value to the macroarthropod found. This could mean that low pH values support soil fertility and crop production which then influences the distribution of the soil macroarthropod. Statistical analysis indicated that there was no significant different (X^2=79.966, P=0.356) between family of macroarthropod and pH range. There was no significant difference (X^2=95.025, P=0.69) between the family of macroarthropod and the sites of sample collection.

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Table 1: Dominant occurrence of soil macroarthropod group in each of the four vegetable plots

Macroarthropod Group	Cabbage (%)	Maize (%)	Potatoe (%)	Carrot (%)	Total (%)
Hymenoptera	114(18.78)	155(22.54)	173(28.50)	165(27.18)	607(61.88)
Coleoptera	28(12.79)	154(70.32)	24(10.96)	13(5.34)	219(22.32)
Diplopoda	8(25.00)	24(75.00)	-	-	32(3.26)
Homoptera	20(86.96)	1(4.35)	2(8.69)	-	23(2.35)
Thysanoptera	3(100.00)	-	-	-	3(0.31)
Orthoptera	5(62.50)	1(12.50)	19 (12.50)	1(12.50)	8(0.82)
Odonata	-	-	-	1(100.00)	1(0.10)
Lepidoptera	3(30)	1(10)	-	6(60)	10(1.02)
Hemiptera	-	-	1(100.00)	-	1(0.10)
Araneida	4(80)	-	-	1(20)	5(0.02)
Chilopoda	-	2(100.00)	-	-	2(0.02)
Crustacea	-	-	70(100.00)	-	70(7.14)
Total	**185(18.86)**	**338(34.46)**	**271(27.63)**	**187(19.06)**	**981(100.00)**

TABLE 2: Abundance of Different Development Stages of Soil Macroarthropod Fauna in the study area

	Macroarthropod class	No of Larvae Sites					No of Nymphs Sites					No of Pupae Sites					No of Adults Sites					TOTAL
		CH	DA	DO	RO	KWA	CH	DA	DO	RO	KWA	CH	DA	DO	RO	KWA	CH	DA	DO	RO	KWA	
;e	Insecta	-	-	2	3	-	-	-	-	-	17	-	-	-	-	-	14	47	2	55	33	173
	Myriapoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	5	-	8
	Arachnida	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2
	Crustacea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Insecta	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	63	78	113	29	28	312
	Myriapoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	8	-	5	3	26
	Arachnida	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Crustacea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	-	-	25	15	70
!	Insect	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	28	40	79	28	28	203
	Myriapoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Arachnida	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Crustacea	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	
	Insecta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35	40	37	34	36	187
	Myriapoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Arachnida	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Crustacea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	TOTAL			2	3						17		1		5		180	216	233	181	143	981

CH = Chol
DA = Dahwol
DO = Dogonuh
RO = Roryen
KWA = Kwaha

ANOVA: $P<0.05$.

Table 3: Effect of soil temperature and pH variation across study sites on the abundance of macroarthropods

	CABBAGE	T(^{0}C)	pH	MAIZE	T(^{0}C)	pH	POTATOE	T(^{0}C)	pH	CARROT	T(^{0}C)	pH
Dogonuh	6	26.0	6.48	113	26.0	7.12	79	28.0	6.30	37	26.5	7.64
Kwaha	50	28.5	5.72	46	26.5	5.77	28	28.0	6.16	36	28.8	6.76
Roryen	63	26.5	3.52	59	28.0	4.23	28	28.6	4.14	39	26.0	4.62
Chol	14	26.0	6.16	103	26.0	5.93	28	28.0	5.32	35	26.5	6.25
Dahwol	50	28.0	7.02	87	26.0	5.72	40	26.5	5.86	40	26.5	6.18
TMM	**183**	**27**	**5.78**	**408**	**26.5**	**5.75**	**203**	**27.8**	**5.56**	**187**	**26.7**	**6.29**

No of macroarthropods & Mean Soil T (^{0}C) for Plots Studied
TMM= Total macroarthropod & Mean T (^{0}C)
NB: Mean Soil T (^{0}C) is based on 5 samples across sites.

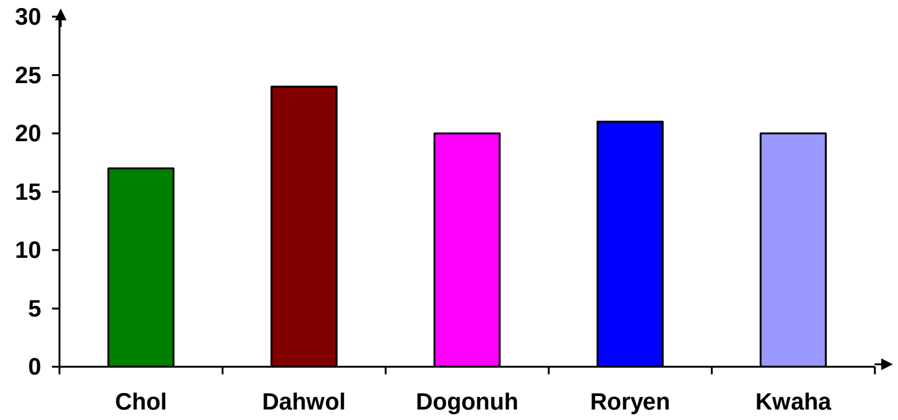

Fig 1. Relative Abundance of soil macroarthropod in relation to sampling sites

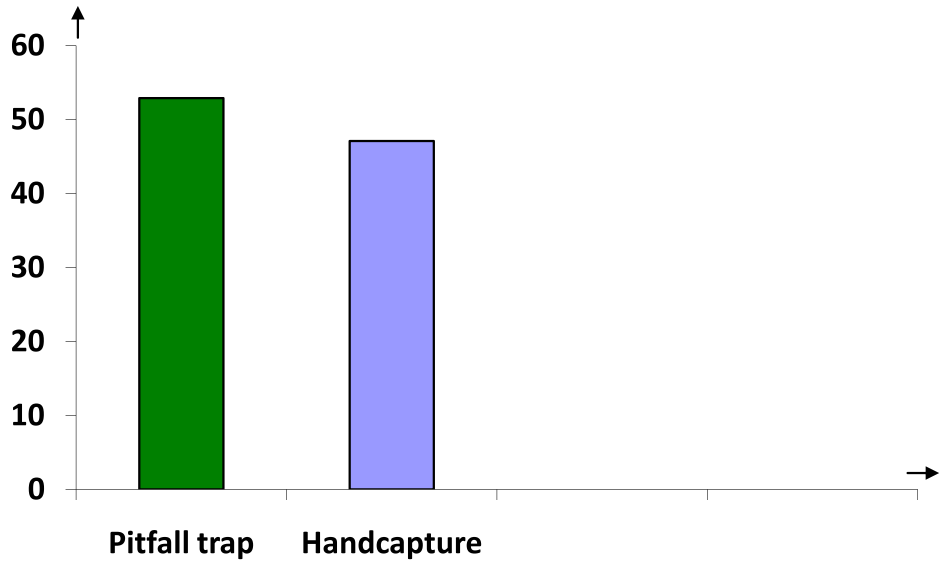

Fig 2. Percentage occurrence of sampling technique.