Influence of N, P, K and moisture content on the population density of below ground fauna at Keibul Lamjao National Park, Manipur

Mema Devi, Waikhom

Abstract— Variation in the average population density of Acarina and Collembola and Megafauna with NPK and moisture content have analysed by applying F-test and found significantly different (P<0.001) during the 12 months study period. P is found to have positive significant impact on population of Collembola by positive Coefficient, 0.14 with 95% CI: 0.03- 0.26 significant at (P< 0.05) level. The four independent factors have insignificant effects but explained 17% (R^2 =0.167) of the total variation in the population density of Acarina during the study period. Similarly other fauna representing Megafauna, the four factors are explained 14% (R^2= 0.144) of the population density during the same study period.

Index Terms— Acarina, Collembolla, Megafauna, Mesofauna and Phumdi.

1 INTRODUCTION

Soil is a complex biological system and is the habitat of many soil organisms representing soil fauna. Keibul Lamjao National Park (KLNP), situated along the south eastern corner of Loktak Lake of Manipur is made up of a unique type of soil, a thick mat of organic debris locally known as phumdi. This phumdi reaches up to a thickness of 1.5 to 2.0 meters and remain floating with about one fifth above the level of water. KLNP is famous for being the natural habitat of brow antlered deer *Rucervus eldii eldii* (Mc Clelland) and is the only type of National Park found all over the world. Soil animals like meso and mega fauna together perform the magnificent work of decomposition, mineralization and nutrient cycling of the remains of plant and plant products. Although a lot of studies on the flora and vertebrate fauna had been studied and published, no meso and mega fauna studies have so far been reported from this park. Knowing the role of these fauna in different types of soil, internationally, the present work has been taken up and it will provide a good scientific data of this Park for various parameters.

Mesofauna comprises those animals whose size range from (0.2 to 2.0) mm. These include collembola, mites and nematodes besides other groups. Acarines or mites and Collembola or springtails are considered for the present investigation. Megafauna includes those animals whose size range from 2mm onwards to above including Coleoptera, Diptera larva, Chilopoda, Isopoda, Gastropoda, Enchytraeidae, Lumbricidae and even large vertebrates. Vertebrate animals are not considered for the present investigation as they are not found in the below ground. The distribution of animals in the soil is correlated to the nutrients present in the soil. The important ecological feature of KLNP is a more or less continuous mat made up of heterogeneous mass of soil, vegetation and organic matters in different degrees of decay locally called phumdi. The dominant plants that include in the formation of phumdi are *Salvinia natans, Azolla pinnata, Pistia stratiotes, Echornia crassipes, Cyperus iria etc*. [6].

The high proportion of humus matter in the phumdi gives it a low specific gravity and high buoyancy causing it to float in a loose formation. This floating mass continues to accumulate more soil particles and humus, thus the growth activity of reedy grass and tender bushes is accumulated. As more vegetation growth has added each year, it becomes thicker and heavier and at certain areas its thickness reaches up to 3m or more [6]. The whole area of KLNP is made up of such a stretch of phumdi and is the natural habitat of *Rucervus eldii eldii*, the only deer found at KLNP, Manipur (India) alone. Below ground fauna are represented by Acarines and Collembola representing mesofauna and the rest represents the megafauna.

Acarines are cosmopolitan in distribution and found in almost every terrestrial, marine and fresh water habitat known to man. The Collembola or springtails are primitive wingless insects. They are cosmopolitan in distribution and are amongst the most abundant of all the soil inhabiting arthropods.

Considering the great role of the soil fauna in decomposition, mineralization and nutrient cycling, the present study has been taken up. The aim of the present study is to present the monthly population dynamics of Acarina, Collembola and others. Also to study the macronutrients and moisture contents of phumdi and their association with the phumdi fauna.

2 METHODOLOGY

2.1 COLLECTION OF SAMPLES

The present investigation was carried out for one year, from January 2012 to December 2012. The study area was demarcated into three sites. Site I near the boundary of the Park region, Site II, about 100 m from the boundary and Site III the

• *Dr.W.Mema Devi is currently working as an Associate Professor in the Department of Zoology, G,P.Women's College, Imphal, Manipur, India, PH:+919436027910. E-mail: memawaikhom@gmail.com*

interior of the Park area. Phumdi samples were collected on monthly intervals by using a sharp dagger for cutting the Phumdi. Six replicates were taken from each site. All together 18 samples were taken for every month. A total of 216 samples were collected during the study period. The phumdi samples were taken to the laboratory for extraction and transferred to the extraction box as soon as possible.

The moisture content of the phumdi soil was analysed by Gravimetric method i.e, oven dried at 105^0 C for 24 hours [5]. Total nitrogen was measured by acid digestion Kjeldalh procedure [1]. Available phosphorous was measured by ammonium molybdate stannous chloride method [7] and Potassium by flame photometer [8].

The extraction of phumdi soil was based on the modified Tullgren funnel [3], [2]. The heating source for each funnel was a 40 watt electric bulb. Low settings were used so that the soil animals may not be trapped inside the rapidly drying soil. The extraction was left to dry for 5 to 7 days. The extracted animals were collected in tube containing solution of 80 % ethanol and 1% glycerine. At the end of the extraction period the tubes containing the extracted fauna were removed from the funnels. The contents of the tube were washed into the petri dishes several times with 80% alcohol. The animals were sorted out into different groups with the help of a fine pipette and number- 0 brush. Counting was done using a dissecting binocular microscope. Preservation was done in 87 parts of 70% alcohol 5 parts by glycerol and 8 parts glacial acetic acid. All the counts were expressed as monthly averages of 6 replicates per 500 gm. of dry phumdi soil.

For mega fauna animals, they were sorted and counted with the help of naked eye. They are identified as far as upto family level and some upto generic and specific levels.

2.2 RESULTS AND DISCUSSIONS

To analyse the variation in the average population density of the three faunal groups under study viz., Mesofauna (Collembola and Acarina) and others representing Megafauna according to 12 different months in a year, a set of 18 observations for each animal group with macronutrients level of Nitrogen, N (%); Phosphorous, P (mg/kg), Potasium, K (mg/kg) and Moisture (%) are taken every month. The distribution of the mean population of these animals with respect to different months is depicted in Table 1. Applying F-test, the mean populations of the animals have been observed to be significantly different during the 12 - months ($P<0.001$).

The maximum mean population of Collembola is seen in the month of June (104.43) followed by May (97.43) and April (87.94). The lowest population of this animal is observed in August (6.93). The Acarina has its highest population in the month of May (416.09) followed by March (339.63) and February (238.50). As in the case of Collembola and Acarina have their lowest population in the month of August (6.93) and (20.72) respectively. Similarly Megafauna reaches its maximum mean population of 121.32 in the month of May just falling to 87.94 in April and the lowest population (69.38) is observed in the month of February.

In the present findings, similar pattern of variation in the population of these three animal groups have been observed in different months of the study period. It might be due to different levels of macronutrients and moisture contents during the study period of 12 months. In the present findings, there is a gradual upward trend as started from January (51.48), the mean population of Collembola reaches its maximum population of 104.43 in the month of June. It suddenly falls down to its lowest population of 6.93 in August. It again moves with an upward trend with irregular mode and marked 45.45 in the month of December. With a significant fluctuation during January (167.12) to April (146.57) through February (238.50) and March (339.63), the mean population of Acarina reaches its maximum figure of 416.09 in the month of May. It is sharply falling down to its lowest figure of 20.72 and slightly rises up in December (86.36). With the maximum level of 121.32 in May and its minimum level of 9.09 in December, the mean population density of other fauna representing Megafauna moves in a irregular fashion of variation starting from 42.33 in January through 69.38 in February and 31.84 in march and rises its highest point 121.32 in May and again sharply declined to June (24.57).

Table 1
Mean population densities of Mesofauna and Megafauna for the study period.

Month	Animals		
	Mesofauna / 500 gm. dry phumdi (Collembolla)	Mesofauna / 500 gm. dry phumdi (Acarina)	Megafauna / 500 gm (dry phumdi)
January	51.48	167.12	42.33
February	60.71	238.50	69.38
March	84.90	339.63	31.84
April	87.94	146.57	87.94
May	97.06	416.09	121.32
June	104.43	122.86	24.57
July	15.78	23.67	11.83
August	6.93	20.72	13.72
September	27.69	36.93	23.08
October	18.43	43.02	61.45
November	12.50	37.45	12.50
December	45.45	86.36	9.09
Total	**51.11**	**139.91**	**42.42**
P values of F test	**P<0.001**	**P<0.001**	**P<0.001**

Regression analysis:

It is done to investigate the effects of the macronutrients on how it influence the variability in Meso and Mega fauna of

phumdi soil namely Collembola, Acarina and others. The variation in the densities of animals may be influenced by macronutrients such as Nitrogen, N (%); Phosphorous, P(mg/kg), Potassium, K (mg/kg) and Moisture (%) levels. Regression analysis for the case where a response variable and a single explanatory variable are related by a simple linear regression model. In the situation where there is a quantitative response variable say for instance, different observations of population density of the animals during 12 months in a year which is likely to be influenced by more than one independent or predictor variables, the model becomes multiple regression model. In this analysis, the population density of the three animals under study is assumed to be functionally related with four factors like N (%), P (mg/kg), K (mg/kg) and Moisture (%) levels.

Population density of fauna = f [N (%), P(mg/kg), K (mg/kg), Moisture (%)]

In this multiple regression analysis, the population density of Meso and Mega fauna of phumdi soil of KLNP is functionally related with their four macronutrients background variables. The phumdi's background variables are defined by N (%), P(mg/kg), K (mg/kg) and Moisture (%). Using the zero order correlation matrix, the problem of multi collinearity is checked at maximum 'r = 0.75' (see Table 2). The results of the analysis are interpreted in term of regression coefficient, t-value with 95% confidence interval (CI) and P-value. The regression coefficients are computed for easier way of interpretation.

Table 2
Correlation Matrix

Parameters	Total N (%)	Total P /Kg of dry phumdi	Total K /Kg of dry phumdi	Collembola /500 gm of dry phumdi	Acarina /500 gm of dry phumdi	Megafauna /500 gm of dry phumdi	Moisture (%)
Total N (%)	1						
Total P (in Kg)	0.75**	1					
Total K (in Kg)	-0.26	0.06	1				
Collembola in 500 gm.	0.03	0.22	-0.02	1			
Acarina in 500 gm .	0.11	0.29	0.01	0.76**	1		
Megafauna in 500 gm of dry phumdi	-0.25	-0.06	0.16	0.56**	0.68**	1	
Moisture (%)	0.03	-0.33	-0.10	0.01	-0.36*	0.07	1

** Correlation is significant at the 0.01 level; * Correlation is significant at the 0.05 level

Among the four background variables under study, only one that is P has positive significant impact on the population of Collembola during the study period. It is witnessed by +ve coefficient, 0.14 with 95% CI: 0.03 to 0.26, significant at 0.05 level (P<0.05). This statistically significant impact of P is observed when the joint effects of the remaining three factors say N, K and Moisture are controlled. While controlling the joint effect of three other factors, moisture is also having +ve but statistically insignificant effect on the animal (see Table 3). It may also be observed that the two factors that is N and K seems to have –ve but insignificant impacts on the fauna. However N is likely to have its significant impact on the Collembola after adjusting the effects of other three variables under study owing to its marginal level of critical value (0.14, P=0.05). In this analysis, at least 17% (R^2=0.169) of the total variation in the mean population density of Collembola during study period has been explained by the four factors N, P, K and Moisture (see Table 3).

Table 3
Regression Analysis on Collembola, Acarina and Megafauna with N, P, K and Moisture content

Model	Variable	B	S. E	t	P-value	95% CI for B	
						Lower	Upper
Mesofauna (Collembola) R^2=0.169	(Constant)	4.30	34.48	0.13	0.90	-66.03	74.63
	Total N (%)	-47.47	23.26	-2.01	0.05	-94.92	-0.03
	Total P (in Kg)	0.14	0.06	2.51	0.02	0.03	0.26
	Total K (Kg)	-0.01	0.01	-1.10	0.28	-0.02	0.01
	Moisture (%)	0.06	0.04	1.36	0.18	-0.03	0.14
Mesofauna (Acarina) R^2=0.167	(Constant)	132.29	127.07	1.04	0.31	-126.88	391.45
	Total N (%)	-34.98	85.72	-0.41	0.69	-209.81	139.86
	Total P (in Kg)	0.20	0.21	0.93	0.36	-0.23	0.62
	Total K(in Kg)	-0.01	0.02	-0.38	0.71	-0.06	0.04
	Moisture (%)	-0.21	0.15	-1.37	0.18	-0.53	0.10
Megafauna (others) R^2=0.144	(Constant)	26.38	35.09	0.75	0.46	-45.19	97.95
	Total N (%)	-46.84	23.67	-1.98	0.06	-95.13	1.44
	Total P (in Kg)	0.09	0.06	1.52	0.14	-0.03	0.21
	Total K(in Kg)	0.01	0.01	-0.03	0.98	-0.01	0.01
	Moisture (%)	0.05	0.04	1.26	0.22	-0.03	0.14

Though having insignificant effects, the four independent factors or so called predictors have explained 17% (R^2=0.167) of the total variation in the population density of Acarina during study period. In the similar way, the four predictors have explained 14% (R^2=0.144) of the total variation in the popula-

tion density of Megafauna during same period of twelve months. It may be observed that N has negative influences on the three fauna while adjusted the joint effects of other three predictors i.e. macronutrients irrespective of their statistical significance levels. In contrast with, P has positive influence on the three groups of fauna. Thus, the present findings have highlighted that the animals under study have statistically associated with the three macronutrients and moisture content at Keibul Lamjao National Park of Manipur. No comparative statement is made with the findings of the present study because of the peculiar and unique nature of the habitat which is the only type all over the world.

ACKNOWLEDGMENT

The author is grateful to UGC, New Delhi for providing financial assistance in the form of Major research Project and acknowledges the cooperation and services rendered by the Principal, G.P. College and its office towards the completion of the Project.

REFERENCES

[1] Anderson,J.H. and J.S.Ingram, *Tropical Soil Biology and Fertility, A Handbook of Method 1 Eds.* U. K., C. A. B. International, 1993

[2] Luxton,M., *Studies on the Astigmata mites of a Danish beech wood soil*. Pedobiologia 22: 29- 38, 1981

[3] Macfadyen,A., *Improved funnel type extractors for soil Arthropodes,* J. Anim. Ecol. 39 : 171 – 184, 1981

[4] Mc Celland,J., "Description of the Sangai, *cervus* (Rusa) *frontallis* : Cal. J. Nat.,". Hist. 11(2) : 401 – 409, 1982

[5] Misra,R, *Ecology work Book*. Oxford and IBH pub. Co. Calcutta, India, 36-49, 1968

[6] Samungou, K., In. Endangered Manipur Brow Antlered Deer. An Environmental Assessment. 7 – 29, 2010

[7] Sparling, G.P., K.N. Shale and A.J., " Quantifying the contribution from the soil microbial biomass to the extractable levels of fresh and air dried soils.," Aust. J. of soil Res. 23 : 613 – 621, 1985

[8] Steward,E.A., "Chemical analysis of ecological materials," Blackwell Scientific Publication, Oxford, 1971