Population density and diversity of Soil mites (Order: acarina) in agroforestry habitat: Relationship to Soil temperature and Soil moisture

Nisha Sharma and Hina Parwez*

Department of Zoology,
Aligarh Muslim University, Aligarh, 202002. (U.P.), India.

Abstract
Soil arthropods are a vital link in the food chain as decomposer and without these organisms, nature would have no way of recycling organic material on its own. The process of decomposition is controlled largely by soil arthropods in conjunction with some soil invertebrates. Which include the mites (Acarina), springtails (Collembola) followed by some families of insecta and then arachnids. Soil Acarina was the very small free-living soil and litter microarthropods which were most abundant and dominant group in soil-litter sub system and plays an important role in sustaining the agroecosystem by maintaining the edaphic factors through decomposition and mineralization. Fluctuations in the population density and diversity of mites up to the depth of 10 cm of soil were determined over 12 months period in an agroforestry habitat at Aligarh Muslim University, Aligarh (U.P.), India. The objective of this study was to evaluate the population density and diversity of soil acarina in a semi arid zone of western U.P. in India. The extraction of soil Acarina was done by modified Tullegren funnel and analyses of edaphic factors such as- soil temperature, soil moisture, organic carbon, available nitrogen, phosphate were done by standard laboratory methods. Pearson correlation coefficient (r) was used to determine the relationship of Acari population densities with edaphic factors such as soil temperature, soil moisture, organic carbon content, available nitrogen etc. of soil. The result showed that among Acarina, Cryptostigmata and Mesostigmata were the most-abundant when the soil temperature was 18˚C to 33˚C whereas, Astigmata showed low population
densities during most of the sampling period and reached high abundance only in October 2012.

**Keywords:** Soil acarina, Agroforestry, Cryptostigmata, edaphic factors

**INTRODUCTION:**

The soil is one of the most valuable resources on this planet. The soil is also a complex living body that breaths, assimilates organic and inorganic elements, breakdowns and mineralizes organic matters of biological origin, and stores reserves as organic matter. In soil, these functions are accomplished by organisms inhabiting through their metabolism. Soil is also an important for habitat for different groups of mesofauna. Soil acarina are very small free living soil and the litter microarthropods which was most abundant and dominating group in soil litter sub system and plays an important role in sustaining agriculture by maintaining the edaphic factors through decomposition and mineralization. The higher concentration of population density of soil acarina in the agroforestry habitat attributed to the availability of food, accumulation of litter and optimum growth of acarine population while the disturbances in edaphic factors have a negative impact on soil microarthropod community. Soil acarina was divided into four sub orders viz. Cryptostigmata, Mesostigmata, Prostigmata and Astigmata. The population density of soil Acarina depends on various physico-chemical properties of soil such as porosity and permeability of the soil, soil temperature, soil moisture and the presence of inorganic elements and components, organic matters and the pH of the soil. A study on the micro arthropod population reveals that soil mites occur predominantly in all type of soils. They are the major constituents of the soil. The studies on the population densities of the soil mites and other microarthropod organisms in India came to the *Kishore Bharati Bhagini Nibedita College, Behala, Kolkata-700 060. **23/2, Siddhinath Chatterjee Road, Kolkata-700 060. 2 Rec. zool. Surv. India limelight of scientific investigation chiefly through the works of Singh and Mukherjee (1971), Singh and Pillai (1975), Bhattacharya, Joy and Joy (1981), Mazumdar and Deb (1991a, 1991b), Sanyal (1991), Sanyal and Sarkar (1993), Sengupta and Sanyal (1991), Sarkar, Sanyal and Chakraborty (2007).

**MATERIALS AND METHOD:**

The study was conducted in Aligarh Muslim university, Aligarh (India). the climate of the area is semi arid characterized by low precipitation, high evaporation hot summer days and moderate winter temperature. The soil through the study area is clay loam. To determine the population density of soil mites found in the depth of 0-10 cm of
soil, soil mites were collected randomly with the help of a corer modified by Averbach and Crossley (1960). The soil samples were collected bimonthly for a period of two years. Extraction of microarthropods was done in a modified Tullegren-Funnel. The insects collected were preserved in 70% alcohol and identified in a stereozoom microscope. Analysis of edaphic factors such as soil temperature, soil moisture, and pH, content of organic carbon, nitrate and phosphate were done by standard laboratory methods. Temperature was measured by directly immersing the soil thermometer into the soil up to the required depth, Relative humidity by a Dial Hydrometer, pH by electric pH meter and soil moisture (water content) by Dowdeswell’s (1959) method. Organic carbon was estimated by rapid titration method as described by Walkey and Black (1934), Nitrogen content (N) by Jackson (1966) method, Phosphorus content (P) by Molybdenum blue test and Potash content (K) by Jackson (1966) method.

RESULT AND DISCUSSION:

Plantations are a part of Agroforestry schemes planned by the government to serve the ecosystem and create a green belt. The site of our experiment under the agroforestry was Teak plantation (Tectona grandis). The population of soil mites from this site comprised of Cryptostigmata, Mesostigmata, Prostigmata and Astigmata. There is either positive or negative correlation between temperature, moisture, pH, organic carbon and available nitrogen. The average soil temperature and moisture is recorded in Teak plantations. Soil temperature in Teak plantations exhibited an increasing trend along with the soil depth which may be due to rain that keeps the surface cooler than lower region. The higher soil temperature in top layer in Teak plantations except for rainy season may be due to exposure to sun light and litter vegetation on the ground. The slight decrease in temperature in 0-5 cm depth than 5-10 cm depth in rainy season is due to continuous rainfall that helps in raising temporary small vegetation cover that to keep the surface cool. Higher rainfall together with high relative humidity followed by vegetation growth leads to the increase of soil moisture content during rainy season.

Acarina was found to be dominant group comprising 44.42% and 36.39% of the total soil microarthropods in both years respectively. These results are in conformity with Seastedt (1984) who reported that collembolan (springtails) and Acari (Mites) usually account for up to 95% of total numbers of microarthropod. Chitrapati (2002) also reported that Acarina comprised 66% and 63% of total soil microarthropods. The higher density of microarthropods in Acarina in upper layer of the soil (0-5 cm) was characterized by favorable moisture condition, adequate living space aeration ratio and rich accumulation of organic debris (Peterson, 1980; Hagvar, 1983) had also observed higher density of microarthropod population in the upper layers of the soil.
In the present study, maximum population of Acarina during rainy season reached the peak in August followed by summer and winter season with minimum record during January 2012. Many earlier workers also reported greater abundance of Acarina in the upper soil layer than the lower depth (Wallwork, 1970; Niijima, 1971 and Alfred et al. 1991).

In the present study, maximum population growth during rainy season reached the peak in August. This may be due to favorable, physico-chemical factors i.e. optimum condition of moisture, organic carbon content etc. during rainy season as the population buildup of soil microarthropods is influenced by a variety of factors viz., vegetation, soil, climate etc. and their interaction (Narula et al. 1998). Badejo et al. (1997) reported maximum population of Acarina when there was high moisture content. Loots and Ryke (1966) reported minimum population during winter season. Soil Acarina in the upper soil layers was primarily found to be influenced by moisture content and secondarily by temperature conditions (Strong, 1967). In the present investigation also similar pattern was observed in the population density of Acarina representing maximum in the upper soil layer at 0-5 cm. The seasonal variation of Acarina in the present investigation was attributed to cumulative effect of all physico-chemical factors rather than a single factor influence. Petersen (1980) and Hagyar (1983) had also shown that the higher densities of micro-arthropods population occurred in the upper layers of the soil. Hattar et al. (1998) and Chitrapati (2002) also reported maximum population of Acarina during rainy season and observed decreasing trend with the onset of winter. Environmental factors such as high soil organic matter content, proper soil moisture conditions throughout the year, soil temperatures without heat extremes in summer, nearly neutral pH levels are favorable conditions for soil mite development. It is well known and documented that a high soil organic matter content is usually beneficial for most soil animal groups (Edwards and Lofty 1969, Ghilarov 1975, Bandyopadhyaya et al. 2002), and that biodiversity is relatively strongly linked to available energy resources and essential nutrients (Pokarzhevskii and Krivolotskii 1997). We inferred that the observed soil temperature and moisture conditions were mostly due to the presence of permanent vegetation that ameliorates the microclimate through the plant cover, as has been suggested by other authors (Adejuyigbe et al. 1999, Rasmussen 1999, Donegan et al. 2001). The positive correlations of soil pH with total mite, mesostigmatid, and astigmatid densities seem to show a tendency toward a neutral pH preference of these taxa as a group. Although acidity is considered one of the major factors determining the species composition of soil invertebrate communities, responses of mites to pH is less clear than for other groups, e.g., earthworms (Van Straalen 1998). There is information about the pH preferences of some soil mites species in the laboratory (e.g., Van Straalen and Verhoef 1997, Liiri et al. 2002), but it has been suggested that the response of a species to soil pH can change with changing environmental factors, i.e., it can be dependent on the context (Liiri et al. 2002).
The Cryptostigmata and Mesostigmata were the most-abundant group. These groups generally maintain the highest numerical abundance followed by the Mesostigmata, Prostigmata, and Astigmata (Davis 1963, Hermosilla and Rubio 1974, Hermosilla et al. 1977, Seastedt 1984, Curry and Momen 1988), and we found a similar pattern. In the present study, we found comparable proportions for the Mesostigmata and Oribatida, if the average of all samples is considered. This agrees with the observations of Bedano and Cantú (2003) and with those of Davis (1963) in natural grassland in the UK, where populations of Oribatida and Mesostigmata were relatively similar in magnitude to each other and more abundant than the other 2 suborders. A predominance of the Oribatida is a common feature of natural sites. These mites are found with greatest density in mature, stable sites and are often the dominant components of the soil mite fauna in such environments (Curry 1969, Edwards and Lofty 1969, Siepel 1996, Cancela da Fonseca and Sarkar 1998, Hulsmann and Wolters 1998, Behan-Pelletier 1999). It has been suggested that microarthropod abundance tends to be greatest in spring and summer and lowest in winter (King and Hutchinson 1976, Wallwork 1976, Edwards 1991, Bardgett et al. 1993, Bardgett and Cook 1998). In general, seasonal fluctuations of Acari densities are associated with soil moisture, temperature, and litter availability (Bardgett and Cook 1998). Low densities of mites during the winter in this study could be attributed to low soil temperatures rather than to the soil moisture regime. This assessment agrees with observations that temperature was more important as a regulator of microarthropod abundance than was soil moisture in some experimental studies (MacKay et al. 1986, Whitford 1981, Noble et al. 1996). The summer soil temperatures might not have limited the populations as appears to be the case under warmer climatic conditions (Badejo 1990, Adejuyigbe et al. 1999). In contrast to the other groups, the Astigmata showed low population densities during most of the sampling period and reached high abundance only in Oct 2012. Our data support the idea that natural soils surrounded by agricultural lands within agroecosystems are able to sustain abundant soil mite fauna since densities obtained here are within the range of values reported from other studies carried out in similar conditions. This study provides important information regarding soil mite populations in natural soils within agroecosystems and represents useful reference data for soil degradation studies. Furthermore, this report is of special importance at the local and regional levels, due to the scarcity of information on soil mites of India, and it is a precursor to more-detailed research at lower hierarchical taxonomic levels.
**Table 1 (a):** Pearson Correlation between Acarina population and edaphic factors during experimental year

<table>
<thead>
<tr>
<th></th>
<th>Cryptostigmata</th>
<th>Mesostigmata</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-5cm</td>
<td>5-10cm</td>
</tr>
<tr>
<td>Soil Temperature</td>
<td>0.114</td>
<td>-0.379</td>
</tr>
<tr>
<td>Soil Moisture</td>
<td>0.118</td>
<td>0.174</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td><strong>0.639</strong></td>
<td>-0.519</td>
</tr>
<tr>
<td>pH</td>
<td><strong>0.577</strong></td>
<td>0.367</td>
</tr>
<tr>
<td>Organic Carbon</td>
<td>0.104</td>
<td><strong>0.578</strong></td>
</tr>
<tr>
<td>Organic Matter</td>
<td>0.096</td>
<td>-0.169</td>
</tr>
<tr>
<td>Electrical Conductivity</td>
<td>0.027</td>
<td><strong>-0.615</strong></td>
</tr>
<tr>
<td>Available Nitrogen</td>
<td>-0.208</td>
<td>-0.337</td>
</tr>
<tr>
<td>Phosphate</td>
<td>0.453</td>
<td>-0.126</td>
</tr>
<tr>
<td>Potassium</td>
<td>0.289</td>
<td>-0.080</td>
</tr>
</tbody>
</table>

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

**Table 1 (b):** Pearson Correlation between Acarina population and edaphic factors during experimental year

<table>
<thead>
<tr>
<th>Soil Edaphic factors</th>
<th>Acarina Prostigmata</th>
<th>Acarina Astigmata</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-5cm</td>
<td>5-10cm</td>
</tr>
<tr>
<td>Soil Temperature</td>
<td>0.320</td>
<td>0.378</td>
</tr>
<tr>
<td>Soil Moisture</td>
<td>0.007</td>
<td>0.085</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>0.413</td>
<td>0.194</td>
</tr>
<tr>
<td>pH</td>
<td><strong>0.628</strong></td>
<td>0.447</td>
</tr>
<tr>
<td>Organic Carbon</td>
<td>0.249</td>
<td><strong>0.999</strong></td>
</tr>
<tr>
<td>Organic Matter</td>
<td>0.254</td>
<td><strong>0.639</strong></td>
</tr>
<tr>
<td>Electrical Conductivity</td>
<td>-0.130</td>
<td>-0.366</td>
</tr>
<tr>
<td>Available Nitrogen</td>
<td>0.159</td>
<td>0.288</td>
</tr>
<tr>
<td>Phosphate</td>
<td>-0.424</td>
<td><strong>-0.627</strong></td>
</tr>
<tr>
<td>Potassium</td>
<td>0.536</td>
<td>0.164</td>
</tr>
</tbody>
</table>

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed)
Population density and diversity of Soil mites (Order: acarina)...

Figure 1: Mean population of Soil Acarina during the experimental period.

ACKNOWLEDGEMENT

The authors are grateful to the former chairman Prof. Iqbal Parwez, Department of Zoology, A. M. U., Aligarh for providing necessary research facilities.

REFERENCES


Nigeria


[30] **King LK, KJ Hutchinson. 1976.** The effects of sheep stocking intensity on
the abundance and distribution of mesofauna in pastures. J. Appl. Ecol. 13: 41-55


