STUDIES ON THE ECOLOGY OF SOIL MICROARTHROPODS IN CULTIVATED FIELD AND MUNICIPAL WASTE DISPOSAL SITES OF CACHAR DISTRICT, ASSAM

ABSTRACT

AN ABSTRACT SUBMITTED TO ASSAM UNIVERSITY IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN THE DEPARTMENT OF ECOLOGY AND ENVIRONMENTAL SCIENCE

By

LEIMAPOKPAM AMARJIT SINGH

DEPARTMENT OF ECOLOGY AND ENVIRONMENTAL SCIENCE
E.P. ODUM SCHOOL OF ENVIRONMENTAL SCIENCES
ASSAM UNIVERSITY
SILCHAR – 788011
ASSAM, INDIA
2015
The soil is a physically and chemically diverse environment that is used by a wide variety of invertebrate animals and microorganisms. Soil mesofauna, which includes soil organisms ranging from 0.1 to 2 mm in body width, are normally dominated by Acari (mites) and Collembola (springtails) but also include Protura, Diplura, Symphyla as well as smaller forms of millipedes, centipedes, spiders, potworms and pseudoscorpions. In most soils, about 90% of the microarthropod population is composed of Collembola (springtails) and Acarina (mites) and are involved in decomposition of organic matter, the regulation of microbial activity and in nutrient cycles for the exchange of energy and matter. Soil inhabiting arthropods belonged to three classes: Insecta, Arachnida and Myriapoda. Insecta is represented by nine (9) orders - Collembola, Protura, Diplura, Hemiptera, Orthoptera, Thysanoptera, Diptera, Hymenoptera and Coleoptera. Two orders of Myriapoda viz. Chilopoda and Diplopoda and only five orders of Arachnida –Cryptostigmata, Mesostigmata, Prostigmata, Spider and Pseudoscorpion were represented in the collection. The role of microarthropods in decomposition and nutrient cycling has been long established and due to their importance in decomposition and distribution of organic matter, soil and litter microarthropods have been suggested as useful bioindicators of the effect of land management on nutrient dynamics.

The entire thesis is comprised of the following Chapters:

**Chapter I:** General introduction with description of study site and objective was illustrated in this chapter in a comprehensive manner.
Chapter II. Review of literature was consulted chronologically in respect to abroad and India critically and analyzed all the relevant literatures.

Chapter III. In Municipal solid waste disposal site (MSW), the observed average amount of daily disposal of waste materials which is 88.35 tonnes is higher than the data available from the Silchar Municipal Board which is 50 tonnes per day. The reason for this finding may be due to the different calculation of the amount of waste where in this study the volume of waste disposed was calculated mainly on the basis of capacity of the vehicle (in tonnes) used and its frequency of disposal per day.

Sixteen (16) orders of three classes viz. Arachnida, Insecta and Myriapoda under Phylum Arthropoda were extracted from all the six study sites. Of them, class insecta was found to be dominant in all the study sites followed by arachnida and myriapoda. Both cryptostigmatid mites and collembo contributed 46.39%, 59.47%, 47.44% and 61.52% from Municipal solid waste disposal site, Municipal solid waste control site, cultivated site and cultivated control sites, respectively. In case of Municipal solid waste treated cultivated field both contributed 65.64% whereas the control grassland field is consists of 66.91%. In the present study twenty five (25) species of cryptostigmatid mites and seventeen (17) species of collembo were recorded from soil in all the six study sites. All the extracted species number of cryptostigmatid mites and collembo were higher in all the ecosystems taken as control sites than the ecosystems which is more disturb or polluted site. Among the cryptostigmatid mite, species Galumna flabellifera and Scheloribates albialates were found to be dominant in all the study sites while in case of collembo, Cryptopygus thermopheleus and Lepidocyrtus magnificuawere were found to be dominating in both the Municipal solid waste and cultivated sites. Whereas Seira indica and
Isotomina thermophila were found to be dominating in municipal solid waste control and cultivated control sites, respectively. Entomobrya sp was found to be dominating in both the municipal solid waste treated and control study sites.

CHAPTER IV. Population dynamics of soil dwelling microarthropods was studied in all the six study sites which showed their peak occurrence during June to September, when maximum amount of rainfall occurred in this part of India. Among the soil microarthropods extracted from six different sites, collembola and cryptostigmata in particular were found to be the predominant arthropod group in all the study sites. The distributing patterns of soil microarthropods seem to be controlled by the prevailing microclimatic conditions. The positive correlation of cryptostigmata abundance with rainfall was also recorded. The seasonal fluctuation trend of collembola in which maximum density of population occurs during rainy season when prevailing microclimatic conditions are favorable for growth and showed gradual decrease during dry season from November to February.

In the present study maximum population of collembola was recorded in the monsoon period in both the treated as well as in control study site where collembola population was found to be more in the treated site than the control study site. Higher population of collembola in treated soil might be due to the presence of better food and moisture for their survival during this study period.

Multiple regression analysis revealed that combination of all the climatic factors have positive and significant influences on the population of different soil microarthropod group. In partial correlation analysis it was found that rainfall, relative humidity and atmospheric temperature influenced the population distribution in which rainfall and atmospheric temperature having more influence on the majority of microarthropod groups.
CHAPTER V. Community structure of the soil microarthropods was analyzed with Berger-Parker dominance index, Shannon-Wiener Diversity index, Evenness index and Morishitas index of Similarity. Range of dominance index of total microarthropod in MSW CONT was found to be higher than the MSW which might be due to the presence of more dominant microarthropod groups in MSW-CONT site. In the present findings, grassland having more diversity as compared to other study areas. This might be due to more disturbances in investigated areas as compared to grassland site which was taken as a control. The similarity range of cryptostigmata found between MSW and MSW CONT was found to be higher and the reason for this might be due to available of similar cryptostigmatid species between these systems. Moreover, location of the two study sites were near to each other, so migration could have occurred between the systems.

CHAPTER VI. In the present investigation soil textural class analysis revealed that in all the six different study sites, percentage of sand was more in the soil than silt and clay. Among all the study sites, municipal solid waste disposal site was having the highest sand percentage value. Soil moisture content remained high mostly during the monsoon period (June to September) in all the six (6) study sites. But in municipal solid waste disposal site (MSW), soil moisture content remained high during post monsoon periods (October to November) also. This might be due to dumping of different types of food waste, vegetables and other materials every day to the sampling areas which may prevent or slow down the evaporation process in this site. Municipal solid waste treated cultivated field (MSW TREAT) was having the highest organic carbon content followed by municipal solid waste disposal site (MSW). The influence of organic carbon on soil microarthropod showed positive and
significant effect with total cryptostigmata and total collembolan in cultivated site (CULT) and in control site of municipal solid waste treated cultivated field. Total nitrogen content of soil showed higher concentration in municipal solid waste disposal site (MSW) as compared to all the other study sites. In Municipal solid waste disposal control site (MSW CONT), total nitrogen showed positive and significant relationship with total cryptostigmata, total collembola and total microarthropods. In cultivated control (CULT CONT) and municipal solid waste treated fields (MSW TREAT) also all the three groups of microarthropods showed positive and significant relationship. Available phosphorous did not exhibit any clear-cut relationship with total microarthropods, total cryptostigmata and total collembola in all the study sites except in municipal solid waste disposal site (MSW) where it shows positive and significant relationship with total cryptostigmata and total microarthropod population. In case of extractable potassium, it did not exhibit any significant relationship with the population of total microarthropod, total cryptostigmata and total collembola in all the study sites. Four heavy metals (Cu, As, Pb and Cd) which were studied in three different sites i.e. Municipal solid waste disposal site (MSW), Municipal solid waste control site (MSW CONT) and Cultivated site (CULT). Among these three contrasting sites, during the seasonal study period, municipal solid waste disposal site (MSW) was having the highest concentration of all the four metals than the other two study sites. ANOVA results showed that there was no significant difference in metal concentration between the three sites of study except lead (Pb) which showed significant difference of concentration of this particular metal between the sites (F=7.146 p<0.01). Tukey test also revealed that between municipal solid waste disposal site (MSW) and municipal
solid waste control site (MSW CONT) there was a significant difference in lead (Pb) concentration (p<0.01). It also revealed that between municipal solid waste disposal site (MSW) and cultivated site (CULT) there was a significant difference in lead (Pb) concentration (p<0.05). Correlation between the total Cryptostigmata, total collembola and total microarthropods with the four heavy metals (Cu, As, Pb and Cd) showed that in municipal solid waste disposal site (MSW), there was no any significant relationship between the microarthropod population and heavy metals (p>0.05). But in cultivated site (CULT) it showed a different trend where correlation proved negative but significant relationship between the microarthropod population and arsenic (As) metal only. In our present findings for Cu element, the observe values were all above the desirable limit in a unpolluted soil i.e 36 mg/kg but below the maximum limit in all the studied sites in different seasons. On an average, the values were higher in Municipal solid waste disposal site which indicated the contamination of this metal was more in this site. In case of Pb the observed values are less than the desirable limit in a unpolluted soil i.e 85 mg/kg but well below the maximum limit (530 mg/kg) in cultivated and municipal solid waste control sites in all the seasons but in municipal solid waste disposal site, desirable values were higher in most of the seasons which indicated the higher toxicity of Pb than the other two studied types of soil. But for Cd, observed values were more or less equal to the desirable limit i.e 0.8 mg/kg and less than the maximum limit (12 mg/kg) in all the three study sites at different seasons of the year. In case of As the observed values were less than the global maximum limit in soil i.e 10 mg/kg in all the seasons of the three different study sites but observed to be highest in Municipal solid waste disposal site than the other two study sites.
CHAPTER VII. General discussion was elaborated in this chapter. Sixteen (16) orders of three classe viz. Arachnida, Insecta and Myriapoda under Phylum Arthropoda were extracted from all the six study sites. Of them, class insecta was found to be dominant in all the study sites followed by arachnida and myriapoda. Among Arachnida, cryptostigmatids was found to be dominant. During wet months density and diversity was higher in all the study sites. During the seasonal study period, municipal solid waste disposal site (MSW) was having the highest concentration of all the four metals (Cu, As, Pb and Cd) than the other two study sites i.e Municipal solid waste control and cultivated site.

CHAPTER VIII. Relevant and updated literature regarding ecology of microarthropod population with special reference to cryptostigmatid mite and collembolan in respect to climatic and edaphic factors were consulted and cited as a list of references.