STUDIES ON THE POPULATION STRUCTURE AND DYANAMICS OF A SOIL COLLEMBOLAN – *LOBELLA CORALLINA* IN RELATION TO SOIL EDAPHIC FACTORS

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Abstract: *The soil collembolan Lobella corallina was selected to study the population density in relation to soil edaphic factor in four different seasons. The population density of Lobella was very high during pre-monsoon and post-monsoon season, and low during monsoon and summer seasons. The principal component analysis revealed that soil pH control the density and distribution of Lobella. Similarly, abundance is controlled by soil temperature. Decreasing in the soil moisture content adversely affected its richness. Soil organic carbon percentage has no effect in the distribution and density of this animal, as the proportionate eigene value was zero.*

Keywords: Soil arthropods, Lobella, Population density, Species richness

1. INTRODUCTION

The soil is a natural body of mineral and organic constituents differentiated into horizons of variable depth, which differs from the material below in morphology, physical make up, chemical properties, composition and biological characteristics. Soil micro invertebrates are the least studied and most neglected group of fauna but they have the magnanimity of keeping the terrestrial ecosystem intact by doing first phase decomposition leading to biomass and energy cycle for the rest of terrestrial life. The mesobiota includes the nematodes, the small oligochaete worms, the smaller insect larvae and especially the micro arthropods of the latter, the soil mites acarina and spring tails (collembolan) are often the most abundant from which remain permanently in the soil. Nematodes are plentiful in soil and litter. Their biomass may be equal to that of earth worms

Soil micro fauna play an important role in all the decomposition process in the soil. The micro biota includes the soil algae, bacteria, fungi and protophyta (Biswas and mukherjee 1987). They cannot decompose the complex organic matter. So the soil micro arthropods make a surface for the decomposition of large organic matter in to small inorganic substance. Soil micro arthropods include the isopods, arachnids insects and myriapods. Other quite primitive soil animals are the molluscans (slugs and snails), in which most of them feed on living plants. Lobella is one of the small organisms living in the soil which play a great role to improve soil fertility. These soil organisms are very commonly seen in decaying woods and leaves. These small organism prefers a wide range of habitat, favours good agricultural growth and increase in the yield.

The dead organic matter is colonized by a variety of soil organisms most importantly micro organisms which derive energy for growth from the oxidative decomposition of complex organic molecules. The organic matter of soil arise from the debris of green plants, animals residues and excreta that are deposited on the surface and mixed to a variable extend with the mineral component (Resull, 1973). A

geologically localized group of individuals of same kind at a particular time represents a population. Density of population denotes the number of individuals of a species over a unit area at a given time.

Climate factors such as seasonal changes in the daily amount of sunlight rainfall and temperature are environmental factors that affect population growth of micro organism. The soil edaphic factors such as soil pH, temperature, moisture and organic carbon content also affect the population of Lobella. Soil micro organisms lower the dead organic matter on the earth's surface and discharge nutrients from the decaying organic matter for living plants to utilize. Based on the above facts, the present study focuses on the population diversity of Soil collembolan *Lobella corallina* with respect to soil edaphic factors.

2. MATERIALS AND METHODS

2.1 Experimental animal

The species selected for this study is *Lobella corallina* (phylum- arthropoda, class- insecta, order- collembola). It is a small wingless insect having a cosmopolitan distribution. It is found in the soil, decaying vegetation, under the litter and debrises. They are red in colour. They migrate up to a depth of 1 m to the surface layer. The maximum length in the adult stage is 5mm. Body is very soft, wingless with 3 pairs of short and stumpy appendages. Spring organ is present at the back of the tail. A pair of small antenna, a pair of compound eye and several cilia is present in the body.

2.2 Collection of species

Soil samples were collected from different rubber plantation of Chengannur Taluk of Alappuzha district, Kerala. Samples were collected in each month, from March 2009 to February 2010. Soil samples were collected and packed in a polythene bag and taken to the laboratory for the collection of Lobella inside the soil.

2.3 Extraction of animal

The collected soils were placed in to a tray of 15 X 25cm and soils spread uniformly into it using a soil spatula. Further, the animals were hand sorted and taken to 10% formalin. The number from each sample then converted to area in meter square (m^2). Ten sites were demarcated in the plantation for the collection of soil in each month. These samples were randomly selected from the plantation area.

2.4 Edaphic factors

The samples were analyzed for pH, moisture content (%) and organic carbon content (OC %) (Trivedy and Goel 1987). Soil temperature (^oC) was measured from the site itself during sampling using a soil thermometer.

2.5 Statistical analysis

The data from the 10 sample were converted in to area in m^2 and mean value along with standard error was calculated. The data were pooled in to four seasons, they are pre monsoon (March, April, May), monsoon (June, July, August), post monsoon (September, October, Novmber) and summer (December, January, February).

Chi square test was employed to find any deviation in the sampling numbers from different sites during a season. Similarly two-way ANOVA was conducted to find any significance difference in the density of Lobella and edaphic factors of the soil in different seasons and also between the sites. Principal component analysis (PCA) of the category multivariate analysis was employed to find out the principal factors affecting the

population dynamics of the *Lobella coralina*. This was done by using the statistical software SPSS.

3. RESULTS

3.1 Population density

Population density of the animal was very high during pre-monsoon (1.255 per m^2 in thousands) and post monsoon (1.255 per m^2 in thousands).In pre-monsoon, among the 10 study sites more or less equal numbers were obtained. The highest number was from study Site 1(1.3 per m^2 in thousands) and least was from study Site 6 (1.21 per m^2 in thousands). The other sites showed a variation between 1.22 and 1.29 per m^2 in thousands. The least S.E was observed in study Site-1 (0.006) and highest SE was observed in study Site-9 (0.041).

In monsoon, the highest population density was obtained from Site-9 (0.80 per m^2 in thousands) and the least population density was obtained from the Site-1 (0.70 per m^2 in thousands). The other sites showed a variation between 0.71 and 0.79 per m^2 in thousands. The standard error was highest in Site-1 (0.039) and least in Site-3 (0.015).The mean population density of Lobella was 0.748 per m^2 in thousands during monsoon season.

During post-monsoon, the highest population density was obtained from Site-3 (1.30 per m^2 in thousands) and the least from Site-8 (1.21 per m^2 in thousands). The other sites showed the variation between 1.23 and 1.29 per m^2 in thousands. The highest SE was observed in the Site-5 (0.05 per m^2 in 000') and the least was observed in the Site-9 (per m^2 in thousands)

In summer the highest population density was obtained from Site-7 (0.60 per m^2 in thousands) and least was observed from the Site-4 (0.52 per m^2 in thousands). The other sites showed the variation between 0.52 and 0.59 per m^2 in thousands. The highest SE was obtained in the Site-10 (0.05 per m^2 in thousands) and the lowest was obtained in the Site-6 (0.031 per m^2 in thousands). The mean population density was 0.554 per m^2 in thousands during summer.

The chi square test result showed that there is no significant difference in the population density of Lobella in different samples for pre-monsoon and summer ($p>0.05$). The two-way ANOVA showed that there is no significant difference in the population density of different samples of various sites during same season ($p > 0.05$) and there is great difference in the population density of Lobella in different seasons ($p < 0.05$).

3.2 Soil edaphic factors

3.2.1 pH

Soil pH varied in different seasons but the mean value showed that the pH was same during pre-monsoon and post monsoon (5.54) and also monsoon and summer (6.35). Among 10 study sites in pre-monsoon, the highest soil pH was obtained from Site 2 and Site 10 (5.8) and the lowest was obtained from Site 3 and Site 8 (5.3). Other sites showed a variation of pH between 5.4 and 5.7 in which the sites showed more acidic during the pre-monsoon. In monsoon, the mean soil pH observed was 6.35 with a lower pH from Site 3 and Site 8 (6.1) and the highest pH was observed from Site 2 (6.7). Other sites showed a variation of pH between 6.2 and 6.0. During monsoon, the pH was observed as less acidic and nearer to neutrality. During summer, the mean soil pH observed was 6.35 with a highest value from Site 5 (6.9) and the lowest was observed from Site 2 (6.1). Other sites showed a variation of pH between 6.2 and 6.8. During summer also the pH of the soil was nearer to neutrality. The chi square test value was 1 (one) in all seasons and the critical chi

square value was 16.619 for 0.05 level of significance this showed there is no great variation in the soil pH at different sites for the same season. Two way ANOVA results showed that there is no significance difference in the soil pH of different sample of various size during same season ($p < 0.05$) and there is great difference in the soil pH during different season ($p < 0.05$).

3.2.2 Soil Temperature

The mean soil temperature during pre monsoon was 26.9^0C, 23.4^0C in monsoon, 26^0C in post monsoon and 28.9^0C in summer respectively. The highest variation was observed in summer. In pre monsoon, the temperature ranges between 26^0C to 28^0C and in monsoon the temperature ranges from 22^0C to 25^0C and in summer it was observed between 28^0C to30^0C. The chi square test value as 0.999 in all season and the critical chi square value was 16.919 for 0.05 level of significance. This showed that there are great variations in soil temperature at different sites for the same season. Two way ANOVA results showed that there is no significant difference in the soil temperature of different sample of various size during same season ($p > 0.05$)and there is great difference in the soil temperature during different seasons ($p < 0.05$).

3.2.3 Soil moisture (%)

The mean soil moisture was observed as 82.2 during pre monsoon, 87 in monsoon, 82 in post monsoon, and 77 during summer respectively. Highest moisture content was observed during monsoon and lowest was observed during summer. The moisture content varied between 80% to 85% during pre monsoon, 86% to 89% during monsoon, 80% to 84 in post monsoon and 75% to 79% during summer respectively. The chi square value was 0.999 in all seasons and the critical chi square value was 16.919 for 0.05 level of significance. The results showed that there is a great variation in soil moisture content in different sites for the same season. Two way ANOVA results showed that there is no significant difference in the soil moisture content of different sample of various size during same season ($p > 0.05$) and there is great difference with seasons ($p < 0.05$).

3.2.4 Organic Carbon

The mean Organic carbon content observed was 2.33% in pre-monsoon, 2.11% in monsoon, 2.34 in post monsoon and 3.09 in summer. The organic carbon content varied between 2-2.6% during post monsoon, 2-2.2% in monsoon, 2-2.5% in post monsoon and 3-3.2% during summer. The chi square value was 0.999 for pre-monsoon and post-monsoon, 1 for monsoon and summer ($p > 0.05$) the result showed that there is no significant difference in the OC content of soil during same season. Two way ANOVA results showed that there is no significant difference in the soil OC content in different samples of various size during same season ($P > 0.05$) and there is great difference in the soil organic carbon content during different season ($p < 0.05$) .

3.3 Principal component analysis

The principal component analysis gives a brief account on the role of different edaphic factors in the distribution and population density of soil Collembolan, *Lobella corallina*. As per Principle Component, pH is the principle edaphic factor controlling the population density of Lobella in soil. The second soil edaphic factor which control the density of Lobella is temperature. The third soil factor which affect the density of this animal is soil moisture percentage. Organic carbon percentage in soil was found to be the least influencing factor of the soil which determines and controlling the distribution and density of *Lobella corallina*.

4. DISCUSSION

From this study, it was found that population density of Lobella was very high during monsoon and summer. The highest population density during pre-monsoon and post- monsoon was due to low soil pH, optimum soil temperature & adequate soil moisture. Monsoon and summer showed low population density of this animal due to increased pH towards neutrality and low moisture content and high soil temperature. Lobella prefers a soil pH between 5 and 5.5 as in the case of any other soil micro arthropods (Sanal Kumar and Sujatha, 1996). It cannot withstand a neutral or an alkaline pH in the soil. This is almost same as in the case of soil diplopodes (Swarupanandan.,1995). A soil pH below 5 is also intolerable to this species.

Swarupanandan. S, (1995) reported that, the optimum temperature for Lobella was 26-27^{0}C and his temperature is good for most of the soil organism to survive. A soil temperature below 24^{0}C and above 28^{0}C is also not good for the propagation of this species. This is the case with most of the collembolan (Thomas.,1992). Soil moisture is a crucial factor controlling the distribution of soil collembolans (Sanal Kumar and Sujatha, 1996). If the soil moisture is above 85% and below 80%, the soil organisms suffer much to thrive well. This is the reason why monsoon and summer seasons showed low population density of this animals in the soil. Sanal Kumar and Swarupanandan (1995) reported that, soil moisture of 80-83% is very good for the proper existence and adequate propagation of soil Collembolans, Proturance and Acari.

The analysis of various soil factors in relation to the distribution abundance of Lobella revealed the important factors as pH, temperature , moisture and organic carbon in decreasing order in their effect controlling the distribution and abundance of soil collembolan *Lobella corallina.*

Table 1. Population Density of *Lobella coralline* during Pre monsoon, Monsoon, Post monsoon and Summer

Sites	Pre monsoon (Mean±S.E)	Monsoon (Mean±S.E)	Post Monsoon (Mean±S.E)	Summer (Mean±S.E)
Site 1	1.3±0.006	0.70±0.039	1.29±0.040	0.56±0.045
Site 2	1.24±0.007	0.79±0.022	1.22±0.034	0.50±0.030
Site 3	1.27±0.010	0.72±0.015	1.30±0.017	0.59±0.049
Site 4	1.29±0.014	0.76±0.027	1.26±0.025	0.52±0.042
Site 5	1.23±0.008	0.74±0.035	1.23±0.05	0.57±0.047
Site 6	1.21±0.018	0.71±0.019	1.28±0.013	0.54±0.031
Site 7	1.25±0.020	0.78±0.038	1.25±0.021	0.60±0.037
Site 8	1.22±0.009	0.73±0.024	1.21±0.029	0.53±0.044
Site 9	1.26±0.041	0.80±0.016	1.27±0.012	0.58±0.048
Site 10	1.28±0.011	0.75±0.023	1.24±0.033	0.55±0.05
Mean	1.255	0.748	1.255	0.554

Table 2. Soil pH of different study sites during different seasons

Sites	Pre monsoon (Mean±S.E)	Monsoon (Mean±S.E)	Post Monsoon (Mean±S.E)	Summer (Mean±S.E)
Site 1	5.4±0.004	6.2±0.034	5.3±0.041	6.4±0.043
Site 2	5.8±0.005	6.7±0.021	5.8±0.032	6.1±0.034
Site 3	5.3±0.011	6.1±0.014	5.5±0.014	6.7±0.044

Site 4	5.7±0.012	6.4±0.021	5.2±0.024	6.0±0.045
Site 5	5.5±0.004	6.5±0.034	5.7±0.03	6.9±0.046
Site 6	5.7±0.016	6.3±0.016	5.4±0.012	6.2±0.034
Site 7	5.5±0.023	6.6±0.037	5.6±0.022	6.5±0.036
Site 8	5.3±0.010	6.1±0.022	5.8±0.026	6.8±0.043
Site 9	5.4±0.012	6.4±0.014	5.2±0.014	6.3±0.047
Site 10	5.8±0.014	6.2±0.025	5.5±0.033	6.6±0.02
Mean	5.54	6.35	5.54	6.35

Table 3. Temperature of the soil at different study sites during different seasons

Sites	Pre monsoon (Mean±S.E)	Monsoon (Mean±S.E)	Post Monsoon (Mean±S.E)	Summer (Mean±S.E)
Site 1	26±0.03	23±0.03	26±0.05	28±0.04
Site 2	26±0.05	24±0.04	26±0.05	29±0.05
Site 3	2±0.02	22±0.05	25±0.04	29±0.06
Site 4	28±0.02	25±0.06	27±0.05	30±0.05
Site 5	27±0.02	24±0.04	25±0.06	28±0.05
Site 6	27±0.05	24±0.03	27±0.06	30±0.04
Site 7	28±0.05	23±0.04	26±0.04	30±0.04
Site 8	26±0.06	22±0.05	27±0.05	28±0.06
Site 9	28±0.05	25±0.06	25±0.06	29±0.05
Site 10	26±0.04	22±0.07	26±0.06	28±0.05
Mean	26.9	23.4	26	28.9

Table 4. Soil moisture at different study sites during different seasons

Sites	Pre monsoon (Mean±S.E)	Monsoon (Mean±S.E)	Post Monsoon (Mean±S.E)	Summer (Mean±S.E)
Site 1	82±0.01	87±0.04	84±0.04	78±0.04
Site 2	80±0.02	85±0.05	80±0.05	75±0.05
Site 3	85±0.04	89±0.03	81±0.06	77±0.05
Site 4	80±0.05	86±0.05	83±0.03	79±0.05
Site 5	83±0.04	88±0.03	82±0.04	76±0.04
Site 6	81±0.03	85±0.06	80±0.05	75±0.03
Site 7	82±0.04	89±0.03	81±0.04	79±0.02
Site 8	84±0.05	87±0.05	84±0.05	78±0.03
Site 9	85±0.04	88±0.05	83±0.03	77±0.02
Site 10	80±0.03	86±0.04	82±0.04	76±0.03
Mean	82.2	87	82	77

Table 5. Soil Organic content at different study sites during different seasons

Sites	Pre monsoon (Mean±S.E)	Monsoon (Mean±S.E)	Post Monsoon (Mean±S.E)	Summer (Mean±S.E)
Site 1	2.6±0.021	2.0±0.043	2.1±0.048	3.0±0.045
Site 2	2.1±0.031	2.1±0.042	2.7±0.047	3.2±0.048
Site 3	2.0±0.032	2.2±0.034	2.0±0.036	3.0±0.038
Site 4	2.5±0.042	2.2±0.046	2.6±0.048	3.1±0.041
Site 5	2.4±0.053	2.0±0.056	2.2±0.059	3.2±0.052
Site 6	2.3±0.054	2.1±0.057	2.3±0.058	3.0±0.053
Site 7	2.2±0.012	2.2±0.014	2.5±0.01	3.2±0.017
Site 8	2.6±0.032	2.0±0.036	2.0±0.037	3.1±0.036
Site 9	2.1±0.012	2.2±0.014	2.7±0.016	3.0±0.018
Site 10	2.5±0.065	2.1±0.069	2.3±0.068	3.1±0.061
Mean	2.33	2.11	2.34	3.09

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