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# SOIL ACARINA AND COLLEMBOLA IN FOREST AND CULTIVATED LAND OF KHASI HILLS, MEGHALAYA.

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## INTRODUCTION

During the last decade considerable work has been done on the Indian soil fauna, and quite a number of reports exist on the soil fauna of North-East India with particular reference to Meghalaya (Reddy & Alfred 1977, 1978a, 1978b ; Vatsauliya and Alfred 1980 ; Darlong & Alfred, 1982 ; Hattar & Alfred 1986 ; Paul & Alfred 1986). Most of these studies are confined to jhum cultivation and pine forest soils of Khasi Hills, Meghalaya, and as such there is hardly any work done on cultivated system from this region. The study was undertaken to compare the distribution and diversity of mesofauna with particular reference to Collembola and Acarina of pine forest soil and an adjacent cultivated land, for one annual cycle at four different soil depths.

## MATERIALS AND METHODS

The study sites were located in Shillong at an altitude of 1500 m. The sites studied comprised of a pine forest (*Pinus kesiya* Royle) and an adjacent plot of cultivated land belonging to vegetable research station, Government of Meghalaya, Shillong. Seasonal vegetables were grown in the vegetable land. The usual type of tillage followed in the hills of North-East India was carried out and a rotational method of agronomic practices were followed. Both the sites have an area of 2.5 ha. of flat and undulating slopes. Although soil samples were taken out fortnightly intervals from September, 1981 to August, 1982, the results are presented as monthly averages. In both the systems soil samples consisted of 5 cm. sq. in surface area to a depth of 40 cms. divided into four depths of 10 cm. each. Five random cores of each soil layer from each system were collected by a rectangular iron cover (5×5×10 cm.) and extraction of soil fauna was done using modified Tullgren funnels (Macfadyen, 1953 ; Southwood, 1966). The period of extraction was 7-10 days at constant 40°C depending on the moisture content of soil samples. Similarly soil samples were also collected for analysing the physico-chemical parameters. The method of Walkey and and Black (1934) was followed for the analysis of the chemical factors of soil. The fauna were statistically analysed for their C. V., species diversity (Shannon Weiner) and species similarity (QS).

## RESULTS AND DISCUSSION

*Analysis of Edaphic factors :*

The soils of the Ecosystems studied were (a) pine forest—sandy loam in texture and brown in colour (b) cultivated land—sandy loam in texture and light brown in colour. Different factors were analysed by taking samples from four soil depths. The minimum and maximum values of soil factors analysed are given in Table 1. The contents of organic carbon, soil conductivity, phosphate and potassium were found to vary seasonally in both systems. The temperature, pH and moisture content was found to vary significantly. The humidity recorded was quite high.

*Vertical Distribution pattern of Collembola :*

The mean seasonal density of Collembola in pine forest and cultivated land as given in Fig. I for one annual cycle from September 1981 to August, 1982 reveals that in the upper 0-10 cm. soil depth in pine forest (Fig. IA) the Collembola were recorded maximum in November and minimum in December, and in the cultivated land maximum in February and minimum in October.

In the 10-20 cm. soil depth in pine forest (Fig. IB) they were maximum in January and minimum in August, and in cultivated land maximum in April and minimum in December.

In the 20-30 cm. and 30-40 cm. (Figs. IC & ID) soil depths their numbers were significantly low in both the systems but their numbers fluctuated in different months.

Altogether 11 species of Collembola viz. *Cryptopygus thermophelus*, *Isotoma (Desoria) trispinata*, *Dicranocentrus singularis*, *D. fraternus*, *Megalothorax minimus*, *Sphaeridea cf. cornuta*, *Entomobrya* spp. *Metıcoelura* spp. *Siera* spp. *Sminthurinus bimaculatus* and *Onychiurus* spp. were recorded in pine forest. In the cultivated land 6 species of Collembola viz. *Isotoma (Desoria) trispinata*, *Megalothorax minimus*, *Xenylla* spp. *Folsomides* spp., *Onychiurus* spp. and *Sphaeridae cf. cornuta* were recorded.

In the upper 0-10 cm. and 10-20 cm. soil depths, 4 species of Collembola viz. *Isotoma (Desoria) trispinata*, *Megalothorax minimus*, *Sphaerdea cf. cornuta* and *Onychiurus* spp. were common to both the systems as against 11 and 6 species in pine forest and cultivated land respectively. The species *Isotoma (Desoria) tripinata* was dominant in both the systems and its density being two times higher in the cultivated land in the 0-10 cm soil depth and reverse in the case of 10-20 cm soil layer.

In the 20-30 cm soil layer the no. of species sharply reduced to six in pine forest with marked reduction in their density and was found to be constant at six species in cultivated land. Out of the two species viz. *Megalothorax minimus* and *Sphaeridea of cornuta* being common to both the systems the latter species was dominant in both the systems.

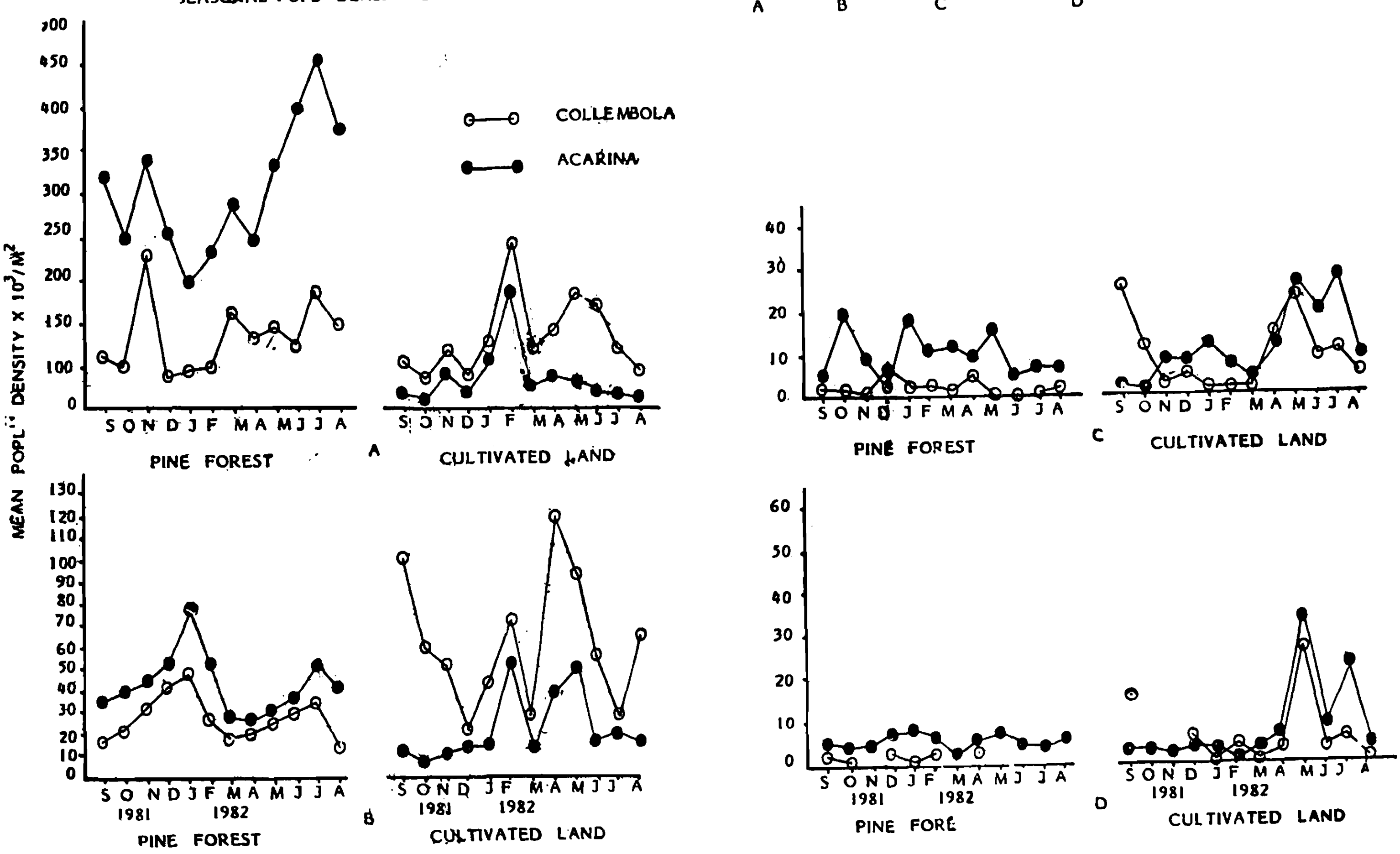
In the 30-40 cm soil layer in pine forest the no. of species further reduced to four as well as in cultivated land. In this layer two species viz. *Sphaeridea cf. cornuta* and *Onychiurus* spp. were common to both the systems, the former being domiuant in pine forest and *Xenylla* spp. in cultivated land. As seen in Table 2 for C. V. values (%) cultivation seems to have very little impact on Collembola as compared to the forest.

*Vertical Distribution pattern of Acarina* :

The mean seasonal density of Acarina in pine forest and cultivated land as given in Fig. I for one annual cycle from September 1981 to August 1982 reveals that in the upper 0-10 cm (Fig. IA) soil depth the Acarina were recorded maximum in July and minimum in December and in cultivated land maximum in February and minimum in October.

FIG. I.

SEASONAL POPL^N DENSITY OF COLLEMBOLA AND ACARINA AT 0-10 CM, 10-20 CM, 20-30 CM, AND 30-40 CM SOIL DEPTHS.
A B C D




In the 10-20 cm soil depth in pine forest (Fig. IB) they were maximum in February and May (two peaks) and minimum in October.

In the 20-30 cm and 30-40 cm soil depth (Fig. IC & D) their numbers were significantly low but their numbers fluctuated in different months.

Altogether 8 species of Acarina viz. *Epilohmannia* spp. *Galumna* spp. *Scheloribates albialatus, S. huancayensis, Parasitus divortus, Pseudoparasitus* spp. *Eremobelba* spp. and *Dolicheremaeus* spp. were recorded in pine forest. In the cultivated land 5 species of Acarina viz. *Scheloribates albialatus, Oppia* spp. *Rhysotritia ardua, Gamasodes assamensis* and *Parasitus divortus* were recorded.

In the upper 0-10 cm and 10-20 cm soil depth 2 species of Acarina viz. *Schelaribates albialatus* and *Parasitus divortus* were common to both the systems as against 8 and 5 species in pine forest and cultivated land respectively. The species *Scheloribates albialatus* was found to be dominant in both the systems.

In the 20-30 cm and 30-40 cm soil depths only one species namely *Parasitus divortus* was common to both the systems while *Scheloribates huancayensis* was dominant in 20-30 cm soil depth and *Epilohmannia* spp. in 30-40 cm soil depth in pine forest. In cultivated land *Parasitus divortus* was dominant in both these depths. As seen in Table 3 for C. V. values (%) for Acarina the values were always higher in the cultivated land than in pine forest indicating the disturbed nature of the former system.

*Parameters affecting Mesofaunal Distribution and Diversity* :

Soil temperature throughout the sampling period varied slightly depending on vegetative cover and soil depth. Generally higher relative humidity and vegetative cover increased the moisture content of the soil especially near the surface exposing the mesofauna to greater temperature and moisture fluctuations. Changes in soil depth coincide with similar changes in moisture, temperature, organic matter, quality and quantity, pore space and soil temperature (Wallwork, 1970 ; Mitchell, 1979). Fluctuation in these factors tended to decrease with depth as the physical environment became more stable. Within the soil environment various layers are produced which provide various micro-habitats able to support different species of Collembola and Acarina. The numbers of Collembola and Acarina greatly decreased with depth due to similar-drops in organic matter and pore space volume in pine forest but in cultivated land the reduction was less as compared to pine forest. It is the combination of many soil factors which might have contributed to the overall mesofaunal composition of both cultivated land and pine forest. In view of the present study it could be inferred that the collective influence of all the factors in controlling the population and vertical distribution of soil mesofauna especially Collembola and Acarina was more pronounced in both the systems studied.

In general the soil fauna of arable land is less abundant and diversified than the fauna of forested ecosystems (Edwards & Lofty 1969 ; Ghilarov, 1975). This is evident from data of cultivated land as compared with pine forest and the number of species recorded in each system. Similar sampling and extraction techniques were used in both the ecosystems ; the difference between them being due to litter accumulation in pine forest which have a great impact on the abundance of many species of Acarina. An experiment performed by Karg (1967) showed the importance of litter layer that when it is removed from the forest site, the abundance and species number were reduced by more than 50% and the species composition became similar to that in the cultivated land, as is evident in our present study. The abundances reported in this paper are high for Acarina in pine forest as compared to cultivated land. The Collembola being in the reverse (cf. Hale, 1967). The Collembola seem to be less affected by cultivation than Acarina (Christiansen, 1964).

In the present investigation it was seen that interestingly enough the pine forest possessing higher number of species reveal their possible occupation of most ecological niches in a rather stabilised ecosystem where fluctuations of abiotic factors are most extreme. The reverse is in cultivated land where number of species decreased because of the catastrophes imposed on the system by ploughing, harrowing, manure, insecticides, application of fertilizers, cultivation and harvesting etc. Ploughing and harrowing generally decrease the abundance of soil animals (Tischler 1955 ; Sheals 1956 ; Ghilarov 1975 ; Edwards 1977). The direct negative effects of ploughing are partly due to abrasive damage to the animals and partly due to trapping of animals in the soil when it is inverted and the existing system of cracks and pores is destroyed. Since the cultivated land studied was subject to intensive ploughing and harrowing it could have possibly affected the mesofaunal composition as compared to pine forest. Secondary affects, e.g., drying of the uppermost part of the soil and removal of litter from the surface probably could affect the mesofaunal composition in cultivated land as compared to pine forest. Thus cultivated land harboured a depleted soil fauna because of frequency and type of cultivation and degree of plant cover and intensity of soil cultivation and the species diversity of Collembola and Acarina reduced as

TABLE 1. Minimum and Maximum Values of Soil Factors in Four Different Soil Depths in Pine Forest & Cultivated Land.

| Ecosystem | Depths | Temp. °C | Moisture % | pH units | T.S.S. % | Org. Carbon Kg/ha | P. Kg/ha | K. Kg/ha |
|---|---|---|---|---|---|---|---|---|
| | 0-10 cm | 8.5-21.0 | 17.95-57.07 | 4.83-6.16 | 5.00-26.66 | 1.95-4.31 | 1.34-30.64 | 42.93-214.66 |
| Pine Forest | 10-20 cm | 8.0-21.0 | 12.03-73.89 | 5.00-6.36 | 5.33-81.33 | 1.50-4.29 | 0.74-23.91 | 29.86-158.66 |
| | 20-30 cm | 7.5-20.3 | 15.88-69.90 | 4.73-6.10 | 5.66-62.00 | 1.56-3.97 | 0.74-34.23 | 33.60-166.13 |
| | 30-40 cm | 7.2-19.1 | 10.32-66.94 | 4.83-6.16 | 4.66-34.33 | 0.78-3.74 | 3.46-35.12 | 13.06-322.93 |
| | 0-10 cm | 9.0-22.0 | 12.86-71.23 | 5.75-6.67 | 10.53-48.26 | 1.37-2.41 | 1.95-32.25 | 45.19-258.23 |
| Cultivated | 10-20 cm | 8.8-19.9 | 16.92-80.26 | 5.81-6.54 | 12.45-53.56 | 1.15-2.15 | 1.76-28.39 | 50.53- 26.87 |
| Land | 20-30 cm | 8.1-19.3 | 19.28-78.71 | 5.61-6.19 | 9.36-38.73 | 1.03-1.87 | 1.25-19.78 | 37.83-215.26 |
| | 30-40 cm | 7.8-18.7 | 20.54-73.35 | 5.35-5.87 | 7.85-31.92 | 0.68-1.07 | 1 04-15.53 | 23.29-161.35 |

TABLE 2. Mean population densities of Collembola species and their co-efficient of Variance in pine forest & cultivated land.

| Cultivated Land | 0-10 cm | | | 10-20 cm | | | 20-30 cm | | | 30-40 cm | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | ±S.E. | C.V. (%) | Mean | ±S.E. | C.V. (%) | Mean | ±S.E. | C.V. (%) | Mean | ±S.E. | C.V. (%) |
| 1. *Isotoma* (*Desoria*) *trispinata* | 83.75 | 11.01 | 44.55 | 33.50 | 5.52 | 57.07 | 0.83 | 0.27 | 113.02 | — | — | — |
| 2. *Megalothorax minimus* | 9.83 | 1.80 | 63.45 | 6.00 | 0.80 | 46.06 | 1.15 | 0.59 | 178.00 | — | — | — |
| 3. *Onychiurus* spp. | 16.75 | 2.27 | 47.01 | 6.67 | 1.35 | 70.37 | 1.83 | 0.43 | 81.97 | 2.08 | 0.96 | 159.45 |
| 4. *Sphaeridea cf cornuta* | 3.08 | 0.50 | 56.23 | 1.92 | 0.40 | 71.60 | 3.33 | 0.99 | 103.64 | 1.00 | 0.46 | 156.52 |
| 5. *Xenylla* spp. | 8.83 | 0.84 | 33.09 | 10.50 | 1.94 | 64.01 | 1.25 | 0.44 | 123.67 | 2.00 | 0.92 | 159.53 |
| 6. *Folsomides* spp. | 6.75 | 0.66 | 34.07 | 3.33 | 0.43 | 65.04 | 1.58 | 0.58 | 128.00 | 0.92 | 0.31 | 117.57 |
| **Pine Forest** | | | | | | | | | | | | |
| 1. *Isotoma* (*Desoria*) *trispinata* | 39.66 | 6.18 | 54.00 | 9.33 | 1.41 | 52.60 | — | — | — | — | — | — |
| 2. *Megalothorax minimus* | 5.83 | 0.87 | 52.19 | 1.42 | 0.43 | 105.85 | 0.17 | 0.11 | 227.82 | — | — | — |
| 3. *Onychiurus* spp. | 10.08 | 1.49 | 51.22 | 1.92 | 0.67 | 120.46 | — | — | — | 0.17 | 0.11 | 227.82 |
| 4. *Sphaeridea cf cornuta* | 5.52 | 1.05 | 69.43 | 4.58 | 0.75 | 57.06 | 1.00 | 0.23 | 80.00 | 0.67 | 0.22 | 115.61 |
| 5. *Dicranocentrus singularis* | 11.08 | 1.93 | 60.44 | 2.08 | 0.40 | 66.44 | 0.25 | 0.13 | 178.88 | — | — | — |
| 6. *Dicranocentrus fraternus* | 6.91 | 1.09 | 54.74 | 1.25 | 0.39 | 108.51 | — | — | — | — | — | — |
| 7. *Cryptopygus thermophelus* | 20.00 | 3.46 | 70.48 | 4.08 | 0.51 | 43.77 | 0.33 | 0.14 | 148.45 | — | — | — |
| 8. *Entomobrya* spp. | 5.33 | 0.98 | 63.70 | 0.50 | 0.19 | 134.16 | — | — | — | — | — | — |
| 9. *Siera* spp. | 5.63 | 0.92 | 56.65 | 0.58 | 0.26 | 155.17 | 0.42 | 0.19 | 157.93 | 0.17 | 0.11 | 227.82 |
| 10. *Metacoelura* spp. | 6.25 | 1.31 | 72.88 | 0.33 | 0.19 | 196.38 | 0.08 | 0.08 | 353.55 | — | — | — |
| 11. *Sminthurinus bimaculatus* | 6.91 | 1.41 | 70.82 | 1.17 | 0.36 | 108.11 | — | — | — | 0.25 | 0.13 | 178.88 |

TABLE 3. Mean population densities of Acarina species and their co-efficient of Variance in pine forest & cultivated land.

| Cultivated Land | 0-10 cm | | | 10-20 cm | | | 20-30 cm | | | 30-40 cm | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | ±S.E. | C.V. (%) | Mean | ±S.E. | C.V. (%) | Mean | ±S.E. | C.V. (%) | Mean | ±S.E. | C.V. (%) |
| 1. *Scheloribates albialatus* | 36.41 | 8.70 | 82.85 | 11.25 | 2.75 | 84.84 | — | — | — | — | — | — |
| 2. *Parasitus divortus* | 13.67 | 2.51 | 63.70 | 4.25 | 0.91 | 74.48 | 5.58 | 1.67 | 103.81 | 4.33 | 1.94 | 154.89 |
| 3. *Rhysotritia ardua* | 4.50 | 0.86 | 66.00 | 3.91 | 0.84 | 74.43 | 2.50 | 0.51 | 71.33 | 3.00 | 0.76 | 87.62 |
| 4. *Gamasodes assamensis* | 3.67 | 1.16 | 109.16 | 0.58 | 0.19 | 115.65 | 2.17 | 0.64 | 101.69 | 0.33 | 0.19 | 196.38 |
| 5. *Oppia* spp. | 6.58 | 1.45 | 76.29 | 2.33 | 0.59 | 88.47 | 1.25 | 0.41 | 113.70 | 0.83 | 0.34 | 144.07 |
| **Pine Forest** | | | | | | | | | | | | |
| 1. *Scheloribates albialatus* | 101.41 | 13.75 | 46.98 | 20.33 | 2.47 | 42.14 | — | — | — | — | — | — |
| 2. *Parasitus divortus* | 36.91 | 3.59 | 33.40 | 9.00 | 1.08 | 41.57 | 3.75 | 0.65 | 60.28 | 1.50 | 0.43 | 100.44 |
| 3. *Epilohmannia* spp. | 28.75 | 2.95 | 35.57 | 2.00 | 0.37 | 64.03 | 1.08 | 0.29 | 92.12 | 0.83 | 0.34 | 144.07 |
| 4. *Galumna* spp. | 46.33 | 6.00 | 44.86 | 3.00 | 0.52 | 60.27 | 0.92 | 0.29 | 103.15 | 1.83 | 0.30 | 56.52 |
| 5. *Scheloribates hyancayensis* | 25.91 | 3.96 | 52.95 | 3.33 | 0.58 | 60.58 | 3.17 | 0.69 | 75.84 | — | — | — |
| 6. *Psudoparasitus* spp. | 16.25 | 1.89 | 40.40 | 3.00 | 0.90 | 104.45 | — | — | — | 1.58 | 0.29 | 63.29 |
| 7. *Eremobelba* spp. | 25.00 | 2.91 | 40.39 | 1.58 | 0.64 | 141.52 | 1.00 | 0.25 | 84.85 | — | — | — |
| 8. *Dolicheremaeus* ssp. | 24.50 | 2.90 | 39.56 | 2.17 | 0.61 | 97.86 | — | — | — | — | — | — |

TABLE 4. Q.S. Values of Collembola & Acarina between pine forest and adjacent cultivated land.

| Mesofauna | 0-10 | 10-20 | 20-30 | 30-40 |
|---|---|---|---|---|
| Collembola | 54.44 | 54.44 | 33.33 | 50.00 |
| Acarina | 30.77 | 30.77 | 11.11 | 12.5 |

compared to the forest system. The investigation also revealed that the abundance of soil mesofauna in cultivated land was higher in comparision to number of species as compared to pine forest.

However, eveness is indicative of phenomena in the reverse in that cultivated land reversal means more eveness than in the pine forest which could be attributed to cumulative influence of minor fluctuations in various abiotic factors which probably contribute a factorial complex thereby nullifying the effect of individual components.

The Q.S. value of Collembola between the two systems were much higher than that of Acarina (Table 4). Both the groups showed respective similarities atleast upto 20 cm depth, beyond which the values were much lower. However, at the extreme depth of 30-40 cm the Collembola tended to show a higher value of Q.S.

## SUMMARY

The present study deals with particular reference to Acarina (Mites) and Collembola (Springtails) and to their vertical distribution and diversity in Forest soil and an adjacent cultivated land.

The forest comprised of a sub-tropical pine and the cultivated land belonged to the local vegetable research station where seasonal vegetables were grown on a rotation basis.

Soil fauna was analysed from soils taken upto a depth of 40 cm. at intervals of 10 cm. each.

Results indicate higher density of Acarina and Collembola in forest and comparatively less in the case of cultivated land. Species richness is less in the arable system as compared to the forest soils.

The results are discussed in relation to certain physicochemical parameters and influence of agricultural practices on soil fauna.

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