

## Population dynamics of soil Acarina in natural and degraded forest ecosystem at Pathalipam, Lakhimpur, Assam

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**Abstract:** Population density of soil Acarina in natural and degraded forest sites were studied for one year at Lakhimpur, Assam (26°48' - 27°53' N latitude and 93°42' - 94°20' E longitude, 101 amsl). Vertical and seasonal distribution of total soil Acarina were more in natural forest ( $396.74 \times 10^2 m^{-2}$ ) than degraded forest ( $226.32 \times 10^2 m^{-2}$ ) and showed a significant decrease from upper layer to deeper layers (0-30cm). In natural forest soil Acarina recorded higher population during rainy season ( $228.66 \times 10^2 m^{-2}$ ), followed by summer ( $108.74 \times 10^2 m^{-2}$ ) and winter season ( $59.34 \times 10^2 m^{-2}$ ) than degraded forest respectively. While physical factors exhibited significant correlation with soil Acarina except relative humidity, some chemical factors were significant correlation and some were insignificant relation with soil Acarina.

**Key words:** population density of soil Acarina in different seasons and soil depth, Natural and Degraded forest ecosystem of Lakhimpur, Assam.

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### I. Introduction

Acarina was the very small free-living soil and litter microarthropods which was most abundant and dominant group in soil-litter sub system and plays an important role in sustaining forest ecosystem by maintaining the edaphic factors through decomposition and mineralization of leaf litter. The higher concentration of population density of soil Acarina in natural forest attributed to close canopy with vegetation cover, availability of food, accumulation of litter and optimum physico-chemical factors that favour optimum growth of acarine population, while disturbances and lack of canopy in degraded forest site have a negative impact on soil microarthropods community. Soil Acarina are divided into four sub orders viz. Cryptostigmata, Mesostigmata, Prostigmata and Astigmata. They are seen associated with highly organic, decomposing material such as manure. Reduction of vegetation cover and the consequent changes in microclimate has shown negative effects on survival and reproduction of soil microarthropods, however, abundance of soil microarthropods is ecologically important to maintain soil fertility status through decomposition and nutrient cycling for forest restoration (Seastedt, 1984; Badejo and Straalen, 1993; Wardle and Giller, 1996). Doulo and Kakati (2009) recorded higher population of soil micro arthropods in natural site exhibiting conspicuous vertical distribution and seasonal variation in both sites. Hence the present study was carried in natural and degraded forest ecosystem in the abundance, distribution, density and species diversity of soil and litter microarthropods in relation to certain climatic and edaphic factors in this region in Dulung reserve forest, Pathalipam, Lakhimpur district of Assam.

### II. Materials and Methods

#### Study sites

The present investigation was carried out in two adjoining area of natural and degraded forest ecosystem in Dulung Reserve Forest of Lakhimpur district, Assam which lies at 26°48' - 27°53' N latitude and 93°42' - 94°20' E longitude at an altitude of 101 m above mean sea level, covering an area of 9900.23 hectre. While the natural forest site comprises of rich vegetation, the vegetation in degraded forest site is comparatively thin vegetation due to human activities and occasional logging of forest tree. The first dominant trees species that form the canopy layer is *Keyia assamica* (30%). The second dominant trees are *Mesua ferrea* (15%). The smaller trees are belong to the families of *Lauraceae*, *Euphobiaceae*, *Araliaceae*, *Ficaseae* and *Rubiaceae* having 5 to 15m height and *shrubs* are *Alpinia allughas*, *Alpina pudica* L. *Calamus erectus* (Climber), *Calamus viminalis*, *Leucas lavandulaefolia* Sm. *Solanum indicum* L., *Clerodendrum viscosum* Vent. *Clerodendrum serratum* (L), etc. Very small plants i.e., *herbs* are *Centella asiatica* L., *Mimosa pudica* L., *Coix lacrymal- jobi* L. *Job's tears*, were found abundantly in natural site while degraded forest was mostly represented by less herbs, shrubs etc due to diturbances of human being.

#### Climate

The climate of the area is monsoonic with three distinct seasons i.e. summer, rainy and winter. The ombrothermic data (Fig. 1) based on twenty years (1987–2006) highlights the climatic condition of Lakhimpur district which reveals that June to September constitute rainy seasons while October to May comprise dry

period. The dry period can be further divided into moist summer (February to May) and cool dry (October to January) season. Thus there is distinct summer (February to May), rainy (June to September) and winter (October to January) seasons. While February constitute the transitional month between winter and summer, October is the transitional month between rainy and winter season.

The meteorological data during the study period from October 2006 to September 2007 is shown in (Fig.1). The average minimum and maximum air temperature was recorded in the month December, 2007 (9.10°C) and August, 2007 (34.03°C) respectively. The maximum relative humidity was recorded in the month July, 2007 (96.73%) and the minimum was (26.03%) in the month June, 2007 at 8-30 hours. The highest record was of 91% in the month of July, 2007 and the lowest was recorded in the month of April, 2007 of (52.4 %) at 17-30 hours. The maximum annual rainfall during the study period was recorded in the month of June (853.8 mm) and minimum in the month of December and January (13.3 mm). The total annual rainfall was 3753 mm.

### **Sampling and extraction**

In both the natural and degraded forest ecosystem, the sampling collection sites are divided into lower, middle and upper elevation site. Each site is further divided into three different plots having an area of 10m x 10m size which are approximately 25m to 30m apart from each other. Soil samples for microarthropods were collected from each area at different soil depths i.e. 0-10 cm, 10-20cm and 20-30cm by using soil corer with sampler size of 3.925 cm<sup>2</sup> (10 cm in height and 5cm in diameter). Sampling for soil Acarina was initiated in October, 2006 and continued till September, 2007 with an interval of one month. All the sampling was done in the morning between 9:00am and 11:00am in mid week of the each month. Three replicates one from each area was collected from upper, middle and lower elevation sites from both ecosystems. As such, 324 samples (three replicates one from each area was collected from upper, middle and lower elevation) were collected from each ecosystem for 12 months during study period. For analysis of physico-chemical characteristics, soil samples were also collected in similar manner from the adjacent sampling area of Acarina. After collection, each sample was immediately transferred into individual polythene bag, labeled and packed to avoid moisture loss and any kind of disturbance to Acarina during its transit period. The samples were immediately brought to the laboratory and Acarina were extracted with the help of modified Tullgren funnel as described by Crossley and Blair (1991). Soil Acarina were extracted into collecting vial, containing 70% ethanol, transferred into a petridish, identified and counted into various taxa with the help of binocular microscope and densities m<sup>-2</sup> calculated.

### **Soil analysis**

Physico-chemical characteristics of soil such as temperature, moisture, pH, organic carbon, total nitrogen, available phosphorus, and potassium were analysed during each sampling period in order to study the impact of these factors on the population changes of microarthropods. Soil temperature was recorded with the help of soil thermometer; Soil moisture content was determined by gravimetric method (Misra, 1968 and Wilde *et al.*, 1985); Soil pH was determined by using a portable glass electrode pH meter (Anderson and Ingram, 1993); soil organic carbon was determined by modified Walkey and Black method (Anderson and Ingram, 1993); Soil total nitrogen was determined by acid digestion Kjeldahl procedures (Anderson and Ingram, 1993); Soil available phosphorus was determined by ammonium molybdate stannous chloride method (Sparling *et al.*, 1985); Soil potassium and sodium were determined by flame photometer (Steward, 1971). Data on monthly rainfall, relative humidity and air temperature were measured in the field during the study period.

## **III. Result and Discussion**

Acarina was found to be dominant group comprising 39.26% and 37.51% of the total soil microarthropods in natural and degraded sites respectively. Higher abundance of Acarina among soil microarthropods were also reported in different forest ecosystem (Ryke and Loots, 1967; Mitchell, 1977; Wallwork, 1983; Sarkar, 1991). Chitrapati (2002) reported that Acarina comprised 66% and 63% of total soil microarthropods. Doulo (2007) also reported that Acarina comprised 42.4% and 40.8% of the total soil microarthropods in natural and degraded in forest sites respectfully in Lumami, Nagaland. The Acarina population was recorded to be 1.75 times higher in the natural forest (396.74 x 10<sup>2</sup>m<sup>-2</sup>) than the degraded site (226.32 x 10<sup>2</sup>m<sup>-2</sup>) **Table 1**. Hazra (1991) also reported a decrease in population percentage of mites in deforested site as compared to the reserve forest. Wood (1960) reported that organic matter together with the moisture present in the soil made a condition highly favourable for higher concentration of mites. Morris (1978) also recorded higher concentration of soil fauna in ungrazed site than grazed site.

Monthly variation of total population density of Acarina exhibited similar trend in both natural and degraded forest. With the initial record of 24.68 x 10<sup>2</sup>m<sup>-2</sup> and 15.27 x 10<sup>2</sup>m<sup>-2</sup> during October, the number decreases to minimum during January (5.90 x 10<sup>2</sup>m<sup>-2</sup> and 1.93 x 10<sup>2</sup>m<sup>-2</sup>) in natural and degraded forest respectively and gradual increases in both natural and degraded forest reaching the peak during August (70.77

$\times 10^2\text{m}^{-2}$  and  $40.08 \times 10^2\text{m}^{-2}$  respectively) (**Fig. 2**). In both study sites, 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. Many workers have also reported higher population of soil microarthropods during rainy season and a sharp decline during summer months (Sanyal 1996; Reddy and Venkataiah 1990).

The seasonal vertical distribution pattern also showed a decreasing trend with increase in soil depth in both study sites (**Fig. 3 a,b**). 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 0-10cm. The seasonal variation of Acarina in both sites in the present investigation may be attributed to cumulative effect of all physico-chemical factors rather than a single factor influence. Petersen (1980) and Hagvar (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 on set of winter. Acarina population in natural forest ecosystem showed maximum density in the month of August in 0-10cm during raining season and minimum in 20-30 cm in winter season. Natural forest had higher population density of 19.18%, 68.47% and 123.45% in 0-10cm, 10-20cm and 20-30cm layer respectively than degraded site. Higher population density at 0-10cm layer (>47% in natural and 66% in degraded site) may be due to climatic influence, adequate living space, favourable moisture condition, aeration rate and accumulation of nutrient in humus soil (Reddy and Venkataiah,1990). However sharp declination of population density in lower soil layers of 10-20 and 20-30cm in degraded site than natural site may be attributed to poor living space, insufficient food resources and inimical microclimatic condition which results in maximum migration to top layer. Doulo and Kakati (2009) also recorded over 46% and 54% of microarthropods at 0-10cm layer in natural and degraded site respectfully. Except for 0-10cm (rainy and summer season) and 20-30cm (winter) summer season, analysis of varience showed significant seasonal difference among other soil depths in degraded site while in natural forest difference was significant in all soil depths except in 20-30cm during summer season.

Soil Acarina was positive relationship between temporal variation of different physical factors in both natural and degraded forest ecosystem except for relative humidity.

Air temperature, soil temperature, soil moisture showed highly significant positive correlation with Acarina, ( $p < 0.001$ ) and also statistically to show the effect of abiotic factors on fluctuation in both natural and degraded forest ecosystem except relative humidity.

The positive correlation between soil temperature and Soil micro arthropods such Collembola and Acarina in natural and degraded forest ecosystem from Imphal Valley has been reported by (Mukharji and Singh, 1970; Mitra, 1977; Bhattacharya and Raychoudhuri ,1979; Choudhuri and Pande,1979; Sanyal,1982; Reddy ,1984 Narula, 1998; Chitrapati, 2002). It appears that the pattern of the temporal changes in the abundance of soil microarthropods vary from area to area depending on the local micro climatic conditions.

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**Table 1: Seasonal variation of Acarina (Numbers  $\pm$  S.E.)  $\times 10^2\text{m}^{-2}$  in natural and degraded forest ecosystem at Pthalipam, Lakhimpur.**

Forest Type	Season	Soil layers			Total
		0-10cm	10-20cm	20-30cm	
Natural	Winter	32.05 $\pm$ 1.69	17.25 $\pm$ 1.04	10.04 $\pm$ 1.16	59.34 $\pm$ 3.10
	Summer	55.16 $\pm$ 3.07	35.17 $\pm$ 1.72	18.41 $\pm$ 1.28	108.74 $\pm$ 2.21
	Rainy	101.39 $\pm$ 3.52	83.60 $\pm$ 0.86	43.67 $\pm$ 1.43	228.66 $\pm$ 2.04
	Annual	188.60 $\pm$ 1.33	136.02 $\pm$ 1.20	72.12 $\pm$ 0.69	396.74 $\pm$ 3.63
		a= 47.54%	34.28%	18.18%	100%

Degraded	Winter	20.17 ± 1.12	8.28 ± 0.88	4.02 ± 0.11	32.47 ± 1.20
	Summer	51.65 ± 3.64	13.67 ± 2.15	7.37 ± 0.36	72.69 ± 1.27
	Rainy	78.87 ± 1.74	28.87 ± 0.42	13.42 ± 3.28	121.16 ± 4.06
	Annual	150.69 ± 1.05	50.82 ± 3.78	24.81 ± 4.11	226.32 ± 3.27
		a= 66.58%	22.46%	10.96%	100%

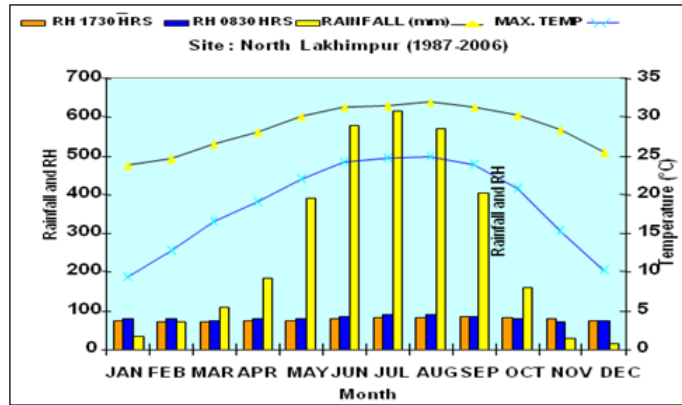


Fig. 1: Ombrothermic diagram based on twenty years (1987–2006)

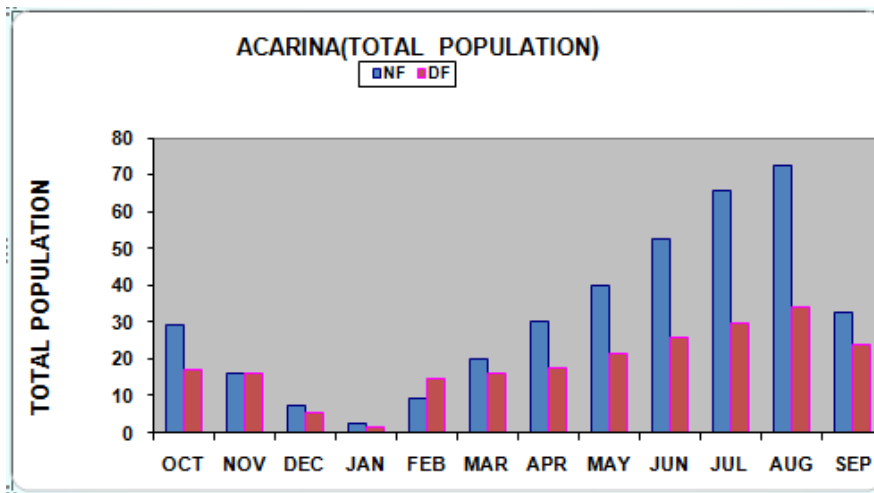
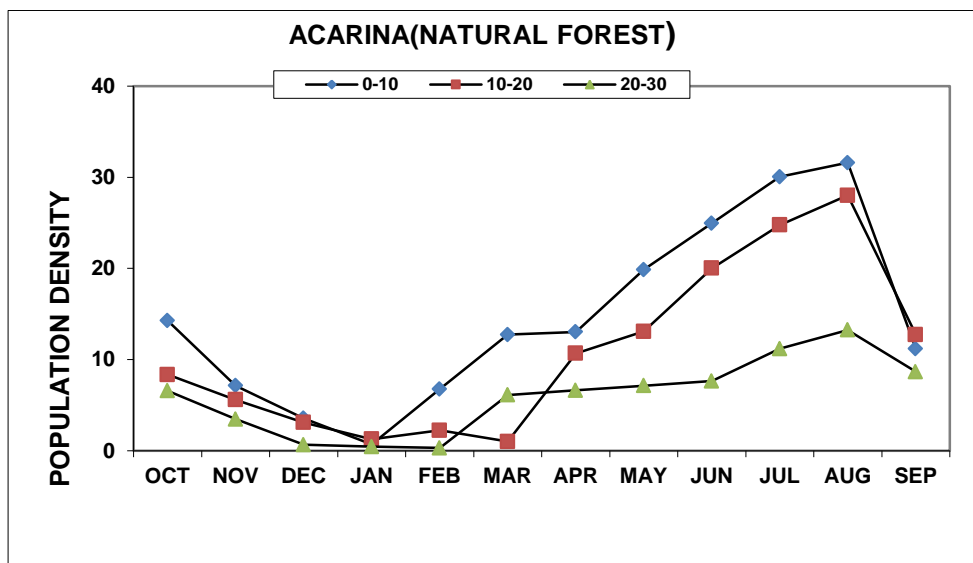


Fig. 2: Monthly fluctuation of total Acarina population density (Numbers x10<sup>2</sup>m<sup>-2</sup>) in natural (NF) and degraded (DF) forest ecosystem.



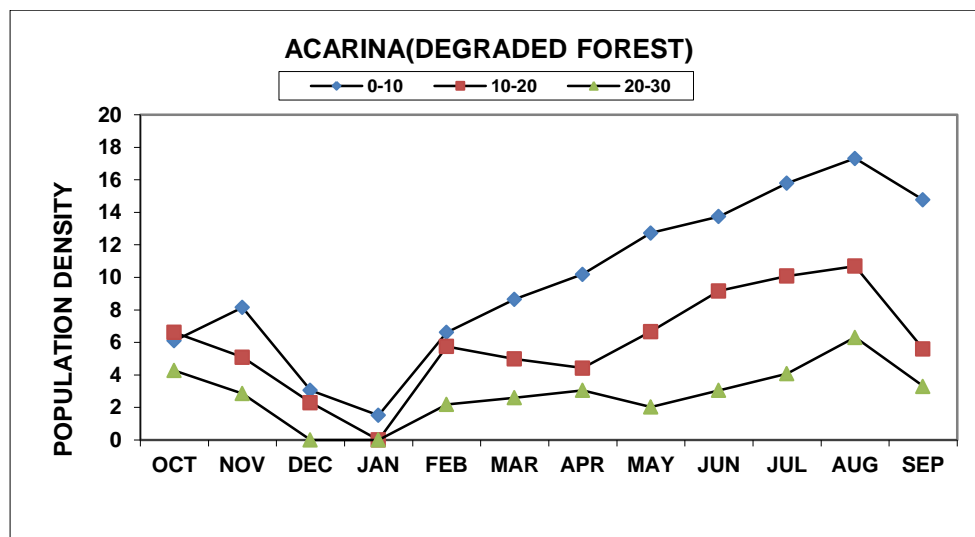


Fig. 3: Monthly vertical distribution of total Acarina population density (Numbers x 10<sup>2</sup>m<sup>-2</sup>) in different soil layers of (a) natural (NF) and (b) degraded (DF) forest ecosystem

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