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A comparative study on the diversity, distribution and abundance of acari population in natural and reclaimed habitat

SONI KUMARI TIWARI AND KUMARI MONIKA

University Department of Zoology, Ranchi University, Ranchi

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ABSTRACT

Acari are among the most commonly available diverse fauna consisting of various species. They serve as biological indicators of soil quality. They also indicate habitat disturbance and level of mitigation strategies. A comparative study on Acari population was done on soil samples of reclaimed forest at Ghatotand coal mining area and natural forest with respect to its distribution, diversity and seasonal abundance pattern to understand their role in reclamation accomplishment. For better understanding of seasonality pattern correlation between various edaphic factors was also observed. Significant positive correlation was observed between moisture and organic carbon content both at natural (0.8806) and reclaimed (0.6382) forest. Ten species of Acari were found at both natural and reclaimed forest. Rhagidia sp. was found to be the most abundant species at both natural and reclaimed forest while Caloglyphus sp. was least abundant. The species diversity of natural forest was comparatively higher yet a considerable decline was observed in summer season. Monsoon peak and summer decline in population was observed at both the forests. Seasonal abundance of various Acari followed similar pattern yet a considerable difference in community structure was observed. The population fluctuation of Acari in summer season was higher at reclaimed forest than that of natural forest.

Keywords: Mesofauna, Species Diversity, Reclamation, Seasonality pattern

INTRODUCTION

Jharkhand is a state rich in natural resources and famous for its coal mines located among thick forest cover. Coal mining activity started here in the year 1946. Earlier, pit mining method was employed which was gradually replaced by opencast mining method in 1978 causing severe damage to natural forest ecosystem. At present, some 4300 acres of land have been leased out to the companies for the mining purpose. Within the existing coal mine area run either by Tata Colliery or by C.C.L. Tata colliery owns and manages 259 sq.km area of open cast mining in the name of West Bokaro colliery and reclamation of used sites is an age-old process which is much more visible and successful amongst all the open casts in the vicinity. This also includes the practices of community development services extended to affected villages as well as common people. Barren undulating land has been gradually replaced by reclaimed forests largely managed by Tata collieries.

Soil fauna plays an important role in soil development (Pawluk, 1985) and enhancement of soil quality (Seastedt, 1984). Acari represents quantitatively abundant and species rich group of organisms which are inhabitants of litter and top soil and play a major role in decomposition of organic matter and formation of humus profile (Bradford *et al.* 2007; Huhta, 2007) thus playing an important role in soil dynamics (Wallwork,1967). Soil mesofauna, mostly Acari along with Collembolans also serve as major bio-indicators of soil health and reclamation success (Battigelli, 2011). The present study was conducted at a 15 years old reclaimed forest which is planted over overburdened sites of Tata collieries; Ghatotand (Latitude 23^0 47' 27" N, longitude 85^0 34' 28"E) and compared with natural forest of Sarubera, District Hazaribagh 10Km away from reclaimed forest. The reclamation of mined out area has been done keeping thrust on plantation of native species as well as water requirement. Jatropha (*Curcas*), chakundi (*Cassia tora*) and Rain tree (*Samanea saman*) were the main vegetation at reclaimed forest. The general vegetation of natural forest is essentially tropophilous but with a tendency towards xerophytes. The forest is deciduous in summer. The forest cover is fairly dense during monsoon months comprised of annual as well as perennial species. Sal (*Shorea robusta*), Palas

University Department of Zoology, Ranchi University, Ranchi, Jharkhand – 834008
Corresponding author email – sonitiwati@ranchiuniversity.ac.in, monika8092@gmail.com

(*Butea frondosa*), Karanj (*Pongamia glibber*) etc. as main perennial trees while forest floor beset with thick litter cover. The main purpose of this study was the comparison of communities of soil mesofauna among natural and reclaimed sites and to generate baseline data to allow for long-term observation of resettlement on disturbed sites. It was suggested that to maintain sustainance of soil ecosystem, protection of soil ecosystem biodiversity plays a crucial role (Rombke *et al.* 2005). Collection of baseline data on the density, diversity and distribution of soil fauna is essential in order to utilize the community as biological indictors of quality of soil and observe changes in disturbed ecosystems (Behan-Pelletier 1999). Comparative study of Acari community at natural and reclaimed forest will lead to a better understanding of impact of anthropogenic activity and reclamation on soil biodiversity aiding to development of soil bio-indicator system.

MATERIALS AND METHODS

Surface soil samples (15 cm depth) have been collected fortnightly from 5 randomly selected sites of both reclaimed and natural forest with the help of O'Connor's corer. The behavioral dynamic method (Wallwork, 1970) was employed for extraction. Extraction of mesofauna was done by placing the sample in Multiple Tullgren's funnel (Ducarme *et al.* 2002) and light stimulus was given for a period of 24 to 36 hrs with gradual increase in intensity of illumination. The organisms were collected in saturated Picric acid solution and mounted in 10% polyvinyl alcohol supplemented with Glycerol and Lactic Acid.

Acari were identified up to family or order using range of taxonomic keys (O' Connell and Bolger, 1994) and visually counted under microscope. Shannon Weiner's Species Diversity was calculated using formula

$$H' = -\sum p_i \ln(p_i) \quad \text{OR}$$

H'= - ∑(Ni/N) × ln (Ni/N)

Where

H' = The Shannon Weiner Diversity Index

p_i= the relative abundance of each group of organisms

The index of evenness or equitability (J) were estimated using the formula as given by Krebs (1976)

J = H'/H'$_{max}$ when H'$_{max}$ = LogS × 1/ Log 2

Soil temperature was measured by inserting soil thermometer to a depth of 10cm. The moisture content was determined by drying the soil in a hot air up to 105˚C. The pH was measured by systronic Grip pH meter in soil suspension. Soil organic carbon was estimated by rapid titration method as described by Walkley and Black (1934). Total nitrogen of the soil was determined by Sprangels method (Jackson, 1973). Phosphorus was determined by Molybdenum blue test method. Potassium in soil samples was done by Jackson's method (1966).

RESULTS AND DISCUSSION

The soil characteristic studied on various parameters viz. temperature, moisture, pH, organic carbon content showed similar variation pattern at both natural and reclaimed forest. The maximum and minimum soil temperature was recorded in month of June and January respectively at both natural and reclaimed forest. It was 26.6˚C and 12.7˚C for natural and 25.7˚C and 12.0˚C for reclaimed forest. The winter temperature ranged between 12°C to 21˚C at reclaimed forest while 11˚C to 20˚C at natural forest. Summer temperature ranged 27˚C – 37˚C at reclaimed and 25˚C to 35˚C at natural forest. The soil moisture content of both the forest was found to be almost similar throughout study period. The maximum and minimum soil moisture content at natural forest measured 24.6% and 10.1%. Similarly, it was 24.0% and 9.5% for reclaimed forest. There was a wide range of variation in summer and monsoon months for both the sites. Soil temperature and moisture were negatively correlated for both sites while organic carbon content has positive correlation with moisture. The soil pH at both the sites always remained slightly acidic to neutral with very little variation (6.8 – 7.0). During rainy season, soil pH tends to remain more acidic (pH 6.5 -6.8) than summer. The pH tends to decline with increase in moisture content.

The organic carbon content at natural forest was greater throughout the year (Imtimongla, 2024) than reclaimed forest though the variation pattern was almost similar. High

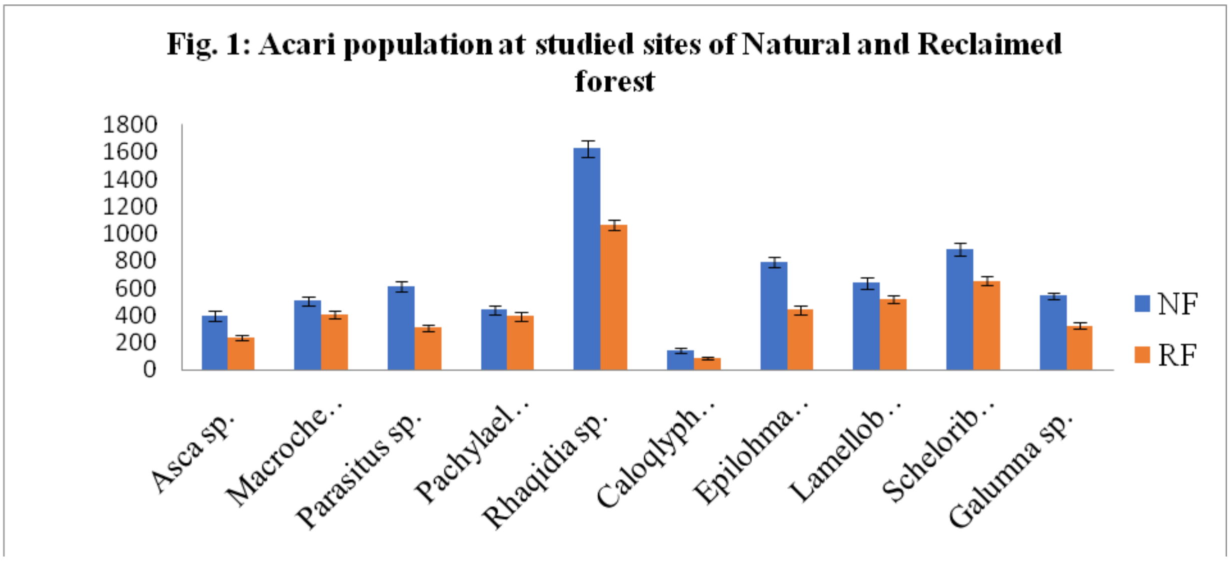


Table 1: Seasonal abundance of acari at reclaimed forest

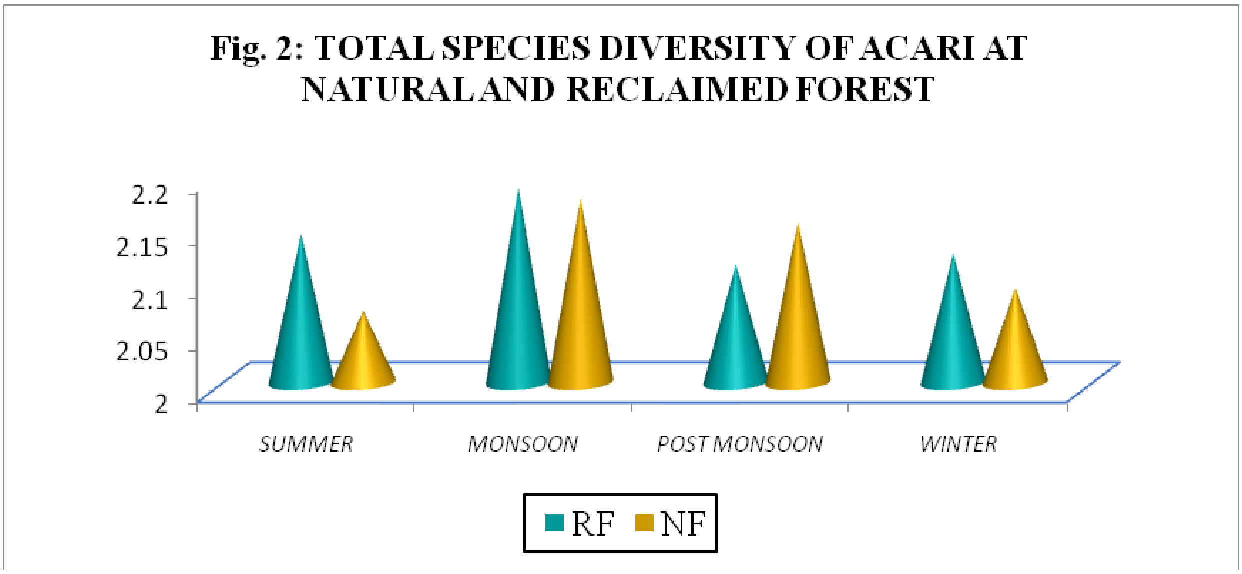
Season	*Asca sp.*	*Macrocheles sp.*	*Parasitus sp.*	*Pachylaelaps sp.*	*Rhaqidia sp.*	*Caloqlyphus sp.*	*Epilohmannia sp.*	*Lamellobates sp.*	*Schelori bates sp.*	*Galumna sp.*
Summer	0.039	0.075	0.073	0.082	0.164	0.014	0.105	0.118	0.214	0.112
Monsoon	0.056	0.094	0.071	0.095	0.217	0.026	0.106	0.113	0.139	0.079
Post monsoon	0.048	0.095	0.069	0.086	0.278	0.019	0.094	0.110	0.131	0.064
Winter	0.061	0.084	0.066	0.084	0.241	0.012	0.094	0.132	0.160	0.061

organic carbon content was observed during monsoon and post monsoon season at both sites (S.K. Chaudhary, 2024). Comparatively low organic carbon content was observed in summer i.e. March to May while highest value was observed in month of August at both the natural (3.51) and reclaimed (2.58) forest.

Table 2: Seasonal abundance of acari at natural forest

Season	*Asca sp.*	*Macrocheles sp.*	*Parasitus sp.*	*Pachylaelaps sp.*	*Rhaqidia sp.*	*Caloqlyphus sp.*	*Epilohmannia sp.*	*Lamellobates sp.*	*Scheloribates sp.*	*Galumna sp.*
Summer	0.049	0.076	0.043	0.054	0.239	0.007	0.149	0.120	0.179	0.079
Monsoon	0.061	0.089	0.074	0.073	0.229	0.025	0.120	0.096	0.135	0.092
Post monsoon	0.068	0.072	0.068	0.073	0.253	0.025	0.122	0.098	0.129	0.087
Winter	0.059	0.075	0.061	0.064	0.292	0.018	0.119	0.096	0.137	0.074

The faunal composition and fluctuation pattern was similar for both the forest. In accordance to finding (Kampichler *et al.* 2000, Battigeli, 2011) Acari was most abundant species group along with the collembolans. This indicates the successful restoration of soil at reclaimed site (Andres and Mateos, 2006). Ten species of Acari was observed at both natural and reclaimed forest during the two year of investigation period. These species were *Asca* sp., *Macrocheles* sp., *Rhagidia* sp, *Caloglyphus* sp, *Parasitus* sp., *Pachylaelaps* sp., *Epilohmannia* sp., *Lamellobates* sp., *Scheloribates* sp., and *Galumna* sp. *Rhagidia* sp. was most abundant species during whole study period while *Caloglyphus* sp. was the least abundant Acari among all species recorded. Collembolans being early colonizers (Kaczmarek *et al.* 1995, Koehler 1998, Irmler 2000) dominate the reclaimed site along with Acari but they are comparatively more sensitive to change in nutrient pulses (Siepel 1995, Koehler 2000, Behan-Pelletier 2003). The pattern of seasonal abundance of species was similar for both natural and reclaimed forest. The present finding of high Acari population in monsoon and winter months is in accordance to



finding of (Maribie, 2009). Species diversity for natural forest was higher than reclaimed forest and the variation was more pronounced in summer season than other seasons of the year (Fig.2).

It was observed that in all the four seasons, the seasonal species diversity of Acari increased in reclaimed forest and the increase was observed in monsoon and winter season when the environmental conditions were favourable for Acari population. This also advocates the higher sensitivity of mites towards soil moisture content (Abbas and Parwez 2012). Acari are K- selected species (Battigeli, 2011). These species have long life. The low metabolic rate helps them to survive with very low food intake along with limited dispersal possibility (Mitchell 1977). This feature did not allow them to take advantage of rapid changes in food resources. This enables them to suffer the impact of disturbance which results in organism loss (Behan-Pelletier 1999). Reclamation prescription significantly influences density and community structure of soil mesofauna.

REFERENCES

Abbas MJ and Parwez H (2012) Impact of edaphic factors on the diversity of soil microarthropods in an ecosystem at Aligarh. *Indian journal of fundamental and applied life sciences* **2**(1) 185-191.

Adeduntan, Sunday Adeniyi (2009) Diversity and abundance of soil mesofauna and microbial population in South–Western Nigeria. *African Journal of Plant Science* Vol. **3** (9), pp. 210-216

Al-Assiuty, A.I., Bayoumi, B.M, Khalil, M.A., and van Straalan, N.M. (1993) The influence of vegetational type on seasonal abundance and species composition of soil fauna at different localities in Egypt. *Pedobiologia*, **37**: 210-222.

Andrés, P. and Mateos, E. (2006) Soil mesofaunal responses to post-mining restoration treatments. *Applied Soil Ecology*. 33:67-78.

Battigelli J.P., Spence J.R., Langor D.W., Berch, S. (2004) Short-term impact of forest soil compaction and organic matter removal on soil mesofauna density and oribatid mite diversity – Can. J. *Forest Res*. **34**: 1136–1149.

Baumbrough, B., (1999) Soil collembola under different conifer species on southern Vancouver Island, British Columbia. *University of British Columbia*. Dept. of Soil Science. PhD Thesis.

Behan-Pelletier V.M. (2003) Acari and Collembola biodiversity in Canadian agricultural soils – Can. J. *Soil Sci*. 83: 279–288.

Behan-Pelletier, V.M. (1999) Oribatid mite biodiversity in agroecosystems: role for bioindication. *Agriculture, Ecosystems and Environment* **74**:411-423.

Belfield W (1956) The Arthropoda of the soil in a West African pasture. *J Anim Ecol* **25**:275–287.

Blair, J.M., Parmelee, R.W., Wyman, R.L. (1994) A comparison of the forest floor invertebrate communities of four forest types in the northeastern U.S. *Pedobiologia*, **38**: 146-160.

Decha Wiwatwitaya Æ Hiroshi Takeda (2005) Seasonal changes in soil arthropod abundance in the dry evergreen forest of north-east Thailand, with special reference to collembolan communities. *Ecol Res* **20**: 59–70

Ducarme X., Andre H.M., Lebrun Ph. (2002) Soil biodiversity: myth, reality or conning? – *Oikos*, **96**: 3–24.

Hansen, R. A. (2000) Diversity in the decomposing landscape. Pp. 203-219. In Coleman D. C. and P. F. Hendrix (eds.) Invertebrates as web masters in ecosystems. *CAB International Press*, **352** pp.

Hopkins SP (1997) Biology of Springtails (Insect: Collembola). *Oxford University Press*, Cambridge, UK.

Imtimongla, Y.K. Sharma and J.B. Bordoloi (2024) Altitudinal and land use influence on soil properties in Nagaland. Annals of Plant and Soil Research **26**(3): 395-402

Irmler U (2000) Changes in the fauna and its contribution to mass loss and N release during leaf litter decomposition in two deciduous forests. *Pedobiologia* **44**, 105-118.

Jackson, M.L. (1973) Soil Chemical Analysis. Prentice Hall of India, Private Limited, New Delhi. P.478.

Jackson, R.M. (1966) Life in the soil William Dower and Sons Ltd. London &Beccles.

Kampichler CS, Dzeroski TI, Wieland R (2000) Application of machine learning techniques, relationship between habitat features and Collembola community soil *Biol. Biochem*. **32**: 197-209.

Knoepp D.J., Coleman C.D., Crossley D.A. and Clark S.J. (2000) Biological indices of soil quality: anecosystem case study of their use. *Forest Ecology Management*. **38** 357-368.

Koehler H (1998) Secondary succession of soil mesofauna: A thirteen-year study. *Applied Soil Ecology* **9**, 81-86.

Koehler H.H. (2000) Natural regeneration and succession – results from a 13 years study with reference to mesofauna and vegetation, and implications for management – Landscape Urban Plan. **51**: 123–130.

Madej G. (2004) Development of communities of mesostigmatid mites (Arachnida, Acari) in areas of postindustrial wastelands– Wyd. *Uniwersytetu Slaskiego, Katowice*, 206 pp.

Maribie, C. W. (2009) Survey of soil mites (Acari) abundance and diversity in different land use types in Embu and Taita districts, Kenya Msc Thesis University of Nairobi

Mitchell, M.J. (1977) Population dynamics of oribatid mites (Acari, Cryptostigmata) in an Aspen woodland soil. *Pedobiologia*, **17**:305-319.

Muturi, J.J.; Mbugi, J.P.; Mueke, J.M.; Lagerlóf, J.; Mungatu, J. K.; Nyamasyo, D. and Gikungu, M. (2009) Collembola density and diversity along a gradient of land-use types in Embu district, Eastern Kenya. *Tropical and Subtropical Agroecosystems*, **11**, 361-369.

Pawluk, S. 1985. Soil micromorphology and soil fauna: Problems and importance. *Quaestiones Entomologicae*. **21**:473-496.

Sanjeev K. Chaudhary (2024) Physico-chemical properties, available nutrient content and their inter-relationship in soils under rain fed maize-wheat cropping system, district Reasi (J&K). *Annals of Plant and Soil Research* **26**(1): 82-88.

Seastedt, T. (1984) The role of microarthropods in decomposition and mineralization processes. *Ann. Rev Entomol*. **29**:25-46.

Siepel H. (1995) Application of microarthropod life-history tactics in nature management and ecotoxicology – *Biol. Fertil. Soils*, **19**: 75–83.