ECOLOGICAL STUDIES OF SOIL ARTHROPODS IN FOREST AND JHUM SYSTEMS OF LAITKOR, MEGHALAYA

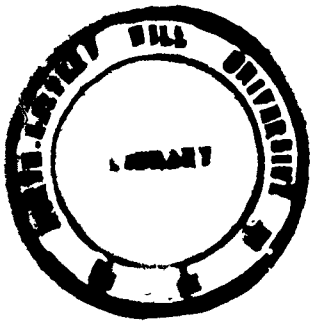
By

Vincent Thansanga Darlong, M. Sc.

DEPARTMENT OF ZOOLOGY
SCHOOL OF LIFE SCIENCES

SUBMITTED IN FULFILMENT OF THE REQUIREMENT
OF THE DEGREE OF

DOCTOR OF PHILOSOPHY



To

THE NORTH-EASTERN HILL UNIVERSITY
SHILLONG-793001
INDIA

NOVEMBER, 1984

Thesis

NEHRU Library
Acc. No. 101778
Acc. Date 24/6/87
Class. No.
Sub. Heading by
Cata. by
Transcribed by

DS
S74.5264
DAR

भारत सरकार
GOVERNMENT OF INDIA

तार का पता :
'जूलसर', शिलांग
Tel. address :
''Zoolsur, Shillong''
Phone-23638

पूर्वीय प्रादेशिक केन्द्र,
भारतीय प्राणी सर्वेक्षण,
रीसा कालोनी, शिलांग।
EASTERN REGIONAL STATION,
ZOOLOGICAL SURVEY OF INDIA,
RISA COLONY, SHILLONG-793003

No. F.

Dated

Dr. J.R.B. Alfred,
Deputy Director

I certify that the thesis entitled "Ecological Studies of Soil Arthropods in Forest and Jhum Systems of Laitkor, Meghalaya", submitted by Mr. Vincent Thansanga Darlong for the Degree of Doctor of Philosophy of the North-Eastern Hill University, Shillong embodies the record of original investigation carried out by him under my supervision. He has been duly registered and the thesis presented is worthy of being considered for the Award of the Ph.D. Degree. This work has not been submitted for any Degree of any other University.

Dated : November 17th, 1984
Place : Shillong.

Signature of the Supervisor.

A C K N O W L E D G E M E N T

An investigation of this type would be beyond the capacity of a single individual and I have received valuable assistance from many people. It is a pleasure to acknowledge their contributions.

To Dr. J.R.B. Alfred, formerly Reader in Zoology, NEHU, and now Deputy Director, Eastern Regional Station, Zoological Survey of India, Shillong for supervision, constant encouragement and direction with experienced judgement and effort beyond the call of duty, I owe a great debt of gratitude.

I record my deep appreciation to Dr. J.P. Thapliyal, FNA, Professor and Head, Department of Zoology, NEHU, for the facilities extended to me and more so, for his kindness and understanding. I am most happy to acknowledge my debt to Prof. R. George Michael and Prof. M.K. Khare, former heads of the department, for their encouragement and advice. That the present work was initiated under their tenure is gratefully recalled and acknowledged.

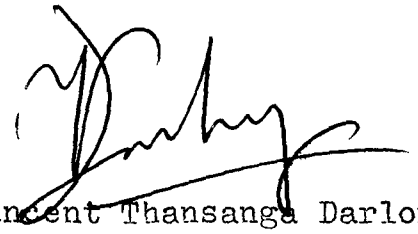
Thanks are also due to Prof. R.R. Mishra, Dean of the School of Life Sciences, Dr. R.K. Rai, Head of Geography Department and Prof. R. Lalthantluanga, Head of Biochemistry Department for their kind permission to avail the facilities of duplicating machine, Microsystem 1120 and Moscal calculator, respectively.

Dr. S.K. Mitra, Superintending Zoologist, Zoological Survey of India, Calcutta had kindly identified the collembolan species. My former teacher at St. Anthony's College, Shillong, Prof. R.K. Bhattacharjee donated the type-specimens of D. singularis and D. fraternus for my ready reference. The acarine species were identified by Dr. A.K. Sanyal, Zoologist, ZSI, Calcutta. Dr. Haridashan, Dr. S. Jamir

and Dr. S. Myrthong helped me in the identification of the plant species. To all of them I feel immensely indebted.

The assistance received from colleagues and friends, particularly Prabhakaran, Amal, Pinku, Debu, Mipun, Hattar, Didi, Achintya, Dilip, Barnabas, Golden, Julian, Yogendra, Goel, Mrs. P. Chaurasia, Bijoyda (for the photography), Salil (for the line diagrams) and Bah Nah are formally and gratefully acknowledged. And to Catherine, I only say "Thank you very much" for I know best all that she deserves in the making of this thesis.

Finally, I owe much to the farmer, who had willingly sacrificed a portion of his farmland (jhum fallow) for two years, knowing only that it meant something for "science".



(Vincent Thansanga Darlong)

C O N T E N T S

Inner cover page	... ...	i
Supervisor's Certificate	... ...	ii
Acknowledgement	... ...	iii
Introduction and Review of Literature	... ...	1
Study area	... ...	32
Materials and Methods	... ...	42
Results		
Abiotic factors	... ...	55
Biotic factors		
Annual densities	... ...	78
Population dynamics	... ...	214
Community analysis	... ...	319
Discussion	... ...	345
General discussion	... ...	389
Concluding remarks	... ...	392
References	... ...	395

.....

P L A T E S

			facing page
1	:	Shillong city from study site	24
2	:	Slashed vegetations arranged in rows	25
3	:	Slashed vegetations in the process of arrangements	25
4	:	Pre-burn jhum plot	26
5	:	Burning of jhum	26
6	:	Post-burning jhum plot	27
7	:	Collection of unburned vegetations	27
8	:	Jhum plot ready for cultivation	28
9	:	Jhum fallow preparing for recultivation	28
10	:	Forest study area	35
11	:	Profile of the forest soil	35
12	:	Jhum (fallow) study area	36
13	:	Profile of the jhum soil	36
14	:	Part of jhum study area preparing for recultivation	37

.....

F I G U R E S

facing page

1a. Map of Meghalaya showing the study site. 33

1b. Physiographical map of the study site. 34

2 . Seasonal fluctuations of meteorological data. 56

3 . Seasonal fluctuations of air, litter and soil temperature. 59

4 . Seasonal fluctuations of soil and litter moisture content. 62

5 . Seasonal fluctuations of soil particle sizes. 64

6 . Seasonal fluctuations of soil porosity. 66

7 . Seasonal fluctuations of litter weights. 68

8 . Seasonal fluctuations of pH values. 70

9 . Seasonal fluctuations of conductivity. 72

10. Seasonal fluctuations of organic carbon. 75

11. Seasonal fluctuations of nitrogen. 77

12. Seasonal fluctuations of total soil fauna in the forest and jhum systems. 215

13. Seasonal fluctuations of total soil fauna in different layers of the forest & jhum systems. 216

14. Seasonal fluctuations of Collembola. 219

15. Seasonal fluctuations of Hypogastruridae. 222

16. Seasonal fluctuations of Poduridae. 222

17. Seasonal fluctuations of Isotomidae. 224

18. Seasonal fluctuations of Isotoma (Desoria) trispinata. 226

19. Seasonal fluctuations of Cryptopygus thermophilus. 229

20. Seasonal fluctuations of "other isotomids". 231

21. Seasonal fluctuations of Entomobryidae. 233

22. Seasonal fluctuations of Dicranocentrus singularis. 235

23. Seasonal fluctuations of Dicranocentrus fraternus. 235

24. Seasonal fluctuations of Entomobrya sp. 238

25. Seasonal fluctuations of Lepidocyrtus sp. 239

26. Seasonal fluctuations of Salina sp. 239

27. Seasonal fluctuations of Isotobryoides sp. 241

28. Seasonal fluctuations of Seira sp. 241

29. Seasonal fluctuations of Metacoelura sp. 243

30. Seasonal fluctuations of "other entomobryids" 245

facing page

31. Seasonal fluctuations of Sminthuridae. 247
32. Seasonal fluctuations of Sphaeridia cornuta. 249
33. Seasonal fluctuations of Sminthurinus bimaculatus. 249
34. Seasonal fluctuations of Megalothorax minimus. 251
35. Seasonal fluctuations of Acarina. 253
36. Seasonal fluctuations of Astigmata. 256
37. Seasonal fluctuations of Prostigmata. 258
38. Seasonal fluctuations of Mesostigmata. 260
39. Seasonal fluctuations of Parasitus diviortus. 263
40. Seasonal fluctuations of "other mesostigmatid mites" 265
41. Seasonal fluctuations of Cryptostigmata. 267
42. Seasonal fluctuations of Rhysotritia ardua. 269
43. Seasonal fluctuations of Euphthiracarus sp. 271
44. Seasonal fluctuations of Mesotritia sp. 272
45. Seasonal fluctuations of Galumna sp. 274
46. Seasonal fluctuations of Neoribates sp. 276
47. Seasonal fluctuations of Dolicheremaeus sp. 277
48. Seasonal fluctuations of Eremobelba sp. 279
49. Seasonal fluctuations of Brachychthonius sp. 281
50. Seasonal fluctuations of Suctobelba sp. 281
51. Seasonal fluctuations of Uropodidae. 284
52. Seasonal fluctuations of "other oribatid mites" 284
53. Seasonal fluctuations of "Other Arthropods". 287
54. Seasonal fluctuations of Insecta. 289
55. Seasonal fluctuations of Diplura. 292
56. Seasonal fluctuations of Protura. 292
57. Seasonal fluctuations of Diptera. 295
58. Seasonal fluctuations of Coleoptera. 295
59. Seasonal fluctuations of Hymenoptera (Formicidae). 297
60. Seasonal fluctuations of Orthoptera. 300
61. Seasonal fluctuations of Dermaptera. 300
62. Seasonal fluctuations of Hemiptera. 302
63. Seasonal fluctuations of Psocoptera. 302
64. Seasonal fluctuations of Insect larvae. 304
65. Seasonal fluctuations of Isoptera. 304
66. Seasonal fluctuations of Myriapoda. 307

facing page

67. Seasonal fluctuations of Chilopoda. 309
68. Seasonal fluctuations of Diplopoda. 309
69. Seasonal fluctuations of Pauropoda. 311
70. Seasonal fluctuations of Symphyla. 311
71. Seasonal fluctuations of Arachnida. 313
72. Seasonal fluctuations of Pseudoscorpionida. 315
73. Seasonal fluctuations of Araneida. 315
74. Seasonal fluctuations of Isopoda. 318
75. Seasonal fluctuations of the number of collembolan species and diversity indices (Total systems). 321
76. Seasonal fluctuations of the number of collembolan species and diversity indices (0-10 cm layers). 324
77. Seasonal fluctuations of the number of collembolan species and diversity indices (10-20 cm layers). 328
78. Seasonal fluctuations of the similarity indices of Collembola.(Total systems). 331
79. Seasonal fluctuations of the similarity indices of Collembola (0-10 cm layers). 333
80. Seasonal fluctuations of the similarity indices of Collembola (10-20 cm layers). 333
81. Seasonal fluctuations of the number of oribatid species and diversity indices (Total systems). 336
82. Seasonal fluctuations of the number of oribatid species and diversity indices (0-10 cm layers). 339
83. Seasonal fluctuations of the similarity indices of oribatid species (Total systems). 343
84. Seasonal fluctuations of the similarity indices of oribatid species (0-10 cm layers). 343

.....

TABLES

			facing page
I	:	Numbers and percentages of total soil fauna.	80
II	:	Numbers and percentages of Collembola.	80
III	:	Numbers and percentages of Poduridae.	84
IV	:	Numbers and percentages of Hypogastruridae.	84
V	:	Numbers and percentages of Isotomidae.	88
VI	:	Numbers and percentages of *Isotoma* (*Desoria*) *trispinata*.	88
VII	:	Numbers and percentages of *Cryptopygus thermophilus*.	93
VIII	:	Numbers and percentages of "other isotomids".	93
IX	:	Numbers and percentages of Entomobryidae.	98
X	:	Numbers and percentages of *Dicranocentrus fraternus*.	98
XI	:	Numbers and percentages of *D. singularis*.	102
XII	:	Numbers and percentages of *Entomobrya* sp.	102
XIII	:	Numbers and percentages of *Salina* sp.	107
XIV	:	Numbers and percentages of *Metacoelura* sp.	107
XV	:	Numbers and percentages of *Seira* sp.	110
XVI	:	Numbers and percentages of *Lepidocyrtus* sp.	110
XVII	:	Numbers and percentages of *Isotobryoides* sp.	113
XVIII	:	Numbers and percentages of "other entomobryids	113
XIX	:	Numbers and percentages of Sminthuridae	117
XX	:	Numbers and percentages of *Sphaeridia cornuta*.	117
XXI	:	Numbers and percentages of *Sminthurinus bimaculatus*.	121
XXII	:	Numbers and percentages of *Megalothorax minimus*.	121
XXIII	:	Numbers and percentages of Acarina.	125
XXIV	:	Numbers and percentages of Astigmata.	125
XXV	:	Numbers and percentages of Prostigmata.	130
XXVI	:	Numbers and percentages of Mesostigmata.	130
XXVII	:	Numbers and percentages of *Parasitus diviortus*	136
XXVIII	:	Numbers and percentages of "other mesostigmatid mites".	136
XXIX	:	Numbers and percentages of Cryptostigmata.	142
XXX	:	Numbers and percentages of *Rhysotritia ardua*.	142
XXXI	:	Numbers and percentages of *Euphthiracarus* sp.	146

facing page

XXXII : Numbers and percentages of Mesotritia sp. 146
XXXIII : Numbers and percentages of Galumna sp. 150
XXXIV : Numbers and percentages of Neoribates sp. 150
XXXV : Numbers and percentages of Dolicheremaeus sp. 154
XXXVI : Numbers and percentages of Eremobelba sp. 154
XXXVII : Numbers and percentages of Suctobelba sp. 158
XXXVIII: Numbers and percentages of Brachychthonius sp. 158
XXXIX : Numbers and percentages of Uropodidae. 161
XL : Numbers and percentages of "other oribatid mites" 161
XLI : Numbers and percentages of "Other Arthropods". 166
XLII : Numbers and percentages of Insecta. 166
XLIII : Numbers and percentages of Protura. 171
XLIV : Numbers and percentages of Diplura. 171
XLV : Numbers and percentages of Diptera. 175
XLVI : Numbers and percentages of Coleoptera. 175
XLVII : Numbers and percentages of Hymenoptera. 181
XLVIII : Numbers and percentages of Isoptera. 181
XLIX : Numbers and percentages of Orthoptera. 185
L : Numbers and percentages of Dermaptera. 185
LI : Numbers and percentages of Hemiptera. 189
LII : Numbers and percentages of Psocoptera. 189
LIII : Numbers and percentages of Insect larvae. 194
LIV : Numbers and percentages of Myriapoda. 194
LV : Numbers and percentages of Chilopoda. 198
LVI : Numbers and percentages of Diplopoda. 198
LVII : Numbers and percentages of Symphyla. 203
LVIII : Numbers and percentages of Pauropoda. 203
LIX : Numbers and percentages of Arachnida. 207
LX : Numbers and percentages of Araneida. 207
LXI : Numbers and percentages of Pseudoscorpionida. 211
LXII : Numbers and percentages of Isopoda. 211
LXIII : Correlation coefficient between abiotic factors and Collembola in the litter layer of the forest. 364
LXIV : Correlation coefficient between abiotic factors and Collembola in the 0-10 & 10-20 cm layers of the forest soil. 365

facing page

LXV : Correlation coefficient between the abiotic factors and Collembola in the 0-10 & 10-20 cm layers of the jhum soil. 366

LXVI : Correlation coefficient between the abiotic factors and Acarina in the litter layer of the forest system. 367

LXVII : Correlation coefficient between the abiotic factors and Acarina in the 0-10 & 10-20 cm layers of the forest soil. 368

LXVIII: Correlation coefficient between the abiotic factors and Acarina in the 0-10 & 10-20 cm layers of the jhum soil. 369

LXIX : Correlation coefficient between the abiotic factors and "Other Arthropods" in the litter layer of the forest system. 370

LXX : Correlation coefficient between the abiotic factors and "Other Arthropods" in the 0-10 cm layer of the forest soil. 371

LXXI : Correlation coefficient between the abiotic factors and "Other Arthropods" in the 10-20 cm layer of the forest soil. 372

LXXII : Correlation coefficient between the abiotic factors and "Other Arthropods" in the 0-10 cm layer of the jhum soil. 373

LXXIII: Correlation coefficient between the abiotic factors and "Other Arthropods" in the 10-20 cm layer of the jhum soil. 374

.....

INTRODUCTION

AND

REVIEW OF LITERATURE

1. INTRODUCTION AND REVIEW OF LITERATURE

1.1. General introduction

A forest ecosystem comprises one of the most complex of communities. Trees, shrubs, herbs and mosses are the easily perceptible botanical components of such a community. Moulds, bacteria, algae and other lower plants are less conspicuous. The animal components of this ecosystem are much less striking, particularly those that live in/on the soil. Nevertheless, all phyla of the animal kingdom, possessing a terrestrial mode of life, composing of species of great diversities and sizes, are represented in the forest ecosystem. It is near to impossible for studying the total animal kingdom in such a forest ecosystem. Hence, for the present investigation and with particular reference to the work it is intended to convey, we confined our study to the soil components of this vast ecosystem.

The pedological literature abounds in definitions of soil in terms of its state, of its function and of factors and processes of its formation. Soil is that land cover of solid, liquid and gaseous materials. It lies below the observable interphase between the atmosphere and forest floor or grass-sedge or cropped land floor, and above the geologic substratum that appears relatively unaltered (Hole, 1981). The soil is also usually inclusive of the litter of organic debris. It is actually a major multilayered stratum in a larger and even more complex biocenose (Ghilarov, 1968).

This soil teems with life, inhabited by a bizarre assortment of living creatures. Soil fauna or soil animals as they are known collectively, is a broad term, and may be defined as one that participates in the dynamics of a soil body (Hole,1981) or applicable to all groups of animals which spend their life wholly or partly, in soil and litter (Drift, 1951).

Of these, the phylum Arthropoda, which include more known species of animals than all other groups of living organisms together, also contain the greatest diversity of soil inhabiting species. Kuhnelt (1963) had observed that there was hardly an arthropodan group which was not found in the soil. However, this bulk of arthropodan fauna in the soil is represented by Acarina and Collembola (Kevan, 1965), and other less abundant groups like Symphyla, Pauropoda, Protura, Diplura, Hymenoptera, Chilopoda, Diplopoda, Coleoptera, Araneida, Isopoda, Psocoptera, Dermaptera, Orthoptera, Diptera, Pseudoscorpionida, etc. Nematodes, enchytraeids, earthworms, molluscs and protozoans also form a major portion of the soil biocenose. However, for the present work, soil fauna would mean the arthropod fauna in soil in general with Collembola and Acarina in particular.

With the above in mind, the present investigation was carried out on these soil fauna, not only in the forest soil but simultaneously in that of a man-induced system, viz. jhum, also. The main objectives of the present work were to identify the various soil arthropod groups, their densities, population fluctuations and their intricate relationships with various

edaphic and climatological factors for at least two annual cycles. Though this could be looked at from individual and population levels, while making comparisons between two such systems as forest soil and jhum soil, it would be necessary to have community relationships at least for the major faunal groups. Moreover, the idea was to arrive at similarity indices between two such systems using the community data. The latter would enable an understanding into the colonization and successional patterns of these faunal groups in a disturbed soil condition as compared with that of a supposedly stable forest ecosystem.

1.2. The growth of soil zoology

Soil fauna represent one of the most complex, difficult and rewarding areas of current biological exploration. Contact with this frontier has received inadequate attention from pedologists for a long time, despite early works by White (1789) Darwin (1840, 1881) and Muller (1879, 1884) on earthworms and other invertebrate soil fauna, evaluating their role in humus formation. In greater details, the general studies of soil fauna has, however, begun with Diem's (1903) pioneering investigation of certain Swiss alpine soils, and subsequently supplemented by the contributions of Cameron (1913), Bornebusch (1930), Joffe (1936), Frenzel (1936), Jacot (1940), Forsslund (1945), Kubiena (1948) and Gilyarov (1949), who had drawn the attention of pedologists to the important role of animals in the formation of soil.

It may, perhaps, be argued that soil zoology has been developing towards maturity as a discrete discipline for the last thirty or forty years. Landmarks in this maturation process include the appearance of Kuhnelt's (1950) Bodenbiologie, produced in an English edition in 1961, summarizing the greater part of what was known about soil animals, and Franz's (1950) Bodenzoologie, in which he emphasized the practical implications of the study of the soil fauna.

These works heralded rapid spawning of concurrent literature and international symposia, devoted exclusively to soil animals, culminating in the publications and compilations of Delamare-Debouttéville(1951), Hartmann(1951), Drift (1951), Lawrence (1953), Kevan (1955, 1962), Nosek (1957), Farb (1959), Murphy (1962), Doeksen and Drift (1963), Burges and Raw (1967), Graff and Satchell (1967) and Vanek (1975). These authors have drawn together a considerable amount of information on the general biology and ecology of soil animals, and have done much to stimulate interest in this field. Also symptomatic of this interest was the creation of international journals of soil biology and ecology, viz. Pedobiologia in 1961 and Revue D'Ecologie et de Biologie du Sol in 1964.

Thereafter, research on soil fauna has been pursued with vigour by increasing number of investigators, as evidenced by rapid accumulation of literature on soil fauna. Texts on animal ecology, which have long paid scant attention to soil animals, have also given increasing recognition to soil fauna, and

some of them (Tischler, 1955; Macfadyen, 1957, 1963a; Balogh, 1958) lay heavy emphasis upon it.

The rapid accumulation of literature on soil fauna during this period was also due to simultaneous availability of improved soil fauna sampling techniques, largely due to the works of Macfadyen (1953, 1955, 1961a) and Alexander and Jackson (1955), though most were improvements and modifications of Tullgren's(1917) apparatus. Further evidence of rapid expansion since 1950, of the discipline of soil zoology has been treated by Wallwork (1970, 1976), Franz (1975) and others.

With the inception of the International Biological Programme in 1964, which aims at "world study of biological productivity and human adaptability", soil ecology studies has been sponsored by the section on terrestrial productivity. The result of this programme was the birth of an IBP Handbook, entitled, "Methods of Study in Quantitative Soil Ecology : Population, Production and Energy Flow" (Phillipson, 1971), which describes methods for biological research in soil ecology. This was also indicative of the beginning of quantitative approach to soil faunal studies with special reference to productivity and energy flow, which is now major thrust-areas of many soil faunal investigations in different parts of the world.

The last (and the 8th in the series) International Colloquium on Soil Zoology was held in September 1982 at the Catholic University of Louvain, Belgium. The Colloquium proceedings appeared in a volume: "A New Trend in Soil Biology", (Lebrun *et al.*, 1983).

1.3. Soil fauna studies in India

Systematic survey of literature on Indian soil fauna in general and soil arthropods in particular, is difficult as they are distributed in obscure journals. Scanty literature on the subject speaks of its poor attention received from Indian pedologists. Nevertheless, there is growing evidence of interest among Indian workers as indicated by the proceedings of the two national symposia "Soil Biology and Ecology in India" (Edwards and Veeresh, 1978) and "Progress in Soil Biology and Ecology in India" (Veeresh, 1981). These publications attempt to bridge the gap in the knowledge of soil biology and ecology in this country, which is, as yet insignificant when compared to her vast landscape variations and severe pressures on her fragile soils. Added to this venture is the creation of Indian Journal of Soil Biology and Ecology, the first issue of which appeared in September 1981. The recent appearance of a volume entitled, "Applied Soil Biology and Ecology" (Veeresh and Rajagopal, 1983) is indeed a landmark in the progress of the study of soil fauna in India. The State of Art Report : Zoology(1980) also gives comprehensive idea of the current status of soil zoology, particularly persons and institutions engaged in studies and reserach in the country and elsewhere.

The earliest taxonomic records of soil fauna from the Indian sub-continent dates back to Pocock (1892), reporting upon the ground-dwelling myriapods of the then Ceylon (Sri Lanka) and Southern India. Writing on the then British India, Bingham

(1903) reported on many of the ground-dwelling ants. While Imms (1912) and Carpenter (1917) described new collembolan genera and species of this sub-continent, contributions on acarine systematics and taxonomy were made by Pearce (1906), Ewing (1910), Jacot (1933) and Baker (1945).

Ecological investigation of soil arthropods in India was first undertaken by Trehan (1945), who reported on the density-fluctuations of microarthropods in seasons and effects of various factors on them as existed in a cotton field environ of Lyallpur (now in Pakistan). Shrikande and Pathak (1948) attempted to evaluate the roles of insects and earthworms in soil fertility. With these initial ecological works it was, however, appropriate that Dhillon (1964a,b) emphasized on the sampling tools, techniques and extraction apparatus for the ecological investigations of soil microarthropods as would have been suitable to Indian context.

Qualitative and quantitative studies of microarthropods occurring in association with different crop plots and uncultivated fields are known through the works of Mukharji and Singh (1967, 1970), Singh and Mukharji (1971, 1973), Singh and Pillai (1975, 1981), Prabhoo (1976), Gupta and Mukharji (1976a, b, 1978), Bhattacharya and Raychaudhuri (1979), Veeresh et al. (1981), Pai and Prabhoo (1981), Haq et al. (1981) and Rishi (1981). The contribution of Banerjee (1972) was the only exception deviating from general population studies to the role of microarthropods in humus formation. Reports on tropical decidu-

ous forest soil and litter microarthropods are limited in the works of Singh and Singh (1975) and Singh and Mahajan (1981). The soil and litter mesofauna of evergreen forests of the Himalayas in Kashmir is known through the works of Raina *et al.* (1981). Hazra (1982) made a preliminary report of the soil arthropods of Silent Valley.

To these general Indian workers, fragmentary knowledge of the soil fauna of North-East India is through the limited reports in papers by Reddy and Alfred (1977, 1978a,b) and Reddy (1980, 1981), Hattar and Alfred (1984) and Paul and Alfred (1984) concentrating on the arthropod populations of the pine forest floors at higher elevations of Meghalaya; Vatsauliya and Alfred (1980, 1981) and Vatsauliya (1981) reporting on the soil fauna of jhum fallows at lower elevations; Darlong (1979) and Darlong and Alfred (1982, 1984) showing the differences in the arthropod structure in the forests and jhum fallows of this region.

1.4. Literature on the fauna of forest soils

For the purpose of the present study, the following summary of the most important literature is confined to those investigations that concern the whole fauna or arthropod groups of the forest soils. The first to make a comprehensive investigation into the forest soil fauna was Diem (1903), on the Swiss alpine forests. Ramann (1911) described fauna of forest soils in Germany. He was perhaps one of the first to reveal the great importance of soil fauna in humus formation.

In Bavaria, an investigation into the composition of litter fauna in pine forests was made by Pillai (1922) and some years later Pfetten (1925) made a similar investigation for a spruce wood. They showed that great numbers of fauna occur in the forest litter layer and that a quantitative study can be performed in considerably smaller samples.

Grimmett (1926) studied the soil fauna of a beech forest in New Zealand. He examined his samples for the macrofauna and consequently, his recovery for the microfauna, such as mites and collembolans were appreciably low.

In Czechoslovakia, Soudek (1928) made a comprehensive investigation into the fauna of a spruce wood. He also calculated a daily production of excrements for collembolans, mites and enchytraeids. In the same year Tragardh (1928) published a study on the soil fauna of a Swedish wood.

Bornebusch (1930) published a detail study of the soil fauna of Danish forests. Besides reporting the quantitative results of some of the dominant groups, such as earthworms, mites, collembolans, etc., he dealt at length, the results concerning the role of soil fauna in litter decomposition.

Ulrich (1933) studied the litter fauna of a spruce wood with slow decomposition and a mixed beech-oak forest with a fairly good rate of decomposition. He related the fluctuations in numbers of fauna with the data on the climate. In the same year in Germany, Butovitsch and Lehner (1933) and Volz

(1934) investigated from mor and mull soils. Some years later, Fourman (1936, 1938, 1939) studied the significance of soil fauna in litter decomposition. He described the humification of tree-stumps and critically emphasized the stumps as hiding and gathering points for the soil fauna.

From the tropical Panama, Williams (1941) studied the soil fauna of a primeval forest. His investigation yielded numerous new genera and species. He also made attempts to discuss the ecological characteristics of some of the dominant groups.

Eaton and Chandler (1942) studied the composition of the fauna of different soil types in New York. The works of Hope (1943) and Pearse (1946) showed that American fauna resembled greatly the European forms, quantitatively and taxonomically.

Forsslund (1943) published an extensive study of the fauna of Swedish forest soil. He calculated the density, frequency and dominance of various species of soil fauna occurring in scotch pines and spruces with different undergrowths.

Jahn (1944) studied the fauna of the soil in pine aforestation of different ages in Austria. She related climatic factors as an influence on the fluctuation in the total numbers of the soil fauna, their development and vertical movement.

Strickland (1945, 1947) published two investigative reports on the fauna of the soil of cocoa plantations and compared it with that of native woods and a savannah biotope in

Trinidad. He also made attempts to show the influence of human activities on soil fauna.

Analysis of the faunal composition of a beech forest floor in Holland was made by Drift (1951). This publication deals extensively with the population dynamics over the seasons and vertical distributions of various soil faunal groups as was observed in such undisturbed forest floors.

Murphy (1955) studied the ecology of the fauna of forest soils. Di Castri (1963) published a work on the fauna of a broad-leaved forest floor in Chili. In the same year, Drift (1963) compared the soil fauna of a forest in Suriname with that of a plot of cultivated land. Maldague and Hilger(1963) studied leaf litter fauna of an equatorial rain forest. Greenslade and Greenslade (1968) investigated the density and vertical distribution of the soil and litter fauna of a lowland rain forest and grassland in the Solomon Islands.

McColl (1974) made a preliminary survey of soil faunal composition of six different forest types of West Coast, South Island. In Australia, Plowman (1979, 1981a) made an investigation into the litter and soil fauna of sub-tropical forests. She described the ecological characteristics of the Australian soil fauna and concluded resemblances with those of similar forest soils of the world.

More recently, Streit (1982) investigated a mixed beech-oak-pine forest in Switzerland for its arthropod popula-

tions. Similarly, Poursin and Ponge (1984) studied the microarthropod populations of forest humus in France.

Numerous literature on the forest soil fauna of Russian sub-continent are also available. Recent ones of importance are those of Ghilarov and Perel (1971) and Ghilarov (1979). These works include investigative results on the soil fauna of mixed coniferous-deciduous broad-leaved forests of Soviet Far East and beech-fir mixed forests of Caucasus. Recently, Nadvornyj (1983) studied the ecological aspects of soil mesofauna in the Ukrainian forest steppe.

From the Indian sub-continent, Singh and Singh (1975) and Singh and Mahajan (1981) made ecological investigation of soil and litter fauna of tropical deciduous forests. From the evergreen forests of Kashmir, Raina et al. (1981) and Rishi (1981) described the ecological characteristics of the soil and litter fauna. Hazra (1982) made a comprehensive report of the soil and litter faunal composition of forests of the Silent Valley in Kerala.

In addition to these, Reddy and Alfred (1977) and Hattar and Alfred (1984) studied the population fluctuations and community structures of soil arthropods from the sub-tropical pine forests of Meghalaya, North-East India. Very recently Sarkar (1984a) studied the soil microarthropod community of a deciduous forest in Tripura

1.5. Literature on Collembola

After the classification of the soil fauna according to their body sizes by Drift (1951) and Wallwork (1970), literature now exists for microfauna, mesofauna and macrofauna. However, the bulk of soil faunal literature is devoted to the studies of meso- or micro-fauna in general, and Collembola and Acarina in particular.

Collembola usually takes second place only to the acari among the air-breathing fauna of the soil. Ecological studies on Collembola are numerous from different parts of the world. Some of the important ones, particularly from the forest soils or related habitats are those of Davis (1928), MacLagan (1932), Ford (1937, 1938), Glasgow (1939), Baweja (1939), Forsslund (1945), Weis-Fogh (1948), Schaller (1949), Strenzke (1949), Drift (1951), Salt (1952, 1955), Macfadyen (1952, 1963b), Bellinger (1954), Murphy (1955), Kubiena (1955), Sheals (1957), Balogh (1958), Haarløv (1960), Cragg (1961), Kuhnelt (1961), Poole (1961, 1963), Dhillon and Gibson (1962), Milne (1962), Kitazawa (1962), Davis (1963), Hale (1963, 1966, 1967), Christiansen (1964), Torne (1965), Ogino *et al.* (1965), Marcuzzi (1966), Naglitsch (1966), Poinsot (1966), Whitkamp and Crossley (1966), Niijima (1966a,b, 1971, 1975), Huhta *et al.* (1967, 1969), Wood (1967), Tanaka (1967, 1970), Tamura (1967, 1976), Joosse (1969, 1970, 1971, 1973, 1975, 1981), Usher (1969, 1970), Vannier (1970) Butcher *et al.* (1971), Willard (1973), Takeda (1973, 1976, 1978, 1979a,b, 1983, 1984), Blackith (1974), Fjellberg(1975), Kaczma-

rek (1975), Joosse and Testerink (1977), Pomeroy (1977), Leinaas (1978, 1981, 1983), Wiggins et al. (1979), Mertens and Blancquaert (1980), Testerink (1982), Hagvar (1982), Huhta and Mikkonen (1982), Mertens et al. (1982), Wolters (1983), and Seastedt and Crossley (1984).

Systematics of Indian Collembola are known through the works of Imms (1912), Carpenter (1917), Yosii (1966), Prabhoo (1971a,b), Mitra (1973, 1976a,b, 1982), Mitra and Choudhuri (1973), Tyagi and Baijal (1979), Prabhoo and Muraleedharan(1980) and Mari Mutt and Bhattacharjee (1980).

Ecological studies on Indian Collembola are those of Choudhuri (1960, 1961, 1962, 1963a,b), Choudhuri and Roy (1965, 1967, 1970, 1971a,b,c, 1972), Singh and Mukharji (1971, 1973), Singh and Pillai (1973, 1975, 1981), Singh and Singh (1975), Choudhuri and Banerjee (1975), Prabhoo (1976), Gupta and Mukharji (1976a,b, 1978), Reddy and Alfred (1977, 1978a,b), Singh and Singh (1978), Hazra (1978), Choudhuri et al. (1978), Mitra et al. (1978), Bhattacharya and Raychaudhuri (1979), Reddy (1980, 1981) Vatsauliya (1981), Pai and Prabhoo (1981), Raina et al. (1981), Rishi (1981), Haq et al. (1981), Veeresh et al. (1981), Singh and Mahajan (1981), Mahajan and Singh (1981), Mukherjee and Roy (1981), Hazra and Choudhuri (1981), Mitra et al. (1981), Barlong and Alfred (1984), Kurup and Prabhoo (1984), Panda and Guru (1984), and Roy and Banerjee (1984).

101778.
15

1.6. Literature on Acarina

Acarina or mites are numerically the most abundant faunal groups in most soils. Some of the important ecological studies on soil acari, particularly the oribatei, are those of Weis-Fogh (1948), Drift (1951), Macfadyen (1952), Karppinen (1955), Haarløv (1955, 1960), Sheals (1957), Wallwork (1958, 1959, 1967, 1970, 1983), Eitminaviciute (1959), Woolley (1960), Tarras-Wahlberg (1961), Nef (1962), Davis (1963), Madge (1964), Hayes (1965), Berthet and Gerard (1965), Block (1965, 1966a,b), Harding (1967), Wood (1967), Marshall (1968), Reeves (1969), Popp (1970), Fujikawa (1970a,b, 1974), Metz (1971), Usher (1971, 1975), Butcher et al. (1971), Anderson (1971, 1978), Hammer (1972), Luxton (1972, 1975, 1981a,b,c,d,e), Price (1973, 1975), Pande and Berthet (1975), Price and Benham (1976), Mitchell (1977, 1978, 1979), Behan et al. (1978), Aitchison (1979a), Thomas (1979), Baath et al. (1980), Plowman (1981b,c), Athias-Binche (1981) and Karg (1982).

Our knowledge on the systematics of Indian soil acari, with particular reference to the oribatid mites, are due to that of Pearce (1906), Ewing (1910), Jacot (1933), Baker (1945), Aoki (1965), Prasad (1965, 1974), Bhaduri and Raychaudhuri (1967, 1968), Chakrabarti and Bhaduri (1972), Chakrabarti et al. (1972, 1973), Hafeez-Kardar (1972, 1974), Bhattacharya et al. (1974), Bhaduri et al. (1974), Bhaduri et al. (1975), Haq(1978), Pramanik and Raychaudhuri (1978), Gupta (1981) and Mohanasundaram (1982).

However, acarine ecology in India is only of recent interest as evident from Mukharji and Singh (1970), Singh and Mukharji (1971), Singh and Pillai (1975, 1976), Choudhuri and Banerjee (1975 , 1977) , Singh (1978) , Bhaduri and Raychaudhuri (1978), Choudhuri et al. (1978), Choudhuri and Pande (1979, 1982), Joy and Bhattacharya (1981), Sanyal (1981), Sanyal and Bhaduri (1982), Bhattacharya and Chatterjee (1984), Sanyal and Sarkar (1984) and Sarkar (1984b).

1.7. Literature on "Other Arthropods"

Accounts of soil arthropods other than Collembola and Acarina are also provided in the general studies of soil fauna by Drift (1951), Kuhnelt (1961), Kevan (1962), Wallwork (1970, 1976) and Babbatt (1983), as well as in the collection of papers edited by Doekson and Drift (1963), Burges and Raw (1967), Graff and Satchell (1967), Phillipson (1970), Vanek (1975), Edwards and Veeresh (1978), Veeresh (1981) and Lebrun et al.(1983). In addition to these, a brief review of some of the major groups of soil arthropods other than Collembola and Acarina, with particular reference to the Indian works, are as follows.

Protura and Diplura:

Proturans and diplurans are often neglected by soil zoologists because they are rarely collected in large numbers. Notable contributions on the ecological studies of these groups from different habitats are Tuxen (1949, 1965), Raw (1956), ..

Engelman (1961), Kuhnelt (1961), Nosek (1975, 1977, 1982), Gunnarsson (1980), Tomlin and Miller (1982) and Nadvornyj (1983).

From Indian soils, Choudhuri and Roy (1970) reported the presence of Protura in some districts of West Bengal. Singh and Mukharji (1971) listed the different species of Diplura occurring in and around Varanasi in Uttar Pradesh. Prabhoo (1972) reported the different species of Protura from South India, notably Kerela. Reddy (1980) recorded both proturans and diplurans from the Pine forest soils of Meghalaya. More recently, Ghaisas and Ranade (1981) recorded Diplura from Poona.

Hemiptera/Homoptera:

Indian works on this group has been chiefly directed as pests of agricultural crops, notable among them being Ayyar and Ramakrishna (1930, 1940), Lal and Singh (1947), Channa Basavanna and Rajagopal (1978). Reddy (1980) recorded the hemipterans in the pine forest floor of Meghalaya. Recently, Ghosh (1981) gave an account of the ecology of the subterranean aphids of India.

Isoptera (Termites):

Termites form a dominant group among soil living organisms, particularly in the warmer regions of the world. Numerous literature exist on this group perhaps because of their role as destructive pests and contribution to soil fertility. As far back as 1886, Drummond suggested that in the tropics,

the termites play a part in improving and preserving soil fertility equal to that of earthworms, as described by Darwin (1881) for temperate countries. Recent works on termites are those of Hesse (1955), Kemp (1955), Nye (1955), Robinson (1958), Maldague (1959), Lee and Wood (1971), Arshad et al. (1982) and Anderson and Wood (1984).

An excellent review of recent advances in termite research in India has been done by Sen-Sarma (1981). Earlier, Roonwal (1958) reviewed the extent of termite research in India, particularly between the period 1947-1957. Most recent ecological works on Indian termites are those of Chhotani (1981) and Roonwal (1981).

Hymenoptera (Formicidae):

Ants are one of the best known social insects. Myrmecology or the science of ant study had been in progress since the middle of the 18th century. Hence, innumerable literature exists on the study of ants inhabiting the soils. However, the most recent ones are those of Elmes (1978), Petal (1980), Goesswald (1981), Elmes and Wardlaw (1982).

A brief review of the study of ants in India had been given by Verghese and Veeresh (1978). Early workers in Indian myrmecology include Rothney (1890), Wroughton (1892), Bingham (1903) and Lal (1939). Recent contributors are Gupta (1963, 1964, 1966, 1968a,b, 1970), Reddy et al. (1981), Reddy and Ao (1984).

Pauropoda:

Pauropods are minute organisms, rarely more than 1-2 mm in length and are seldom found in large numbers in the soil. Pauropods had been extensively studied by Starling (1944), Lawrence (1953, 1964), Cloudsley-Thompson (1958), Leinaas (1974) and Moore (1982).

Very little information is available on Indian pauropods. Singh and Mukharji (1971, 1973) recorded these organisms from the sugarcane fields. Reddy (1980) recorded these organisms from the pine forests of Meghalaya.

Symphyla:

Notable contributions on the ecology of symphylids are those of Verhoeff (1934a,b), Michelbacher (1949), Edwards (1955, 1958, 1959, 1961), Anglade (1967) and Leinaas (1974).

From Indian soils, the symphylids have been recorded by Singh and Mukharji (1971), Vatsauliya (1981), Darlong and Alfred (1982) from different habitats. These authors have also shown that symphylids, though considered to be rare animals, were the most numerous myriapods present in the soil.

Pseudoscorpionida:

The Chelonethi or pseudoscorpions, although not very common in soils, have been ecologically well documented by Ressl and Beier (1958), Gasdorf and Goodnight (1963) and Gabbutt(1967).

From India, pseudoscorpions have been collected from different habitats by Choudhuri and Roy (1970), Singh and Mukharji (1971), Reddy (1980) and Vatsauliya (1981).

Chilopoda and Diplopoda:

Some of the recent notable ecological works on these groups are those of Bocock and Heath (1967), Saito (1967), Wallwork (1970), Davis and Sutton (1977), Davis et al. (1977), Geoffroy (1981), Enghoff (1983), Nadvornyj (1983), Kokhiya (1983), Kime and Wauthy (1984), Phillipson & Meyer (1984) and Snider('84).

The early works of Pocock (1892), Silvestri (1916) and Attems (1937) were limited to taxonomical descriptions of some of the Indian and oriental millipedes. Recent works on Indian millipedes are those of Rangaswamy and Channa Basavanna (1969), Rangaswamy et al. (1978a,b), Bano and Krishnamoorthy (1978,1981) and Mukhopadhyay and Saha (1981). No ecological data is available on Indian Chilopoda except that they had been recorded as components of soil fauna by Reddy (1980), Vatsauliya (1981) and others.

Isopoda (woodlice):

A considerable amount of literature exist on the ecological studies of soil-dwelling isopods from different parts of the world, and some of these include Sutton (1972), Davis and Sutton (1976) and Nadvornyj (1983). However, no ecological data exist on Indian isopods, except perhaps the records of David

(1965, 1978) as pests of sugarcane plantations in Tamil Nadu and Reddy (1980) as component of pine forest soil arthropods in Meghalaya.

Coleoptera:

Recent ecological studies on soil-dwelling coleopterans include Evans (1969), Greenslade (1972), Aitchison (1979a), Peck and Forsyth (1982), Nadvornyj (1983), and Dennison and Hodkinson (1984a, b).

Important studies on Indian soil-dwelling coleopterans and their white grubs are those of Stebbing (1914), Fletcher (1917, 1920), Ayyar (1922), Trehan (1929), Mathur and Singh (1959), Siddappaji and Channa Basavanna (1978), Viswanath et al. (1978), Tayade and Raodeo (1978), Yadava et al. (1978), Dutta and Sengupta (1981). Most of these studies, however, are limited to the reports or records of beetles and their grubs as silvicultural and agricultural pests.

In addition to the foregoing literature on arthropods other than Collembola and Acarina, ecological studies of recent importance for spiders (Uetz, 1975; Koponen, 1975, 1977; Waldof, 1976), diptera (Aitchison, 1979c; Mollon, 1982; Hovemeyer, 1984) and insect larvae (Nabialczyk-Karg, 1980) are also available from different parts of the world. However, similar studies of soil fauna from Indian sub-continent are greatly wanting.

1.8. "Jhum" (Shifting cultivation) in North-East India and the soil fauna

The prehistoric origin of shifting cultivation is credited to the Neolithic period about 8000-7000 B.C. on the strengh of archaeological evidences, when human society changed from food-gathering to food-production (Sharma, 1976). Therefore the practice of burning slash to prepare swidden is not less than 10,000 years (Solheim, 1967) but man's use of fire to clear and alter natural communities for other reasons is much older (Sauer, 1967; Stewart, 1970; Pullan, 1975; Scott, 1977). This ancient form of slash and burn agriculture, known differently in different tribal belts (who practice this type of traditional cultivation), is still predominant among the hill people of the humid tropics and sub-tropics of the world.

Known as "Jhum" or "Jhumming" in North-East India, the cycle of this primitive agricultural operation in this region is marked by the following stages: (1) selecting a forested hilly land; (2) clearing the forest tract by cutting or slashing the vegetation; (3) allowing the slashed vegetation to dry; (4) making fire line and burning the dried forest into ashes; (5) collecting and clearing unburned logs and branches; (6) worship and sacrifice; (7) dibbling and sowing of seeds of various crops; (8) weeding (several times during a cropping period); (9) watching and protecting the crops; (10) harvesting; (11) thrashing and storing; (12) merry making and (13) fallowing, i.e. abandoning for natural regeneration of the forest for a considerable

number of years after which the cycle is repeated. In its traditional form, the jhum cycle (the intervening fallow period after which the forested fallow land is similarly recultivated) used to be 20-30 years, but has now been reduced to 4-5 years due to increased population pressure.

The pattern of jhum at higher elevation of the Khasi Hills of Meghalaya, as around Shillong, is a modification of the typical type as outlined above. Here the destruction of the forest (dominated by Pinus kesiya Royle ex Gordon) is only partial. Instead of complete clearing of the forest, only the undergrowths and lower branches of the trees are slashed and arranged over the land that has been prepared into parallel ridges and furrows. During the months of late February to early March, a thin layer of soil is placed over the dried plant biomass that were arranged over the ridges and burned. Organic manure, in the form of cowdung, is also applied in the soil before planting the crops (Plates : 1-9).

A mixture of crops are grown together in the same field. Soon after the burn and a few weeks before the onset of monsoon, the tuber crops like Solanum tuberosum, Ipomoea batatus, and Colocasia antiquorum are planted on the ridges. Sowing of cereal (Zea mays), legume (Phaseolus vulgaris) and a few cucurbits (Cucurbita maxima and Cucumis sativus) are done just after the onset of monsoon. Along each ridge, usually three distinct rows of sowing is done through dibbling with a mixture of both Solanum tuberosum and Zea mays mixed together. Planting of Colo-

Plate : 1. The view of Shillong from a part of the Laitkor forest, close to the study area.

PLATE : 1

THE VIEW OF SHILLONG FROM A PART OF the Laitkor Forest, Close to the Study Area.

Plate : 2. The small branches, twigs and leaves of slashed vegetation arranged in rows and allowed to dry.

Plate : 3. A farmer is arranging the slashed vegetation into rows over the ridges.

The small branches, twigs & leaves of slashed vegetation arranged in rows & allowed to dry.

PLATE : 2

A farmer is arranging the slashed vegetation into rows over the ridges.

PLATE : 3

Plate : 4. Soil-covered dry vegetations arranged in ridges and furrows, ready for burning.

Plate : 5. The dried vegetation is being burnt.

Soil-covered dry vegetation arranged in ridges & furrows, ready for burning

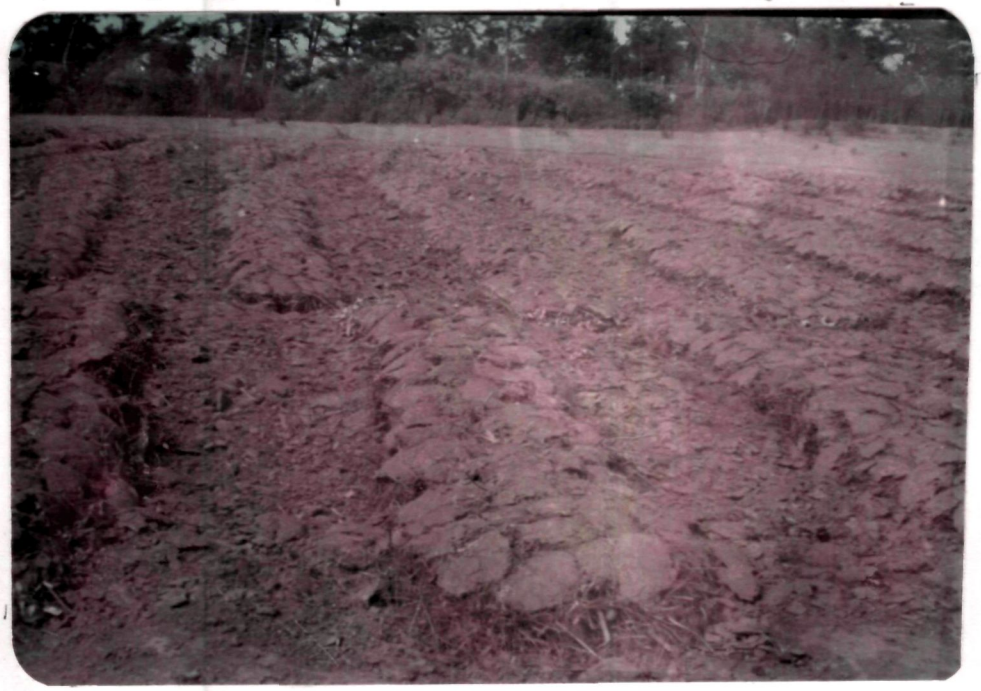


PLATE : 4

The dried vegetation is being burnt.

PLATE : 5

Plate : 6. As the plot looks just after burning.

Plate : 7. The unburned vegetation is being collected for (usually) reburning.

As the plot looks just after burning.

PLATE : 6

The unburned vegetation is being collected for reburning.

PLATE : 7

Plate : 8. A jhum plot ready for cultivation.

Plate : 9. An old jhum plot (fallow) under preparation for recultivation.

A Jhum plot ready for cultivation.

PLATE : 8

An old Jhum plot (fallow) under Preparation for recultivation.

PLATE : 9

casia antiquorum is confined generally to the top and bottom part of each ridge and the cucurbits are sown at random, but widely scattered on the ridge. Phaseolus vulgaris is sown around the pine trees which provide support to it. After the harvest of the tuber crops in July-August, a winter crop of Solanum tuberosum is sown along the ridges. Harvesting of Zea mays and Phaseolus vulgaris is done in September-October, after which Brassica oleracea seedlings are planted along with the winter crop of Solanum tuberosum. Harvesting of these winter crops are done in November and then the field is left uncultivated between December to March, during which the field is prepared following similar procedures (slashed vegetations are collected from adjoining forest), if second year of cultivation is to be done; otherwise the field is abandoned for regeneration of natural vegetation (Mishra and Ramakrishnan, 1981).

Controlled burning, which is prevalent in different parts of the world, is an accepted and widely used forest management practice. It is used chiefly to reduce fire hazard and secondarily, to create conditions appropriate for the establishment of future forest stands (Ahlgren and Ahlgren, 1960; Rowe, 1970; Kilgore, 1972, 1973, 1976; Viereck, 1973).

In slash and burn agriculture, although fire performs the necessary function of clearing the new swidden and converting slash to fertilizing ash, it has three less desirable side effects: (1) certain nutrients are lost from the system as volatiles (Lewis, 1974); (2) soil surfaces are exposed to possible

erosion by water and wind; and (3) changes to the physical and chemical properties of soil are initiated. Destruction of the original vegetation cover and creation of an entirely different microclimatic and radiation conditions at ground level also results. These effects, however, are part of the original reason for felling the forest.

Such adverse effects from burning and the effects of fire on ground and soil animals do exist (Rice, 1932; Heyward and Tissot, 1936; Pearse, 1943; Ahlgren and Ahlgren, 1965; Buffington, 1967; Huhta, 1971; Metz and Farrier, 1971a,b; Vlug and Bordon, 1973; Christensen and Kimber, 1975; Merrett, 1976; Lussenhop, 1976; Roesgaard and Lindhardt, 1979; Kuebelboeck, 1982; Majer, 1984).

Further, it is a tradition to criticize shifting cultivation as a waste of land and human resources (FAO, 1957). However, recent investigations indicated several ecological benefits of shifting cultivation, including advantages of intercropping and forest fallow in pest control and maintenance of soil quality (Jaiyebo and Moore, 1964; Clarke, 1976; Wilken, 1977), the favourable energy input to energy output ratio (Rappaport, 1971), and the rich abundance of useful plants available from forests under fallows (Arnason et al., 1980). And yet, modern shifting agriculture is not without ecological problems. Recent pressure for land has led in turn to sedentation (intensification of land use through establishment of permanent villages), degradation of habitats, decreasing yields, etc. (Clarke, 1976).

Thus, shifting agriculture is now alternately condemned and praised. This peculiar traditional sustaining activity of a section of humid tropical population continues to draw the attention of investigators from different parts of the world (Freeman, 1955; Schlippe, 1956; Bartlett, 1956; Conklin, 1957; Pelzer, 1957; Carneiro, 1960, 1961; Webster and Wilson, 1966; Denevan, 1966, 1971; Harris, 1971; Odum, 1971; Watters, 1971; Sanchez, 1973, 1976; Scott, 1974; Manshard, 1974; Zinke et al., 1978; Arnason et al., 1982; Montagnini and Jordan, 1983).

Literature on the jhum system (shifting cultivation) of India in general, and North-East India in particular, are limited to the socio-economic, socio-cultural, soil nutrients, low yields, secondary plant successional status (Pakem et al., 1976; Borthakur et al., 1978; Ramakrishnan et al., 1978; Ramakrishnan and Toky, 1978, 1981; Toky and Ramakrishnan, 1981a,b;82; Mishra and Ramakrishnan, 1981, 1983a,b) and microbial populations (Deka, 1981). In comparison, the few data which exist on the ecological studies of soil fauna of jhum, and the role of soil fauna in the recuperation of the soil under such conditions of stress, are found in Vatsauliya and Alfred (1980), Vatsauliya (1981) and Darlong and Alfred (1982, 1984).

STUDY AREA

2. STUDY AREA

2.1. Location

The present investigation was carried out in a part of the protected forest, known as "Laitkor Reserved Forest". The forest has northerly drainage system and extends between south-eastern to southern side of the montane temperate city of Shillong (25°.34'N ; 91°.56'E). The protected forest lies in the Shillong Plateau and the plateau extends between the longitudes 91°.15'E to 92°.46'E and latitudes 25°.15'N to 25°.45'N, in the State of Meghalaya, North-East India. The actual sampling area (forest and jhum) is situated at an elevation of 1890-1900 m above m.s.l. of the general study site. It is located, about 9 km from Shillong (off N.H. 44) and 1.5 km to the east of Laitkor Peak (1929.3 m) (Fig. 1a & 1b; Plates : 10-14).

2.2. Origin

Physio-geographically, the area represents a remnant of an ancient plateau of pre-Cambrian Indian peninsular shield, uplifted to its present height. The kernel of the plateau is the exposed gneisses and schists, covered in this area by pre-Cambrian quartzites, intruded later by younger granites. The ancient peripheral surface of the plateau is still preserved with marks of different cycles of denudation, hidden beneath the Mesozoic traps along the central southern fringe and Cretaceous/ Tertiary and post-tertiary sediments.

The Shillong Plateau, indeed has a chequered evolutiona-

Fig. 1a. Showing the map of Meghalaya and the location of the study site (Laitkor).

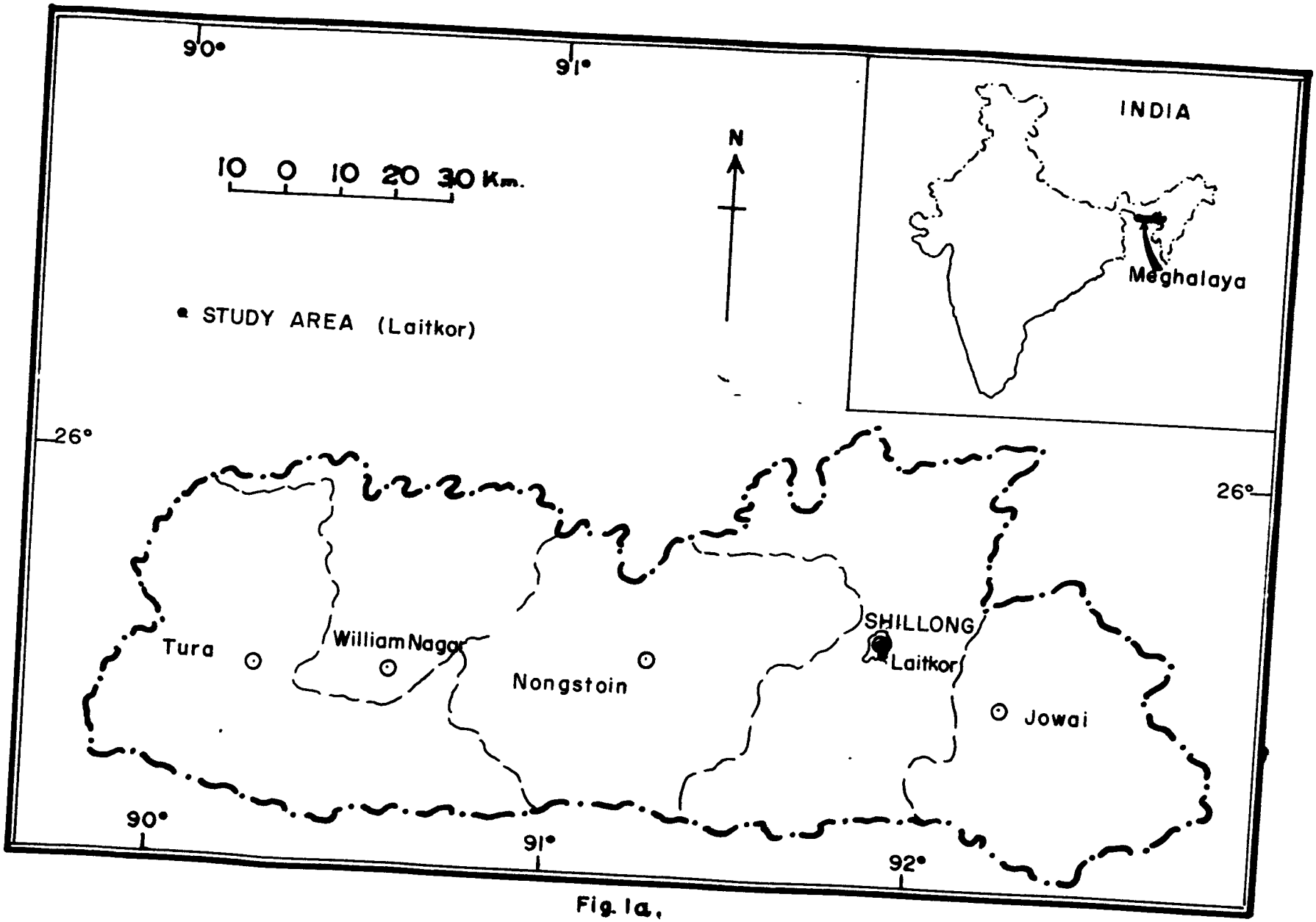

90°
91°
10 0 10 20 30 Km.
N
INDIA
Meghalaya
STUDY AREA (Laitkor)
26°
26°
Tura
William Nagar
Nongstoin
SHILLONG
Laitkor
Jowai
90°
91°
92°

Fig. 1a.

Fig. 1b. Showing the physiographical map of Laitkor forest and its adjoining areas, indicating the location of the study area.

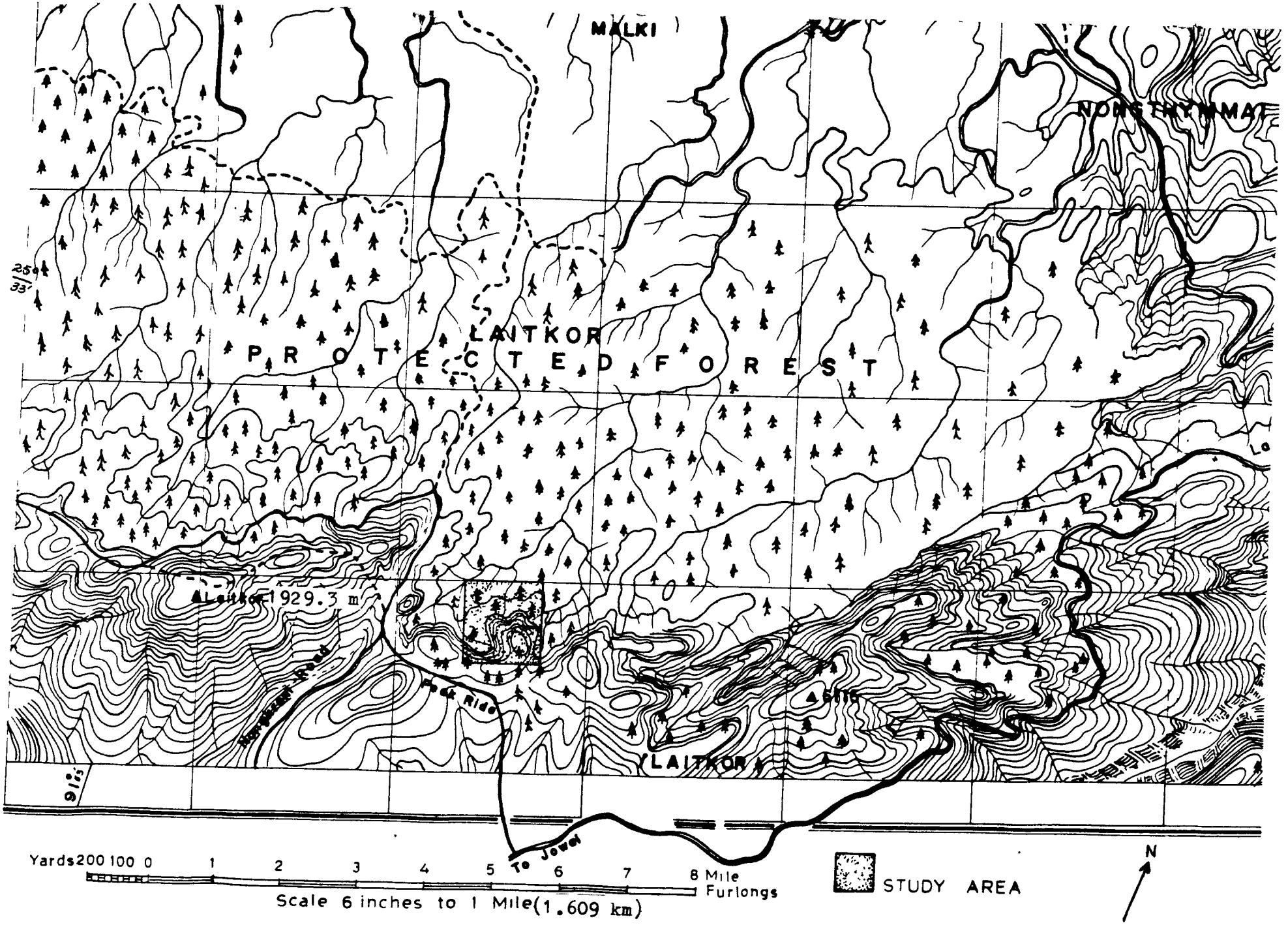

MALKI
NONGTHYMMAI
PROTECTED FOREST
LAITKOR
1929.3 m
LAITKOR
Yards 200 100 0 1 2 3 4 5 6 7 8 Mile
Furlongs
To Jowai
STUDY AREA
N
Scale 6 inches to 1 Mile(1.609 km)

Fig. 1b

Plate : 10. Showing a part of the forest study area.

Plate : 11. Showing the soil profile of the forest with the litter layer.

PLATE : 10

PLATE : 11

Plate : 12. Showing the jhum plot (fallow) at the end of the study period.

Plate : 13. Showing the soil profile of the above area.

PLATE : 12

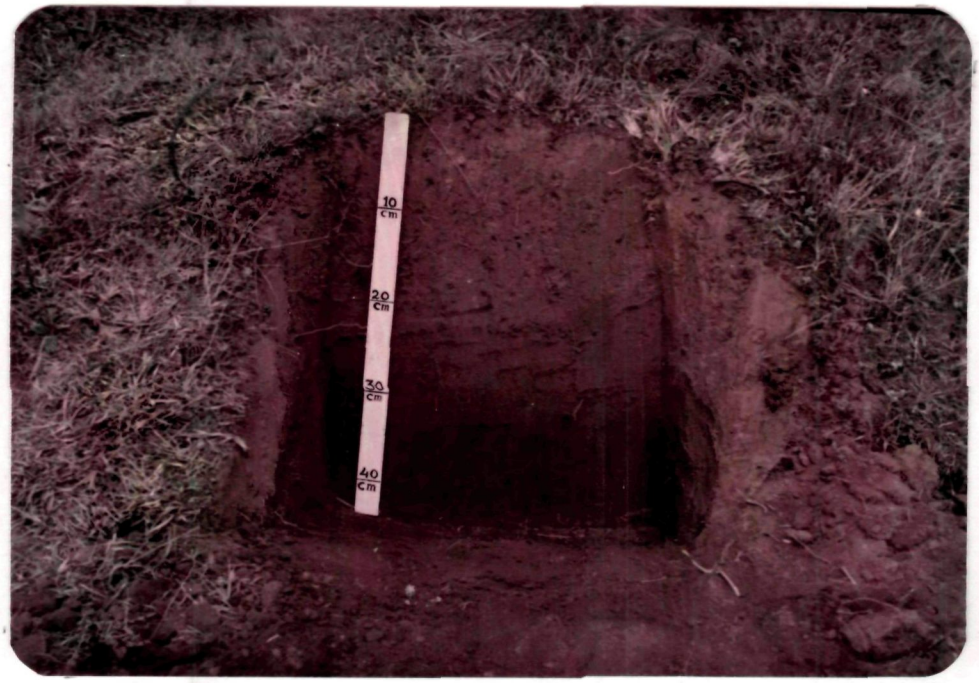


PLATE : 13

Plate : 14. Showing a part of the jhum study area (adjacent to the forest area) under preparation for recultivation.

PLATE : 14

ry history of emergence and sub-mergence through different geological events since Mesozoic to present day as indicated by the polycyclic erosional surface and configuration at various levels. The waters of the encroaching Tethy's Sea submerged the plateau during the Mesozoic and Tertiary period and it was uplifted from the sea-bed at the time of the emergence of the Himalayas. Thus, the whole of Meghalaya hills were once a part of the peninsular shield representing a segment of the old 'Gondwanaland' of the pre-Cambrian period (Zimba, 1978).

2.3. Topography and soil description

The Shillong Plateau and the study site in general, is made up of hard crystalline rocks of granite and gneisses. Often layers of sandstones, limestones and conglomerates with subordinate clays, are superimposed over these harder rocks.

In the undisturbed zones, the soil profile in the forest sampling area shows a sharp boundary between the A-layer and the B-layer. The organic layer (hereafter referred to as litter) is recognizable into L-, F- and H-layer. The L-layer (freshly fallen litter layer) is about 1-3 cm in thickness, consisting of pine needles, cones, twigs and other fallen leaves and inflorescence. The F-layer (fermentation layer) is about 2-3 cm in thickness, consisting of rootlets and partially decomposed litter with portions of plant structures still recognizable in many occasions. The H-layer (humus layer) is comparatively thinner, ranging between 1-2 cm in thickness. The B-layer begins from 3-5 cm depth.

The soil of the forest sampling area is light orange to dark brown in colouration. It is loamy in texture with fine silt constituting the major fractions. The ratio of fine silt to sand is approximately 80:20 percent. Gravels of different sizes are also abundant in the area. Further, the soils of the forest sampling area are characterised by a very high organic matter content (as detailed in the Results).

The jhum sampling area also has similar soil types as that of the forest. Here the fine silt constituted about 77-79 percent. Unlike the forest soils, a characteristic feature in jhum is the total absence of the litter layer.

2.4. Vegetation

2.4.1. Vegetation of the forest

The forest sampling area was a pine (Pinus kesiya Royle ex Gordon) dominated forest. Other less abundant trees of the area were Rhus javanica Linn., Cinnamomum glanduliferum Meisn , Machilus khasyana Meisn and Cassia sp. Many of these older trees were covered with mosses, lichens and other epiphytic plants , and occasionally entangled by creepers and twiners such as Rubia cardifolia Linn., Vitis sp., etc.

The shrub layer, particularly in rainy season, was dominated by Eupatorium adenophorum Spreng, Eurya japonica Thunb., Osbeckia nepalensis Hk., Rubus ellipticus Smith, Colquhounia vestita Wall and Viburnum sp.

The field layer consisted of a profuse growth of evergreen and deciduous seedlings, herbs and grasses, such as Anemone rivularis Buch-Nam ex Dc., Ophiopogon wallichiana Kunth (Hk. f.), Cantleya lutea Roule, Cyanotis vaga (Lour) J.A. et J.H. Schutt, Galium elegans Wall, Anaphalis cinnamomea Cl., Potentilla fulgens Wall, Isachne himalaica Hk.f., Capillipedium assimile (Steud.) A. Camus., Arundinella bengalensis Spreng, Imperata cylindrica (Linn.) P. Beauv., etc.

2.4.2. Vegetation of the jhum

The jhum sampling area was also an original pine (Pinus kesiya Royle ex Gordon) stand, belonging to a private local-owner. During the first and second year of investigation, the jhum sampling area was invaded by various species of evergreen and deciduous seedlings and annuals and perennials.

In succeeding order of decreasing abundance, the shrub species were Eupatorium adenophorum Spreng, Osbeckia stellata D. Don, Colquhounia vestita Wall, Daphne cannabina Wall and Rubus khasianus Cord.

The herbaceous vegetation was composed of Trifolium repens Linn., Hypochaeris radicata Linn., Potentilla fulgens Wall, Pteridium equilinum Linn., Oenotheria rosea Hit., Selaginella sp. and Pimpenilla sp.

The rich growth of grasses was made up of Eragrostis nigra Nees ex Stend., Imperata cylindrica (Linn.) P. Beauv., Axonopus compressus (Sw.) P. Beauv. and Oplismenus burmannii P. Beauv.

Besides these, dry stalks of maize (Zea mays Linn.) and potato (Solanum tuberosum Linn.), which were cultivated during jhumming, were frequently encountered, particularly during the first year of sampling.

2.5. Climate

The climate of the region is controlled by the seasonal winds of the South-West Monsoons and the North-East Winter Winds. Hence, the region experiences approximately two months (March-April) of spring, five months (May to September) of summer/rainy season, two months (October-November) of autumn, and three (December-February) of winter season. Usually from the middle of April to the middle of May, the temperature reaches the maximum and this short period may be termed as the dry summer season.

In general, the region enjoys a sub-tropical monsoon climate, the summer temperature reaching a miximum of 26°C and the mean winter temperature falling down to 6°C (as low as 2°C on hill-tops), marked by appearance of ground frost at night and early morning for most of the winter. The average annual rainfall is 250-300 cm, the maximum annual average of 1,200 cm being recorded at nearby Cherrapunjee and Mawsynram platforms, the world's rainiest spots.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

3.1. Demarcation and precautions of the sampling areas

Experimental plots, measuring about 100 x 100 m^2 each were demarcated in both the forest and jhum areas. The sampling areas, as far as possible, were kept undisturbed from:

(a) the nearby villagers, who frequented into the forest to collect dry branches and fallen twigs for their fuel;

(b) the grazing herds and the herdsmen, who occasionally collected below-ground herbs and shrubs for fodder;

(c) the local farmers, who collected leaf-ladden twigs and freshly fallen litter for burning in the cultivated fields, particularly during the months of January-February;

(d) accidental forest fires, mainly caused by the carelessness and irresponsibilities of the local herdsmen.

3.2. Design of sampling

A sampling scheme was devised to cover twenty-four months between July 1980 to June 1982. Samples were taken at fortnightly intervals during this period. All the collections were made in the morning hours between 0800-1000.

In each of the forest and jhum sites, sampling areas of approximately 100 x 100 m^2 were demarcated. In order to ensure a good coverage, each of the forest and jhum sampling areas was divided into four plots (Plots: I, II, III & IV) of equal sizes (25x25 m^2 each). It was decided that the most representative method of sampling would be to take a random sample from Plots: I

& II in the first and from Plots: III & IV during the second fortnight of every month. This was thought to give some measure of 'between-plot' variations. Thus, from each plot, soil samples were collected in triplicate per month: (i) for faunal extraction, (ii) for moisture content determination and (iii) for pH and conductivity estimation.

In order to study the vertical distribution of the fauna, samples were collected upto the depth of 40 cm, divided into four layers of 0-10 cm, 10-20 cm, 20-30 cm and 30-40 cm in both the forest and jhum sampling areas. The litter layer in the forest area was sampled separately.

3.3. Collection and treatment of samples

To sample the litter layer in the forest, a wooden frame, having an inner surface area of 10 x 10 cm^2, was constructed. On each sampling occasion, litter sample was excavated by placing the frame on the forest floor and cutting the litter with a sharp knife along the inner edge of the frame. Therefore, the litter samples were also 10 x 10 cm^2 in surface area. The litter samples were then immediately but gently hand-picked into polythene bags, labelled and packed. In this way 4 samples were collected during each month and a total of 4x24 or 96 samples during the 24 months of the investigation period for faunal extraction.

Forest soil samples were taken from below the litter samples, except on few occasions when stones and larger rootlets were encountered. Such samples consisted of soil cores

5 x 5 cm^2 in surface area to a depth of 40 cm, divided into four layers of 0-10 cm, 10-20 cm, 20-30 cm and 30-40 cm respectively, and each core being 250 cc in volume. Soil samples were removed with a rectangular iron sampler. This method is comparable to the method used by earlier workers from this region (Reddy, 1980; Vatsauliya, 1981; Darlong & Alfred, 1982). All the soil samples were kept in individual popythene bags, labelled and packed. Each month, therefore, one sample was taken from each of the four plots and four soil profiles. Thus, a monthly collection of forest soil samples for faunal extraction from 4 plots and 4 layers amounted to 4 x 4 or 16 samples. The total number of samples during the 24 months of investigation period accumulated to 16x24 or 384 samples.

A similar method of collecting procedure was conducted for the removal of soil samples from the jhum sampling areas. Thus, collections from the jhum soils for the faunal extraction aggregated to 4x4 or 16 samples per month from 4 plots and 4 soil layers, and 16x24 or 384 samples during the two years of study. Litter not being available was not collected.

On each sampling occasion, the litter and soil samples were carefully transported to the laboratory to prevent possible death or injury of the organisms. The samples were transferred to the extraction funnels within an average of one hour after the field collection.

3.4. Method of faunal extraction

The apparatus used for the extraction of the fauna from

the litter and soil was based on the modified Tullgren funnel as described by Macfadyen (1953). Eighteen Tullgren funnels were arranged in two rows of nine funnels each and used for extraction.

It was not possible to test the efficiency of the apparatus directly, but the results obtained in the present investigation compare favourably with those of Reddy (1980), Vatsauliya (1981) and Darlong & Alfred (1982).

The litter samples were transferred into the larger funnels. They became 5-7 cm thick in the sample container. The distance between the heat-source (60 W Bajaj bulb) and the top surface of the litter samples in the sample container was 15($\pm$2) cm.

The soil samples were transferred into the smaller funnels, carefully broken (when necessary) and heaped over the wire mesh of the funnel. The heaped soil sample became 4-5 cm through its thickest section. The distance between the heat-source and the samples in the funnels approximated to 17($\pm$1) cm.

The temperature in the extraction cabinet was 39($\pm$2)^{o}C. It was observed that the extraction of the fauna was completed within 4-5 days, but the samples were kept till the end of the 6th or beginning of the 7th day.

The soil arthropods were extracted into collecting tubes, containing 80% alcohol. Thus, during each month of present investigation, soil arthropods were extracted from 4 litter samples, 16 (4 samples of 4 layers) forest soil and 16 (4 samples 4 layers) jhum soil samples. However, all the counts were expressed as monthly averages per m^2 in the results.

3.5. Identification of the fauna

At the end of each extraction period, the tubes containing the extracted fauna were removed from the funnels. The contents of the tubes were emptied into a petridish, and the tubes were washed (into the petridish) several times with 80% alcohol. The arthropods were picked up with forceps or a fine pipette and sorted into three categories, viz. Collembola, Acarina and other arthropods. Counting was done under a dissecting binocular microscope. Preservations were done in 80% alcohol, to which was added few drops of glycerine to prevent accidental dessication.

Collembola were identified and counted, as far as possible, till species level. The specimens were cleared and mounted in Salmon's (1949) polyvinyl alcohol-lactophenol medium. Some of the specimens were expanded in warm lactic acid (Bellinger, 1954) and then studied. These procedures were followed with the majority of the specimens at the beginning of the identification; thereafter, increasing familiarity with the fauna permitted determination of most specimens under microscope without such treatment.

The Acarina were counted into sub-orders Astigmata, Prostigmata, Mesostigmata and Cryptostigmata (Oribatida). Of these, only the oribatids could be identified and counted upto genera or species and only one species of Mesostigmata could be identified.

For the purpose of the identification of the oribatid genera/species, the technique of temporary open mounting method, as described by Balogh (1972) was followed. The specimens pre-

served in 80% alcohol were transferred into an equal mixture of 90% alcohol and lactic acid placed in a small vial. These were stored open (without stoppers) at room temperature, in dustproof cabinets. With the evaporation of alcohol, the mites remain in the lactic acid, and in one to three weeks, the mites became suitable for microscopic examination. The oribatid mites were then individually mounted in a cavity slide, using lactic acid medium. Having finished with the study, the oribatid specimens were re-transferred into a mixture of 80% alcohol and few drops of glycerine. These techniques were followed with the majority of the specimens at the beginning of the study; thereafter, increasing familiarity with the mites rendered easy recognition without such technical mountings.

The arthropods other than Collembola and Acarina that occurred during the period of present investigation were sorted to the smallest readily recognizable groups, viz. orders only. Therefore, in the present study it was not possible to do more than to count their numbers at order level, without making any distinction between genera or species.

3.6. Community analysis

The collembolan and oribatid communities of the forest and jhum soils were analysed for their measures of species diversity and similarity, using the following statistic formulae.

3.6.1. Species diversity

Species diversity (sometimes called species heterogenei-

ty), a characteristic unique to the community level of biological organization, was analysed using the following measures.

3.6.1.1. Margalef's index

The simplest measure of species diversity is the number of species or the species richness, which was calculated after Margalef (1968) as modified by Brower & Zar (1977):

$$D_a = (s-1)/\log N$$

where, D_a = Margalef's index

s = number of species and

N = total number of individuals.

3.6.1.2. Shannon-Wiener diversity index

This measure of species diversity, based on information theory or related to the concept of "uncertainty", was calculated after Shannon & Weaver (1949):

$$H' = -\sum_{i=1}^{s} p_i \log p_i$$

where, H' = measure of Shannon-Wiener diversity

s = number of species and

p_i = proportion of the total number of individual occurring in species i.

However, in the present context, H' was calculated, using its algebraic manipulation as the equivalent equation after Brower & Zar (1977):

$$H' = (N \log N - \sum n_i \log n_i) / N$$

where, n_i = total number of individuals occurring in species i or abundance of species i, and

N = total number of individuals of all the species.

3.6.1.3. $H_{max'}$

The maximum possible diversity of H' or $H_{max'}$ was calculated using the following formula:

$$H_{max'} = \log s$$

where, s = number of species or category.

3.6.1.4. Evenness

The evenness (Pielou, 1966) of the individuals' distribution among the species, designated by the quantity J' (also sometimes referred to as homogeneity or relative diversity), was calculated using the following formula:

$$J' = H'/H_{max'}$$

3.6.1.5. Redundance value

The redundance value, designated by the quantity R, was calculated using the formula:

$$R = 1 - J'$$

3.6.2. Community similarity

The similarities/dissimilarities of the collembolan and oribatid communities in the forest and jhum systems were worked out using the following indices:

3.6.2.1. Sørensen's coefficient of similarity (CC_s)

The coefficient of community similarity of Sørensen (1948), also known as Quotient of Similarity (Q/S) was calculated after Brower & Zar (1977):

$$CC_s = \frac{2c}{s_1 + s_2}$$

where, c = number of species common to both communities

s_1 = number of species in community 1 (forest)

s_2 = number of species in community 2 (jhum).

3.6.2.2. Morisita's index

This measure of community similarity (Morisita, 1959) is based on Simpson's index of dominance (Simpson, 1949), the probability that two randomly selected individuals from a community will be of the same species:

$$\lambda_1 = \frac{\sum x_1(x_i-1)}{N_1(N_1-1)}$$

is the Simpson dominance index for community 1, where x_i is the number of individuals in species i in community 1 (forest), and N_1 is the total number of individuals in community 1 i.e., forest ($N_1 = x_i$); likewise:

$$\lambda_2 = \frac{\sum y_i(y_i-1)}{N_2(N_2-1)}$$

where, for community 2, $_2$ is Simpson's dominance index, y_i is the abundance of species i, and $N_2 = y_i$, the total number of individuals in community 2 (jhum).

The Morisita index of community similarity (also called Morisita's index of overlap; Horn, 1966) is:

$$I_M = \frac{2\sum x_i y_i}{(\lambda_1 + \lambda_2)N_1 N_2}$$

3.6.2.3. Average faunal resemblance

The average faunal resemblance between the forest and jhum communities were calculated using the formula:

$$\text{Average Faunal Resemblance} = \frac{c(s_1+s_2)}{2s_1 s_2} \times 100$$

where, c = number of species common to both communities

s_1= total number of species in community 1 (forest)

s_2= total number of species in community 2 (jhum).

3.7. Abiotic factors

Physico-chemical factors of the habitats studied were air temperature, soil/litter temperature, moisture contents, pH, specific conductance, soil porosity, soil particle size, organic carbon, nitrogen, litter weights and meteorological factors. These studies were performed on each fortnightly sampling occasion of both the forest and jhum sampling areas.

In the forest sampling area, temperature was measured for the litter and the four soil profiles. Measurement was read from an ordinary mercury thermometer, set a few centimeters deep into the litter and soil for about 2-3 minutes.

Litter temperature was measured in the field just before collection of the samples for faunal extraction. Collections being done at fortnightly intervals for two years, therefore, litter temperatures were measured on 96 occasions during the entire study period.

However, soil temperatures were not measured from the samples collected for faunal extractions because it was thought that once the soil was disturbed, sampling should be immediate and continuous in order to arrest possible escape of organisms from the "immediate core zones". Therefore, soil temperatures were measured from the nearest area of the samples collected for extractions, in each profile. In this way, for each of the soil layers, temperature was recorded on 96 occasions, and a total of 384 occasions for all the four layers during the two years of investigation.

The air temperature of the forest sampling area was recorded with an ordinary mercury thermometer, by holding it or hanging it on a tree twig for 2-3 minutes about 1 m above the forest floor. A total of 96 readings were taken for the air temperature during the study period.

On each fortnightly sampling occasion, a second set of litter and soil samples for moisture content determinations were collected from each plot of the forest sampling area in a manner collected for the first set. In the laboratory, the wet or fresh weights of the litter and soil samples were determined before keeping them in the hot air oven at 60°C, by spreading evenly in large petri plates. After 72-80 hours of exposure, the oven-dried samples were re-weighed. From these data, moisture contents of the litter/soil samples were calculated and expressed as percentage ratio of water to dry weight. Moisture contents were calculated from 96 litter samples and 384 soil samples during the two years of study. (These values of the fresh weights and dry weights of the litter in gram were subsequently used for correlating with the faunal components, as the variations between these weights and those of the samples used for faunal extractions were more or less and consistently the same, both in terms of fresh weights and dry weights).

A third set of litter and soil samples were collected for pH and conductivity measurements. pH was read by an electric pH meter (Systronic : Type 331), using 1:5 ratio of soil/litter suspension in double-distilled water. Conductivity in micro mhos per cm was measured by a Conductivity Bridge (Elico CM 82).

On each sampling occasion, the porosity or pore spaces of the soils, expressed in percentages, were worked out after Keen as quoted by Misra (1972).

The above oven-dried litter and soil samples (after moisture content determinations) were sieved through a sieve (B.S. 150). These sieved samples were used for estimation of organic carbon and nitrogen contents (expressed in percentages). Micro-Kjeldohl method for nitrogen and Walkey & Black's rapid titration method for organic carbon detection as described by Allen (1974) were adopted.

Particle size of the soil at each profile was measured by an ocular micrometer taking about 1000 particles at random on a slide from the sieved samples, following the method of Choudhuri & Roy (1971).

All the above parameters (except litter weights) were similarly studied for the different profiles of the jhum soils on each fortnightly sampling occasion.

Data for daily rainfall, humidity, duration of sunshine, maximum and minimum temperature for Shillong and its adjoining areas were collected from the Meteorological Station at Upper Shillong. All the physico-chemical and meteorological data are represented as monthly averages. Rainfall figures are given in monthly total.

RESULTS

4. RESULTS

4.1. Abiotic factors

4.1.1. Seasonal variations

The various abiotic factors undertaken in the present study were classified into three major categories:

(a) Meteorological factors, viz. maximum-minimum temperature of the atmosphere, rainfall, relative humidity and duration of the sunshine;

(b) Physico-edaphic factors, viz. air temperature, litter temperature, moisture content, particle size of the soil, porosity of the soil and litter weights;

(c) Chemico-edaphic factors, viz. pH, conductivity, organic carbon and nitrogen.

4.1.1.1. Meteorological factors

4.1.1.1a. Maximum and minimum temperature of the atmosphere:

Daily records of maximum and minimum temperature of the study period were obtained from the local meteorological station. Each of these records were averaged for their monthly values as illustrated in Fig. 2. Maximum temperature ranged from 10.7°C in November 1980 to 24.2°C in August 1980 during the first annual cycle, and 15.4°C (December 1981) to 25°C (May 1982) in the second annual cycle. The average minimum temperature ranged between 5.9°C (January 1981) and 18.2°C (July 1980) during the first annual cycle, while the second annual cycle ranges were between 6.2°C (February 1982) and 17.7°C (July 1981).

Fig. 2. Showing the seasonal fluctuations of the meteorological data of the region for two annual cycles (Rainfall data are monthly totals; others are mean monthly).

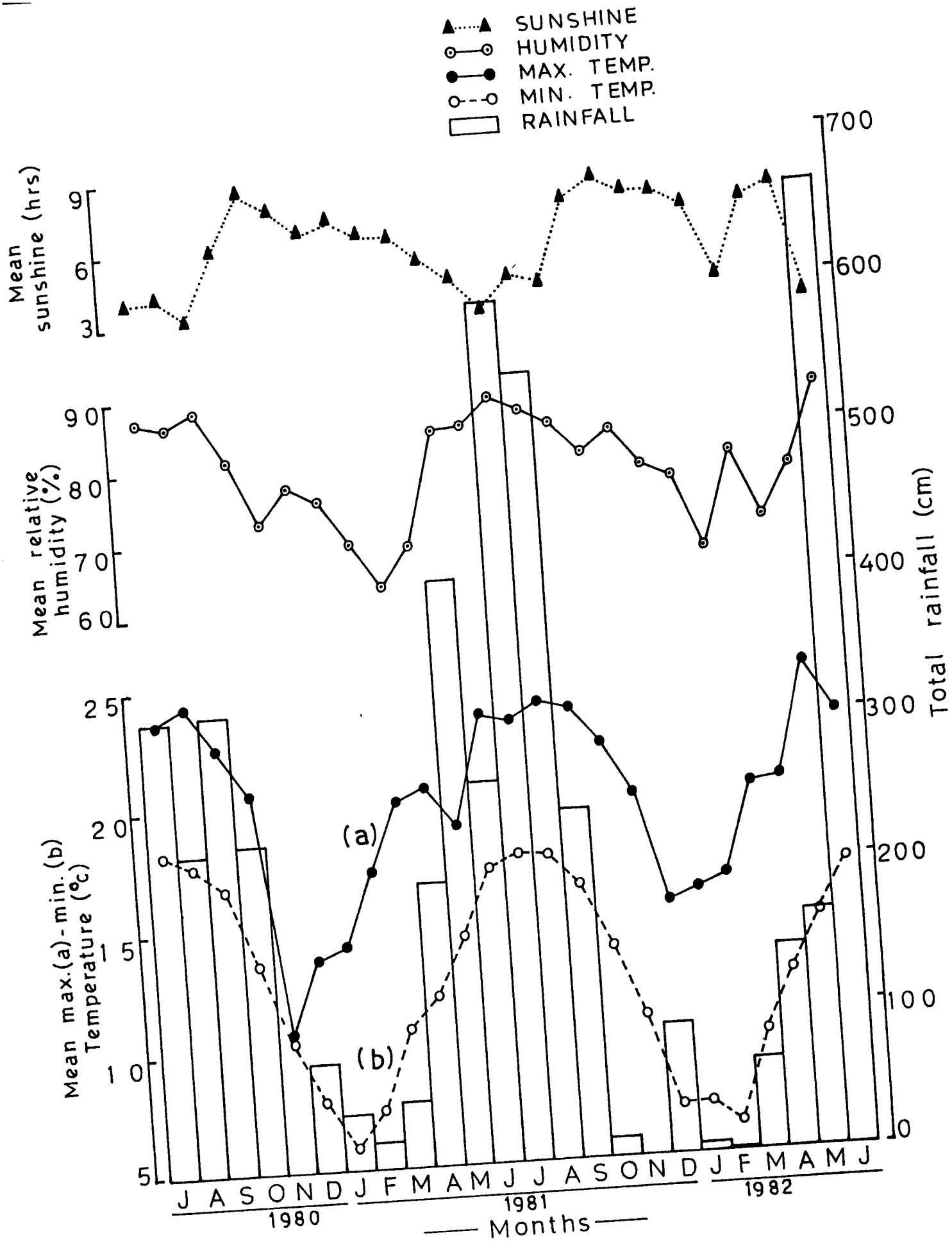

SUNSHINE
HUMIDITY
MAX. TEMP.
MIN. TEMP.
RAINFALL
Mean sunshine (hrs)
Mean relative humidity (%)
Mean max.(a)-min.(b) Temperature (°c)
Total rainfall (cm)
(a)
(b)
J A S O N D J F M A M J J A S O N D J F M A M J
1980
1981
1982
Months

Fig. 2

4.1.1.1b. Rainfall

The daily records of rainfall, as obtained from the meteorological station, were totalled for the concerned month and plotted as such (Fig. 2). Rainfall had a summer maxima and a winter minima, true for both the annual cycles. The months of November of both the annual cycles recorded nil rainfall, while May 1981 (401 cm) was the rainiest month during the first annual cycle and June 1982 (663 cm) in the second annual cycle. Although the rainiest months of the two annual cycles did not synchronize, the second year of the sampling period was exceptionally wet.

4.1.1.1c. Relative humidity

The daily measurements of relative humidity obtained from the local meteorological station were brought into monthly averages. These measurements appear in Fig. 2 and show that the most humid month of the first annual cycle was September 1980 (88%) and the least was in March 1981 (63%). In the second annual cycle, bimodal peaks of maxima (88%) were recorded both in July 1981 and June 1982, and a minimum of 66.5% in February 1982. Although the rising patterns of humidity fluctuations closely resembled that of the rainfall for summer maxima, the least humid periods appeared to be during the late winter and early spring.

4.1.1.1d. Duration of sunshine

Daily sunshine periods, measured in hours at the meteorological station were obtained and represented as monthly averages in Fig. 2. The average monthly sunshine durations ranged

from 3.2 hours (September 1980) to 8.3 hours (November 1980) during the first annual cycle, while in the second annual cycle, it was from 3.0 hours (June 1982) to 8.2 hours (November 1981). There appeared a distinct contrariety between the fluctuations of sunshine periods and rainfall, in that, the months with least rainfall recorded maximum sunshine periods and vice versa.

4.1.1.2. Physico-edaphic factors

4.1.1.2a. Air temperature:

Fortnightly records of air temperatures, summed up as monthly averages, separately for the forest and jhum sampling areas are illustrated in Fig. 3. In the forest sampling area, the air temperature ranged from 12.1°C (February 1981) to 25.7°C (July 1980) in the first annual cycle, and 11.2°C (December 1981) to 24°C (March 1982) during the second annual cycle. In the jhum sampling area, the month of February recorded minimum temperature of the air for both the annual cycles (February 1981: 14.2°C; February 1982: 11.6°C). Maximum temperatures of the air were 23.4°C in August 1980 during the first, and 27.6°C in March 1982 during the second annual cycles.

4.1.1.2b. Litter and soil temperature:

Temperature of the litter and different layers of the soil were recorded fortnightly. These were converted into their monthly averages and are illustrated in Fig. 3. Litter temperature ranged from 13.2°C (December 1980) to 22.1°C (August 1980)

Fig. 3. Showing the seasonal fluctuations of the mean monthly temperature of air, litter and soil profiles for two annual cycles.

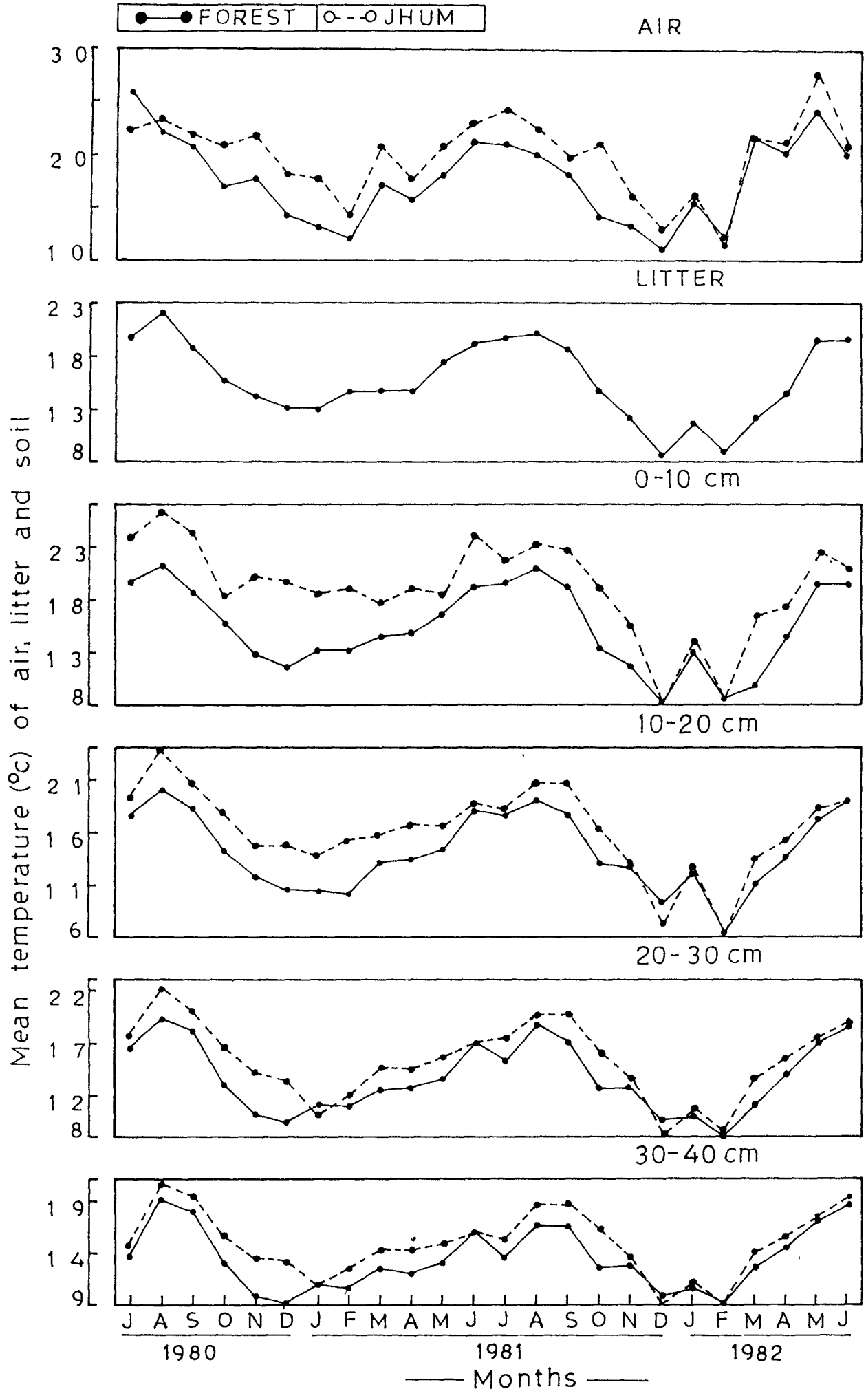

FOREST
JHUM
AIR
LITTER
0-10 cm
10-20 cm
20-30 cm
30-40 cm
Mean temperature (°c) of air, litter and soil
J A S O N D J F M A M J J A S O N D J F M A M J
1980
1981
1982
Months

Fig. 3

during the first annual cycle. The maximum and minimum values for the second annual cycle were 20.4°C (August 1981) and 8.8°C (December 1981), respectively.

The soil temperature of the forest for different layers was seen to reach a peak in August, true for both the annual cycles. These values for the first annual cycle were 21.1°C, 20.1°C, 19.4°C & 19.1°C and 21.0°C, 19.1°C, 18.7°C & 18.2°C during the second annual cycle at 0-10 cm, 10-20 cm, 20-30 cm & 30-40 cm layers, respectively. However, the two annual cycles recorded minimum temperatures in two different months, December 1980 being for the first and February 1982 for the second annual cycles. These minima values at 0-10, 10-20, 20-30 & 30-40 cms soil layers were 11.8°C, 10.5°C, 9.6°C & 9.6°C in December 1980 and 8.2°C, 6.5°C, 8.2°C & 9.2°C during February 1982, respectively.

In jhum areas, temperature at different soil layers reached maximum in August, true for both the annual cycles of investigation. The temperature figures in the first annual cycle were 26.3°C, 23.7°C, 22.1°C & 20.7°C and for the second annual cycle were 23.2°C, 20.9°C, 19.6°C & 18.9°C at 0-10, 10-20, 20-30 & 30-40 cms soil layers,respectively. Minimum soil temperatures recorded in January 1981 of the first annual cycle were 17.8°C, 13.9°C, 10.2°C & 11.3°C at 0-10, 10-20, 20-30 & 30-40 cms soil layers, respectively. During the second annual cycle, these values recorded in February 1982 as minimum temperatures were 8.4°C, 6.4°C, 8.4°C & 9.2°C at 0-10 cm, 10-20 cm, 20-30 cm & 30-40 cm soil layers, respectively.

4.1.1.2c. Moisture content:

Mean monthly percentage estimates of moisture content of the litter and each of the four profiles of the forest and jhum soils are illustrated in Fig.4. The moisture content of the litter layer was the most variable. It ranged from 14.2% in February 1981 to 173.3% in July 1980 during the first annual cycle, while the second annual cycle values ranged from 33.4% in February 1982 to 192.3% in August 1981.

However, moisture content of different layers of forest and jhum soils showed a peak of maxima and minima in different months during the two years of study, although the trends indicated a summer maxima and a winter minima. Thus, during the first annual cycle, the moisture content of the forest soil layers ranged from 40.3% (November 1980) to 72.5% (May 1981) at 0-10 cm; 39.1% (September 1980) to 66.4% (May 1981) at 10-20 cm; 28.2% (September 1980) to 56.8% (May 1981) at 20-30 cm; 28.5% (September 1980) to 58.5% (January 1981) at 30-40 cm. In the second annual cycle, the range of these estimates were 35.2% (February 1982) to 86.6% (August 1981) at 0-10 cm; 35.5% (November 1981) to 63.0% (August 1981) at 10-20 cm; 39.7% (November 1981) to 64.6% (June 1982) at 20-30 cm; 44.0% (November 1981) to 62.9% (June 1982) at 30-40 cm soil layer.

In the jhum soil, the moisture content of the first annual cycle ranged from 22.3% (March 1981) to 57.5% (May 1981) at 0-10 cm; 29.0% (February 1981) to 58.8% (May 1981) at 10-20 cm; 33.0% (February 1981) to 61.6% (May 1981) at 20-30 cm; 34.6%

Fig. 4. Showing the seasonal fluctuations of the mean monthly moisture content (%) of the litter and soil (in different profiles) for two annual cycles.

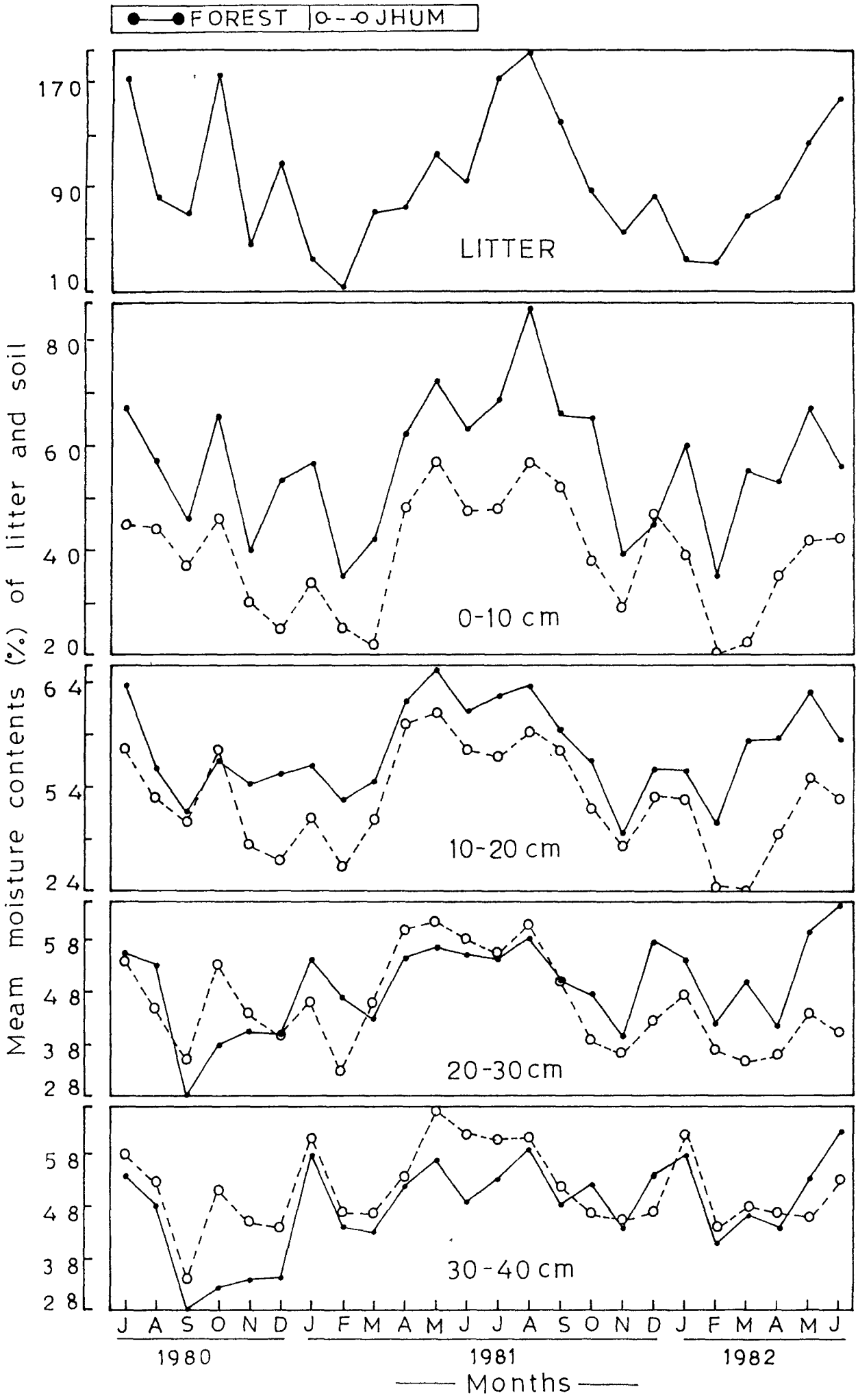

FOREST
JHUM
LITTER
0-10 cm
10-20 cm
20-30 cm
30-40 cm
Meam moisture contents (%) of litter and soil
170
90
10
80
60
40
20
64
54
24
58
48
38
28
J A S O N D J F M A M J J A S O N D J F M A M J
1980
1981
1982
Months

Fig. 4

(September 1980) to 67.1% (May 1981) at 30-40 cm. The ranges of these values in the second annual cycle were 20.6% (February 1982) to 52.9% (September 1981) at 0-10 cm; 24.2% (March 1982) to 51.2% (September 1981) at 10-20 cm; 35.3% (March 1982) to 61.4% (August 1981) at 20-30 cm; 44.0% (February 1982) to 62.9% (January 1982) at 30-40 cm.

4.1.1.2d. Particle size:

The particle sizes of the forest and jhum soils of different profiles are illustrated in Fig. 5. Although negligible, the sizes of the soil particles varied in different layers of the forest and jhum soils. In the first annual cycle of investigation, the sizes of the forest soil particles ranged from 0.075 mm (November 1980) to 0.101 mm (February 1981) at 0-10 cm; 0.071 mm (May 1981) to 0.097 mm (February 1981) at 10-20 cm; 0.070 mm (June 1981) to 0.088 mm (January 1981) at 20-30 cm; 0.071 mm (June 1981) to 0.083 mm (February 1981) at 30-40 cm. During the second annual cycle, the ranges of these values for different forest soil depths were 0.079 mm (December 1981) to 0.115 mm (September 1981) at 0-10 cm; 0.071 mm (March 1982) to 0.099 mm (August 1981) at 10-20 cm; 0.074 mm (January 1982) to 0.092 mm (October 1981) at 20-30 cm; 0.071 mm (May 1982) to 0.087 mm (November 1981) at 30-40 cm soil layers.

In the jhum soils, the particle sizes were observed to range between the extremes of 0.065 mm (January 1981) to 0.082 mm (September 1980 and May 1981) at 0-10 cm; 0.069 mm (September 1980) to 0.089 mm (May 1981) at 10-20 cm; 0.071 mm (Sep-

Fig. 5. Showing the seasonal fluctuations of the mean monthly soil particle sizes (mm) for two annual cycles.

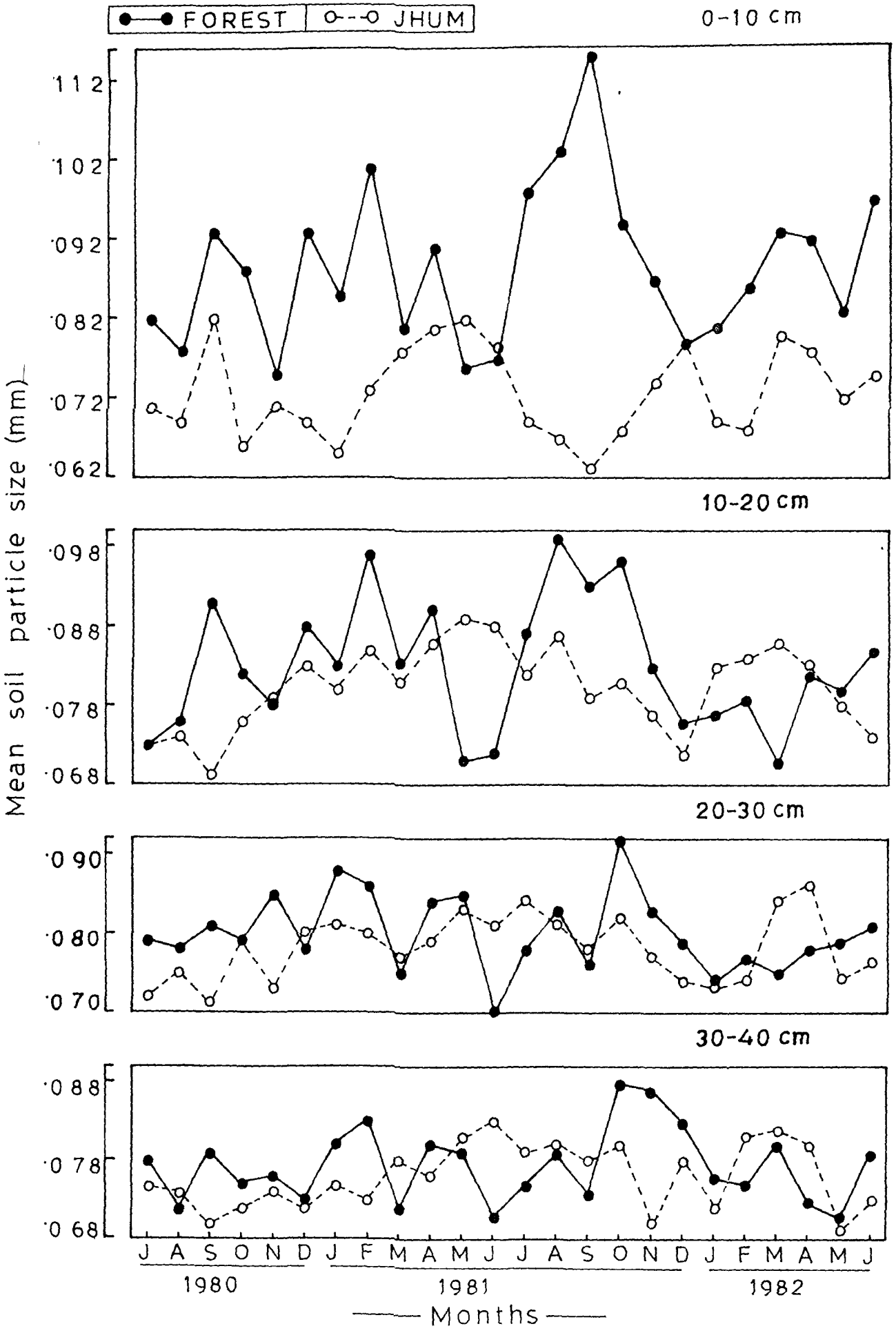

FOREST
JHUM
0-10 cm
1·12
1·02
·92
·82
·72
·62
10-20 cm
·98
·88
·78
·68
20-30 cm
·90
·80
·70
30-40 cm
·88
·78
·68
Mean soil particle size (mm)
J A S O N D J F M A M J J A S O N D J F M A M J
1980
1981
1982
Months

Fig. 5

tember 1980) to 0.089 mm (May 1981) at 10-20 cm; 0.071 mm (September 1980) to 0.083 mm (May 1981) at 20-30 cm; 0.070 mm (September 1980) to 0.083 mm (June 1981) at 30-40 cm soil layers, during the first annual cycle. The ranges for the second annual cycle were 0.063 mm in September 1981 to 0.080 mm in March 1982 at 0-10 cm; 0.072 mm in December 1981 to 0.087 mm in August 1981 at 10-20 cm; 0.073 mm in January 1982 to 0.086 mm in April 1982 at 20-30 cm; 0.069 mm in May 1982 to 0.082 mm in March 1982 at 30-40 cm soil layers.

4.1.1.2e. Porosity:

The percentage porosity or pore spaces of the forest and jhum soils at different layers for two annual cycles are illustrated in Fig. 6. The results indicated that the porosity of the general study sites were remarkably high.

In the forest, the percentage porosity of soils at different layers showed maxima in March 1981 and minima in October 1980 during the first annual cycle. The maximum estimates were 75.7%, 56.5%, 54.5% & 52.7% at 0-10, 10-20, 20-30 & 30-40 cms soil layers, respectively. Minimum porosity as recorded in October 1980 of the first annual cycle were 71.1%, 48.3%, 46.8% & 45.0% respectively at 0-10, 10-20, 20-30 & 30-40 cm soil layers. During the second annual cycle, porosity ranged from 72.8% in July 1981 to 76.2% in October 1981 at 0-10 cm; 48.6% in July 1981 to 56.3% in June 1982 at 10-20 cm; 48.2% in July 1981 to 55.8% in March 1982 at 20-30 cm; 47.1% in April 1982 to 53.8% in March 1982 at 30-40 cm soil layers.

Fig. 6. Showing the seasonal fluctuations of the mean monthly soil porosity (%) for two annual cycles.

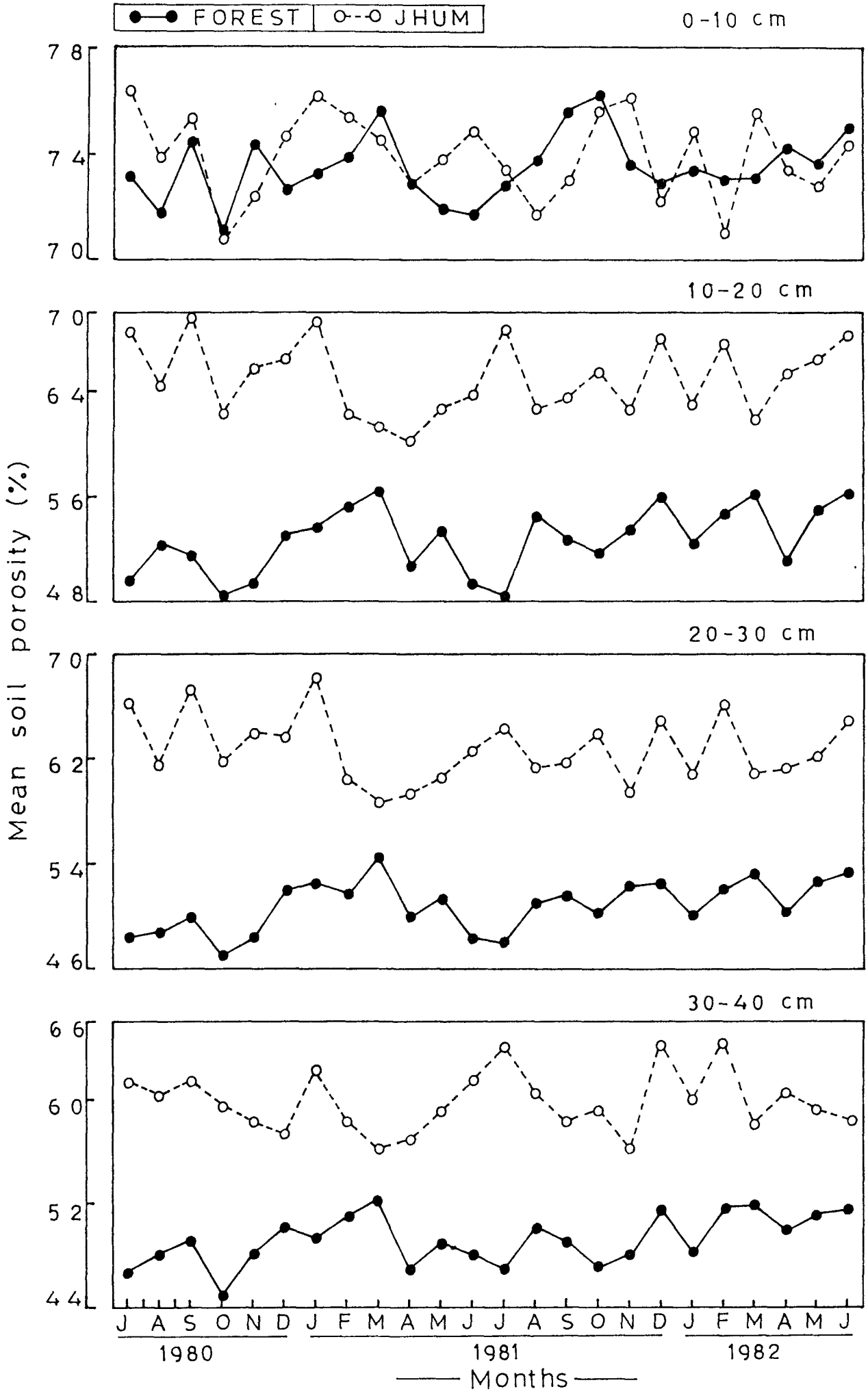

FOREST
JHUM
0-10 cm
10-20 cm
20-30 cm
30-40 cm
Mean soil porosity (%)
7 8
7 4
7 0
6 4
5 6
4 8
6 2
5 4
4 6
6 6
6 0
5 2
4 4
J A S O N D J F M A M J J A S O N D J F M A M J
1980
1981
1982
Months

Fig. 6

The percentage porosity of the jhum soils in different layers were more or less the same as that of the forest soils during both the annual cycles of present investigation. Thus, during the first annual cycle, the values were varying from 70.8% in October 1980 to 76.4% in July 1980 at 0-10 cm soil layer; 60.3% in April 1981 to 69.2% in January 1981 at 10-20 cm layer; 58.8% in March 1981 to 68.4% in January 1981 at 20-30 cm layer and 56.1% in March 1981 to 66.2% in January 1981 at 30-40 cm soil layer. During the second annual cycle, the minimum and maximum values of percentage porosity were 71.0% (February 1982) and 76.1% (November 1981) at 0-10 cm layer; 61.7% (March 1982) and 68.8% (July 1981) at 10-20 cm layer; 59.4% (November 1981) and 66.2% (February 1982) at 20-30 cm layer; 56.1% (November 1981) and 64.6% (February 1982) at 30-40 cm soil layer, respectively.

4.1.1.2f. Litter weights

The monthly average fresh weights and dry weights of the litter for the two annual cycles of present investigation are illustrated in the Fig. 7. The fresh weights of the litter varied from a minimum of 78.4 g in February 1981 to a maximum of 220.5 g in September 1980 during the first annual cycle of investigation. During the second annual cycle, the fresh weights of the litter ranged from a minimum of 76.9 g in November 1981 to a maximum of 193.9 g in May 1982.

Fig. 7. Showing the seasonal fluctuations of the mean monthly litter weights for two annual cycles.

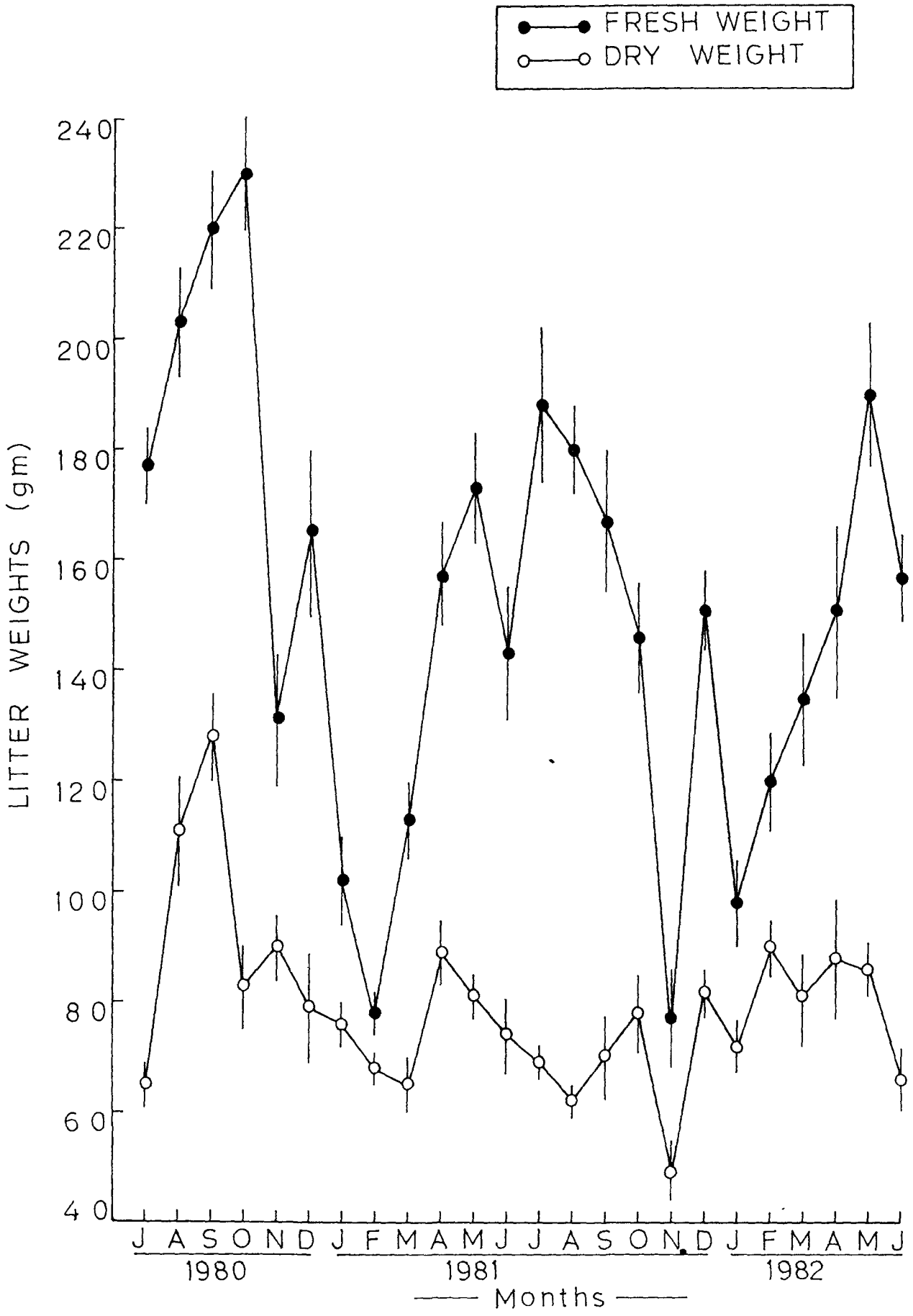

FRESH WEIGHT
DRY WEIGHT
LITTER WEIGHTS (gm)
240
220
200
180
160
140
120
100
80
60
40
J A S O N D J F M A M J J A S O N D J F M A M J
1980
1981
1982
Months

Fig. 7

The dry weights of the litter ranged from a minimum of 64.9 g (July 1980 & March 1981) to a maximum of 128.0 g in September 1980 during the first annual cycle. In the second annual cycle, minimum dry weight of the litter was observed in November 1981 (49.0 g) and maximum in February 1982 (90.6 g).

4.1.1.3. Chemico-edaphic factors

4.1.1.3a. pH

The mean monthly values of the pH of the litter and different layers of the forest and jhum soils are illustrated in Fig. 8. In general, the study sites exhibited a high range of acidity, characteristic of a typical pine forest. Thus, the pH values of the litter layer ranged from 4.8 minima in January 1981 to 5.7 maxima in June 1981 during the first annual cycle of investigation. The minimum-maximum values of the second annual cycle were 4.6 (January & February 1982) and 5.7 (August 1981), respectively. In the different soil profiles of the forest system, the minimum-maximum ranges of the pH were respectively 4.8 in March 1981 to 6.0 in September 1980 at 0-10 cm layer; 5.2 in February 1981 to 6.4 in August 1980 at 10-20 cm layer; 5.4 in January-February 1981 to 6.7 in August 1980 at 20-30 cm layer; 5.5 in February 1981 to 6.8 in August 1980 at 30-40 cm layer during the first annual cycle of investigation.

Fig. 8. Showing the seasonal fluctuations of the mean monthly pH values of the litter and soil for two annual cycles.

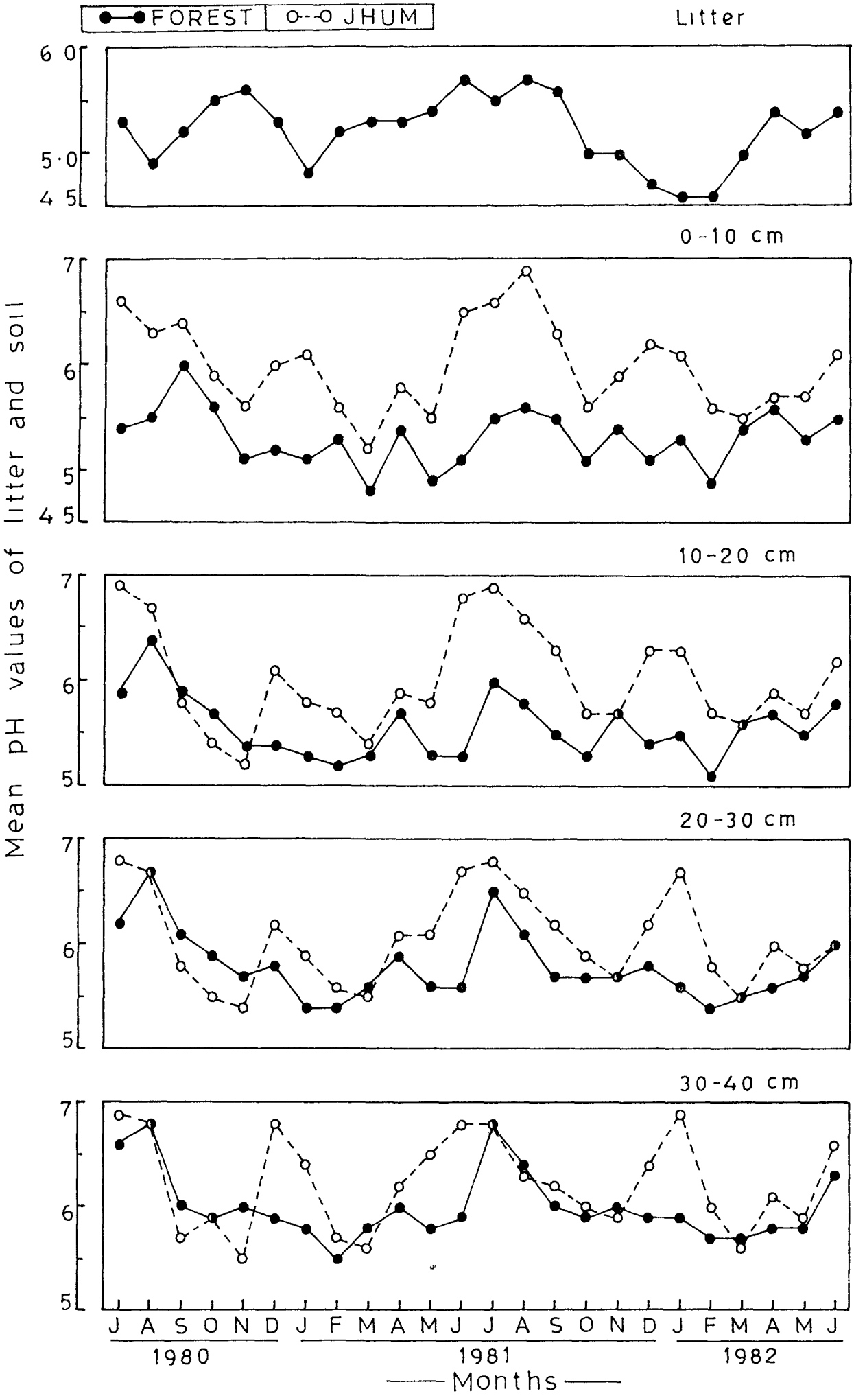

FOREST
JHUM
Litter
6·0
5·0
4·5
0-10 cm
7
6
5
4·5
10-20 cm
20-30 cm
30-40 cm
Mean pH values of litter and soil
J A S O N D J F M A M J J A S O N D J F M A M J
1980
1981
1982
Months

Fig 8

The pH values of the second annual cycle ranged from 4.9 (February 1982) to 5.6 (August 1981 & April 1982) at 0-10 cm; 5.1 (February 1982) to 6.0 (July 1981) at 10-20 cm; 5.4 (February 1982) to 6.5 (July 1981) at 20-30 cm; 5.7 (February-March 1982) to 6.8 (July 1981) at 30-40 cm layers of the forest soil.

The different layers of the jhum soils manifested the following range of pH values during the first annual cycle: 5.2 (March 1981) to 6.6 (July 1980) at 0-10 cm; 5.4 (October & March) to 6.9 (July 1980) at 10-20 cm; 5.4 (November 1980) to 6.8 (July 1980) at 20-30 cm; 5.5 (November 1980) to 6.9 (July 1980) at 30-40 cm. These values in the second annual cycle were 5.5 (March 1982) to 6.9 (August 1981) at 0-10 cm; 5.6 (March 1982) to 6.9 (July 1981) at 10-20 cm; 5.5 (March 1982) to 6.8 (July 1981) at 20-30 cm; 5.6 (March 1982) to 6.9 (January 1982) at 30-40 cm soil layers.

4.1.1.3b. Conductivity

The values of the specific conductance of the litter and different layers of the forest and jhum soils are illustrated in Fig. 9. In the litter layer, the values were 23.2 (August 1980) to 50.0 micro mhos/cm in March 1981 during the first annual cycle, and 24.5 (June 1982) to 66.6 micro mhos/cm in April 1982 during the second annual cycle. The different layers of the forest soils indicated diverse values of conductivity readings in different months of the study period. These values, during the first annual cycle, were 10.9 (August 1980) to 16.2

Fig. 9. Showing the seasonal fluctuations of the mean monthly specific conductance of the litter and soil for two annual cycles.

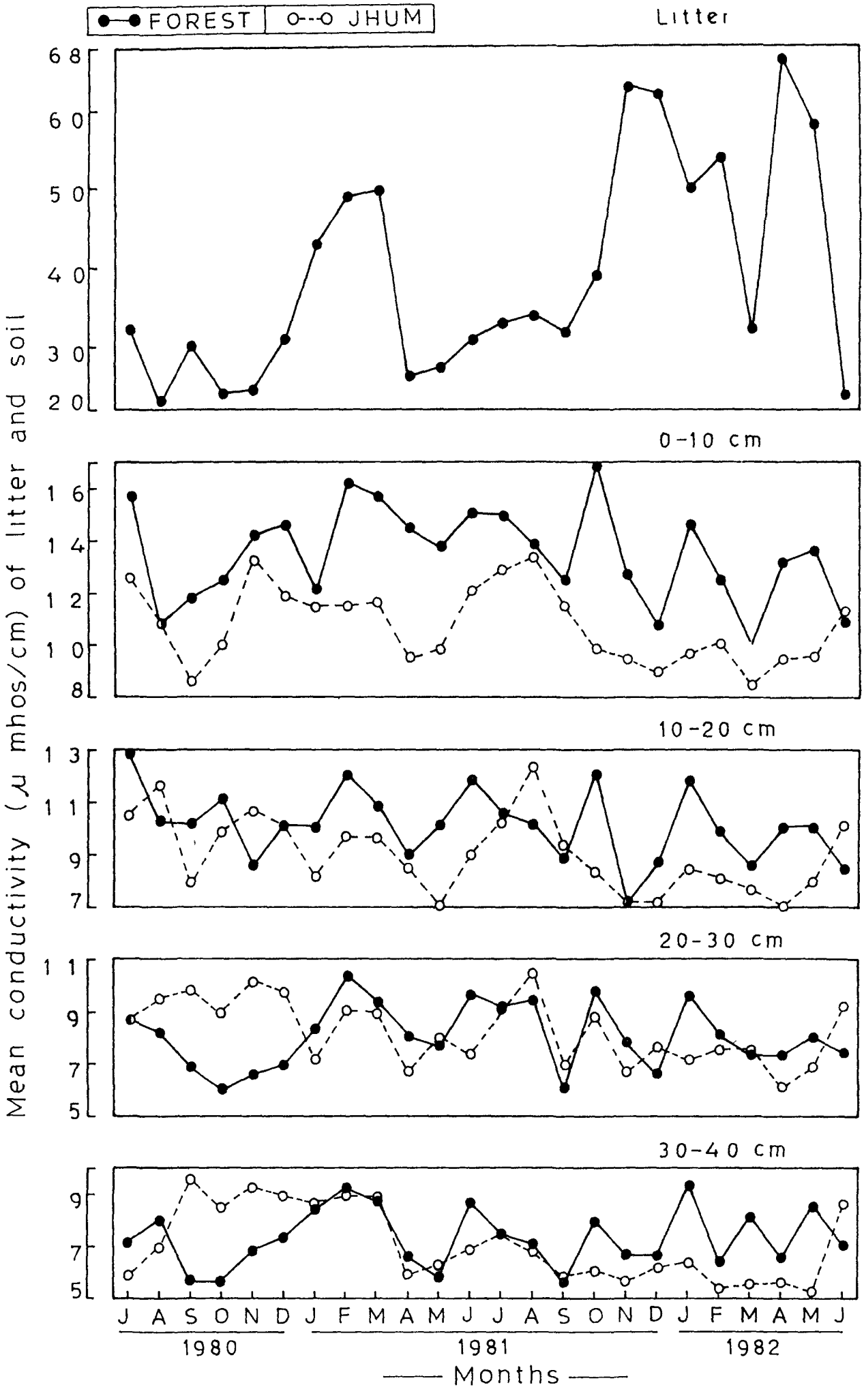

FOREST
JHUM
Litter
0-10 cm
10-20 cm
20-30 cm
30-40 cm
Mean conductivity (μ mhos/cm) of litter and soil
J A S O N D J F M A M J J A S O N D J F M A M J
1980
1981
1982
Months

Fig. 9

micro mhos/cm in February 1981 at 0-10 cm; 8.6 (November 1980) to 12.9 micro mhos/cm in July 1980 at 10-20 cm; 6.0 (October 1980) to 10.4 micro mhos/cm in February 1981 at 20-30 cm and 5.7 (September-October 1980) to 9.2 micro mhos/cm in February 1981 at 30-40 cm. The ranges of the second annual cycle were 10.0 (March 1982) to 16.9 micro mhos/cm in October 1981 at 0-10 cm; 7.2 (November 1981) to 12.1 micro mhos/cm in October 1981 at 10-20 cm; 6.1 (September 1981) to 9.9 micro mhos/cm in October 1981 at 20-30 cm, and 5.6 (September 1981) to 9.4 micro mhos/cm in January 1982 at 30-40 cm soil depth.

In the jhum soils, the specific conductance, during the first annual cycle of investigation ranged from 9.9 (May 1981) to 12.6 micro mhos/cm (July 1980) at 0-10 cm; 7.1 (May 1981) to 11.7 micro mhos/cm (August 1980) at 10-20 cm; 6.7 (April 1981) to 10.2 micro mhos/cm (November 1980) at 20-30 cm and 5.9 (July 1980 & April 1981) to 9.6 micro mhos/cm (September 1980) at 30-40 cm soil layer. The minima-maxima ranges of conductivity during the second annual cycle were 8.5 (March 1982) to 13.4 micro mhos/cm (August 1981) at 0-10 cm; 7.1 (April 1982) to 12.4 micro mhos/cm (August 1981) at 10-20 cm; 6.1 (April 1982) to 10.5 micro mhos/cm (August 1981) at 20-30 cm and 5.3 (March 1982) to 8.7 micro mhos/cm (June 1982) at 30-40 cm.

4.1.1.3c. Organic carbon

Fig. 10 shows the percentage organic carbon contents of the forest and jhum soils for two annual cycles. During the first annual cycle, the organic carbon contents of the litter

ranged from 12.35% (July 1980) to 19.58% (November 1980). The ranges of these values for the second annual cycle were 11.18% in July 1981 to 20.12% in May 1982. In the forest soils, the organic carbon contents of the first annual cycle ranged from only 4.62% (February 1981) to 6.68% (September 1980) at 0-10 cm; 2.64% (August 1980) to 3.64% (September 1980) at 10-20 cm; 1.44% (November 1980) to 2.67% (July 1980 & May 1981) at 20-30 cm; 1.06% (October 1980) to 2.40% (July 1980) at 30-40 cm. For the second annual cycle, the values were varying from 4.82% (July 1981) to 6.78% (June 1982) at 0-10 cm; 2.82% (December 1981 & March 1982) to 3.37% (October 1981) at 10-20 cm; 1.74% (October 1981) to 2.79% (July 1981 & March 1982) at 20-30 cm; 1.53% (September 1981) to 2.85% (March 1982) at 30-40 cm.

In contrast, the percentage organic carbon contents of the jhum soils were much reduced, being 2.67% (April 1981) to 2.88% (September 1980) at 0-10 cm; 2.31% (July & August 1980) to 2.85% (February 1981) at 10-20 cm; 1.38% (August 1980) to 2.76% (March 1981) at 20-30 cm; 1.20% (October 1980) to 2.43% (March 1981) at 30-40 cm soil layers during the first annual cycle. The second annual cycle values ranged from 2.64% (March 1982) to 2.94% (September 1981 & May 1982) at 0-10 cm; 2.40% (July 1981) to 2.91% (February 1982) at 10-20 cm; 2.07% (July 1981) to 2.82% (December 1981 & February 1982) at 20-30 cm; 1.92% (January 1982) to 2.88% (November 1981) at 30-40 cm depth of the jhum soil.

Fig. 10. Showing the seasonal fluctuations of the mean monthly organic carbon content of the litter and soil for two annual cycles.

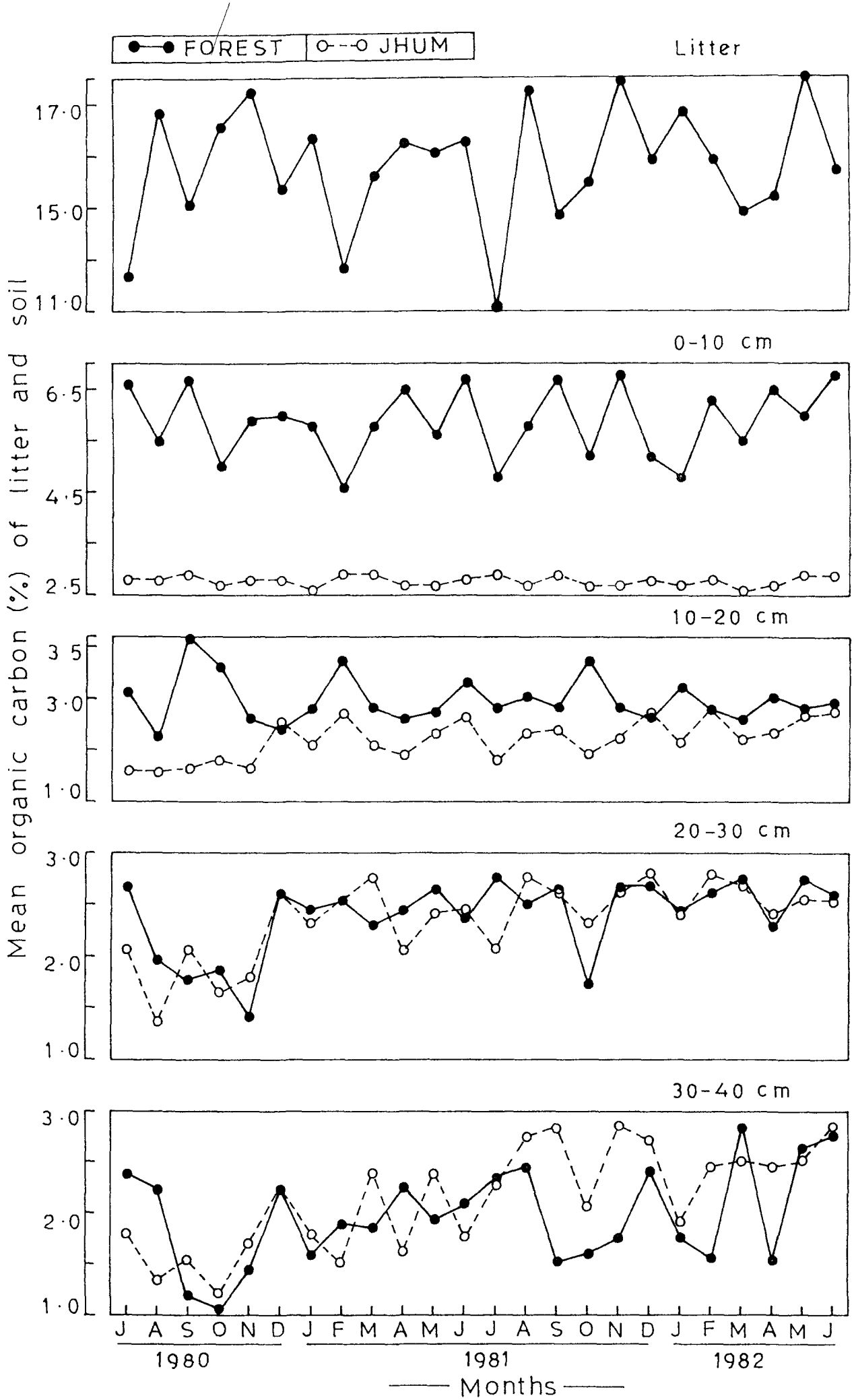

FOREST
JHUM
Litter
17·0
15·0
11·0
0-10 cm
6·5
4·5
2·5
10-20 cm
3·5
3·0
1·0
20-30 cm
3·0
2·0
1·0
30-40 cm
3·0
2·0
1·0
Mean organic carbon (%) of litter and soil
J A S O N D J F M A M J J A S O N D J F M A M J
1980
1981
1982
Months

Fig. 10

4.1.1.3d. Nitrogen

The percentage nitrogen contents of the forest and jhum soils are represented in the Fig. 11. In the forest and during the first annual cycle, these values ranged from 0.076% (June 1981) to 0.093 (August 1980) in the litter layer; 0.039% (May 1981) to 0.056% (August 1980 & February 1981) at 0-10 cm; 0.030% (February & May 1981) to 0.043% (August 1980) at 10-20 cm; 0.021% (May 1981) to 0.030% (September 1980) at 20-30 cm; 0.010% (April 1980) to 0.019% (October 1980 & May 1981) at 30-40 cm soil depths. These values for the second annual cycle were varying from 0.065% (January 1982) to 0.088% (March 1982) in the litter layer; 0.035% (April 1982) to 0.054% (September 1981) at 0-10 cm; 0.035% (February 1982) to 0.046% (November 1981) at 10-20 cm; 0.026% (August 1981) to 0.042% (March 1982) at 20-30 cm; 0.013% (September 1981) to 0.028% (June 1982) at 30-40 cm of the for st soil.

In the jhum soils, the percentage of nitrogen estimates ranged from 0.025% (May 1981) to 0.039% (July 1980) at 0-10 cm; 0.040% (September 1980 & June 1981) to 0.058% (October 1980) at 10-20 cm; 0.058% (September 1980) to 0.112% (June 1981) at 20-30 cm; 0.037% (October 1980) to 0.073% (June 1981) at 30-40 cm during the first annual cycle. These estimates for the second annual cycle ranged from 0.020% (February & April 1982) to 0.031% (October 1981) at 0-10 cm; 0.040% (January 1982) to 0.065% (October 1981 & June 1982) at 10-20 cm; 0.084% (March 1982) to 0.109% (June & October 1981) at 20-30 cm; 0.067% (June 1981 & March 1982) to 0.083% (May 1982) at 30-40 cm depth of the jhum soil.

Fig. 11. Showing the seasonal fluctuations of the mean monthly nitrogen content of the litter and soil for two annual cycles.

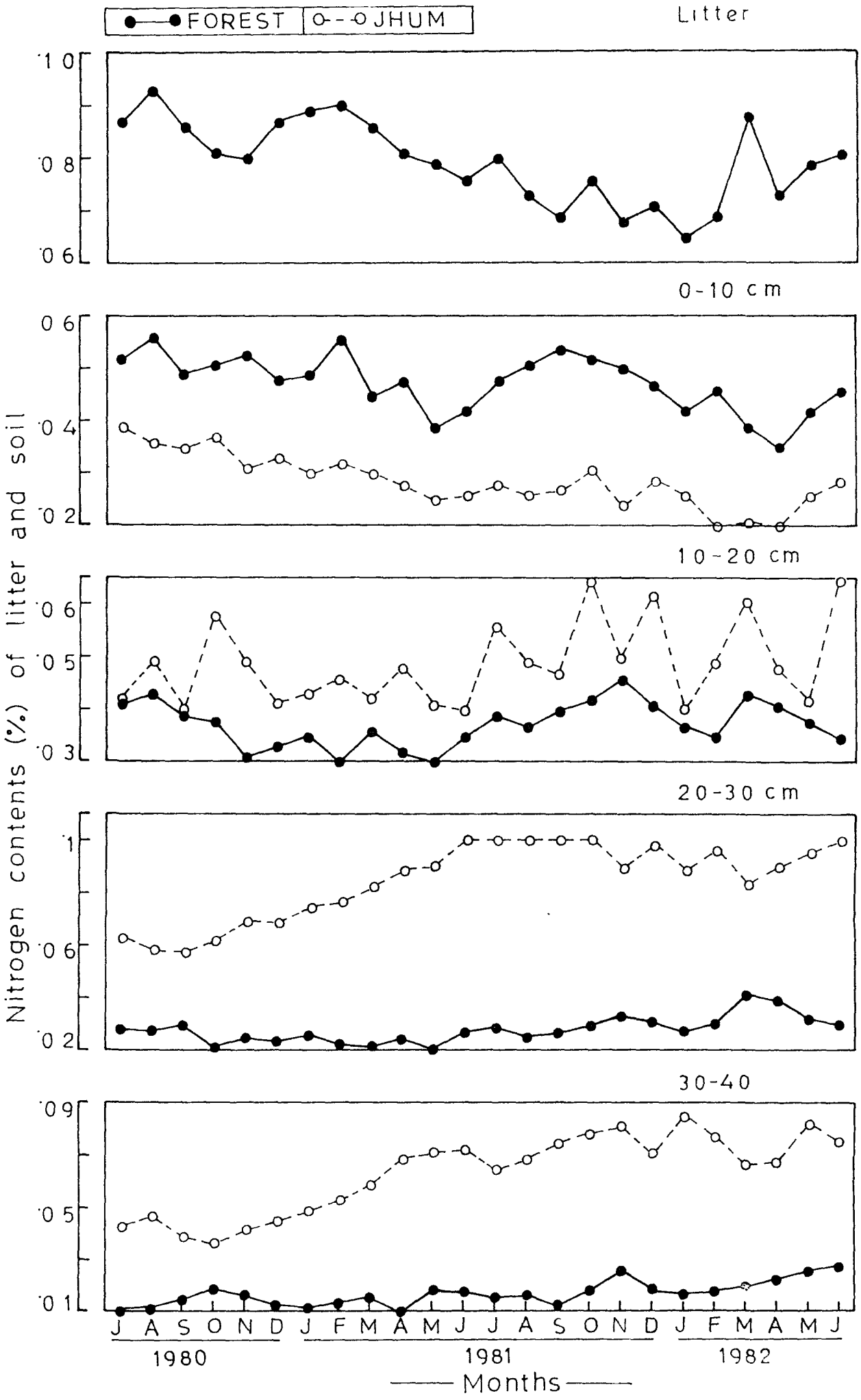

FOREST
JHUM
Litter
1·0
0·8
0·6
0-10 cm
0·6
0·4
0·2
10-20 cm
0·6
0·5
0·3
20-30 cm
1
0·6
0·2
30-40
0·9
0·5
0·1
Nitrogen contents (%) of litter and soil
J A S O N D J F M A M J J A S O N D J F M A M J
1980
1981
1982
Months

Fig. 11

4.2. Biotic factors

The arthropod groups encountered in the present investigation belong to the following classes. The respective orders are in parentheses:

1) Insecta (Protura, Diplura, Collembola, Diptera, Coleoptera, Hymenoptera, Isoptera, Orthoptera, Dermaptera, Hemiptera, Psocoptera and Insect larvae);

2) Arachnida (Acarina, Araneida and Pseudoscorpionida);

3) Myriapoda (Symphyla, Pauropoda, Chilopoda and Diplopoda);

4) Crustacea (Isopoda).

However, for brevity and more so in terms of their quantitative abundances and the important role that certain groups play in soil studies, Collembola and Acarina have been dealt with separately upto family, generic and specific levels and all other arthropods **only upto** order levels. In addition to these three categorizations, the total soil fauna, inclusive of all categories, has also been treated singularly.

4.2.1. Annual variations

4.2.1.1. Total soil fauna

Table I shows the total fauna of the forest and jhum soil with their vertical distributions during the two annual cycles of investigation. Soil fauna of the forest amounted to $22,313 \times 10^2/m^2$ during the first annual cycle and $23,519 \times 10^2/m^2$

in the second annual cycle. When the vertical distributions of the first annual cycle were observed, the fauna amounted to $14,436x10^2/m^2$ at litter layer, $6,556x10^2/m^2$ at 0-10 cm, $1,200x10^2/m^2$ at 10-20 cm, $76x10^2/m^2$ at 20-30 cm and $44x10^2/m^2$ at 30-40 cm of the forest soil layers. During the second annual cycle the total numbers of extracted fauna were $15,186x10^2/m^2$ for the litter layer, $6,884x10^2/m^2$ from 0-10 cm, $1,173x10^2/m^2$ from 10-20 cm, $240x10^2/m^2$ from 20-30 cm and $36x10^2/m^2$ from 30-40 cm of the forest soil.

In contrast, the jhum soils' total extracted fauna were $4,402x10^2/m^2$ and $4,995x10^2/m^2$ during the first and second annual cycles, respectively. The depth-wise densities of the total soil fauna for the jhum were $3,482x10^2/m^2$ (0-10 cm), $748x10^2/m^2$ (10-20 cm), $120x10^2/m^2$ (20-30 cm) and $52x10^2/m^2$ (30-40 cm) during the first annual cycle. During the second annual cycle the densities revealed were $3,657x10^2/m^2$ at 0-10 cm, $1,110x10^2/m^2$ at 10-20 cm, $112x10^2/m^2$ at 20-30 cm and $116x10^2/m^2$ at 30-40 cm of the soil layers.

Table I. Showing the total number of soil fauna in the forest and jhum systems and in their different layers during the two annual cycles of study (Standard error in parentheses).

Table II. Showing the total number and percentages of Collembola in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total soil fauna

Table I

SITES	LAYERS	TOTAL SOIL FAUNA	
		FIRST ANNUAL CYCLE	SECOND ANNUAL CYCLE
FOREST	LITTER	14436 (±382.8)	15186 (±355.4)
	0 - 10 cm	6556 (±190.8)	6884 (±267.5)
	10 - 20 cm	1201 (±65.35)	1173 (±91.21)
	20 - 30 cm	76 (±10.06)	240 (±20.51)
	30 - 40 cm	44 (±11.11)	36 (±07.15)
	TOTAL	22313 (±827.7)	23519 (±635.0)
JHUM	0 - 10 cm	3482 (±127.6)	3657 (±183.3)
	10 - 20 cm	748 (±19.27)	1110 (±65.66)
	20 - 30 cm	120 (±15.29)	112 (±11.72)
	30 - 40 cm	52 (±12.87)	116 (±08.76)
	TOTAL	4402 (±139.7)	4995 (±244.5)

TABLE II

SITES	LAYERS	COLLEMBOLA					
		FIRST ANNUAL CYCLE			SECOND ANNUAL CYCLE		
		a	b	c	a	b	c
FOREST	LITTER	7784 (±94.52)	75.90	53.92	8401 (±163.8)	77.38	55.32
	0 - 10cm	2108 (±33.26)	20.55	32.15	2092 (±39.91)	19.27	30.39
	10 - 20cm	348 (±20.97)	3.39	28.97	336 (±19.78)	3.09	28.65
	20 - 30cm	16 (±1.58)	0.16	21.05	28 (±4.95)	0.26	11.67
	30 - 40cm	-	-	-	-	-	-
	TOTAL	10256 (±121.1)	100.0	45.96	10857 (±186.7)	100.0	46.16
JHUM	0 - 10cm	943 (±41.38)	83.08	27.08	1065 (±44.34)	78.71	29.12
	10 - 20cm	180 (±7.82)	15.86	24.07	268 (±15.50)	19.81	24.14
	20 - 30cm	12 (±1.08)	1.06	10.00	20 (±1.73)	1.48	17.86
	30 - 40cm	-	-	-	-	-	-
	TOTAL	1135 (±38.04)	100.0	25.78	1353 (±49.77)	100;0	27.09

4.2.1.2. Collembola

The two annual densities of Collembola and their numbers in different layers of the forest and jhum soils are given in the Table II. The table also shows the percentages of Collembola among themselves (vertical distribution) and among the total soil fauna at each depth. Collembola, therefore, constituted $10,256x10^2/m^2$ as density and formed 45.96% of the total forest soil fauna during the first annual cycle. The density of Collembola increased though marginally during the second annual cycle to $10,857x10^2/m^2$, forming 46.16% of the total forest soil fauna.

The vertical distributions i.e., the densities of Collembola at the different soil layers, during the first annual cycle were $7,784x10^2/m^2$ at litter layer, $2,108x10^2/m^2$ at 0-10 cm layer, $348x10^2/m^2$ at 10-20 cm and $16x10^2/m^2$ at 20-30 cm layer. The vertical percentage distributions of Collembola among themselves were 75.90% (litter), 20.55% (0-10 cm), 3.39% (10-20 cm) and 0.16% (20-30 cm). Among the total fauna of the forest soil, Collembola accounted for 53.92% at the litter layer, 32.15% at 0-10 cm, 28.97% at 10-20 cm and 21.05% at 20-30 cm soil layers.

The second annual cycle densities of Collembola at different layers of the forest soil were $8,401x10^2/m^2$ (litter), $2,092x10^2/m^2$ (0-10 cm), $336x10^2/m^2$ (10-20 cm) and $28x10^2/m^2$ (20-30 cm). Among themselves vertically, the collembolan percentages were 77.38% (litter), 19.27% (0-10 cm), 3.09% (10-20 cm) and 0.26% (20-30 cm). During this second annual cycle, Collembola formed 55.32% (litter), 30.39% (0-10 cm), 28.65% (10-20 cm) and 11.67% (20-30 cm) of the total forest soil fauna.

In the jhum soil, the density of Collembola was 1,135 $x10^2/m^2$ during the first annual cycle. This number constituted 25.78% of the total soil fauna. With an increased density of $1,353x10^2/m^2$ during the second annual cycle, Collembola formed 27.09% of the total soil fauna of the jhum.

When the patterns of vertical distributions of Collembola were observed in the jhum soil, they were $943x10^2/m^2$ at 0-10 cm, $180x10^2/m^2$ at 10-20 cm and $12x10^2/m^2$ at 20-30 cm soil depths during the first annual cycle of investigation. Among themselves for vertical distribution, the Collembola were 83.08% at 0-10 cm, 15.86% at 10-20 cm and 1.06% at 20-30 cm soil layers. However, among the total soil fauna at different layers, the collembolan percentage compositions were 27.08% at 0-10 cm, 24.07% at 10-20 cm and 10.0% at 20-30 cm.

During the second annual cycle, the densities of Collembola at different soil depths were $1,065x10^2/m^2$, $268x10^2/m^2$ & $20x10^2/m^2$ respectively at 0-10 cm, 10-20 cm & 20-30 cm. Vertically and among themselves, the collembolan compositions at different layers were 78.71% (0-10 cm), 19.81% (10-20 cm) and 1.48% (20-30 cm). Among the total soil fauna of the jhum at different depths, the collembolan percentages were 29.12% (0-10 cm), 24.14% (10-20 cm) and 17.86% (20-30 cm).

Collembola encountered in the present study belong to six families, viz. Poduridae, Hypogastruridae, Isotomidae, Entomobryidae, Sminthuridae and Neelidae.

a. Family Poduridae

Table III illustrates the two annual cycle densities of the family Poduridae and their percentages among the different categories of the soil fauna. The first annual cycle density of Poduridae was $74x10^2/m^2$, constituting 0.72% of the total Collembola and 0.33% of the total fauna of the forest soil. In the second annual cycle, the total density of Poduridae increased to $95x10^2/m^2$, forming 0.88% of the total Collembola and 0.40% of the total forest soil fauna.

The density of Poduridae in the litter layer during the first annual cycle was $74x10^2/m^2$. Thus, Poduridae formed 0.95% of total Collembola and 0.51% of the total fauna of the litter layer. In the second annual cycle, the density of Poduridae was $95x10^2/m^2$ and formed 1.13% of the total Collembola of the litter and 0.62% of the total litter fauna.

Poduridae did not occur beyond the litter layer of the forest. Also, the podurids were totally absent in the jhum soil during the period of present investigation. Further, neither the genera nor the species of Poduridae could be identified.

b. Family Hypogastruridae

The two annual cycle densities of the family Hypogastruridae and their percentages among the different categories of the soil fauna are illustrated in the Table IV. The density of Hypogastruridae during the first annual cycle was $91x10^2/m^2$. This density made up 0.89% of the total Collembola and 0.41% of

Table III. Showing the total number and percentages of the family Poduridae (Collembola : Insecta) in the forest system and in its litter layer during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total Collembola

d : Percentages in total soil fauna

Table IV. Showing the total number and percentages of the family Hypogastruridae (Collembola : Insecta) in the forest system and in its litter layer during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total Collembola

d : Percentages in total soil fauna

TABLE III

COLLEMBOLA (FAMILY)	SITES	LAYERS	FIRST ANNUAL CYCLE				SECOND ANNUAL CYCLE			
			a	b	c	d	a	b	c	d
Poduridae	FOREST	LITTER	74 (±3.24)	100.0	0.95	0.51	95 (±6.22)	100.0	1.13	0.62
		0 - 10cm	-	-	-	-	-	-	-	-
		10 - 20cm	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-
		TOTAL	74 (±3.24)	100.0	0.72	0.33	95 (±6.22)	100.0	0.88	0.40
	JHUM	0 - 10cm	-	-	-	-	-	-	-	-
		10 - 20cm	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-
		TOTAL	-	-	-	-	-	-	-	-

TABLE IV

COLLEMBOLA (FAMILY)	SITES	LAYERS	FIRST ANNUAL CYCLE				SECOND ANNUAL CYCLE			
			a	b	c	d	a	b	c	d
Hypogastruridae	FOREST	LITTER	91 (±4.10)	100.0	1.17	0.63	77 (±4.55)	100.0	0.92	0.51
		0 - 10cm	-	-	-	-	-	-	-	-
		10 - 20cm	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-
		TOTAL	91 (±4.10)	100.0	0.89	0.41	77 (±4.55)	100.0	0.71	0.33
	JHUM	0 - 10cm	-	-	-	-	-	-	-	-
		10 - 20cm	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-
		TOTAL	-	-	-	-	-	-	-	-

the total forest soil fauna. The second annual cycle density of Hypogastruridae was $77x10^2/m^2$, comprising 0.71% of the total Collembola and 0.33% of the total forest soil fauna.

Since the Hypogastruridae occurred only at the litter during both the annual cycles, therefore, the total density of these collembolans in the forest soil equalled the litter-layer densities. However, Hypogastruridae showed variable percentages in the litter layers, being 1.17% of the total Collembola and 0.63% of the total fauna of the litter during the first annual cycle of the present investigation. In the second annual cycle, Hypogastruridae formed 0.92% of the total Collembola of the litter and 0.51% of the total fauna of the forest soil.

The hypogastrurids were not recovered beyond the litter layers of the forest. In the jhum soil too, the hypogastrurids were totally absent during the period of present investigation. Neither the genera nor the species of this family could however, be identified.

c. Family Isotomidae

The two annual cycle densities of the family Isotomidae and their percentages among the different categories of the soil fauna are given in the Table V. The total number of individuals of isotomids during the first annual cycle was $7,692x10^2/m^2$, forming 75.0% of the total Collembola and 34.47% of the total forest soil fauna. The second annual cycle density of the isotomids increased to $8,201x10^2/m^2$, comprising 75.54% of the

total Collembola and 34.87% of the total forest soil fauna.

The vertical distributions of these collembolans were $5,679x10^2/m^2$ at litter layer, $1,680x10^2/m^2$ at 0-10 cm, $317x10^2/m^2$ at 10-20 cm and $16x10^2/m^2$ at 20-30 cm. Among themselves vertically, the isotomids were 73.83% (litter), 21.84% (0-10 cm), 4.12% (10-20 cm) and 0.21% (20-30 cm). Among the total collembolan fauna at different soil layers, the percentage contributions of Isotomidae were 72.96% (litter), 79.70% (0-10 cm), 91.09% (10-20 cm) and 100.0% (20-30 cm). Among the total fauna of the soil, these collembolans formed 39.34% (litter), 25.62% (0-10 cm), 26.39% (10-20 cm) and 21.05% (20-30 cm).

During the second annual cycle, densities of Isotomidae were $6,278x10^2/m^2$ (litter), $1,608x10^2/m^2$ (0-10 cm), $287x10^2/m^2$ (10-20 cm) and $28x10^2/m^2$ (20-30 cm). Among themselves vertically, the percentage distributions of Isotomidae were 76.55% (litter), 19.61% (0-10 cm), 3.50% (10-20 cm) and 0.34% (20-30 cm). Of the total Collembola in each layer, Isotomidae formed 74.73% at litter layer, 76.86% at 0-10 cm layer, 85.42% at 10-20 cm layer and 100.0% at 20-30 cm layer. Of the total fauna of each layer, Isotomidae constituted 41.34%, 23.36%, 24.47% and 11.67%, respectively at litter, 0-10 cm, 10-20 cm and 20-30 cm soil depths.

In the jhum soil, Isotomidae comprised 83.79% of Collembola and 21.60% of the total fauna of the jhum soil during the first annual cycle. The number of isotomids for this period was $951x10^2/m^2$. During the second annual cycle, the total number of isotomids in the jhum soil increased to $1,139x10^2/m^2$ and

formed 84.18% of the total Collembola of the jhum soil. Of the total fauna of the jhum soil, Isotomidae constituted 22.80% during the same period.

In different depths of the jhum soil, the first annual cycle densities of Isotomidae were $759x10^2/m^2$, $180x10^2/m^2$ & $12x10^2/m^2$, respectively at 0-10 cm, 10-20 cm & 20-30 cm soil depths. Vertically among themselves, the patterns of jhum soil depth-wise percentages of Isotomidae were 75.81% (0-10 cm), 18.93% (10-20 cm) and 1.26% (20-30 cm). Further, Isotomidae constituted 80.49% of total Collembola and 21.79% of total jhum soil fauna at 0-10 cm; 100.0% of Collembola and 24.07% of total soil fauna at 10-20 cm; 100.0% of Collembola and 10.00% of total soil fauna at 20-30 cm.

During the second annual cycle, the densities of Isotomidae were $851x10^2/m^2$, $268x10^2/m^2$ & $20x10^2/m^2$ respectively, at 0-10, 10-20 & 20-30 cms soil depths. Among themselves vertically, the percentage compositions of Isotomidae were 74.71% (0-10 cm), 23.53% (10-20 cm) and 1.76% (20-30 cm). Among total Collembola in different layers of the jhum soil, Isotomidae constituted 79.91%, 100.0% & 100.0% respectively, at 0-10 cm, 10-20 cm & 20-30 cm soil depths. Of the total fauna of the jhum soil during the second annual cycle, Isotomidae made up 23.27%, 24.14% & 17.86% respectively at 0-10, 10-20 & 20-30 cms soil depths.

Two species of Isotomidae were identified: Isotoma (Desoria) trispinata MacGillivray and Cryptopygus thermophilus Axelson. All the other isotomids are described under the category 'other isotomids'.

Table V. Showing the total number and percentages of the family Isotomidae (Collembola : Insecta) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total Collembola

d : Percentages in total soil fauna

Table VI. Showing the total number and percentages of Isotoma (Desoria) trispinata MacGillivray (Isotomidae : Collembola : Insecta) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in family Isotomidae

d : Percentages in total Collembola

e : Percentages in total soil fauna

TABLE V

COLLEMBOLA (FAMILY)	SITES	LAYERS	FIRST ANNUAL CYCLE				SECOND ANNUAL CYCLE			
			a	b	c	d	a	b	c	d
Isotomidae	FOREST	LITTER	5679 (±93.98)	73.83	72.96	39.34	6278 (±157.21)	76.55	74.73	41.34
		0 - 10cm	1680 (±30.98)	21.84	79.70	25.62	1608 (±40.18)	19.61	76.86	23.36
		10 - 20cm	317 (±20.66)	4.12	91.09	26.39	287 (±16.75)	3.50	85.42	24.47
		20 - 30cm	16 (±1.58)	0.21	100.0	21.05	28 (±4.95)	0.34	100.0	11.67
		30 - 40cm	-	-	-	-	-	-	-	-
		TOTAL	7692 (±114.34)	100.0	75.00	34.47	8201 (±182.72)	100.0	75.54	34.87
	JHUM	0 - 10cm	759 (±43.39)	75.81	80.49	21.79	851 (±35.02)	74.71	79.91	23.27
		10 - 20cm	180 (±7.82)	18.93	100.0	24.07	268 (±15.50)	23.53	100.0	24.14
		20 - 30cm	12 (±1.08)	1.26	100.0	10.00	20 (±1.73)	1.76	100.0	17.86
		30 - 40cm	-	-	-	-	-	-	-	-
		TOTAL	951 (±40.23)	100.0	83.79	21.60	1139 (±43.94)	100.0	84.18	22.80

TABLE VI

COLLEMBOLA (ISOTOMIDAE)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Isotoma (Desoria) trispinata MacGillivray	FOREST	LITTER	4725 (±75.30)	73.70	83.20	60.70	32.73	5245 (±112.74)	76.44	83.54	62.43	34.54
		0 - 10cm	1431 (±29.42)	22.30	85.18	67.89	21.82	1372 (±44.50)	19.99	85.30	65.58	19.93
		10 - 20cm	238 (±17.32)	3.70	75.08	68.39	19.82	217 (±22.82)	3.26	75.61	64.58	18.50
		20 - 30cm	16 (±1.58)	0.30	100.0	100.0	21.05	28 (±4.95)	0.41	100.0	100.0	11.67
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	6410 (±98.15)	100.0	83.33	62.50	28.73	6862 (±132.56)	100.0	83.67	63.20	29.18
	JHUM	0 - 10cm	624 (±49.23)	79.70	82.21	66.17	17.92	701 (±26.21)	76.61	82.38	65.82	19.17
		10 - 20cm	147 (±5.18)	18.80	81.67	81.67	19.70	194 (±14.18)	21.20	72.39	72.39	17.48
		20 - 30cm	12 (±1.08)	1.50	100.0	100.0	10.00	20 (±1.73)	2.19	100.0	100.0	17.86
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	783 (±47.00)	100.0	82.33	68.99	17.79	915 (±37.18)	100.0	80.33	67.63	18.32

c.1. Isotoma (Desoria) trispinata MacGillivray

Table VI represents the two annual densities of Isotoma (Desoria) trispinata in the forest and jhum soils and their percentage compositions among the different categories of the soil fauna. Thus, Isotoma (Desoria) trispinata recorded a density of $6,410x10^2/m^2$ during the first annual cycle. This species formed 83.33% of the family Isotomidae, 62.50% of the total Collembola and 28.73% of the total forest soil fauna during the first annual cycle. In the second annual cycle, the density of Isotoma (Desoria) trispinata for the total forest soil fauna increased to $6,862x10^2/m^2$, claiming 83.67% of the family Isotomidae, 63.20% of Collembola and 29.18% of the total forest soil fauna during this second annual cycle period.

The vertical distributions of Isotoma (Desoria) trispinata in the forest during the first annual cycle were $4,725x10^2/m^2$, $1,431x10^2/m^2$, $238x10^2/m^2$ & $16x10^2/m^2$ respectively, at litter, 0-10, 10-20 & 20-30 cms soil depths. Among themselves vertically, compositions of this species were 73.70% at litter, 22.30% at 0-10 cm, 3.70% at 10-20 cm and 0.30% at 20-30 cm soil layers. The percentages of this species among its family Isotomidae, total Collembola & total forest soil fauna respectively were 83.20%, 60.70% & 32.73% at the litter layer; 85.18%, 67.89% & 21.82% at 0-10 cm; 75.08%, 68.39% & 19.82% at 10-20 cm; 100.0%, 100.0% & 21.05% at 20-30 cm.

This species number during the second annual cycle at different forest soil depths were $5,245x10^2/m^2$ (litter), $1,372x10^2/m^2$ (0-10 cm), $217x10^2/m^2$ (10-20 cm) and $28x10^2/m^2$(20-30 cm).

Among themselves vertically, Isotoma (Desoria) trispinata contributed 76.44%, 19.99%, 3.26% & 0.41% at litter, 0-10 cm, 10-20 cm & 20-30 cm layers of the forest soil, respectively. In its family Isotomidae, the percentages of this species were 83.54% (litter), 85.30% (0-10 cm), 75.61% (10-20 cm) and 100.0% (20-30 cm). Among the total Collembola at different layers, the species formed 62.43% (litter), 65.58% (0-10 cm), 64.58% (10-20 cm) and 100.0% (20-30 cm). Of the total fauna of the forest soil, the species comprised of 34.54% at litter layer, 19.93% at 0-10 cm, 18.58% at 10-20 cm and 11.67% at 20-30 cm soil layer.

In the jhum soils, Isotoma (Desoria) trispinata accounted for a density of $783 \times 10^2/m^2$ during the first annual cycle. This density constituted 82.33% of the family Isotomidae, 68.99% of the total Collembola and 17.79% of the total fauna of the jhum soil. In the second annual cycle, the species showed an increase of density to $915 \times 10^2/m^2$, and accounting for 80.33% of the family Isotomidae, 67.63% of the total Collembola and 18.32% of the total fauna of the jhum soils.

The densities of Isotoma (Desoria) trispinata in different layers of the jhum soils during the first annual cycle were $624 \times 10^2/m^2$, $147 \times 10^2/m^2$ & $12 \times 10^2/m^2$ respectively at 0-10 cm, 10-20 cm & 20-30 cm. Among themselves vertically, the percentage patterns of the species distributions were 79.70% (0-10 cm), 18.80% (10-20 cm) and 1.50% (20-30 cm). Of the family Isotomidae, the species formed 82.21% at 0-10 cm, 81.67% at 10-20 cm and 100.0% at 20-30 cm. Among the total Collembola, the species formed 66.17% at 0-10 cm, 81.67% at 10-20 cm and 100.0% at 20-30

cm soil depths. Among the total fauna of the jhum soils, the percentage compositions of this species were 17.92%, 19.70% and 10.00% respectively at 0-10 cm, 10-20 cm and 20-30 cm soil layers.

During the second annual cycle, the numbers of Isotoma (Desoria) trispinata were $701x10^2/m^2$ at 0-10 cm, $194x10^2/m^2$ at 10-20 cm and $20x10^2/m^2$ at 20-30 cm. Among themselves vertically, the percentage compositions of the species were 76.61% (0-10 cm), 21.20% (10-20 cm) and 2.19% (20-30 cm). Among its family Isotomidae, the species formed 82.38% at 0-10 cm, 72.39% at 10-20 cm and 100.0% at 20-30 cm. Of the total Collembola and total soil fauna, the species formed 65.82% and 19.17% at 0-10 cm; 72.39% and 17.48% at 10-20 cm; 100.0% and 17.86% at 20-30 cm, respectively.

c.2. Cryptopygus thermophilus Axelson

The two annual cycle densities of Cryptopygus thermophilus in the forest (inclusive of litter) and jhum soils, and their percentage calculations among the different categories of soil fauna are represented in Table VII. The first annual cycle density of this species in the forest was $808x10^2/m^2$, forming 10.51% of the family Isotomidae, 7.90% of the total Collembola and 3.62% of the total forest soil fauna. During the second annual cycle, the species formed $840x10^2/m^2$ in density, accounting for 10.25% of the family Isotomidae, 7.74% of the total Collembola and 3.57% of the total fauna of the forest soils.

The densities of the species in the different layers of the forest soils during the first annual cycle were $650x10^2/m^2$, $112x10^2/m^2$ & $46x10^2/m^2$ respectively at litter, 0-10 cm & 10-20 cm soil depths. Among themselves vertically, the percentage compositions of the species were 80.45% at litter layer, 13.86% at 0-10 cm and 5.69% at 10-20 cm soil depths. Of the family Isotomidae, the species made up 11.45%, 6.67% & 14.51% respectively at litter, 0-10 cm & 10-20 cm soil layers. Of the total Collembola, the species contributed 8.35% (litter), 5.31% (0-10 cm) and 13.22% (10-20 cm). Of the total soil fauna of the forest during the first annual cycle, the species formed 4.50% (litter), 1.71% (0-10 cm) and 3.83% (10-20 cm).

The second annual cycle densities of the species at different forest soil layers were $693x10^2/m^2$ (litter), $107x10^2/m^2$ (0-10 cm) and $40x10^2/m^2$ (10-20 cm). Vertically among themselves, the species formed 82.50% at litter layer, 12.74% at 0-10 cm and 4.76% at 10-20 cm. Of the family Isotomidae, total Collembola and total forest soil fauna, the species formed 11.04%, 8.25% & 4.56% at the litter layer; 6.70%, 5.11% & 1.56% at 0-10 cm layer; and 13.94%, 11.91% & 3.41% at 10-20 cm soil depths, respectively.

In the jhum soil, this collembolan species formed a total density of $70x10^2/m^2$ during the first annual cycle. Further, the species constituted 7.36% of the family Isotomidae, 6.17% of the total Collembola and 1.59% of the total fauna of the jhum soil. The second annual cycle density was $91x10^2/m^2$, forming 7.99% of the family Isotomidae, 6.72% of the total Co-

Table VII. Showing the total number and percentages of Cryptopygus thermophilus Axelson (Isotomidae : Collembola : Insecta) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses
b : Percentages among themselves
c : Percentages in family Isotomidae
d : Percentages in total Collembola
e : Percentages in total soil fauna

Table VIII. Showing the total number and percentages of "other isotomids" in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses
b : Percentages among themselves
c : Percentages in family Isotomidae
d : Percentages in total Collembola
e : Percentages in total soil fauna

TABLE VII

COLLEMBOLA (ISOTOMIDAE)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Cryptopygus thermophilus Axelson	FOREST	LITTER	650 (±44.15)	80.45	11.45	8.35	4.50	693 (±40.33)	82.50	11.04	8;25	4.56
		0 - 10cm	112 (±8.76)	13.86	6.67	5.31	1.71	107 (±11.45)	12.74	6.70	5.11	1.56
		10 - 20cm	46	5.69	14.51	13.22	3.83	40	4.76	13.94	11.91	3.41
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	808 (±51.85)	100.0	10.51	7.90	3.62	840 (±46.87)	100.0	10.25	7.74	3.57
	JHUM	0 - 10cm	51 (±5.76)	72.86	6.72	5.41	1.46	55 (±3.56)	60.44	6.46	5.17	1.50
		10 - 20cm	19 (±3.41)	27.14	10.55	10.55	2.50	36 (±3.03)	39.56	13.43	13.43	3.24
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	70 (±8.34)	100.0	7.36	6.17	1.59	91 (±6.49)	100.0	7.99	6.72	1.82

TABLE VIII

COLLEMBOLA (ISOTOMIDAE)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Other isotomids	FOREST	LITTER	304 (±19.40)	64.14	5.35	3.91	2.11	340 (±15.80)	68.14	5.42	4.05	2.24
		0 - 10cm	137 (±2.86)	28.90	8.15	6.50	2.09	129 (±5.18)	25.85	8.00	6.17	1.87
		10 - 20cm	33 (±3.24)	6.96	10.41	9.48	2.74	30 (±2.94)	6.01	10.45	8.93	2.56
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	--	-
		TOTAL	474 (±24.50)	100.0	6.16	4.60	2.12	499 (±21.22)	100.0	6.08	4.60	2.12
	JHUM	0 - 10cm	84 (±2.12)	85.71	11.07	8.91	2.41	95 (±7.04)	71.43	11.16	8.92	2.60
		10 - 20cm	14 (±0.71)	14.29	7.78	7.78	1.87	38 (±6.65)	28.57	14.18	14.18	3.42
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	98 (±2.68)	100.0	10.31	8.63	2.22	133 (±6.18)	100.0	11.68	9.83	2.66

llembola and 1.82% of the total jhum soil fauna.

The numbers of the species in the different layers of the jhum soil were $51x10^2/m^2$ at 0-10 cm and $19x10^2/m^2$ at 10-20 cm. Vertically among themselves, the species formed 72.86% at 0-10 cm and 27.14% at 10-20 cm. Of the family Isotomidae, total Collembola and total jhum soil fauna at 0-10 cm, the species formed 6.72%, 5.41% and 1.46%, respectively. At 10-20 cm soil layer, the species formed 10.55% of the family Isotomidae, 10.55% of the total Collembola and 2.50% of the total jhum soil fauna.

The second annual cycle densities of Cryptopygus thermophilus were $55x10^2/m^2$ at 0-10 cm and $36x10^2/m^2$ at 10-20 cm soil depths. Among themselves vertically, the species were made up of 60.44% at 0-10 cm and 39.56% at 10-20 cm. Of the family Isotomidae, total Collembola and total fauna of the jhum soil, the species formed respectively 6.46%, 5.17% and 1.50% at 0-10 cm. However, at 10-20 cm soil depth, the species formed 13.43% of the family Isotomidae, 13.43% of the total Collembola and 3.24% of the total jhum soil fauna.

c.3. Other isotomids

Under this category were included those isotomids (Collembola belonging to the family Isotomidae) other than Isotoma (Desoria) trispinata and Cryptopygus thermophilus. Table VIII represents the two annual cycle densities of the "other isotomids" and their percentages among the different categories of the soil fauna of forest and jhum. During the first annual cycle, the total density of these 'other isotomids' in the

forest was $474x10^2/m^2$, constituting 6.16% of the family Isotomidae, 4.60% of the total Collembola and 2.12% of the total forest soil fauna. In the second annual cycle, the total density increased marginally to $499x10^2/m^2$, forming 6.08% of the family Isotomidae, 4.60% of the total Collembola and 2.12% of the total forest soil fauna.

The vertical distributions in different layers of the forest soil were $304x10^2/m^2$ at litter, $137x10^2/m^2$ at 0-10 cm and $33x10^2/m^2$ at 10-20 cm. Among themselves vertically, this group of Collembola formed 64.14%, 28.90% & 6.96% respectively at litter, 0-10 cm & 10-20 cm. Of the family Isotomidae, 'other isotomids' formed 5.35% at litter, 8.15% at 0-10 cm and 10.41% at 10-20 cm. Of the total Collembola, the percentage compositions of the 'other isotomids' at different layers were 3.91% (litter), 6.50% (0-10 cm) and 9.48% (10-20 cm). Among the total fauna of the forest soil, the percentage constituents of this group of Collembola were 2.11% at litter, 2.09% at 0-10 cm and 2.74% at 10-20 cm.

During the second annual cycle, the densities of the 'other isotomids' in different layers of the forest soil were $340x10^2/m^2$ (litter), $129x10^2/m^2$ (0-10 cm) and $30x10^2/m^2$ (10-20 cm). Among themselves vertically, this group made up 68.14% at litter, 25.85% at 0-10 cm and 6.01% at 20-30 cm soil layers. Of the family Isotomidae, total Collembola and total forest soil fauna, the 'other isotomids' formed 5.42%, 4.05% & 2.24% at litter; 8.00%, 6.17% & 1.87% at 0-10 cm; 10.45%, 8.93% & 2.56% at 10-20 cm each, respectively.

In the jhum, the total numbers of 'other isotomids' were $98x10^2/m^2$ during the first annual cycle of investigation. This group of Collembola constituted 10.31% of the family Isotomidae, 8.63% of the total Collembola and 2.22% of the total soil fauna of the jhum. During the second annual cycle, the total number reached $133x10^2/m^2$, being 11.68% of the family Isotomidae, 9.83% of the total Collembola and 2.66% of the total soil fauna of the jhum.

The densities of the 'other isotomids' in the different layers of the jhum soils during the first annual cycle were $84x10^2/m^2$ and $14x10^2/m^2$, respectively at 0-10 cm and 10-20 cm. Among themselves vertically, this group of Collembola formed 85.71% at 0-10 cm and 14.29% at 10-20 cm. Of the family Isotomidae, total Collembola and total jhum soil fauna during the first annual cycle, these collembolans formed 11.07%, 8.91% and 2.41% at 0-10 cm, respectively. However, at 10-20 cm soil depth, this group of Collembola formed 7.78% of the family Isotomidae, 7.78% of the total Collembola and 1.87% of the total jhum soil fauna.

The second annual cycle densities of these collembolans were $95x10^2/m^2$ at 0-10 cm and $38x10^2/m^2$ at 10-20 cm. Vertically among themselves, the group formed 71.43% at 0-10 cm and 28.57% at 10-20 cm. Of the family Isotomidae, total Collembola and total soil fauna at 0-10 cm of the jhum, these collembolans formed 11.16%, 8.92% and 2.60%, respectively. At 10-20 cm depth, these collembolans formed 14.18% of the family Isotomidae, 14.18% of total Collembola and 3.42% of total jhum soil fauna.

d. Family Entomobryidae

The two annual cycle densities of the family Entomobryidae and their percentage compositions among the different categories of the soil fauna in the forest and jhum are represented in the Table IX. During the first annual cycle, the total number of the entomobryids in the forest soil was $1,563x10^2/m^2$, forming 15.24% of the total Collembola and 7.00% of the total forest soil fauna. In the second annual cycle, the total density of entomobryids was $1,616x10^2/m^2$, accounting for 14.88% of the total Collembola and 6.87% of the fauna of the forest soil.

The densities of the entomobryids in the different layers of the forest soil, during the first annual cycle were $1,235x10^2/m^2$ at the litter layer, $297x10^2/m^2$ at 0-10 cm and $31x10^2/m^2$ at 10-20 cm. Among themselves vertically, the percentage distributions of the entomobryids were 79.02% (litter), 19.00% (0-10 cm) and 1.98% (10-20 cm). Of the total Collembola and forest soil fauna during the first annual cycle, the entomobryids formed 15.86% and 8.56% at litter; 14.09% and 4.53% at 0-10 cm; 8.91% and 2.58% at 10-20 cm, respectively.

During the second annual cycle, the densities of entomobryids were $1,242x10^2/m^2$ at litter, $325x10^2/m^2$ at 0-10 cm and $49x10^2/m^2$ at 10-20 cm. Vertically among themselves, the entomobryids formed 76.86% at litter, 20.11% at 0-10 cm and 3.03% at 10-20 cm. Of the total fauna, the percentages of the family Entomobryidae were 14.78% (litter), 15.54% (0-10 cm) and 14.58% (10-20 cm). Of the total forest soil fauna during the second annual cycle, this group of collembolans constituted 8.18% at the

Table IX. Showing the total number and percentages of the family Entomobryidae (Collembola : Insecta) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total Collembola

d : Percentages in total soil fauna

Table X. Showing the total number and percentages of Dicranocentrus fraternus Mari Mutt & Bhattacharjee (Entomobryidae : Collembola : Insecta) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in family Entomobryidae

d : Percentages in total Collembola

e : Percentages in total soil fauna

TABLE IX

COLLEMBOLA (FAMILY)	SITES	LAYERS	FIRST ANNUAL CYCLE				SECOND ANNUAL CYCLE			
			a	b	c	d	a	b	c	d
Entomobryidae	FOREST	LITTER	1235 (±14.22)	79.02	15.86	8.56	1242 (±19.82)	76.86	14.78	8.18
		0 - 10cm	297 (±9.23)	19.00	14.09	4.53	325 (±5.73)	20.11	15.54	4.72
		10 - 20cm	31 (±1.47)	1.98	8.91	2.58	49 (±6.26)	3.03	14.58	4.18
		20 - 30cm	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-
		TOTAL	1563 (±19.41)	100.0	15.24	7.00	1616 (±15.37)	100.0	14.88	6.87
	JHUM	0 - 10cm	128 (±3.76)	100.0	13.57	3.68	145 (±9.02)	100.0	13.61	3.96
		10 - 20cm	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-
		TOTAL	128 (±3.76)	100.0	11.28	2.91	145 (±9.02)	100.0	10.72	2.91

TABLE X

COLLEMBOLA (ENTOMO-BRYIDAE)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Dicranocentrus fraternus Mari Mutt & Bhattacharjee	FOREST	LITTER	253 (±8.95)	83.77	20.49	3.25	1.75	233 (±7.85)	78.98	18.76	2.77	1.53
		0 - 10cm	49 (±2.71)	16.23	16.50	2.30	0.75	62 (±6.36)	21.02	19.10	2.96	0.90
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	302 (±10.06)	100.0	19.32	2.94	1.35	295 (±16.94)	100.0	18.25	2.72	1.26
	JHUM	0 - 10cm	31 (±2.80)	100.0	24.22	3.29	0.89	36 (±9.35)	100.0	24.83	3.38	0.98
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	31 (±2.80)	100.0	24.22	2.73	0.70	36 (±9.35)	100.0	24.83	2.66	0.72

litter layer, 4.72% at 0-10 cm and 4.18% at 10-20 cm soil layers.

In the jhum soil, the total density of entomobryids during the first annual cycle was $128x10^2/m^2$, constituting 11.28 percent of the total Collembola and 2.91% of the total jhum soil fauna. With a density of $145x10^2/m^2$ in the second annual cycle, the entomobryids made up 10.72% of the total Collembola and 2.91% of the total fauna of the jhum soil.

In relation to the vertical distribution of the entomobryids, since the group occurred only at 0-10 cm , their densities at this layer were equivalent to the total densities of the jhum soil, during both the years of investigation. However, the group formed 13.57% of total Collembola and 3.68% of the total jhum soil fauna during the first annual cycle. The percentages of the second annual cycle were 13.61% and 3.96% respectively, of total Collembola and total jhum soil fauna.

The family Entomobryidae had the following genera and species: Dicranocentrus fraternus Mari Mutt & Bhattacharjee, Dicranocentrus singularis Mari Mutt & Bhattacharjee, Entomobrya sp., Salina sp., Metacoelura sp., Seira sp., Lepidocyrtus sp. and Isotobryoides sp. Unidentifiable Collembola belonging to this family are described under the category 'other entomobryids'.

d.1. Dicranocentrus fraternus Mari Mutt & Bhattacharjee

Table X illustrates the first and second annual cycle densities of the species, Dicranocentrus fraternus and their percentages among the different categories of the soil fauna in

both the forest and jhum systems. Thus, the first total annual density of the species in the forest was $302x10^2/m^2$, comprising 19.32% of the family Entomobryidae, 2.94% of the total Collembola and 1.35% of the total forest soil fauna. In the second annual cycle, the total density of the species was $295x10^2/m^2$, accounting for 18.25%, 2.72% and 1.26%, respectively of the family Entomobryidae, total Collembola and total forest soil fauna.

The densities of the species in different layers of the forest were $253x10^2/m^2$ at litter and $49x10^2/m^2$ at 0-10 cm. Vertically among themselves, the species formed 83.77% at litter and 16.23% at 0-10 cm. Of the family Entomobryidae, the species formed 20.49% (litter) and 16.50% (0-10 cm). Among the total Collembola, the species comprised 3.25% at litter and 2.30% at 0-10 cm. Of the total fauna, the percentage compositions of this species were 1.75% (litter) and 0.75% (0-10 cm).

During the second annual cycle, the species densities recorded were $233x10^2/m^2$ (litter) and $62x10^2/m^2$ (0-10 cm). Vertically among themselves, the species formed 78.98% and 21.02% at litter and 0-10 cm soil layer, respectively. Of the family Entomobryidae, total Collembola and total soil fauna, the species respectively formed 18.76%, 2.77% and 1.53% at litter; 19.10%, 2.96% and 0.90% at 0-10 cm soil depths.

In the jhum soil, the species of Dicranocentrus fraternus had a density of $31x10^2/m^2$ during the first annual cycle. The species further accounted for 24.22% of the family Entomobryidae, 2.73% of total Collembola of the jhum soil and 0.70% of the total jhum soil fauna. In the second annual cycle, this

101778
101

group of Collembola had a total number of $36x10^2/m^2$, constituting 24.83% of the family Entomobryidae, 2.66% of the total Collembola and 0.72% of the total jhum soil fauna.

During both the annual cycles of present investigation the species occurred only upto the depth of 10 cm. Hence, the densities at 0-10 cm equalled the total densities of the system. However, the species formed 24.22% of the family Entomobryidae, 3.29% of the total Collembola and 0.89% of the total jhum soil fauna at 0-10 cm during the first annual cycle. The percentages of the species in the second annual cycle were 24.83% of the family Entomobryidae, 3.38% of the total Collembola and 0.98% of the total soil fauna of the jhum at 0-10 cm.

d.2. Dicranocentrus singularis Mari Mutt & Bhattacharjee

The two annual cycle densities of Dicranocentrus singularis and their percentages among the different categories of the soil fauna of the forest and jhum are shown in Table XI. The total annual density of the species was $137x10^2/m^2$, forming 8.76 percent of the family Entomobryidae, 1.34% of the total Collembola, and 0.61% of the total soil fauna during the first annual cycle. With a density of $142x10^2/m^2$ during the second annual cycle, the species formed 8.79% of the family Entomobryidae, 1.31% of the total Collembola and 0.60% of the total forest soil fauna.

The vertical distributions of the species were $129x10^2/m^2$ at litter and $8x10^2/m^2$ at 0-10 cm. Among themselves vertically, the species contributed 94.16% at litter and 5.84% at 0-10 cm. Of the family Entomobryidae, total Collembola and total fau-

Table XI. Showing the total number and percentages of Dicranocentrus singularis Mari Mutt & Bhattacharjee (Entomobryidae : Collembola : Insecta) in the forest system and in its different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in family Entomobryidae

d : Percentages in total Collembola

e : Percentages in total soil fauna

Table XII. Showing the total number and percentages of Entomobrya sp. (Entomobryidae : Collembola : Insecta) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in family Entomobryidae

d : Percentages in total Collembola

e : Percentages in total soil fauna

TABLE XI

COLLEMBOLA (ENTOMO-BRYIDAE)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
	FOREST	LITTER	129 (±4.60)	94.16	10.44	1.66	0.89	124 (±8.04)	87.32	9.98	1.48	0.82
		0 - 10cm	8 (±0.71)	5.84	2.70	0.40	0.12	18 (±1.68)	12.68	5.50	0.86	0.26
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
Dicranocentrus singularis Mari Mutt & Bhattacharjee		TOTAL	137 (±4.71)	100.0	8.76	1.34	0.61	142 (±9.34)	100.0	8.79	1.31	0.60
	JHUM	0 - 10cm	-	-	-	-	-	-	-	-	-	-
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	-	-	-	-	-	-	-	-	-	-

TABLE XII

COLLEMBOLA (ENTOMO-BRYIDAE)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
	FOREST	LITTER	219 (±3.42)	63.48	17.73	2.81	1.52	236 (±3.34)	70.45	19.00	2.81	1.55
		0 - 10cm	126 (±6.84)	36.52	42.40	6.00	1.92	99 (±2.12)	29.55	30.50	4.73	1.44
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	--	-	-	-
Entomobrya sp.		TOTAL	345 (±4.38)	100.0	22.07	3.36	1.54	335 (±3.98)	100.0	20.73	3.08	1.42
	JHUM	0 - 10cm	48 (±3.63)	100.0	37.50	5.09	1.38	42 (±3.72)	100.0	28.97	3.94	1.15
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	48 (±3.63)	100.0	37.50	4.23	1.09	42 (±3.72)	100.0	28.97	3.11	0.84

na of the litter, the species formed 10.44%, 1.66% and 0.89% respectively during the first annual cycle. At 0-10 cm depth, the species formed 2.70% of the family Entomobryidae, 0.40% of the total Collembola and 0.12% of the total forest soil fauna.

During the second annual cycle, the densities of the species at different soil layers were $124x10^2/m^2$ (litter) and $18x10^2/m^2$ (0-10 cm). Among themselves vertically, the percentage distributions of the species were 87.32% (litter) and 12.68% (0-10 cm). Of the family Entomobryidae, the species formed 9.98% at litter and 5.50% at 0-10 cm. Among the total Collembola, the species had 1.48% and 0.86%, respectively at litter and 0-10 cm. The species further formed 0.82%of the total litter fauna and 0.26% of the total soil fauna at 0-10 cm depth of the forest.

The species, Dicranocentrus singularis were not found from the jhum soils during the period of present investigation.

d.3. Entomobrya sp.

Table XII illustrates the numbers of Entomobrya sp. extracted during the first and second annual cycles of study and their percentage compositions among the different categories of the forest and jhum soil fauna. In the forest, the total density of Entomobrya sp. during the first annual cycle was $345x10^2/m^2$, forming 22.07% of the family Entomobryidae, 3.36% of the total Collembola and 1.54% of the total forest soil fauna. With a density of $335x10^2/m^2$ during the second annual cycle, Entomobrya sp. accounted for 20.73% of the family Entomobryidae, 3.08% of the total Collembola and 1.42% of the total forest soil fauna.

The vertical densities of the species during the first annual cycle were $219x10^2/m^2$ at litter and $126x10^2/m^2$ at 0-10 cm soil layer. Among themselves vertically, the species distributions were 63.48% at litter and 36.52% at 0-10 cm soil depth. Of the family Entomobryidae, the percentage share of Entomobrya sp. at litter layer was 17.73% and 42.40% at 0-10 cm. Further, in the litter layer, the species formed 2.81% of the total Collembola and 1.52% of the total litter layer fauna. At 0-10 cm soil depth, the species formed 6.00% of the total Collembola and 1.92% of the total soil fauna of the same layer.

The vertical densities of the Entomobrya sp. during the second annual cycle were $236x10^2/m^2$ at litter and $99x10^2/m^2$ at 0-10 cm layer of the forest. Among themselves vertically, the percentage distribution of this species at litter and 0-10 cm soil layer were 70.45% and 29.55%, respectively. In the litter layer, the species formed 19.00% of the family Entomobryidae, 2.81% of the total Collembola and 1.55% of the total fauna of the litter. At the soil layer of 0-10 cm, the species made up 30.50% of the family Entomobryidae, 4.73% of the total Collembola and 1.44% of the total forest soil fauna of the layer.

In the jhum, Entomobrya sp. had a density of $48x10^2/m^2$ during the first annual cycle. The species constituted 37.50% of the family Entomobryidae, 4.23% of the total Collembola and 1.09% of the total fauna of the jhum soil. The total density of the second annual cycle was $42x10^2/m^2$, forming 28.97% of the family Entomobryidae, 3.11% of the total Collembola and 0.84% of the total jhum soil fauna.

In relation to the vertical distributions of Entomobrya sp., since the species occurred only at 0-10 cm layer of the jhum soil, the densities of the species at this layer made up its total annual densities. However, during the first annual cycle, the species in the jhum soil formed 37.50% of the family Entomobryidae, 5.09% of the total Collembola and 1.38% of the total jhum soil fauna. In the second annual cycle, the species formed 28.97%, 3.94% and 1.15%, respectively of the family Entomobryidae, total Collembola and total jhum soil fauna.

d.4. Salina sp.

Table XIII described the two annual densities and percentages of Salina sp. among the different categories of the forest and jhum soil fauna. During the first annual cycle, the species had a density of $143x10^2/m^2$, accounting for 9.15% of the family Entomobryidae, 1.39% of the total Collembola and 0.64% of the total forest soil fauna. The total density of the second annual cycle was $170x10^2/m^2$ and constituted 10.52% of the family Entomobryidae, 1.57% of the total Collembola and 0.72% of the total forest soil fauna.

The vertical densities of this species in the forest were $115x10^2/m^2$ (litter) and $28x10^2/m^2$ (0-10 cm) during the first annual cycle. Vertically among themselves, the percentage compositions of the species were 80.42% (litter) and 19.58% (0-10 cm). In the litter layer, the species made up 9.31% of the family Entomobryidae, 1.48% of the total Collembola and 0.80% of the total litter fauna. At 0-10 cm soil depth, Salina sp. fo-

rmed 9.40% of the family Entomobryidae, 1.30% of the total Collembola and 0.43% of the total forest soil fauna.

The vertical densities of the species in the second annual cycle were $127x10^2/m^2$ (litter) and $43x10^2/m^2$ (0-10 cm). Among themselves vertically, the species formed 74.71% at litter and 25.29% at 0-10 cm. The percentage compositions of the species among the different faunal categories of the litter were 10.23%, 1.51% and 0.84%, respectively of the family Entomobryidae, total Collembola and total litter fauna. At 0-10 cm soil depth, Salina sp. made up 13.20% of the family Entomobryidae, 2.06% of the total Collembola and 0.62% of the total forest soil fauna of the layer.

In the jhum, the total density of Salina sp. during the first annual cycle was $9x10^2/m^2$. Further, the species constituted 7.03% of the family Entomobryidae, 0.79% of the total Collembola and 0.21% of the total fauna of the jhum soil. The species, however, increased to $23x10^2/m^2$ in density during the second annual cycle, amounting to 15.86% of the family Entomobryidae, 1.70% of the total Collembola and 0.46% of the total soil fauna of the jhum.

The densities of Salina sp. in the jhum at 0-10 cm soil layer were equivalent to the total densities of the fauna, true for both the annual cycles. However, the species formed 7.03% of the family Entomobryidae, 0.95% of the total Collembola and 0.26% of the total jhum soil fauna of the first annual cycle. The second annual cycle percentages were 15.86%, 2.16% and 0.63%, respectively of the family Entomobryidae, total Collembola and total jhum soil fauna at 0-10 cm soil depth.

Table XIII. Showing the total number and percentages of Salina sp. (Entomobryidae : Collembola: Insecta) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses
b : Percentages among themselves
c : Percentages in family Entomobryidae
d : Percentages in total Collembola
e : Percentages in total soil fauna

Table XIV. Showing the total number and percentages of Metacoelura sp. (Entomobryidae : Collembola: Insecta) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses
b : Percentages among themselves
c : Percentages in family Entomobryidae
d : Percentages in total Collembola
e : Percentages in total soil fauna

TABLE XIII

COLLEMBOLA (ENTOMO-BRYIDAE)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Salina sp.	FOREST	litter	115 (±3.29)	80.42	9.31	1.48	0.80	127 (±2.48)	74.71	10.23	1.51	0.84
		0 - 10cm	28 (±3.89)	19.58	9.40	1.30	0.43	43 (±3.24)	25.29	13.20	2.06	0.62
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	143 (±6.81)	100.0	9.15	1.39	0.64	170 (±4.85)	100.0	10.52	1.57	0.72
	JHUM	0 - 10cm	9 (±1.47)	100.0	7.03	0.95	0.26	23 (±0.91)	100.0	15.86	2.16	0.63
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	9 (±1.47)	100.0	7.03	0.79	0.21	23 (±0.91)	100.0	15.86	1.70	0.46

TABLE XIV

COLLEMBOLA (ENTOMO-BRYIDAE)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Metacoelura sp.	FOREST	LITTER	134 (±17.23)	60.91	10.85	1.45	0.93	129 (±8.02)	55.60	10.39	1.18	0.85
		0 - 10cm	86 (±5.34)	39.09	29.00	4.09	1.31	103 (±5.58)	44.40	31.70	4.93	1.50
		10 - 20cm	-	-	--	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	--	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	220 (±19.77)	100.0	14.06	2.15	0.99	232 (±12.23)	100.0	14.36	2.14	0.99
	JHUM	0 - 10cm	40 (±1.68)	100.0	31.25	4.24	1.15	44 (±6.10)	100.0	30.34	4.13	1.20
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	40 (±1.68)	100.0	31.25	3.53	0.91	44 (±6.10)	100.0	30.34	3.25	0.89

d.5. Metacoelura sp.

Table XIV shows the two annual cycle densities of Metacoelura sp. and their percentage compositions among different categories of the forest and jhum soil fauna. The forest site recorded a density of $220x10^2/m^2$ of Metacoelura sp. during the first annual cycle of present investigation. The species made up 14.06% of the family Entomobryidae, 2.15% of the total Collembola and 0.99% of the total fauna of the forest soil. The second annual cycle density of the species increased marginally to $232x10^2/m^2$, accounting for 14.36% of the total Collembola belonging to the family Entomobryidae, 2.14% of the total Collembola and 0.99% of the total fauna of the forest soil.

The vertical distributions of the species during the first annual cycle were $134x10^2/m^2$ (litter) and $86x10^2/m^2$ (0-10 cm) in the forest. Among themselves vertically, the species formed 60.91% and 39.09%, respectively at litter and 0-10 cm. Further, in the litter layer, the species formed 10.85% of the family Entomobryidae, 1.45% of the total Collembola and 0.93% of the total litter fauna. At 0-10 cm soil layer, the species accounted for 29.00% of the family Entomobryidae, 4.09% of the total Collembola and 1.31% of the total soil fauna of the layer.

The vertical densities of the second annual cycle were $129x10^2/m^2$ (litter) and $103x10^2/m^2$ (0-10 cm). Among themselves vertically, the species formed 55.60% at litter and 44.40% at 0-10 cm. Of the family Entomobryidae, total Collembola and total fauna of the litter layer, the species formed 10.39%, 1.18 % and 0.85%, respectively. At the 0-10 cm soil layer, the spe-

cies made up 31.70% of the family Entomobryidae, 4.93% of the total Collembola and 1.50% of the total soil fauna.

In the jhum soil, the density of Metacoelura sp. during the first annual cycle was $40x10^2/m^2$. Further, the species contributed 31.25% of the family Entomobryidae, 3.53% of the total Collembola and 0.91% of the total fauna of the jhum soil. With a total density of $44x10^2/m^2$ in the second annual cycle, the species formed 30.34% of the family Entomobryidae, 3.25% of the total Collembola and 0.89% of the total fauna of the jhum.

At 0-10 cm layer of the jhum soil, the total densities of Metacoelura sp. were $40x10^2/m^2$ and $44x10^2/m^2$, respectively for the first and second annual cycles. The species made up 31.25% of the family Entomobryidae, 4.24% of the total Collembola and 1.15% of the total jhum soil fauna of the first annual cycle. In the second annual cycle, the species made up 30.34% of the family Entomobryidae, 4.13% of the total Collembola and 1.20% of the total jhum soil fauna.

d.6. Seira sp.

The two annual cycle densities of Seira sp. with their percentages among the different categories of the forest and jhum soil fauna are represented in the Table XV. The forest system recorded a total density of $113x10^2/m^2$ during the first annual cycle, constituting 7.23%, 1.10% and 0.51%, respectively of the family Entomobryidae, total Collembola and total forest soil fauna. The total density of the second annual cycle was $99x10^2/m^2$ and comprised 6.13% of the family Entomobryidae, 0.91% of the total Collembola and 0.42% of the total forest soil fauna.

Table XV. Showing the total number and percentages of Seira sp. (Entomobryidae : Collembola : Insecta) in the forest system and in its litter layer during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in family Entomobryidae

d : Percentages in total Collembola

e : Percentages in total soil fauna

Table XVI. Showing the total number and percentages of Lepidocyrtus sp. (Entomobryidae : Collembola: Insecta) in the forest system and in its litter layer during the two annual cycles of study.

a : Numbers, standard error in parenthese

b : Percentages among themselves

c : Percentages in family Entomobryidae

d : Percentages in total Collembola

e : Percentages in total soil fauna

TABLE XV

COLLEMBOLA (ENTOMO-BRYIDAE)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	f	g	c	d	e
	FOREST	LITTER	113 (±3.49)	100.0	9.15	1.28	0.78	99 (±1.83)	100.0	7.97	1.30	0.65
		0 - 10cm	-	-	-	-	-	-	-	-	-	-
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
Seira sp.		TOTAL	113 (±3.49)	100.0	7.23	1.10	0.51	99 (±1.83)	100.0	6.18	0.91	0.42
	JHUM	0 - 10cm	-	-	-	-	-	-	-	-	-	-
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	+	-	-	-	-	-	-	-	-	-

TABLE XVI

COLLEMBOLA (ENTOMO-BRYIDAE)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
	FOREST	LITTER	100 (±10.16)	100.0	8.10	1.07	0.69	109 (±12.82)	100.0	8.78	1.02	0.72
		0 - 10cm	-	-	-	-	-	-	-	-	-	-
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
Lepidocyrtus sp.		TOTAL	100 (±10.16)	100.0	6.40	0.98	0.45	109 (±12.82)	100.0	6.74	1.00	0.46
	JHUM	0 - 10cm	-	-	-	-	-	-	-	-	-	-
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	-	-	-	-	-	-	-	-	-	-

The Seira sp. were recovered only from the litter layer. Hence, the densities of this layer made up the total densities of the species. However, during the first annual cycle, the species formed 9.15% of the family Entomobryidae, 1.28% of the total Collembola and 0.78% of the total fauna of the litter regime. The second annual cycle percentages for the species were 7.97%, 1.30% and 0.65%, respectively of the family Entomobryidae, total Collembola and total litter fauna.

No Seira sp. were recovered from the jhum soils during the period of present investigation.

d.7. Lepidocyrtus sp.

Table XVI represents the first and second annual cycle densities of Lepidocyrtus sp., including the percentage values of the species as compared to the different categories of the forest and jhum soil fauna. The first annual cycle total density of the species was $100x10^2/m^2$, comprising 6.40% of the family Entomobryidae, 0.98% of the total Collembola and 0.45% of the total fauna of the forest soil. With a total density of $109x10^2/m^2$ during the second annual cycle, Lepidocyrtus sp. constituted 6.74% of the family Entomobryidae, 1.00% of the total Collembola and 0.46% of the total forest soil fauna.

From the litter layer, the number of Lepidocyrtus sp. recorded during the first annual cycle was $100x10^2/m^2$, forming 8.10% of the family Entomobryidae, 1.07% of the total Collembola and 0.69% of the total litter fauna. With a density of $109x10^2/m^2$ in the litter layer during the second annual cycle, the

species formed 8.78% of the family Entomobryidae, 1.02% of the total Collembola and 0.72% of the total fauna of the litter.

Lepidocyrtus sp. were totally absent in the jhum soil during the period of the present investigation.

d.8. Isotobryoides sp.

The two annual cycles densities of Isotobryoides sp. and their percentages among the different categories of the fauna in the forest and jhum soils are represented in the Table XVII. In the forest system, the species had a total density of $83x10^2/m^2$ during the first annual cycle and made up 5.31% of the family Entomobryidae, 0.81% of the total Collembola and 0.37% of the total fauna of the forest soil. With a total density of $86x10^2/m^2$ during the second annual cycle, the species made up 5.32% of the family Entomobryidae, 0.79% of the total Collembola and 0.37% of the total forest soil fauna.

Since the species occurred only in the litter regime, the densities at this layer were equivalent to the total densities during both the annual cycles of study. However, the species formed 6.72% of the family Entomobryidae, 1.72% of the total Collembola and 0.58% of the total litter fauna during the first annual cycle. The species constituted 6.92%, 1.53% and 0.57%, respectively of the family Entomobryidae, total Collembola and total litter fauna during the second annual cycle.

In the jhum system, the Isotobryoides sp. were not recorded during the span of the present investigation.

Table XVII. Showing the total number and percentages of Isotobryoides sp. (Entomobryidae : Collembola : Insecta) in the forest system and in its litter layer during the two annual cycles of study.

a : Numbers, standard error in parentheses
b : Percentages among themselves
c : Percentages in family Entomobryidae
d : Percentages in total Collembola
e : Percentages in total soil fauna

Table XVIII. Showing the total number and percentages of "other entomobryids" in the forest system and in its different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses
b : Percentages among themselves
c : Percentages in family Entomobryidae
d : Percentages in total Collembola
e : Percentages in total soil fauna

TABLE XVII

COLLEMBOLA (ENTOMO-BRYIDAE)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
	FOREST	LITTER	83 (±4.18)	100.0	6.72	1.72	0.58	86 (±8.90)	100.0	6.92	1.53	0.57
		0 - 10cm	-	-	-	-	-	-	-	-	-	-
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
Isotobryoides sp.		TOTAL	83 (±4.18)	100.0	5.31	0.81	0.37	86 (±8.90)	100.0	5.32	0.79	0.37
	JHUM	0 - 10cm	-	-	-	-	-	-	-	-	-	-
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	-	-	-	-	-	-	-	-	-	-

TABLE XVIII

COLLEMBOLA (ENTOMO-BRYIDAE)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
		LITTER	89 (±4.30)	74.17	7.21	1.14	0.62	99 (±6.62)	66.89	7.97	1.18	0.65
		0 - 10cm	-	-	-	-	-	-	-	-	-	-
		10 - 20cm	31 (±1.47)	25.83	100.0	8.91	2.58	49 (±6.26)	33.11	100.0	14.58	4.18
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
Other entomobryids		TOTAL	120 (±2.94)	100.0	7.68	1.17	0.54	148 (±9.38)	100.0	9.16	1.36	0.63
		0 - 10cm	-	-	-	-	-	-	-	-	-	-
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	-	-	-	-	-	-	-	-	-	-

d.9. Other entomobryids

The two annual cycle densities of the 'other entomobryids' and their percentage compositions among the different categories of the forest and jhum soil fauna are illustrated in the Table XVIII. With a total density of $120x10^2/m^2$ during the first annual cycle, this group of collembolans formed 7.68% of the family Entomobryidae, 1.17% of the total Collembola of the forest system and 0.54% of the total forest soil fauna. In the second annual cycle, the total density of 'other entomobryids' recorded was $148x10^2/m^2$. Their percentage compositions of the family Entomobryidae, total Collembola and total soil fauna were 9.16%, 1.36% and 0.63%, respectively.

The vertical distributions of the 'other entomobryids' were $89x10^2/m^2$ at litter and $31x10^2/m^2$ at 0-10 cm. Among themselves vertically, the group constituted 74.17% (litter) and 25.83% (10-20 cm). In the litter layer, the group further formed 7.21% of the family Entomobryidae, 1.14% of the total Collembola and 0.62% of the total litter fauna. At 10-20 cm depth of the forest soil, the 'other entomobryids' made up 100.0% of the family Entomobryidae, 8.91% of the total Collembola and 2.58% of the total forest soil fauna.

During the second annual cycle, the densities of this group were $99x10^2/m^2$ (litter) and $49x10^2/m^2$ (10-20 cm). Among themselves vertically, these collembolans were 66.89% at the litter regime and 33.11% at 10-20 cm layer. Of the family Entomobryidae, total Collembola and total fauna of the litter, the group made up 7.97%, 1.18% and 0.65%, respectively. At 10-20 cm

soil depth, they formed 100.0% of the family Entomobryidae of the layer, 14.58% of the total Collembola and 0.63% of the total forest soil fauna.

Interestingly, the jhum soils did not record this category of Collembola during the period of present investigation.

e. Family Sminthuridae

Table XIX illustrates the total numbers of Collembola belonging to the family Sminthuridae and their percentage compositions among the different categories of the forest and jhum soil fauna during the first and second annual cycles. In the forest, the total density of the sminthurids during the first annual cycle was $455x10^2/m^2$. Further, the sminthurids accounted for 4.44% of the total Collembola and 2.04% of the total forest soil fauna. With a total density of $461x10^2/m^2$ during the second annual cycle, the sminthurids formed 4.25% of the total Collembola and 1.96% of the total forest soil fauna.

In relation to the vertical distributions, the densities of the sminthurids were $389x10^2/m^2$ (litter) and $66x10^2/m^2$ (0-10 cm). Vertically among themselves, the sminthurids constituted 85.49% at the litter regime and 14.51% at 0-10 cm depth of the soil. Of the total Collembola and total litter fauna , the sminthurids formed 5.00% and 0.03%, respectively. At 0-10 cm soil layer, the sminthurids were 3.13% of the total Collembola and 1.02% of the total forest soil fauna of the layer.

The vertical densities of the second annual cycle were $371 \times 10^2/m^2$ at litter and $90 \times 10^2/m^2$ at 0-10 cm layer. Among themselves vertically, the percentage distributions of the sminthurids were 80.48% and 19.52%, respectively at the litter and 0-10 cm soil layer. Of the total Collembola and total fauna of the litter, the sminthurids respectively formed 4.42% and 2.44%. Of the total Collembola and total fauna of the 0-10 cm soil depth, the sminthurids formed 4.30% and 1.31%, respectively.

In the jhum system, the total densities of Sminthuridae during the first annual cycle were $40 \times 10^2/m^2$, forming 3.52% of the total Collembola and 0.91% of the total jhum soil fauna. With a total density of $48 \times 10^2/m^2$ during the second annual cycle, the sminthurids formed 3.55% of the total Collembola and 0.96% of the total soil fauna of the jhum.

The sminthurids occurred only at the 0-10 cm soil layer of the jhum. Thus, the densities at this layer represented the total densities of the fauna in the jhum. However, the sminthurids at 0-10 cm soil layer formed 4.24% of the total Collembola and 1.15% of the total jhum soil fauna. In the second annual cycle, the sminthurids constituted 4.51% of the total Collembola and 1.31% of the total fauna of the jhum soil at 0-10 cm depth.

Two species of Sminthuridae were identified: Sphaeridia cornuta Murphy and Sminthurinus bimaculatus Axelson.

Table XIX. Showing the total number and percentages of the family Sminthuridae (Collembola : Insecta) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total Collembola

d : Percentages in total soil fauna

Table XX. Showing the total number and percentages of Sphaeridia cornuta Murphy (Sminthuridae : Collembola : Insecta) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in family Sminthuridae

d : Percentages in total Collembola

e : Percentages in total soil fauna

TABLE XIX

COLLEMBOLA (FAMILY)	SITES	LAYERS	FIRST ANNUAL CYCLE				SECOND ANNUAL CYCLE			
			a	b	c	d	a	b	c	d
Sminthuridae	FOREST	LITTER	389 (±13.75)	85.49	5.00	0.03	371 (±21.92)	80.48	4.42	2.44
		0 - 10cm	66 (±5.87)	14.51	3.13	1.02	90 (±5.67)	19.52	4.30	1.31
		10 - 20cm	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-
		TOTAL	455 (±18.42)	100.0	4.44	2.04	461 (±13.96)	100.0	4.25	1.96
	JHUM	0 - 10cm	40 (±0.71)	100.0	4.24	1.15	48 (±4.02)	100.0	4.51	1.31
		10 - 20cm	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-
		TOTAL	40 (±0.71)	100.0	3.52	0.91	48 (±4.02)	100.0	3.55	0.96

TABLE XX

COLLEMBOLA (SMINTHURIDAE)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Sphaeridia cornuta Murphy	FOREST	LITTER	265 (±8.83)	88.04	68.12	3.40	1.83	256 (±17.57)	84.77	69.00	3.05	1.69
		0 - 10cm	36 (±4.24)	11.96	54.55	1.71	0.55	46 (±3.19)	15.23	51.11	2.20	0.67
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	301 (±11.22)	100.0	66.15	2.94	1.35	302 (±14.71)	100.0	65.51	2.78	1.28
	JHUM	0 - 10cm	18 (±1.78)	100.0	45.00	1.91	0.52	21 (±3.87)	100.0	43.75	1.97	0.57
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	18 (±1.78)	100.0	45.00	1.58	0.41	21 (±3.87)	100.0	43.75	1.55	0.42

e.1. Sphaeridia cornuta Murphy

The two annual densities of Sphaeridia cornuta Murphy and their percentages among the different categories of the fauna of the forest and jhum soils are represented in the Table XX. The first annual cycle had a total density of $301x10^2/m^2$, comprising 66.15% of the family Sminthuridae, 2.94% of the total Collembola and 1.35% of the total forest soil fauna. With a total density of $302x10^2/m^2$ during the second annual cycle, the species constituted 65.51% of the family Sminthuridae, 2.78% of the total Collembola and 1.28% of the total forest soil fauna.

The densities of the species in different layers of the forest soil were $265x10^2/m^2$ (litter) and $36x10^2/m^2$ (0-10 cm). Among themselves vertically, the percentage contributions of the species were 88.04% at the litter regime and 11.96% at 0-10 cm soil layer. In the litter layer, the species constituted as much as 68.12% of the family Sminthuridae, 3.40% of the total Collembola and 1.83% of the total litter fauna. At 0-10 cm soil depth, the species accounted for 54.55% of the family Sminthuridae, 1.71% of the total Collembola and 0.55% of the total fauna of the forest soil of the layer.

The vertical densities of the second annual cycle were $256x10^2/m^2$ at litter and $46x10^2/m^2$ at 0-10 cm. Vertically among themselves, the species revealed percentage distributions of 84.77% and 15.23% at the litter and 0-10 cm soil layer, respectively. In the litter regime, the species made up 69.00% of the family Sminthuridae, 3.05% of the total Collembola and 1.69% of the total litter fauna. At 0-10 cm, the species formed 51.11%

of the family Sminthuridae, 2.20% of the total Collembola and 0.67% of the total forest soil fauna.

In the jhum system, the species had a total density of $18x10^2/m^2$ during the first annual cycle and constituted 45.00% of the family Sminthuridae, 1.58% of the total Collembola and 0.41% of the total jhum soil fauna. During the second annual cycle, the total density of Sphaeridia cornuta increased marginally to $21x10^2/m^2$, constituting 43.75% of the family Sminthuridae, 1.55% of the total Collembola and 0.42% of the total jhum soil fauna.

In relation to the vertical distribution of Sphaeridia cornuta, the species occurred only at 0-10 cm soil depth. Therefore, the densities at this layer represented the total densities of the jhum system. However, during the first annual cycle, the species formed 45.00% of the family Sminthuridae, 1.91% of the total Collembola and 0.52% of the total jhum soil fauna. In the second annual cycle, the species were 43.75% of the family Sminthuridae, 1.97% of the total Collembola and 0.57% of the total jhum soil fauna of the layer.

e.2. Sminthurinus bimaculatus Axelson

The two annual cycles densities of this collembolan species and their percentages among the different categories of the forest and jhum soil fauna are illustrated in the Table XXI. In the forest, the first annual cycle total densities of the species were $154x10^2/m^2$, representing 33.85% of the family Sminthuridae, 1.50% of the total Collembola and 0.69% of the total soil

fauna of the forest. With a total density of $159x10^2/m^2$ during the second annual cycle, Sminthurinus bimaculatus recorded only 34.49% of the family Sminthuridae, 1.46% of the total Collembola and 0.68% of the total forest soil fauna.

The vertical distributions of this species in relation to their annual densities were $124x10^2/m^2$ and $30x10^2/m^2$, respectively at the litter and 0-10 cm soil layer during the first annual cycle. Among themselves vertically, the percentage distributions of the species were 80.52% (litter) and 19.48% (0-10 cm). At the litter layer, the species further calculated 31.88% of the family Sminthuridae, 1.60% of the total Collembola and only 0.86% of the total fauna of the litter regime. At 0-10 cm layer of the forest soil, these collembolans formed 45.45% of the family Sminthuridae, 1.42% of the total Collembola and 0.46% of the total fauna of the forest soil.

During the second annual cycle, the total densities of the species at litter and 0-10 cm were $115x10^2/m^2$ and $44x10^2/m^2$, respectively. Vertically among themselves, the species comprised percentages of 72.33 and 27.67, respectively at the litter and 0-10 cm. Further, at the litter regime, the species constituted 31.00% of the family Sminthuridae, 1.37% of the total Collembola and 0.76% of the total litter fauna. At 0-10 cm, the species contributed 48.89%, 2.10% and 0.64%, respectively of the family Sminthuridae, total Collembola and total forest fauna of the soil.

In the jhum system, the species had a total density of $22x10^2/m^2$ during the first annual cycle. This density calculated

Table XXI. Showing the total number and percentages of Sminthurinus bimaculatus Axelson (Sminthuridae : Collembola : Insecta) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in family Sminthuridae

d : Percentages in total Collembola

e : Percentages in total soil fauna

Table XXII. Showing the total number and percentages of Megalothorax minimus (Neelidae : Collembola : Insecta) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in family Neelidae

d : Percentages in total Collembola

e : Percentages in total soil fauna

TABLE XXI

COLLEMBOLA (SMINTHURIDAE)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Sminthurinus bimaculatus Axelson	FOREST	LITTER	124 (±6.10)	80.52	31.88	1.60	0.86	115 (±5.00)	72.33	31.00	1.37	0.76
		0 - 10cm	30 (±1.68)	19.48	45.45	1.42	0.46	44 (±4.65)	27.67	48.89	2.10	0.64
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	154 (±7.71)	100.0	33.85	1.50	0.69	159 (±8.52)	100.0	34.49	1.46	0.68
	JHUM	0 - 10cm	22 (±1.08)	100.0	55.00	2.33	0.63	27 (±7.58)	100.0	56.25	2.54	0.75
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	22 (±1.08)	100.0	55.00	1.94	0.50	27 (±7.58)	100.0	56.25	2.10	0.54

TABLE XXII

COLLEMBOLA (NEELIDAE)	SITES	LAYERS	V FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	d	d	e	a	b	c	d	e
Megalothorax minimus Willem	FOREST	ZLITTER	316 (±16.99)	82.94	100.0	4.06	2.19	338 (±4.43)	83.05	100.0	4.02	2.22
		0 - 10cm	65 (±2.12)	17.06	100.0	3.08	0.99	69 (±3.94)	16.95	100.0	3.30	1.00
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	381 (±17.43)	100.0	100.0	3.71	1.71	407 (±6.42)	100.0	100.0	3.75	1.73
	JHUM	0 - 10cm	16 (±1.41)	100.0	100.0	1.70	0.46	21 (±2.86)	100.0	100.0	1.97	0.57
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	16 (±1.41)	100.0	100.0	1.41	0.36	21 (±2.86)	100.0	100.0	1.55	0.42

55.00% of the family Sminthuridae, 1.94% of the total Collembola and 0.50% of the total jhum soil fauna. The second annual cycle density increased marginally to $27x10^2/m^2$, constituting as much as 56.25% of the family Sminthuridae, 2.10% of the total Collembola and 0.54% of the total jhum soil fauna.

Since the species occurred only at 0-10 cm layer of the jhum soil, the densities and percentages of the species among the family Sminthuridae at this layer were equal to the total annual values. However, of the total Collembola and total soil fauna of the layer, the species recorded 2.33% and 0.63%, respectively during the first annual cycle. In the second annual cycle, the species formed 2.54% of the total Collembola and 0.75% of the total jhum soil fauna at 0-10 cm depth.

f. Family Neelidae

Megalothorax minimus Willem was the only species of the family Neelidae.

f.1. Megalothorax minimus Willem

Table XXII illustrates the two annual cycle densities of Megalothorax minimus and their percentages among the different categories of the forest and jhum soil fauna. The first annual cycle had a total density of $381x10^2/m^2$, constituting 3.71% of the total Collembola and 1.71% of the total forest soil fauna. In the second annual cycle, the species had a total density of $407x10^2/m^2$, forming 3.75% of the total Collembola and 1.73% of the total forest soil fauna.

The vertical distributions of this species during the first annual cycle were $316x10^2/m^2$ and $65x10^2/m^2$, respectively at the litter and 0-10 cm soil layer. Among themselves vertically, the species formed 82.94% at the litter regime and 17.06% at 0-10 cm soil depth. Of the total Collembola and total fauna of the litter, the species formed 4.06% and 2.19%, respectively. At 0-10 cm layer, the species made up 3.08% of the total Collembola and 0.99% of the total soil fauna.

During the second annual cycle, the densities of Megalothorax minimus at the litter and 0-10 cm layers were $338x10^2/m^2$ and $69x10^2/m^2$, respectively. Vertically among themselves, the species' distributions were 83.05% (litter) and 16.95% (0-10 cm). Further, at the litter layer, this collembolan formed 4.02% of the total Collembola and 2.22% of the total litter fauna. At the 0-10 cm soil depth, this collembolan contributed 3.30% of the total Collembola and 1.00% of the total forest soil fauna.

In the jhum, the species totalled a density of $16x10^2/m^2$ during the first annual cycle, and constituted 1.41% of the total Collembola and 0.36% of the total jhum soil fauna. The second annual cycle recorded $21x10^2/m^2$, accounting for 1.55% of the total Collembola and 0.42% of the total jhum soil fauna.

Megalothorax minimus occurred only up to the depth of 0-10 cm. Therefore, at this depth, this collembolan formed 1.70% of the total Collembola and 0.46% of the total jhum soil fauna during the first annual cycle. The percentage compositions of the species during the second annual cycle were 1.97% and 0.57%, respectively of the total Collembola and total jhum soil fauna.

4.2.1.3. Acarina

The two annual cycle densities of Acarina and their percentages in different depths of the forest and jhum systems are illustrated in the Table XXIII. The first annual cycle totalled $9181x10^2/m^2$ in density and formed 41.15% of the total forest soil fauna. In the second annual cycle, Acarina had a total density of $9770x10^2/m^2$, comprising 41.54% of the total forest soil fauna, inclusive of litter regime.

The numbers of Acarina in different layers of the forest during the first annual cycle were $4932x10^2/m^2$ (litter), $3748x10^2/m^2$ (0-10 cm), $489x10^2/m^2$ (10-20 cm) and $12x10^2/m^2$ (20-30 cm). Among themselves vertically, the percentage distributions were 53.72% (litter), 40.82% (0-10 cm), 5.33% (10-20 cm) and 0.13% (20-30 cm). Of the total forest soil fauna from the different layers, Acarina constituted 34.16% (litter), 57.17% (0-10 cm), 40.72% (10-20 cm) and 15.79% (20-30 cm).

During the second annual cycle, the acarine densities at litter, 0-10 cm, 10-20 cm and 20-30 cm soil layers were, respectively $5325x10^2/m^2$, $3856x10^2/m^2$, $581x10^2/m^2$ and $8x10^2/m^2$. The percentage contributions of the fauna among themselves vertically were 54.50% (litter), 39.47% (0-10 cm), 5.95% (10-20 cm) and 0.08% (20-30 cm). Of the total fauna from the different layers, Acarina constituted 35.07% at litter, 56.01% at 0-10 cm, 49.53% at 10-20 cm and 3.33% at 20-30 cm soil layers.

In the jhum, the total acarine density during the first annual cycle was $2371x10^2/m^2$, comprising 53.86% of the total jhum soil fauna. In the second annual cycle, the total acarine

Table XXIII. Showing the total number and percentages of Acarina in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total soil fauna

Table XXIV. Showing the total number and percentages of Astigmata (Acarina) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total Acarina

d : Percentages in total soil fauna

TABLE XXIII

SITES	LAYERS	ACARINA					
		FIRST ANNUAL CYCLE			SECOND ANNUAL CYCLE		
		a	b	c	a	b	c
FOREST	LITTER	4932 (±96.19)	53.72	34.16	5325 (±85.72)	54.50	35.07
	0 - 10cm	3748 (±130.0)	40.82	57.17	3856 (±158.7)	39.47	56.01
	10 - 20cm	489 (±35.13)	5.33	40.72	581 (±43.58)	5.95	49.53
	20 - 30cm	12 (±2.48)	0.13	15.79	8 (±1.58)	0.08	3.33
	30 - 40cm	-	-	-	-	-	-
	TOTAL	9181 (±235.0)	100.0	41.15	9770 (±266.5)	100.0	41.54
JHUM	0 - 10cm	2067 (±169.5)	87.18	59.36	2204 (±177.9)	82.55	60.27
	10 - 20cm	280 (±13.32)	11.81	37.43	454 (±6.24)	17.00	40.90
	20 - 30cm	24 (±1.47)	1.01	20.00	12 (±1.22)	0.45	10.71
	30 - 40cm	-	-	-	-	-	-
	TOTAL	2371 (±65.11)	100.0	53.86	2670 (±176.4)	100.0	53.45

TABLE XXIV

ACARINA (SUB-ORDER)	SITES	LAYERS	FIRST ANNUAL CYCLE				SECOND ANNUAL CYCLE			
			a	b	c	d	a	b	c	d
Astigmata	FOREST	LITTER	143 (±17.19)	79.44	2.90	0.99	152 (±14.82)	78.76	2.85	1.00
		0 - 10cm	37 (±5.56)	20.56	0.99	0.56	41 (±4.38)	21.24	1.06	0.59
		10 - 20cm	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-
		TOTAL	180 (±22.00)	100.0	1.96	0.81	193 (±18.36)	100.0	1.98	0.82
	JHUM	0 - 10cm	60 (±17.45)	100.0	2.90	1.72	58 (±13.31)	100.0	2.63	1.59
		10 - 20cm	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-
		TOTAL	60 (±17.45)	100.0	2.53	1.36	58 (±13.31)	100.0	2.17	1.16

density in the jhum showed an increase ($2670x10^2/m^2$), constituting 53.45% of the total fauna of the jhum soil.

The vertical densities of the fauna in terms of annual totals were $2067x10^2/m^2$ (0-10 cm), $280x10^2/m^2$ (10-20 cm) and $24x10^2/m^2$ (20-30 cm), during the first annual cycle. Vertically among themselves, Acarina formed 87.18% at 0-10 cm, 11.81% at 10-20 cm and 1.01% at 20-30 cm. Of the total fauna at different layers, Acarina constituted 59.36% (0-10 cm), 37.43% (10-20 cm) and 20.00% (20-30 cm).

The vertical densities of the second annual cycle were $2204x10^2/m^2$ (0-10 cm), $454x10^2/m^2$ (10-20 cm) and $12x10^2/m^2$ (20-30 cm). The vertical percentage distributions of Acarina among themselves were 82.55% at 0-10 cm, 17.00% at 10-20 cm and 0.45% at 20-30 cm. Of the total fauna of the jhum soil at different layers, the Acarina constituted 60.27% (0-10 cm), 40.90% (10-20 cm) and 10.71% (20-30 cm).

The Acarina encountered in the present study are described under four sub-orders: Astigmata, Prostigmata, Mesostigmata and Cryptostigmata or Oribatida.

a. Sub-order Astigmata

The two annual cycle densities of Astigmata and their percentages among the total acari and total soil fauna of forest and jhum systems are represented in the Table XXIV. Thus, a total of $180x10^2/m^2$ was recorded in the forest soil during the first annual cycle. This density accounted for 1.96% of the total Acarina and 0.81% of the total forest soil fauna. The total den-

sity of Astigmata in the second annual cycle increased marginally to $193x10^2/m^2$, forming 1.98% of the total Acarina and 0.82% of the total forest soil fauna.

The vertical densities of Astigmata in the forest were $143x10^2/m^2$ (litter) and $37x10^2/m^2$ (0-10 cm) during the first annual cycle. Among themselves vertically, the percentage distributions of Astigmata at litter and 0-10 cm layers were respectively, 79.44% and 20.56%. Of the total acari and total litter fauna, Astigmata formed 2.90% and 0.99%, respectively. At 0-10 cm soil layer, Astigmata formed 0.99% of the total Acarina and 0.56% of the total forest soil fauna.

During the second annual cycle, the astigmatid mites had the densities of $152x10^2/m^2$ at the litter and $41x10^2/m^2$ at The Astigmata distributed themselves in the ratios of 78.76% at the litter and 21.24% at 0-10 cm. Further, the astigmatid mites formed 2.85% of the total Acarina of the litter and only 1.00% of the total litter fauna. At 0-10 cm, the percentages were to the tune of 1.06% and 0.59%, respectively of the total acarina and total soil fauna of the layer.

In the jhum soil. the total density of Astigmata extracted during the first annual cycle was $60x10^2/m^2$. The astigmatid mites during this period formed 2.53% of the total acari and 1.36% of the total jhum soil fauna. With a density of only $58x10^2/m^2$ during the second annual cycle, the astigmatid mites constituted 2.17% of the total acari and 1.16% of the total fauna of the jhum soil.

The Astigmata occurred only at the 0-10 cm layer of

of the jhum soil, and therefore, had the same densities as the total ones. However, Astigmata at this layer formed 2.90% of the total acari and 1.72% of the total fauna during the first annual cycle. In the second annual cycle, Astigmata formed 2.63% and 1.59%, respectively of the total Acarina and total fauna of the jhum soil at 0-10 cm layer.

b. Sub-order Prostigmata

Table XXV shows the two annual cycle densities of the mite belonging to the sub-order Prostigmata and their percentages among different categories of the forest and jhum soil fauna. In the forest, the prostigmatid mites recorded a total density of $2098 \times 10^2/m^2$ during the first annual cycle, and accounted for 22.85% of the total Acarina and 9.40% of the total forest soil fauna. The total second annual cycle density of Prostigmata was $2175 \times 10^2/m^2$, forming 22.26% of the total Acarina and 9.25% of the total forest soil fauna.

The vertical distributions of the mites were $1031 \times 10^2/m^2$ (litter), $835 \times 10^2/m^2$ (0-10 cm) and $232 \times 10^2/m^2$ (10-20 cm) during the first annual cycle in the forest. Among themselves vertically, prostigmatid mites at different layers formed 49.14% (litter), 39.80% (0-10 cm) and 11.06% (10-20 cm). At the litter layer, the mites formed 20.90% of the Acarina and 7.14% of the total lifter fauna. At 0-10 cm layer, Prostigmata constituted 22.28% of the total acari and 12.74% of the total forest soil fauna. At 10-20 cm layer, Prostigmata were 47.44% and 19.32% of the total acari and total forest soil fauna, respectively.

During the second annual cycle, the vertical densities were $974x10^2/m^2$ (litter), $888x10^2/m^2$ (0-10 cm) and $313x10^2/m^2$ (10-20 cm). Vertically among themselves, the percentage distributions of the mites at the litter, 0-10 cm and 10-20 cm were respectively, 44.78%, 40.83% and 14.39%. Of the total Acarina, these mites formed 18.29% at the litter, 23.03% at 0-10 cm and 53.87% at 10-20 cm depth of the forest soil. Of the total fauna of the forest, the prostigmatid mites made up 6.41% at the litter, 12.90% at 0-10 cm and 26.68% at 10-20 cm.

In the jhum system, the prostigmatid mites had a total density of $1192x10^2/m^2$, forming 50.27% of the total Acarina and 27.05% of the total fauna of the jhum soil during the first annual cycle. With a total number of $1313x10^2/m^2$ during the second annual cycle, the prostigmatid mites constituted 49.18% of the total Acarina and 26.29% of the total jhum soil fauna.

The vertical densities of the mites during the first annual cycle were $1035x10^2/m^2$ (0-10 cm) and $157x10^2/m^2$ (10-20 cm). Vertically among themselves, the percentage distributions of the mites were 86.83% at 0-10 cm and 13.17% at 10-20 cm. Further, at 0-10 cm soil layer, Prostigmata constituted 50.07% of the total acari and 29.72% of the total soil fauna. At 10-20 cm soil depth, the mites formed 56.10% of the total Acarina of the jhum soil and 20.99% of the total jhum soil fauna.

The vertical densities of the second annual cycle were $1070x10^2/m^2$ at 0-10 cm and $243x10^2/m^2$ at 10-20 cm layer. The percentage distributions of the mites, among themselves vertica-

Table XXV. Showing the total number and percentages of Prostigmata (Acarina) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total Acarina

d : Percentages in total soil fauna

Table XXVI. Showing the total number and percentages of Mesostigmata (Acarina) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total Acarina

d : Percentages in total soil fauna

TABLE XXV

ACARINA (SUB-ORDER)	SITES	LAYERS	FIRST ANNUAL CYCLE				SECOND ANNUAL CYCLE			
			a	b	c	d	a	b	c	d
Prostigmata	FOREST	LITTER	1031 (±22.09)	49.14	20.90	7.14	947 (±32.95)	44.78	18.29	6.41
		0 - 10cm	835 (±11.29)	39.80	22.28	12.74	888 (±42.59)	40.83	23.03	12.90
		10 - 20cm	232 (±28.01)	11.06	47.44	19.32	313 (±25.63)	14.39	58.87	26.68
		20 - 30cm	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-
		TOTAL	2098 (±56.03)	100.0	22.85	9.40	2175 (±79.36)	100.0	22.26	9.25
	JHUM	0 - 10cm	1035 (±81.64)	86.83	50.07	29.72	1070 (±134.72)	81.49	48.55	29.26
		10 - 20cm	157 (±13.56)	13.17	56.10	20.99	243 (±7.35)	18.51	53.50	21.89
		20 - 30cm	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-
		TOTAL	1192 (±79.45)	100.0	50.27	27.05	1313 (±127.80)	100.0	49.18	26.29

TABLE XXVI

ACARINA (SUB-ORDER)	SITES	LAYERS	FIRST ANNUAL CYCLE				SECOND ANNUAL CYCLE			
			a	b	c	d	a	b	c	d
Mesostigmata	FOREST	LITTER	537 (±25.64)	49.72	10.89	3.72	558 (±25.42)	48.78	10.48	3.68
		0 - 10cm	282 (±23.99)	26.11	7.52	4.30	313 (±29.06)	27.36	8.12	4.55
		10 - 20cm	249 (±16.71)	23.06	50.92	20.73	265 (±19.57)	23.16	45.61	22.59
		20 - 30cm	12 (±2.48)	1.11	100.0	15.79	8 (±1.58)	0.70	100.0	3.33
		30 - 40cm	-	-	-	-	-	-	-	-
		TOTAL	1080 (±60.17)	100.0	11.76	4.84	1144 (±68.26)	100.0	11.71	4.86
	JHUM	0 - 10cm	323 (±22.29)	69.02	15.63	9.28	354 (±8.26)	62.10	16.06	9.68
		10 - 20cm	121 (±3.39)	25.85	43.20	16.17	204 (±8.50)	35.80	45.00	18.38
		20 - 30cm	24 (±1.47)	5.13	100.0	20.00	12 (±1.22)	2.10	100.0	10.71
		30 - 40cm	-	-	-	-	-	-	-	-
		TOTAL	468 (±22.27)	100.0	19.74	10.63	570 (±12.21)	100.0	21.35	11.41

lly were 81.49% (0-10 cm) and 18.51% (10-20 cm). Of the total acari, Prostigmata formed 48.55% at 0-10 cm and 53.50% at 10-20 cm. Of the total jhum soil fauna, the mites constituted as much as 29.26% and 21.89%, respectively at 0-10 and 10-20 cm layer of the jhum soil.

c. Sub-order Mesostigmata

Table XXVI represents the first and the second annual cycle densities of Mesostigmata and their percentages among the different categories of the forest and jhum soil fauna. It was observed that with a total density of $1080 \times 10^2/m^2$ during the first annual cycle, the mesostigmatid mites formed 11.76% of the total Acarina and 4.84% of the total forest soil fauna. The second annual cycle recorded a total density of $1144 \times 10^2/m^2$, comprising 11.71% of the total Acarina and 4.86% of the total forest soil fauna.

The vertical densities of these mites during the first annual cycle were $537 \times 10^2/m^2$ (litter), $282 \times 10^2/m^2$ (0-10 cm), $249 \times 10^2/m^2$ (10-20 cm) and $12 \times 10^2/m^2$ (20-30 cm). Among themselves vertically, the percentage distributions of the mites were 49.72% (litter), 26.11% (0-10 cm), 23.06% (10-20 cm) and 1.11% (20-30 cm). Of the total acari, Mesostigmata formed 10.89% at litter, 7.52% at 0-10 cm, 50.92% at 10-20 cm and 100.0% at 20-30 cm of the soil depth. Among the total fauna, the mites constituted 3.72% at the litter, 4.30% at 0-10 cm, 20.73% at 10-20 cm and 15.79% at 20-30 cm soil depths of the forest during the first annual cycle of investigation.

The total vertical densities of the mites during the second annual cycle were $558x10^2/m^2$ (litter), $313x10^2/m^2$ (0-10 cm), $265x10^2/m^2$ (10-20 cm) and $8x10^2/m^2$ (20-30 cm). The densities of these mites in percentages, among themselves vertically were 48.78%, 27.36%, 23.16% and 0.70%, respectively at the litter, 0-10 cm, 10-20 cm and 20-30 cm soil layers. Of the total Acarina, the mesostigmatid mites formed 10.48% (litter), 8.12% (0-10 cm), 45.61% (10-20 cm) and 100.0% (20-30 cm). Of the total forest soil fauna, these mites constituted 3.68% (litter), 4.55% (0-10 cm), 22.59% (10-20 cm) and 3.33% (20-30 cm).

In the jhum system, Mesostigmata recorded a total density of $468x10^2/m^2$ during the first annual cycle. Further, the mites formed 19.74% of the total Acarina of the jhum system and 10.63% of the total jhum soil fauna. With a total density of $570x10^2/m^2$ during the second annual cycle, the mesostigmatid mites constituted 21.35% of the total acari-fauna and 11.41% of the total soil fauna of the jhum system.

The vertical distributions of the mites, in relation to their annual densities, were $323x10^2/m^2$ (0-10 cm), $121x10^2/m^2$ (10-20 cm) and $24x10^2/m^2$ (20-30 cm) during the first annual cycle. The percentages of these mites in different layers of the jhum soil, among themselves vertically, were 69.02% (0-10 cm), 25.85% (10-20 cm) and 5.13% (20-30 cm). Of the total acari in different layers of the jhum soil, the mesostigmatid mites were 15.63% at 0-10 cm, 43.20% at 10-20 cm and 100.0% at 20-30 cm. Among the total fauna of the jhum soil at different layers, Mesostigmata formed 9.28% (0-10 cm), 16.17% (10-20 cm) and 20.00% (20-30 cm).

The vertical densities of mesostigmatid mites during the second annual cycle were $354x10^2/m^2$ (0-10 cm), $204x10^2/m^2$ (10-20 cm) and $12x10^2/m^2$ (20-30 cm). Among themselves vertically, the percentage distributions of Mesostigmata were 62.10%, 35.80% and 2.10%, respectively at 0-10 cm, 10-20 cm and 20-30 cm of the jhum soil layers. Of the total acari at different layers of the jhum soil, the mites made up 16.06% at 0-10 cm, 45.00% at 10-20 cm and 100.0% at 20-30 cm. Of the total jhum soil fauna, the mesostigmatid mites comprised 9.68%, 18.38% and 10.71%, respectively at 0-10 cm, 10-20 cm and 20-30 cm layers of the jhum soil during the second annual cycle.

Of the sub-order Mesostigmata, only Parasitus diviortus Athias-Henriot had been identified and the rest are described under the category 'Other mesostigmatid mites'.

c.1. Parasitus diviortus Athias-Henriot

The two annual cycle densities of Parasitus diviortus and their percentages among the different categories of the forest and jhum soil fauna are illustrated in the Table XXVII. In the forest this species of mite had a total annual density of $567x10^2/m^2$ and formed 52.50% of the sub-order Mesostigmata, 6.18% of the total Acarina and 2.54% of the total forest soil fauna during the first annual cycle. With a total annual density of $610x10^2/m^2$ during the second annual cycle, this species of mite constituted 53.32% of Mesostigmata, 6.24% of the total Acarina and 2.59% of the total forest soil fauna.

The vertical distributions of Parasitus diviortus in the forest in relation to its total annual densities during the first annual cycle were $190x10^2/m^2$ (litter), $133x10^2/m^2$ (0-10 cm), $232x10^2/m^2$ (10-20 cm) and $12x10^2/m^2$ (20-30 cm). These densities in percentages and among themselves vertically were as much as 33.50% at litter regime, 23.50% at 0-10 cm layer, 40.90% at 10-20 cm layer and 2.10% at 20-30 cm layer. Of the sub-order Mesostigmata, these mites formed 35.38% (litter), 47.16% (0-10 cm), 93.17% (10-20 cm) and 100.0% (20-30 cm). Among the total Acarina at different layers of the forest soil, Parasitus diviortus formed 3.85% (litter), 3.55% (0-10 cm), 47.44% (10-20 cm) and 100.0% (20-30 cm). Of the total litter or soil fauna, these mites contributed only 1.32% at litter, 2.03% at 0-10 cm, 19.32% at 10-20 cm and 15.79% at 20-30 cm layer of the forest soil.

The vertical distributions of the species in relation to its annual densities during the second annual cycle, in the forest, were $216x10^2/m^2$ (litter), $149x10^2/m^2$ (0-10 cm), $237x10^2/m^2$ (10-20 cm) and $8x10^2/m^2$ (20-30 cm). Vertically among themselves, these mites had the percentage distributions of 25.41% (litter), 24.43% (0-10 cm), 38.85% (10-20 cm) and 1.31% (20-30 cm). Of the total Mesostigmata at different layers of the forest soil, these mites constituted 38.71% (litter), 47.60% (0-10 cm), 89.43% (10-20 cm) and 100.0% (20-30 cm). Of the total acari, the species formed 4.06% (litter), 3.86% (0-10 cm), 40.79% (10-20 cm) and 100.0% (20-30 cm). Of the total fauna of the forest at different layers, these mites comprised of 1.43% at litter regime, 2.17% at 0-10 cm, 20.20% at 10-20 cm and 3.33% at 20-30 cm.

In the jhum system, Parasitus diviortus showed a total density of $218x10^2/m^2$ during the first annual cycle. This species made up 46.58% of the sub-order Mesostigmata, 9.20% of the total Acarina and 4.95% of the total jhum soil fauna. With a total density of $223x10^2/m^2$ during the second annual cycle, the mites formed 39.12% of Mesostigmata, 8.35% of the total Acarina and 4.46% of the total fauna of the jhum soil.

The vertical distributions of the mites in terms of their total annual numbers were $129x10^2/m^2$ (0-10 cm), $65x10^2/m^2$ (10-20 cm) and $24x10^2/m^2$ (20-30 cm). Among themselves vertically, the percentage distributions of the species were 59.17% (0-10 cm), 29.82% (10-20 cm) and 11.01% (20-30 cm). Of the total Mesostigmata at different layers of the jhum soil, the mites formed 39.94% (0-10 cm), 53.72% (10-20 cm) and 100.0% (20-30 cm). Among the total acari of the different jhum soil layers the species constituted 6.24% at 0-10 cm, 23.20% at 10-20 cm, and 100.0% at 20-30 cm. The percentage compositions of the species among the total jhum soil fauna were 3.71%, 8.69% and 20.00%, respectively at 0-10 cm, 10-20 cm and 20-30 cm layers.

The annual densities of the species in different layers of the jhum soil during the second annual cycle were $132x10^2/m^2$ (0-10 cm), $79x10^2/m^2$ (10-20 cm) and $12x10^2/m^2$ (20-30 cm). Vertically among themselves, these densities, in relation to percentage distributions were 59.19% (0-10 cm), 35.43% (10-20 cm), and 5.38% (20-30 cm). Of the total Mesostigmata at 0-10 cm, 10-20 cm and 20-30 cm soil layers, the species respectively formed 37.29%, 38.73% and 100.0%. The percentages of Parasitus

Table XXVII. Showing the total number and percentages of Parasitus diviortus Athias-Henriot (Mesostigmata : Acarina) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in Mesostigmata

d : Percentages in total Acarina

e : Percentages in total soil fauna

Table XXVIII. Showing the total number and percentages of "other mesostigmatid mites" in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in Mesostigmata

d : Percentages in total Acarina

e : Percentages in total soil fauna

TABLE XXVII

ACARINA (MESO-STIGMATA)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
	FOREST	LITTER	190 (±7.15)	33.50	35.38	3.85	1.32	216 (±19.04)	25.41	38.71	4.06	1.43
		0 - 10cm	133 (±8.36)	23.50	47.16	3.55	2.03	149 (±12.64)	24.43	47.60	3.86	2.17
		10 - 20cm	232 (±14.18)	40.90	93.17	47.44	19.32	237 (±15.95)	38.85	89.43	40.79	20.20
		20 - 30cm	12 (±2.48)	2.10	100.0	100.0	15.79	8 (±1.58)	1.31	100.0	100.0	3.33
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
Parasitus diviortus Athias-Henriot		TOTAL	567 (±26.76)	100.0	52.50	6.18	2.54	610 (±41.33)	100.0	53.32	6.24	2.59
	JHUM	0 - 10cm	129 (±13.30)	59.17	39.94	6.24	3.71	132 (±10.27)	59.19	37.29	5.99	3.61
		10 - 20cm	65 (±3.03)	29.82	53.72	23.20	8.69	79 (±3.03)	35.43	38.73	17.40	7.12
		20 - 30cm	24 (±1.47)	11.01	100.0	100.0	20.00	12 (±1.22)	5.38	100.0	100.0	10.71
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	218 (±13.48)	100.0	46.58	9.20	4.95	223 (±12.88)	100.0	39.12	8.35	4.46

TABLE XXVIII

ACARINA (MESO-STIGMATA)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
	FOREST	LITTER	347 (±18.81)	67.64	64.62	7.04	2.40	342 (±7.36)	64.05	61.29	6.42	2.25
		0 - 10cm	149 (±16.05)	29.05	52.84	3.98	2.27	164 (±16.67)	30.71	52.40	4.25	2.38
		10 - 20cm	17 (±3.51)	3.31	6.83	3.48	1.41	28 (±4.51)	5.24	10.57	4.82	2.39
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
Other mesostigmatid mites		TOTAL	513 (±33.56)	100.0	47.50	5.59	2.30	534 (±26.97)	100.0	46.68	5.47	2.27
	JHUM	0 - 10cm	194 (±10.95)	77.60	60.06	9.39	5.57	222 (±2.94)	63.98	62.71	10.07	6.07
		10 - 20cm	56 (±1.47)	22.40	46.28	20.00	7.48	125 (±6.05)	36.02	61.27	27.50	11.26
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	250 (±10.30)	100.0	53.42	10.54	5.68	347 (±4.76)	100.0	60.88	13.00	6.95

diviortus among the total acari-fauna of the different layers of the jhum soil were 5.99% at 0-10 cm, 17.40% at 10-20 cm and 100.0% at 20-30 cm. Of the total jhum soil fauna at different layers, these mites constituted 3.61% (0-10 cm), 7.12% (10-20 cm) and 10.71% (20-30 cm).

c.2. Other mesostigmatid mites

Table XXVIII shows the total annual densities of thi category of mesostigmatid mites in the forest and jhum systems for two annual cycles. The first annual cycle recorded a total density of $513x10^2/m^2$, comprising 47.50% of the total Mesostigmata, 5.59% of the total Acarina and 2.30% of the total forest soil fauna. The second annual cycle density of these mites reached $534x10^2/m^2$, forming 46.68% of the sub-order Mesostigmata, 5.47% of the total Acarina and 2.27% of the total fauna of the forest soil.

The densities of the mites at different soil regimes of the forest during the first annual cycle were $347x10^2/m^2$, $149x10^2/m^2$ and $17x10^2/m^2$ respectively at litter, 0-10 cm and 10-20 cm. Among themselves vertically, the percentages of the group were 67.64% (litter), 29.05% (0-10 cm) and 3.31% (10-20 cm). The percentage compositions of this group of mites, among different layers of the Mesostigmata were 64.62% (litter), 52.84% (0-10 cm) and 6.83% (10-20 cm). Of the total acari at different layers, these mites formed 7.04% at litter, 3.98% at 0-10 cm and 3.48% at 10-20 cm. Of the total fauna, 'other meso-

stigmatid mites' constituted 2.40% at the litter regime, 2.27% at 0-10 cm layer and 1.41% at 10-20 cm layer of the jhum soil.

The vertical densities of these mites during the second annual cycle were $342x10^2/m^2$ (litter), $164x10^2/m^2$ (0-10 cm) and $28x10^2/m^2$ (10-20 cm). These densities in percentages were 64.05% at litter, 30.71% at 0-10 cm and 5.24% at 10-20 cm when calculated vertically among themselves. Of the total Mesostigmata at different layers, these mites formed 61.29% at litter, 52.40% at 0-10 cm and 10.57% at 10-20 cm. Of the total Acarina at different layers of the forest soil, this category of mites constituted 6.42% (litter), 4.25% (0-10 cm) and 4.82% (10-20 cm). Of the total fauna of the forest at different layers, these mites constituted 2.25% at litter, 2.38% at 0-10 cm and 2.39% at 10-20 cm.

In the jhum system, the total density of the 'Other mesostigmatid mites' during the first annual cycle was $250x10^2/m^2$. With this density, these mites constituted 53.42% of the Mesostigmata, 10.54% of the total Acarina and 5.68% of the to-jhum soil fauna. The total second annual cycle density was seen to be $347x10^2/m^2$, which made up 60.88% of the Mesostigmata, 13.00% of the total Acarina and 6.95% of the total jhum soil fauna.

The densities of these mites at 0-10 cm and 10-20 cm layers of the jhum soil during the first annual cycle were respectively $194x10^2/m^2$ and $56x10^2/m^2$. Vertically among themselves the percentage distributions of these mites were 77.60% at 0-10

cm and 22.40% at 10-20 cm. Of the total Mesostigmata, these group of mites formed 60.06% (0-10 cm) and 46.28% (10-20 cm). Among the total acari, these mites made up 9.39% at 0-10 cm depth and 20.00% at 10-20 cm depth. Further, these mites formed 5.57% of the total fauna at 0-10 cm and 7.48% of the total fauna at 10-20 cm depth of the jhum soil.

During the second annual cycle, the annual densities of these mites at different layers of the jhum soil were 222x $10^2/m^2$ (0-10 cm) and 125x$10^2/m^2$ (10-20 cm). These densities in terms of percentages when calculated among themselves vertically were 63.98% at 0-10 cm and 36.02% at 10-20 cm. Of the total Mesostigmata, these mites formed 62.71% (0-10 cm) and 61.27% (10-20 cm). Of the total acari-fauna at 0-10 cm and 10-20 cm, this category of mites constituted 10.07% and 27.50%, respectively. Of the total jhum soil fauna, 'Other mesostigmatid mites' made up 6.07% (0-10 cm) and 11.26% (10-20 cm).

d. Sub-order Cryptostigmata

The two annual cycle densities of Cryptostigmata or the oribatid mites and their percentages among the total acari and total forest and jhum soil fauna in different depths of the soil are given in the Table XXIX. The total number of cryptostigmatid mites during the first annual cycle was 5823x$10^2/m^2$ and formed 63.43% and 26.10%, respectively of the total Acarina and total soil fauna of the forest system. The second annual cycle recorded a total annual density of 6258x$10^2/m^2$, forming as much as 64.05% of the total Acarina and 26.61% of the forest soil fauna.

The densities of the oribatid mites in different layers of the forest soil during the first annual cycle of present investigation were $3221x10^2/m^2$ (litter), $2594x10^2/m^2$ (0-10 cm) and $8x10^2/m^2$ (10-20 cm). These densities in percentages and vertically among themselves, were 55.31% at litter, 44.55% at 0-10 cm and 0.14% at 10-20 cm. Of the total Acarina at different depths of the forest, the oribatid mites made up 65.31% (litter), 69.21% (0-10 cm) and 1.64% (10-20 cm). Of the total fauna of the forest at litter, 0-10 cm and 10-20 cm, Cryptostigmata formed 22.31%, 39.57% and 0.67%, respectively.

During the second annual cycle, Cryptostigmata were $3641x10^2/m^2$ at litter regime, $2614x10^2/m^2$ at 0-10 cm soil depth and only $3x10^2/m^2$ at 10-20 cm depth of the forest soil. Among themselves vertically, the percentage distributions of cryptostigmatid mites were 58.18% (litter), 41.77% (0-10 cm) and only 0.05% at 10-20 cm. Of the total acari of the litter, 0-10 cm and 10-20 cm layers, the oribatid mites respectively formed as much as 68.38%, 67.79% and 0.52%. Among the total fauna, the oribatid or cryptostigmatid mites constituted 23.98% (litter), 37.97% (0-10 cm) and 0.26% (10-20 cm).

In the jhum system, the oribatid mites showed an annual density of $651x10^2/m^2$ during the first annual cycle. These mites constituted 27.46% of the total acari and 14.79% of the total jhum soil fauna. During the second annual cycle, the oribatid mites showed an increase in density ($729x10^2/m^2$) and formed 27.30% of the total Acarina and 14.59% of the total fauna of the jhum soil.

The vertical distributions of the oribatid mites in different layers of the jhum soil during the first annual cycle were $649x10^2/m^2$ (0-10 cm) and $2x10^2/m^2$ (10-20 cm). The vertical distributions of these mites in percentages were 99.69% at 0-10 cm and only 0.31% at 10-20 cm. Of the total acari, oribatid mites formed 31.40% (0-10 cm) and 0.70% (10-20 cm). Of the total jhum soil fauna, they made up 18.64% (0-10 cm) and 0.27% (10-20 cm) during the first annual cycle.

In the second annual cycle, the vertical densities of the cryptostigmatid mites were $722x10^2/m^2$ (0-10 cm) and $7x10^2/m^2$ (10-20 cm). Among themselves vertically, the mites had the percentage distributions of 99.04% and 0.96%, respectively at 0-10 cm and 10-20 cm. Of the total acari, the oribatid mites constituted 32.76% (0-10 cm) and 1.50% (10-20 cm). Of the total fauna of the jhum soil, the oribatid mites constituted 19.74% at 0-10 cm and 0.63% at 10-20 cm.

The cryptostigmatid or oribatid mites encountered during the present study fall under the following genera/species, viz. Rhysotritia ardua Koch, Euphthiracarus sp., Mesotritia sp., Galumna sp., Neoribates sp., Dolicheremaeus sp., Eremobelba sp., Suctobelba sp., Brachychthonius sp. and Uropodidae. The unidentifiable cryptostigmatid mites were described under the category 'Other oribatid mites'.

Table XXIX. Showing the total number and percentages of Cryptostigmata (Acarina) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total Acarina

d : Percentages in total soil fauna

Table XXX. Showing the total number and percentages of Rhysotritia ardua Koch (Cryptostigmata : Acarina) in the forest and jhum systems during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in Cryptostigmata

d : Percentages in total Acarina

e : Percentages in total soil fauna

TABLE XXIX

ACARINA (SUB-ORDER)	SITES	LAYERS	FIRST ANNUAL CYCLE				SECOND ANNUAL CYCLE			
			a	b	c	d	a	b	c	d
Cryptostigmata	FOREST	LITTER	3221 (±47.24)	55.31	65.31	22.31	3641 (±26.59)	58.18	68.38	23.98
		0 - 10cm	2594 (±109.01)	44.55	69.21	39.57	2614 (±108.41)	41.77	67.79	37.97
		10 - 20cm	8 (±1.78)	0.14	1.64	0.67	3 (±0.41)	.05	0.52	0.26
		20 - 30cm	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-
		TOTAL	5823 (±155.10)	100.0	63.43	26.10	6258 (±126.92)	100.0	64.05	26.
	JHUM	0 - 10cm	649 (±64.36)	99.69	31.40	18.64	722 (±74.69)	99.04	32.76	19.
		10 - 20cm	2 (±0.91)	0.31	0.70	0.27	7 (±1.22)	0.96	1.50	0
		20 - 30cm	-	-	-	-	-	-	-	
		30 - 40cm	-	-	-	-	-	-	-	
		TOTAL	651 (±64.61)	100.0	27.46	14.79	729 (±73.57)	100.0	27.30	

TABLE XXX

ACARINA (CRYPTO-STIGMATA)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Rhysotritia ardua Koch	FOREST	LITTER	498 (±21.33)	61.48	15.46	10.10	3.45	542 (±14.44)	63.24	14.89	10.18	3.57
		0 - 10cm	312 (±11.08)	38.52	12.03	8.32	4.76	315 (±17.63)	36.76	12.05	8.17	4.58
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	810 (±31.85)	100.0	13.91	8.82	3.63	857 (±29.80)	100.0	13.70	8.77	3.65
	JHUM	0 - 10cm	96 (±11.39)	100.0	17.79	4.64	2.76	101 (±15.12)	100.0	13.99	4.58	2.76
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	96	100.0	14.70	4.05	2.18	101	100.0	13.86	3.78	2.0

d.1. Rhysotritia ardua Koch

Table XXX represents the two annual cycle densities of Rhysotritia ardua Koch and their percentages among the different categories of the forest and jhum soil fauna. In the forest, the total density of this species during the first annual cycle was $810x10^2/m^2$. The species further comprised 13.91% of the total Cryptostigmata, 8.82% of the total Acarina and 3.63% of the total forest soil fauna. The second annual cycle total density was $857x10^2/m^2$ and made up 13.70% of Cryptostigmata, 8.77% of Acarina and 3.65% of total forest soil fauna.

The vertical densities of the species in the forest during the first annual cycle were $498x10^2/m^2$ (litter) and $312x10^2/m^2$ (0-10 cm). The species did not occur below 10 cm depth. Among themselves vertically, the percentage distributions of these mites at different layers were 61.48% at litter and 38.52% at 0-10 cm. This species formed 15.46% (litter) and 12.03% (0-10 cm) of Cryptostigmata. Of the total Acarina, these mites formed 10.10% at litter layer and 8.32% at 0-10 cm layer. Of the total fauna at litter and 0-10 cm, the species constituted only 3.45% and 4.76%, respectively.

The vertical densities of Rhysotritia ardua during the second annual cycle were $542x10^2/m^2$ (litter) and $315x10^2/m^2$ (0-10 cm). Vertically among themselves, these densities in percentages were 63.24% at litter and 36.76% at 0-10 cm. Of the sub-order Cryptostigmata, the species were 14.89% (litter) and 12.05% (0-10 cm). Of the total acari, the species made up 10.18% (litter) and 8.17% (0-10 cm). Further, the species constituted

3.57% of the litter fauna and 4.58% of the soil fauna at 0-10 cm depth of the forest.

In the jhum system, this species of mite had a total density of $96x10^2/m^2$ during the first annual cycle and constituted 14.70% of Cryptostigmata, 4.05% of Acarina and 2.18% of total fauna of the jhum soil. With a total density of $101x10^2/m^2$ during the second annual cycle, Rhysotritia ardua constituted 13.86% of Cryptostigmata, 3.78% of Acarina and 2.02% of total jhum soil fauna.

This species of mite occurred only at 0-10 cm depth of the jhum soil. Of the Cryptostigmata, Acarina and total fauna at 0-10 cm layer of the jhum soil, Rhysotritia ardua formed respectively 17.79%, 4.64% and 2.76% during the first annual cycle. During the second annual cycle, this species made up 13.99% of Cryptostigmata, 4.58% of Acarina and 2.76% of total fauna at 0-10 cm layer of the jhum soil.

d.2. Euphthiracarus sp.

The two annual cycle densities of Euphthiracarus sp. and their percentages among the different categories of the soil fauna in the forest and jhum systems are shown in the Table XXXI. During the first annual cycle, the forest had a total density of $324x10^2/m^2$, comprising 5.57% of Cryptostigmata, 3.53 percent of Acarina and 1.45% of the total forest soil fauna. The second annual cycle densities of these mites were $311x10^2/m^2$, forming 4.97% of Cryptostigmata, 3.18% of Acarina and 1.32% of total forest soil fauna.

The vertical densities of Euphthiracarus sp. in the forest during the first annual cycle were $175x10^2/m^2$ at litter layer and $149x10^2/m^2$ at 0-10 cm soil layer. Among themselves vertically the percentage distributions of these mites were calculated to be 54.01% at litter layer and 45.99% at 0-10 cm soil layer. Of the total Cryptostigmata, Euphthiracarus sp. formed 5.43% (litter) and 5.74% (0-10 cm). Among the total Acarina at litter and 0-10 cm soil layer, these mites constituted 3.55% and 3.98%, respectively. These mites, further, formed 1.21% of of the total litter fauna and 2.27% of the forest fauna at 0-10 cm soil layer.

During the second annual cycle, the vertical densities of Euphthiracarus sp. were $172x10^2/m^2$ (litter) and $139x10^2/m^2$ (0-10 cm). These densities in percentages and among themselves vertically, were 55.31% (litter) and 44.69% (0-10 cm). Of Cryptostigmata, this genera formed 4.72% (litter) and 5.32% (0-10 cm). Of Acarina, the genera constituted 3.23% (litter) and 3.61% (0-10 cm). Of the total forest fauna of the litter and 0-10 cm layer, these mites comprised 1.13% and 2.02%, respectively.

In the jhum soil, the genera had a total annual density of $18x10^2/m^2$ during the first annual cycle. They formed 2.80% of Cryptostigmata, 0.76% of Acarina and 0.41% of total jhum soil fauna. The second annual cycle density was $15x10^2/m^2$ only and formed 2.06% of Cryptostigmata, 0.56% of Acarina and 0.30% of total jhum soil fauna.

In relation its vertical distribution, Euphthiracarus

Table XXXI. Showing the total number and percentages of Euphthiracarus sp. (Cryptostigmata : Acarina) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total Cryptostigmata

d : Percentages in total Acarina

e : Percentages in total soil fauna

Table XXXII. Showing the total number and percentages of Mesotritia sp. (Cryptostigmata : Acarina) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total Cryptostigmata

d : Percentages in total Acarina

e : Percentages in total soil fauna

TABLE XXXI

ACARINA (CRYPTO-STIGMATA)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Euphthiracarus sp.	FOREST	LITTER	175 (±12.24)	54.01	5.43	3.55	1.21	172 (±10.55)	55.31	4.72	3.23	1.13
		0 - 10cm	149 (±4.65)	45.99	5.74	3.98	2.27	139 (±12.02)	44.69	5.32	3.61	2.02
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	324 (±16.55)	100.0	5.57	3.53	1.45	311 (±22.36)	100.0	4.97	3.18	1.32
	JHUM	0 - 10cm	18 (±2.54)	100.0	2.77	0.87	0.52	15 (±1.58)	100.0	2.08	0.68	0.41
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	18 (±2.54)	100.0	2.80	0.76	0.41	15 (±1.58)	100.0	2.06	0.56	0.30

TABLE XXXII

ACARINA (CRYPTO-STIGMATA)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Mesotritia sp.	FOREST	LITTER	388 (±15.89)	57.74	12.05	7.87	2.69	385 (±13.56)	55.56	10.57	7.23	2.54
		0 - 10cm	284 (±13.47)	42.26	10.95	7.58	4.33	308 (±10.46)	44.44	11.78	7.99	4.47
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	672 (±29.04)	100.0	11.54	7.32	3.01	693 (±21.43)	100.0	11.07	7.09	2.95
	JHUM	0 - 10cm	5 (±1.06)	100.0	0.77	0.24	0.14	15 (±1.22)	100.0	2.08	0.68	0.41
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	5 (±1.06)	100.0	0.80	0.21	0.12	15 (±1.22)	100.0	2.06	0.56	0.30

occurred only at 0-10 cm layer of the jhum soil. At this layer the genera formed 2.77% of Cryptostigmata, 0.87% of Acarina and 0.52% of total jhum soil fauna during the first annual cycle. In the second annual cycle, the genera constituted 2.08% of Cryptostigmata, 0.68% of Acarina and 0.41% of total jhum soil fauna.

d.3. Mesotritia sp.

Table XXXII illustrates the two annual cycle densities of Mesotritia sp. and their percentage values among the different categories of the forest and jhum soil fauna. During the first annual cycle, the genera had an annual density of $672x10^2/m^2$, forming 11.54% of Cryptostigmata, 7.32% of Acarina and 3.01% of total forest soil fauna. With an annual density of $693x10^2/m^2$ during the second annual cycle, the genera formed 11.07% of Cryptostigmata, 7.09% of Acarina and 2.95% of total forest fauna of the soil.

The vertical densities of the genera during the first annual cycle were $388x10^2/m^2$ (litter) and $284x10^2/m^2$ (0-10 cm). These densities, vertically among themselves, were 57.74% (litter) and 42.26% (0-10 cm). The genera formed 12.05% (litter) and 10.95% (0-10 cm) of Cryptostigmata; 7.87% (litter) and 7.58% (0-10 cm) of Acarina; 2.69% (litter) and 4.33% (0-10 cm) of total soil fauna of the layer.

During the second annual cycle, the genera were $385x10^2/m^2$ (litter) and $308x10^2/m^2$ (0-10 cm) in densities. Vertically among themselves, they were 55.56% (litter) and 44.44% (0-10

cm). The genera constituted 10.57% (litter) and 11.78% (0-10 cm) of Cryptostigmata; 7.23% (litter) and 7.99% (0-10 cm) of Acarina; 2.54% of total litter fauna and 4.47% of total soil fauna at 0-10 cm layer.

In the jhum soil, the genera had a total density of only $5x10^2/m^2$ during the first annual cycle, and formed 0.80% of Cryptostigmata, 0.21% of Acarina and 0.12% of total jhum soil fauna. With a total density of $15x10^2/m^2$ during the second annual cycle, Mesotritia sp. constituted 2.06% of Cryptostigmata, 0-56% of total Acarina and 0.30% of total jhum soil fauna.

The vertical distributions of these mites in jhum were limited to the soil layer of 0-10 cm during both the annual cycles. These mites formed 0.77% of Cryptostigmata, 0.24% of Acarina and 0.14% of total jhum soil fauna during the first annual cycle. In the second annual cycle, the genera constituted 2.08% of Cryptostigmata, 0.68% of Acarina and 0.41% of total jhum soil fauna.

d.4. Galumna sp.

The two annual cycle densities of this oribatid genera and their percentages among the different categories of the forest and jhum soil fauna are represented in Table XXXIII. In the forest, Galumna recorded a total density of $671x10^2/m^2$ during the first annual cycle. The genera constituted 11.52% of Cryptostigmata, 7.31% of Acarina and 3.01% of total forest soil fauna. With a density of $708x10^2/m^2$ in the 2nd annual cycle, the genera formed 11.31% of Cryptostigmata, 7.25% of Acarina and 3.01% of total forest soil fauna.

The vertical densities of the genera in the forest during the first annual cycle were $349x10^2/m^2$ (litter) and $322x10^2$ per m^2. These densities, among themselves vertically, were 52.01 percent (litter) and 47.99% (0-10 cm). The genera formed 10.84% (litter) and 12.41% (0-10 cm) of Cryptostigmata; 7.08% (litter) and 8.59% (0-10 cm) of Acarina; 2.42% (litter) and 4.91% (0-10 cm) of total forest soil fauna.

The vertical densities of the genera during the 2nd annual cycle were $404x10^2/m^2$ (litter) and $304x10^2/m^2$ (0-10 cm). These densities, among themselves vertically, were 57.06% (litter) and 42.94% (0-10 cm). The genera formed 11.10% (litter) and 11.63% (0-10 cm) of Cryptostigmata; 7.59% (litter) and 7.88% (0-10 cm) of Acarina; 2.66% (litter) and 4.42% (0-10 cm) of total forest soil fauna.

In the jhum soil, Galumna sp. had a total density of $157x10^2/m^2$ during the first annual cycle. The genera formed as much as 24.10% of Cryptostigmata, 6.62% of Acarina and 3.57% of total jhum soil fauna. With an annual density of $177x10^2/m^2$ during the second annual cycle, the genera formed 24.28% of Cryptostigmata, 6.63% of Acarina and 3.54% of total jhum soil fauna.

The vertical distributions of Galumna sp. revealed their presence only at 0-10 cm soil layer. At this layer, the genera formed 24.19% of Cryptostigmata, 7.60% of Acarina and 4.51% of total jhum soil fauna during the first annual cycle. In the second annual cycle, the genera constituted 24.52% of Cryptostigmata, 8.03% of Acarina and 4.84% of the total fauna of the jhum soil.

Table XXXIII. Showing the total number and percentages of Galumna sp. (Cryptostigmata : Acarina) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses
b : Percentages among themselves
c : Percentages in total Cryptostigmata
d : Percentages in total Acarina
e : Percentages in total soil fauna

Table XXXIV. Showing the total number and percentages of Neoribates sp. (Cryptostigmata : Acarina) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses
b : Percentages among themselves
c : Percentages in total Cryptostigmata
d : Percentages in total Acarina
e : Percentages in total soil fauna

TABLE XXXIII

ACARINA (CRYPTO-STIGMATA)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Galumna sp.	FOREST	LITTER	349 (±20.47)	52.01	10.84	7.08	2.42	404 (±18.32)	57.06	11.10	7.59	2.66
		0 - 10cm	322 (±23.40)	47.99	12.41	8.59	4.91	304 (±16.71)	42.94	11.63	7.88	4.42
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	671 (±30.91)	100.0	11.52	7.31	3.01	708 (±20.45)	100.0	11.31	7.25	3.01
	JHUM	0 - 10cm	157 (±14.26)	100.0	24.19	7.60	4.51	177 (±21.31)	100.0	24.52	8.03	4.84
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	157 (±14.26)	100.0	24.10	6.62	3.57	177 (±21.31)	100.0	24.28	6.63	3.54

TABLE XXXIV

ACARINA (CRYPTO-STIGMATA)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Neoribates sp	FOREST	LITTER	546 (±24.20)	57.23	16.95	11.07	3.78	630 (±27.96)	61.83	17.30	11.83	4.15
		0 - 10cm	406 (±19.78)	42.56	15.65	10.83	6.19	389 (±15.40)	38.17	14.88	10.09	5.65
		10 - 20cm	2 (±0.91)	0.21	25.0	0.41	0.17	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	954 (±39.38)	100.0	16.38	10.39	4.27	1019 (±43.32)	100.0	16.28	10.43	4.33
	JHUM	0 - 10cm	204 (±25.71)	100.0	31.43	9.87	5.86	212 (±22.79)	100.0	29.36	9.62	5.80
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	204 (±25.71)	100.0	31.30	8.60	4.63	212 (±22.79)	100.0	29.08	7.94	4.25

d.5. Neoribates sp.

Table XXXIV shows the densities of Neoribates sp. and their percentages among the different fauna categories of the forest and jhum soil during the two annual cycles of investigation. The forest soil recorded a total density $954 \times 10^2/m^2$ during the first annual cycle. The genera constituted 16.38% of Cryptostigmata, 10.39% of Acarina and 4.27% of total forest soil fauna. With a density of $1019 \times 10^2/m^2$ during the second annual cycle Neoribates made up 16.28% of Cryptostigmata, 10.43% of Acarina and 4.33% of total forest soil fauna.

The vertical densities of the genera during the first annual cycle were $546 \times 10^2/m^2$ (litter), $406 \times 10^2/m^2$ (0-10 cm) and $2 \times 10^2/m^2$ (10-20 cm). These densities, among themselves vertically, were 57.23% (litter), 42.56% (0-10 cm) and 0.21% (10-20 cm). In different layers the genera formed 16.95% (litter), 15.65% (0-10 cm) and 25.00% (10-20 cm) of Cryptostigmata; 11.07% (litter), 10.83% (0-10 cm) and 0.41% (10-20 cm) of Acarina; 3.78% (litter), 6.19% (0-10 cm) and 0.17% (10-20 cm) of total forest soil fauna.

During the second annual cycle, the patterns of the vertical densities of Neoribates sp. were $630 \times 10^2/m^2$ (litter), and $389 \times 10^2/m^2$ (0-10 cm). Vertically among themselves, these mites were 61.83% at litter and 38.17% at 0-10 cm layer. Further the genera formed 17.30% (litter) and 14.88% (0-10 cm) of Cryptostigmata; 11.83% (litter) and 10.09% (0-10 cm) of Acarina; 4.15% (litter) and 5.65% (0-10 cm) of total forest soil fauna.

In the jhum soil, the genera recorded an annual den-

sity of $204x10^2/m^2$ during the first annual cycle, forming 31.30% of Cryptostigmata, 8.60% of Acarina and 4.63% of total jhum soil fauna. During the second annual cycle, the density of the genera increased marginally to $212x10^2/m^2$, constituting 29.08% of Cryptostigmata, 7.94% of Acarina and 4.25% of total jhum soil fauna.

The genera were confined only up to the depth of 0-10 cm of the jhum soil during both the annual cycles. Further, the genera made up 31.43% of Cryptostigmata, 9.87% of Acarina and 5.86% of total jhum soil fauna at 0-10 cm layer during the first annual cycle. During the second annual cycle, the genera constituted 29.36% of Cryptostigmata, 9.62% of Acarina and 5.80% of total jhum soil fauna at 0-10 cm depth.

d.6. Dolicheremaeus sp.

The two annual cycle densities of Dolicheremaeus sp. and their percentages among the different categories of the forest and jhum soil fauna are given in the Table XXXV. The first annual cycle recorded a density of $500x10^2/m^2$, comprising 8.59% of Cryptostigmata, 5.45% of Acarina and 2.24% of total forest soil fauna. The genera numbered $574x10^2/m^2$ during the second annual cycle and formed 9.17% of Cryptostigmata, 5.87% of Acarina of 2.44% of total forest soil fauna.

The vertical densities of the genera during the first annual cycle were $260x10^2/m^2$ (litter), $235x10^2/m^2$ (0-10 cm) and $5x10^2/m^2$ (10-20 cm). These densities in percentages and among themselves vertically were 52.00% (litter), 47.00% (0-10 cm) and 1.00% (10-20 cm). The genera formed 8.07% (litter), 9.06% (0-10

cm) and 65.5% (10-20 cm) of Cryptostigmata; 5.27% (litter), 6.27 % (0-10 cm) and 1.02% (10-20 cm) of Acarina; 1.80% (litter), 3.59% (0-10 cm) and 0.42% (10-20 cm) of total forest soil fauna.

In the second annual cycle, the vertical densities of the genera and percentages among themselves were respectively $288x10^2/m^2$ and 50.18% at the litter layer; $283x10^2/m^2$ and 49.30% at 0-10 cm layer; $3x10^2/m^2$ and 0.52% at 10-20 cm soil layer. Also the genera formed 7.91% (litter), 10.83% (0-10 cm) and 100.0% (10-20 cm) of Cryptostigmata; 5.41% (litter), 7.34% (0-10 cm) and 0.52% (10-20 cm) of Acarina; 1.90% (litter), 4.11% (0-10 cm) and 0.26% (10-20 cm) of total forest soil fauna.

In the jhum soil, Dolicheremaeus sp. showed an annual density of $80x10^2/m^2$ during the first annual cycle. Further, the genera accounted for 12.30% of Cryptostigmata, 3.38% of Acarina and 1.82% of total jhum soil fauna during the first annual cycle. With an annual density of $95x10^2/m^2$ during the second annual cycle, the genera made up 13.03% of Cryptostigmata, 3.56% of Acarina and 1.90% of total jhum soil fauna.

The vertical densities of the mites during the first annual cycle were $78x10^2/m^2$ (0-10 cm) and $2x10^2/m^2$ (10-20 cm). Among themselves vertically, the genera were 97.50% at 0-10 cm layer and only 2.50% at 10-20 cm soil layer. Further, the genera formed 12.02% (0-10 cm) and 100.0% (10-20 cm) of Cryptostigmata; 3.77% (0-10 cm) and 0.70% (10-20 cm) of Acarina; 2.24% (0-10 cm) and 0.27% (10-20 cm) of total jhum soil fauna.

The vertical densities of the mites and percentages among themselves vertically during the second annual cycle were

Table XXXV. Showing the total number and percentages of Dolicheremaeus sp. (Cryptostigmata : Acarina) in the forest and jhum systems and in their different layers for two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total Cryptostigmata

d : Percentages in total Acarina

e : Percentages in total soil fauna

Table XXXVI. Showing the total number and percentages of Eremobelba sp. (Cryptostigmata : Acarina) in the forest and jhum systems and in their different layers for two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total Cryptostigmata

d : Percentages in total Acarina

e : Percentages in total soil fauna

TABLE XXXV

ACARINA (CRYPTO-STIGMATA)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
	FOREST	LITTER	260 (±18.91)	52.00	8.07	5.27	1.80	288 (±13.83)	50.18	7.91	5.41	1.90
		0 - 10cm	235 (±7.63)	47.00	9.06	6.27	3.59	283 (±9.05)	49.30	10.83	7.34	4.11
		10 - 20cm	5 (±0.58)	1.00	62.5	1.02	0.42	3 (±0.41)	0.52	100.0	0.52	0.26
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
Dolicheremaeus sp.		TOTAL	500 (±10.02)	100.0	8.59	5.45	2.24	574 (±19.94)	100.0	9.17	5.87	2.44
	JHUM	0 - 10cm	78 (±9.23)	97.5	12.02	3.77	2.24	91 (±10.10)	95.79	12.60	4.13	2.49
		10 - 20cm	2 (±0.91)	2.5	100.0	0.70	0.27	4 (±0.71)	4.21	57.14	0.90	0.36
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	80 (±9.46)	100.0	12.30	3.38	1.82	95 (±9.64)	100.0	13.03	3.56	1.90

TABLE XXXVI

ACARINA (CRYPTO-STIGMATA)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
	FOREST	LITTER	346 (±9.20)	54.23	10.74	7.01	2.40	415 (±15.38)	63.26	11.40	7.79	2.73
		0 - 10cm	291 (±5.27)	46.61	11.22	7.76	4.44	241 (±19.05)	36.74	9.22	6.25	3.50
		10 - 20cm	1 (±0.58)	0.16	12.5	0.21	0.08	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
Eremobelba sp.		TOTAL	638 (±9.57)	100.0	10.96	6.95	2.86	650 (±31.97)	100.0	10.48	6.71	2.79
	JHUM	0 - 10cm	60 (±2.97)	100.0	9.25	2.90	1.72	62 (±0.91)	100.0	8.59	2.82	1.70
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	60 (±2.97)	100.0	9.20	2.53	1.36	62 (±0.91)	100.0	8.50	2.32	1.24

$91x10^2/m^2$ and 95.79% at 0-10 cm; $4x10^2/m^2$ and 4.21% at 10-20 cm. Further, the genera formed 12.60% (0-10 cm) and 57.14% (10-20 cm) of Cryptostigmata; 4.13% (0-10 cm) and 0.90% (10-20 cm) of Acarina; 2.49% (0-10 cm) and 0.36% (10-20 cm) of total jhum soil fauna.

d.7. Eremobelba sp.

The two annual cycle densities of Eremobelba sp. and their percentages among the different faunal categories are given in the Table XXXVI. In the forest, these mites recorded an annual density of $638x10^2/m^2$ during the first annual cycle. Of Cryptostigmata, Acarina and total forest soil fauna, the genera made up 10.96%, 6.95% and 2.86%, respectively. With an annual density of $656x10^2/m^2$ during the second annual cycle, the genera formed 10.48% of Cryptostigmata, 6.71% of Acarina and 1.79% of total forest soil fauna.

The vertical densities of Eremobelba in different layers of the forest soil were $346x10^2/m^2$ (litter), $291x10^2/m^2$ (0-10 cm) and $1x10^2/m^2$ (10-20 cm) during the first annual cycle of investigation. Among themselves vertically, the percentage distributions of the genera were 54.23% at litter, 46.61% at 0-10 cm and 0.16% at 10-20 cm. Also, Eremobelba formed 10.74% (litter), 11.22% (0-10 cm) and 12.5% (10-20 cm) of Cryptostigmata; 7.01% (litter), 7.76% (0-10 cm) and 0.21% (10-20 cm) of Acarina; 2.40% (litter), 4.44% (0-10 cm) and 0.08% (10-20 cm) of total forest soil fauna.

The vertical densities of the genera during the second

annual cycle were $415x10^2/m^2$ (litter) and $241x10^2/m^2$ (0-10 cm). Vertically among themselves, the percentages of the genera were 63.26% at litter regime and 36.74% at 0-10 cm soil layer. These mites formed 11.40% (litter) and 9.22% (0-10 cm) of Cryptostigmata; 7.79% (litter) and 6.25% (0-10 cm) of Acarina; 2.73% (litter) and 3.50% (0-10 cm) of total forest soil fauna.

In the jhum soil, Eremobelba were $60x10^2/m^2$ (first annual cycle) and $62x10^2/m^2$ (second annual cycle). The mites formed 9.20% of Cryptostigma, 2.53% of Acarina and 1.36% of total jhum soil fauna during the first annual cycle; 8.50% of Cryptostigmata, 2.32% of Acarina and 1.24% of total jhum soil fauna during the second annual cycle.

The genera occurred only at 0-10 cm depth of the jhum soil. At this layer, the mites formed 9.25% and 8.59% of Cryptostigmata; 2.90% and 2.82% of Acarina; 1.72% and 1.70% of total jhum soil fauna, respectively during the first and second annual cycles.

d.8. Suctobelba sp.

Table XXXVII shows the two annual densities of Suctobelba and their percentages among the different categories of the forest and jhum soil fauna. The first annual cycle density was $519x10^2/m^2$ and constituted 8.91% of Cryptostigmata, 5.65% of Acarina and 2.33% of total forest soil fauna. With an annual density of $534x10^2/m^2$ during the second annual cycle, the genera comprised of 8.53% of Cryptostigmata, 5.47% of Acarina and 2.27% of total forest soil fauna.

The vertical densities of these mites in the forest during the first annual cycle were $223x10^2/m^2$ (litter) and $296x10^2/m^2$ (0-10 cm). Vertically among themselves, the genera were 42.97% (litter) and 57.03% (0-10 cm). In the litter layer of the forest, these formed 6.92% of Cryptostigmata, 4.52% of Acarina and 1.54% of total litter fauna. At 0-10 cm layer of the forest soil, these mites accounted for 11.41% of Cryptostigmata, 7.90% of Acarina and 4.52% of total forest soil fauna.

During the second annual cycle, the vertical annual densities were $246x10^2/m^2$ (litter) and $288x10^2/m^2$ (0-10 cm). In relation to the percentages of the mites, vertically among themselves, the values were 46.07% (litter) and 53.93% (0-10 cm). Suctobelba formed 6.76% (litter) and 11.02% (0-10 cm) of Cryptostigmata; 4.62% (litter) and 7.47% (0-10 cm) of Acarina; 1.62% (litter) and 4.18% (0-10 cm) of total forest soil fauna.

In the jhum soil, Suctobelba were only $16x10^2/m^2$ and $20x10^2/m^2$, respectively during the first and second annual cycles of present investigation. Further, the genera formed 2.50% of Cryptostigmata, 0.68% of Acarina and 0.36% of total jhum soil fauna during the first annual cycle. In the second annual cycle, these mites constituted 2.74% of Cryptostigmata, 0.75% of Acarina and 0.40% of total fauna of the jhum soil.

In relation to the vertical distributions, these mites occurred only at 0-10 cm layer of the jhum soil during the first annual cycle. Further, the genera formed 2.47% of Cryptostigmata, 0.78% of Acarina and 0.46% of total jhum soil fauna. of the layer.

Table XXXVII. Showing the total number and percentages of Suctobelba sp. (Cryptostigmata : Acarina) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total Cryptostigmata

d : Percentages in total Acarina

e : Percentages in total soil fauna

Table XXXVIII. Showing the total number and percentages of Brachychthonius sp. (Cryptostigmata : Acarina) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total Cryptostigmata

d : Percentages in total Acarina

e : Percentages in total soil fauna

TABLE XXXVII

ACARINA (CRYPTO-STIGMATA)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Suctobelba sp.	FOREST	LITTER	223 (±13.78)	42.97	6.92	4.52	1.54	246 (±8.91)	46.07	6.76	4.62	1.62
		0 - 10cm	296 (±20.51)	57.03	11.41	7.90	4.52	288 (±20.80)	53.93	11.02	7.47	4.18
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	519 (±21.21)	100.0	8.91	5.65	2.33	534 (±28.79)	100.0	8.53	5.47	2.27
	JHUM	0 - 10cm	16 (±3.21)	100.0	2.47	0.78	0.46	17 (±2.86)	85.00	2.35	0.77	0.46
		10 - 20cm	-	-	-	-	-	3 (±0.58)	15.00	42.86	0.70	0.27
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	16 (±3.21)	100.0	2.50	0.68	0.36	20 (±2.35)	100.0	2.74	0.75	0.40

TABLE XXXVIII

ACARINA (CRYPTO-STIGMATA)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Brachychthonius sp.	FOREST	LITTER	126 (±4.71)	48.28	3.92	2.55	0.87	133 (±22.30)	47.50	3.65	2.50	0.88
		0 - 10cm	135 (±18.19)	51.72	5.20	3.60	2.06	147 (±13.69)	52.50	5.65	3.81	2.13
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	261 (±20.94)	100.0	4.48	2.84	1.17	280 (±22.30)	100.0	4.48	2.87	1.19
	JHUM	0 - 10cm	15 (±2.86)	100.0	2.31	0.73	0.43	32 (±4.74)	100.0	4.43	1.45	0.87
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	15 (±2.86)	100.0	2.30	0.63	0.34	32 (±4.74)	100.0	4.39	1.20	0.64

The vertical densities of these mites during the second annual cycle were $17x10^2/m^2$ (0-10 cm) and $3x10^2/m^2$ (10-20 cm). Vertically among themselves, the percentage distributions of these mites were 85.00% (0-10 cm) and 15.00% (10-20 cm). The genera further formed 2.35% (0-10 cm) and 42.86% (10-20 cm) of Cryptostigmata; 0.77% (0-10 cm) and 0.70% (10-20 cm) of Acarina; 0.46% (0-10 cm) and 0.27% (10-20 cm) of total jhum soil fauna.

d.9. Brachychthonius sp.

The two annual cycle densities of Brachychthonius sp. and their percentages among the different categories of the forest and jhum soil fauna are represented in the Table XXXVIII. During the first annual cycle, these mites had an annual density of $261x10^2/m^2$ in the forest soils and formed 4.48% of Cryptostigmata; 2.84% of Acarina; 1.17% of total forest soil fauna. Their density in the second annual cycle was $280x10^2/m^2$ and constituted 4.48% of Cryptostigmata, 2.87% of Acarina and 1.19% of total forest soil fauna.

The vertical densities of these mites during the first annual cycle were $126x10^2/m^2$ (litter) and $135x10^2/m^2$ (0-10 cm). These densities in percentages and vertically among themselves were 48.28% (litter) and 51.72% (0-10 cm). Further, the genera formed 3.92% (litter) and 5.20% (0-10 cm) of Cryptostigmata; 2.55% (litter) and 3.60% (0-10 cm) of Acarina; 0.87% (litter) and 2.06% (0-10 cm) of total forest soil fauna.

The vertical densities of the genera during the second annual cycle were $133x10^2/m^2$ (litter) and $147x10^2/m^2$ (0-10 cm).

Vertically among themselves, these densities in percentages were 47.50% at litter and 52.50% at 0-10 cm layer. The genera formed 3.65% (litter) and 5.65% (0-10 cm) of Cryptostigmata; 2.50% (litter) and 3.81% (0-10 cm) of Acarina; 0.88% (litter) and 2.13% (0-10 cm) of total forest soil fauna.

In the jhum soil, the total density of Brachychthonius sp. during the first annual cycle was $15x10^2/m^2$, forming 2.30% of Cryptostigmata, 0.63% of Cryptostigmata and 0.34% of total jhum soil fauna. With a total density of $32x10^2/m^2$ during the second annual cycle, these mites constituted 4.39% of Cryptostigmata, 1.20% of Acarina and 0.64% of total jhum soil fauna.

The genera occurred only at 0-10 cm layer of the jhum soil. In this layer, the mites made up 2.31% of Cryptostigmata, 0.73% of Acarina and 0.43% of total jhum soil fauna of the layer during the first annual cycle. In the second annual cycle, the mites formed 4.43% of Cryptostigmata, 1.45% of Acarina and 0.87% of total jhum soil fauna.

d.10. Uropodidae

The two annual cycle variations in the numbers of the mites belonging to the family Uropodidae and their percentages among the different categories of the soil fauna are shown in the Table XXXIX. Thus, the first annual cycle density of these mites was $102x10^2/m^2$, accounting for 1.75% of Cryptostigmata, 1.11% of Acarina and 0.46% of total forest soil fauna. During the second annual cycle, these mites were $115x10^2/m^2$ in density and formed 1.84% of Cryptostigmata, 1.18% of Acarina and 0.49% of total forest soil fauna.

Table XXXIX. Showing the total number and percentages of Uropodidae (Cryptostigmata : Acarina) in the forest system and in its different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in Cryptostigmata

d : Percentages in total Acarina

e : Percentages in total soil fauna

Table XL. Showing the **total** number and percentages of "other oribatid mites" in the forest system and in its different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in Cryptostigmata

d : Percentages in total Acarina

e : Percentages in total soil fauna

TABLE XXXIX

ACARINA (CRYPTO-STIGMATA)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Uropodidae	FOREST	LITTER	66 (±4.64)	64.71	2.05	1.34	0.46	60 (±4.81)	52.17	1.65	1.13	0.39
		0 - 10cm	36 (±6.15)	35.29	1.39	0.96	0.55	55 (±8.96)	47.83	2.10	1.43	0.80
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	102 (±9.96)	100.0	1.75	1.11	0.46	115 (±2.71)	100.0	1.84	1.18	0.49
	JHUM	0 - 10cm	-	-	-	-	-	-	-	-	-	-
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	-	-	-	-	-	-	-	-	-	-

TABLE XL

ACARINA (CRYPTO-STIGMATA)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Other oribatid mites	FOREST	LITTER	244 (±12.03)	65.59	7.58	4.95	1.69	366 (±9.44)	71.62	10.05	6.87	2.41
		0 - 10cm	128 (±13.02)	34.41	4.94	3.41	1.95	145 (±16.63)	28.38	5.55	3.76	2.11
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	372 (±23.48)	100.0	6.39	4.05	1.67	511 (±25.36)	100.0	8.17	5.23	2.17
	JHUM	0 - 10cm	-	-	-	-	-	-	-	-	-	-
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	-	-	-	-	-	-	-	-	-	-

The vertical distributions of Uropodidae in the forest were $66x10^2/m^2$ (litter) and $36x10^2/m^2$ (0-10 cm) during the first annual cycle. Among themselves vertically, Uropodidae were 64.71 percent in the litter regime and 35.29% at 0-10 cm soil layer. Uropodidae formed 2.05% (litter) and 1.39% (0-10 cm) of Cryptostigmata; 1.34% (litter) and 0.96% (0-10 cm) of Acarina; 0.46% (litter) and 0.55% (0-10 cm) of total forest fauna.

During the second annual cycle, the vertical annual densities of Uropodidae were $60x10^2/m^2$ (litter) and $55x10^2/m^2$ (0-10 cm). These densities, vertically among themselves, were 52.17% (litter) and 47.83% (0-10 cm). Further, Uropodidae formed 1.65% (litter) and 2.10% (0-10 cm) of Cryptostigmata; 1.13% (litter) and 1.43% (0-10 cm) of Acarina; 0.39% (litter) and 0.80% (0-10 cm) of total forest soil fauna.

Uropodidae were not recovered from the jhum soils during the period of present investigation.

d.11. Other oribatid mites

The cryptostigmatid mites other than those described above were included under the category 'other oribatid mites'. Table XL represents the two annual cycle densities of these mites and their percentages among the different categories of the soil fauna. During the first annual cycle, these mites had an annual density of $372x10^2/m^2$, accounting for 6.39% of Cryptostigmata, 4.05% of Acarina and 1.67% of total forest soil fauna. These mites showed a remarkable increase to $511x10^2/m^2$ in density during the second annual cycle and formed 8.17% of Cryptosti-

gmata, 5.23% of Acarina and 2.17% of total forest soil fauna of the second annual cycle.

The vertical densities of these 'other oribatid mites' were $244x10^2/m^2$ (litter) and $128x10^2/m^2$ (0-10 cm) during the first annual cycle. Among themselves vertically these mites showed the percentage distributions of 65.59% at the litter layer and 34.41% at 0-10 cm soil layer. These mites further formed 7.58% (litter) and 4.94% (0-10 cm) of Cryptostigmata; 4.95% (litter) and 3.41% (0-10 cm) of Acarina; 1.69% (litter) and 1.95% (0-10 cm) of total forest soil fauna.

The vertical distributions of 'other oribatid mites' in percentages during the second annual cycle were 71.62% ($366x10^2/m^2$) at the litter regime and 28.38% ($145x10^2/m^2$) at 0-10 cm layer of the forest soil. Further, these mites contributed as much as 10.05% (litter) and 5.55% (0-10 cm) of Cryptostigmata; 6.87% (litter) and 3.76% (0-10 cm) of Acarina; 2.41% (litter) 2.11% (0-10 cm) of total forest soil fauna.

However, this group of 'other oribatid mites' were totally absent in the jhum soil during the period of present investigation.

4.2.1.4. Other arthropods

Arthropods other than Collembola and Acarina constituted "other arthropods" in the present investigation. Table XLI represents the two annual densities of 'other arthropods' and their percentages among the different faunal categories of the forest and jhum soil. In the forest, the first annual cycle density of'other arthropods'was $2876x10^2/m^2$ and constituted 12.89% of total forest soil fauna. With an annual density of $2892x10^2/m^2$ during the second annual cycle, arthropods other than Collembola and Acarina formed 12.30% of total forest soil fauna.

The vertical distributions of 'other arthropods' in terms of densities in the forest were $1720x10^2/m^2$ (litter), $700x10^2/m^2$ (0-10 cm), $364x10^2/m^2$ (10-20 cm), $48x10^2/m^2$ (20-30 cm) and $44x10^2/m^2$ (30-40 cm). Vertically among themselves, these densities in percentages were 59.80% (litter), 24.34% (0-10 cm), 12.66% (10-20 cm), 1.67% (20-30 cm) and 1.53% (30-40 cm). Further, these 'other arthropods' formed 11.92% (litter), 10.68% (0-10 cm), 30.31% (10-20 cm), 63.16% (20-30 cm) and 100.0% (30-40 cm) of total forest soil fauna.

During the second annual cycle, the vertical densities were $1460x10^2/m^2$ (litter), $936x10^2/m^2$ (0-10 cm), $256x10^2/m^2$ (10-20 cm), $204x10^2/m^2$ (20-30 cm) and $36x10^2/m^2$ (30-40 cm). The percentage distributions of these 'other arthropods', vértically among themselves, were 50.48% (litter), 32.37% (0-10 cm), 8.85% (10-20 cm), 7.05% (20-30 cm) and 1.25% (30-40 cm). Of the total fauna of the forest at different layers, arthropods other than Collembola and Acarina formed 9.61% at litter, 13.60% at

0-10 cm layer, 21.82% at 10-20 cm layer, 85.00% at 20-30 cm layer and 100.0% at 30-40 cm layer.

In the jhum soils, 'other arthropods' recorded a total annual density of $896x10^2/m^2$ during the first annual cycle and made up 20.36% of total jhum soil fauna. The second annual cycle density was $972x10^2/m^2$ and accounted for 19.46% of total fauna of the jhum soil.

The vertical densities of 'other arthropods' during the first annual cycle were $472x10^2/m^2$ (0-10 cm), $288x10^2/m^2$ (10-20 cm), $84x10^2/m^2$ (20-30 cm) and $52x10^2/m^2$ (30-40 cm). Vertically among themselves, they were 52.70% (0-10 cm), 32.10% (10-20 cm), 9.40% (20-30 cm) and 5.80% (30-40 cm). Of the total jhum soil fauna at different layers, 'other arthropods' formed 13.56% at 0-10 cm, 38.50% at 10-20 cm, 70.00% at 20-30 cm and 100.0% at 30-40 cm soil depths.

The second annual cycle vertical densities were $388x10^2/m^2$ (0-10 cm), $388x10^2/m^2$ (10-20 cm), $80x10^2/m^2$ (20-30 cm) and $116x10^2/m^2$ (30-40 cm). These densities in percentages were 39.92% at 0-10 cm, 39.92% at 10-20 cm, 8.23% at 20-30 cm and 11.93% at 30-40 cm. Further, these 'other arthropods' formed 10.61% (0-10 cm), 34.96% (10-20 cm), 71.43% (20-30 cm) and 100.0 percent at 30-40 cm soil layer.

The 'other arthropods' (i.e. arthropods other than Collembola and Acarina) are described under four classes, viz. Insecta, Myriapoda, Arachnida and Crustacea, and their orders.

Table XLI. Showing the total number and percentages of "Other Arthropods" in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total soil fauna

Table XLII. Showing the total number and percentages of Insecta in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total "Other Arthropods"

d : Percentages in total soil fauna

TABLE XLI

SITES	LAYERS	OTHER ARTHROPODS					
		FIRST ANNUAL CYCLE			SECOND ANNUAL CYCLE		
		a	b	c	a	b	c
FOREST	LITTER	1720 (±224.8)	59.80	11.92	1450 (±198.1)	50.48	9.61
	0 - 10cm	700 (±63.96)	24.34	10.68	936 (±96.51)	32.37	13.60
	10 - 20cm	364 (±47.82)	12.66	30.31	256 (±42.06)	8.85	21.82
	20 - 30cm	48 (±11.22)	1.67	63.16	204 (±21.45)	7.05	85.00
	30 - 40cm	44 (±11.11)	1.53	100.0	36 (±7.15)	1.25	100.0
	TOTAL	2876 (±261.3)	100.0	12.89	2892 (±299.3)	100.0	12.30
JHUM	0 - 10cm	472 (±68.91)	52.70	13.56	388 (±52.43)	39.92	10.61
	10 - 20cm	288 (±22.74)	32.10	38.50	388 (±69.05)	39.92	34.96
	20 - 30cm	84 (±16.40)	9.40	70.00	80 (±12.34)	8.23	71.43
	30 - 40cm	52 (±12.87)	5.80	100.0	116 (±8.76)	11.93	100.0
	TOTAL	896 (±86.78)	100.0	20.36	972 (±96.06)	100.0	19.46

TABLE XLII

ARTHROPODA (CLASS)	SITES	LAYERS	FIRST ANNUAL CYCLE				SECOND ANNUAL CYCLE			
			a	b	c	d	a	b	c	d
Insecta	FOREST	LITTER	860 (±120.10)	51.44	50.00	5.96	736 (±74.48)	40.98	50.41	4.84
		0 - 10cm	396 (±52.48)	23.68	56.60	6.04	596 (±78.85)	33.19	63.67	8.66
		10 - 20cm	324 (±42.11)	19.38	89.01	26.98	232 (±38.34)	12.92	90.63	19.78
		20 - 30cm	48 (±11.22)	2.87	100.0	63.16	196 (±21.76)	10.91	96.08	81.67
		30 - 40cm	44 (±11.11)	2.63	100.0	100.0	36 (±7.15)	2.00	100.0	100.0
		TOTAL	1672 (±169.88)	100.0	58.14	7.49	1796 (±182.03)	100.0	62.10	7.64
	JHUM	0 - 10cm	388 (±59.54)	51.32	82.20	11.14	256 (±33.16)	32.00	65.98	7.00
		10 - 20cm	232 (±18.83)	30.69	80.55	31.01	348 (±68.58)	43.50	89.69	31.35
		20 - 30cm	84 (±16.40)	11.11	100.0	70.00	80 (±12.34)	10.00	100.0	71.43
		30 - 40cm	52 (±12.87)	6.88	100.0	100.0	116 (±8.76)	14.50	100.0	100.0
		TOTAL	756 (±64.40)	100.0	84.37	17.18	800 (±81.85)	100.0	82.31	16.02

a. Class Insecta

Table XLII represents the two annual cycle densities of Insecta and their percentages among the different faunal categories of the forest and jhum soils. Numerical strength of insects during the first annual cycle was $1672x10^2/m^2$ in the forest. Insecta formed 58.14% of arthropods other than Collembola and Acarina and 7.49% of total forest soil fauna. In the second annual cycle, Insecta increased to $1796x10^2/m^2$ and made up 62.10 percent of 'other arthropods' and 7.64% of total forest fauna of the soil.

The vertical distributions of Insecta during the first annual cycle were $860x10^2/m^2$ (litter), $396x10^2/m^2$ (0-10 cm), $324x10^2/m^2$ (10-20 cm), $48x10^2/m^2$ (20-30 cm) and $44x10^2/m^2$ (30-40 cm) in the forest. Vertically among themselves, these densities in percentages were 51.44% (litter), 23.68% (0-10 cm), 19.38% (10-20 cm), 2.87% (20-30 cm) and 2.63% (30-40 cm). Of the total 'other arthropods', Insecta constituted 50.00% at litter, 56.60% at 0-10 cm, 89.01% at 10-20 cm, 100.0% each at 20-30 cm and 30-40 cm. Of the total forest soil fauna at different layers Insecta formed 5.96% (litter), 6.04% (0-10 cm), 26.98% (10-20 cm), 63.16% (20-30 cm) and 100.0% at 30-40 cm soil depth.

During the second annual cycle, the vertical densities of Insecta in different layers of the forest soil were $736x10^2/m^2$ (litter), $596x10^2/m^2$ (0-10 cm), $232x10^2/m^2$ (10-20 cm), $196x10^2/m^2$ (20-30 cm) and $36x10^2/m^2$ (30-40 cm). The percentages of insects, among themselves vertically, were 40.98% at litter, 33.19% at 0-10 cm, 12.92% at 10-20 cm, 10.91% at 20-30 cm and

2.00% (30-40 cm). Of the total other arthropods, Insecta formed 50.41% (litter), 63.67% (0-10 cm), 90.63% (10-20 cm), 96.08% (20-30 cm) and 100.0% (30-40 cm). Of the total soil fauna of the forest, Insecta constituted 4.84% (litter), 8.66% (0-10 cm), 19.78% (10-20 cm), 81.67% (20-30 cm) and 100.0% (30-40 cm).

In the jhum soil, the entomo-faunal recovery for the first annual cycle was $756 \times 10^2/m^2$, comprising 84.37% of the arthropods other than Collembola and Acarina, and 17.18% of the total jhum soil fauna. During the second annual cycle, the Insecta were $800 \times 10^2/m^2$, indicating a marginal increase over the first annual cycle. These counts constituted 82.31% of 'other arthropods' and 16.02% of the total jhum soil fauna.

The vertical distributions of Insecta in the jhum soils were $388 \times 10^2/m^2$ (0-10 cm), $232 \times 10^2/m^2$ (10-20 cm), $84 \times 10^2/m^2$ (20-30 cm) and $52 \times 10^2/m^2$ (30-40 cm), during the first annual cycle. The percentage densities of Insecta among themselves and vertically were 51.32% (0-10 cm), 30.69% (10-20 cm), 11.11% (20-30 cm) and 6.88% (30-40 cm). Insecta formed 82.20% (0-10 cm), 80.55% (10-20 cm), 100.0% (20-30 cm and 30-40 cm) of 'other arthropods'; 11.14% (0-10 cm), 31.01% (10-20 cm), 70.00% (20-30 cm) and 100.0% (30-40 cm) of total jhum soil fauna.

The vertical densities of Insecta during the second annual cycle were $256 \times 10^2/m^2$ (0-10 cm), $348 \times 10^2/m^2$ (10-20 cm), $80 \times 10^2/m^2$ (20-30 cm) and $116 \times 10^2/m^2$ (30-40 cm). These densities in percentages and among themselves vertically, were 32.00% (0-10 cm), 43.50% (10-20 cm), 10.00% (20-30 cm) and 14.50% (30-40 cm). Further, Insecta formed 65.98% (0-10 cm), 89.69% (10-20 cm),

100.0% (20-30 cm and 30-40 cm) of arthropods other than Collembola and Acarina; 7.00% (0-10 cm), 31.35% (10-20 cm), 71.43% (20-30 cm) and 100.0% (30-40 cm) of total jhum soil fauna during the second annual cycle of present investigation.

The class Insecta, which constituted the largest group of arthropods other than Collembola and Acarina ('other arthropods'), were counted into the following orders: Protura, Diplura, Diptera, Coleoptera, Hymenoptera, Isoptera, Orthoptera, Dermaptera, Hemiptera, Psocoptera and insect larvae.

a.1. Protura

The two annual cycle densities of the order Protura and their percentages among the different faunal categories of the forest and jhum soils are shown in the Table XLIII. The proturan counts in the forest were $156x10^2/m^2$ during the first annual cycle of investigation. This number formed 9.33% of Insecta, 5.42% of 'other arthropods' and 0.70% of total forest soil fauna. In the second annual cycle, Protura increased to $184x10^2/m^2$, constituting 10.25% of Insecta, 6.36% of 'other arthropods' and 0.78% of total forest soil fauna.

In the forest, the Protura occurred only in the litter ($128x10^2/m^2$) and 0-10 cm ($28x10^2/m^2$) soil layer. Among themselves vertically, these densities in percentages were 82.05% (litter) and 17.95% (0-10 cm), during the first annual cycle. Further, Protura formed 14.88% (litter) and 7.07% (0-10 cm) of Insecta; 7.44% (litter) and 4.00% (0-10 cm) of 'other arthropods'; 0.89% (litter) and 0.43% (0-10 cm) of forest soil fauna.

During the second annual cycle, the vertical densities of Protura were $120x10^2/m^2$ and $64x10^2/m^2$ respectively at the litter and 0-10 cm soil layer. These densities in percentages, among themselves vertically, were 65.22% (litter) and 34.78% (0-10 cm). Further, the proturans made up 16.30% (litter) and 10.74% (0-10 cm) of Insecta; 8.22% (litter) and 6.84% (0-10 cm) of arthropods other than Collembola and Acarina; 0.79% (litter) and 0.93% (0-10 cm) of total forest soil fauna during the second annual cycle of investigation.

In the jhum system, Protura were recovered only within the depth of 0-10 cm. The first annual cycle density was only $52x10^2/m^2$. This figure computed to be 6.89% of Insecta, 5.80% of 'other arthropods' and 1.20% of total jhum soil fauna. In the second annual cycle, total proturan recovery declined to $24x10^2/m^2$. This formed 3.00% of Insecta in the jhum, 2.47% of 'other arthropods' in the jhum system and 0.48% of total jhum soil fauna during the second annual cycle of study.

With an annual density of $52x10^2/m^2$ at 0-10 cm depth of the jhum soil during the first annual cycle, Protura formed 13.40% of Insecta, 11.02% of 'other arthropods' and 1.46% of total jhum soil fauna at 0-10 cm layer.

During the second annual cycle, the proturans occurred at 0-10 cm ($16x10^2/m^2$) and 10-20 cm ($8x10^2/m^2$) layers of the jhum soil. These densities in percentages and among themselves vertically, were 66.67% (0-10 cm) and 33.33% (10-20 cm). At 0-10 cm, the proturans formed 6.25% of Insecta, 4.12% of 'other arthropods' and 0.44% of total jhum soil fauna of the layer. At

Table XLIII. Showing the total number and percentages of Protura in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses
b : Percentages among themselves
c : Percentages in total Insecta
d : Percentages in total "Other Arthropods"
e : Percentages in total soil fauna

Table XLIV. Showing the total number and percentages of Diplura in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses
b : Percentages among themselves
c : Percentages in total Insecta
d : Percentages in total "Other Arthropods"
e : Percentages in total soil fauna

TABLE XLIII

INSECTA (ORDER)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Protura	FOREST	LITTER	128 (±14.87)	82.05	14.88	7.44	0.89	120 (±13.62)	65.22	16.30	8.22	0.79
		0 - 10cm	28 (±8.50)	17.95	7.07	4.00	0.43	64 (±13.48)	34.78	10.74	6.84	0.93
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	156 (±20.83)	-	9.33	5.42	0.70	184 (±22.35)	-	10.25	6.36	0.78
	JHUM	0 - 10cm	52 (±19.91)	100	13.40	11.02	1.46	16 (±5.90)	66.67	6.25	4.12	0.44
		10 - 20cm	-	-	-	-	-	8 (±2.55)	33.33	2.30	2.06	0.73
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	52 (±19.91)	-	6.89	5.8	1.20	24 (±8.29)	-	3.00	2.47	0.48

TABLE XLIV

INSECTA (ORDER)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Diplura	FOREST	LITTER	64 (±13.02)	59.26	7.44	3.72	0.44	48 (±10.68)	52.17	6.52	3.29	0.32
		0 - 10cm	28 (±5.55)	25.93	7.07	4.00	0.43	20 (±6.68)	21.74	3.36	2.14	0.29
		10 - 20cm	16 (±8.03)	14.81	4.94	4.40	1.33	24 (±6.79)	26.09	10.35	9.38	2.03
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	108 (±11.85)	-	6.46	3.76	0.48	92 (±12.42)	-	5.12	3.18	0.39
	JHUM	0 - 10cm	8 (±3.08)	66.67	2.06	1.69	0.22	28 (±4.34)	70.00	10.94	7.22	0.76
		10 - 20cm	4 (±2.83)	33.33	1.72	1.39	0.54	12 (±3.76)	30.00	3.45	3.09	1.09
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	12 (±5.90)	-	1.59	1.34	0.27	40 (±8.09)	-	5.00	4.12	0.80

10-20 cm depth of the jhum soil, Protura constituted 2.30% of Insecta, 2.06% of arthropods other than Collembola and Acarina and 0.73% of total fauna of the jhum soil.

a.2. Diplura

Table XLIV represents the two annual cycle densities of Diplura and their percentages among the different categories of the forest and jhum soil fauna. The total number of Diplura in the forest was $108x10^2/m^2$ during the first annual cycle. In percentages, these constituted 6.46% of Insecta, 3.76% of 'other arthropods' and 0.48% of total soil fauna of the forest system. During the second annual cycle, the diplurans were $92x10^2/m^2$ and composed of 5.12% of Insecta, 3.18% of 'other arthropods' and 0.39% of total forest soil fauna.

Vertical densities of Diplura were $64x10^2/m^2$ (litter), $28x10^2/m^2$ (0-10 cm) and $16x10^2/m^2$ (10-20 cm) during the first annual cycle. Among themselves vertically, the percentages of Diplura were 59.26% (litter), 25.93% (0-10 cm) and 14.81% (10-20 cm). Of the different faunal categories, Diplura constituted 7.44% (litter), 7.07% (0-10 cm) and 4.94% (10-20 cm) of Insecta; 3.72% (litter), 4.00% (0-10 cm) and 4.40% (10-20 cm) of arthropods other than Collembola and Acarina; 0.44% (litter), 0.43% (0-10 cm) and 1.33% (10-20 cm) of total forest soil fauna during the first annual cycle.

In the second annual cycle, the annual densities of Diplura in different layers of the forest soil were $48x10^2/m^2$ (litter), $20x10^2/m^2$ (0-10 cm) and $24x10^2/m^2$ (10-20 cm). These

densities in percentages and among themselves vertically, were 52.17% (litter), 21.74% (0-10 cm) and 26.09% (10-20 cm). Further Diplura formed 6.52% (litter), 3.36% (0-10 cm) and 10.35% (10-20 cm) of Insecta; 3.29% (litter), 2.14% (0-10 cm) and 9.38% (10-20 cm) of 'other arthropods'; 0.32% (litter), 0.29% (0-10 cm) and 2.03% (10-20 cm) of total forest soil fauna during the second annual cycle of present investigation.

As compared to the forest soil, the recovery of diplu-ran fauna from the jhum soil was very low, particularly so, for the first annual cycle, being $12x10^2/m^2$ only. This count was only 1.59% of Insecta, 1.34% of 'other arthropods' and 0.27% of total jhum soil fauna. The annual density of Diplura during the second annual cycle was $40x10^2/m^2$, comprising 5.00% of Insecta, 4.12% of 'other arthropods' and 0.80% of total soil fauna of the jhum system.

The first annual cycle densities of Diplura in different layers of the jhum were $8x10^2/m^2$ (0-10 cm) and $4x10^2/m^2$ (10-20 cm). These densities, vertically among themselves, were 66.67% (0-10 cm) and 33.33% (10-20 cm). Also, the diplurans formed 2.06% (0-10 cm) and 1.72% (10-20 cm) of Insecta; 1.69% (0-10 cm) and 1.39% (10-20 cm) of arthropods other than Collembola and Acarina; 0.22% (0-10 cm) and 0.54% (10-20 cm) of total jhum soil fauna of the layer.

During the second annual cycle, the vertical densities of Diplura in the jhum soil were $28x10^2/m^2$ (0-10 cm) and $12x10^2/m^2$ (10-20 cm). The percentage distributions of Diplura, among themselves vertically, were 70.00% (0-10 cm) and 30.00% (10-20

cm). Further, Diplura formed 10.94% (0-10 cm) and 3.45% (10-20 cm) of Insecta; 7.22% (0-10 cm) and 3.09% (10-20 cm) of arthropods other than Collembola and Acarina; 0.76% (0-10 cm) and 1.09 % (10-20 cm) of total fauna of the jhum soil.

a.3. Diptera

The two annual cycle densities of Diptera and their percentage values among the various groups of the forest and jhum soil fauna are shown in the Table XLV. The forest soil recorded an annual density of $88x10^2/m^2$ of Diptera during the first annual cycle of investigation. This formed 5.26% of Insecta, 3.06% of 'other arthropods' and 0.40% of total forest soil fauna. In the second annual cycle, Diptera numbered $72x10^2/m^2$ and constituted 4.01% of Insecta, 2.49% of 'other arthropods' and 0.31% of total fauna of the forest system.

In relation to the vertical distributions, the annual densities of Diptera varied from $60x10^2/m^2$ in the litter layer to $28x10^2/m^2$ at 0-10 cm soil layer during the first annual cycle. Vertically and among themselves, the percentage distributions of Diptera were 68.18% (litter) and 31.82% (0-10 cm). Among the Insecta, 'other arthropods' and total fauna of the forest at the litter and 0-10 cm layer of the soil, Diptera accounted for 6.97% and 7.07%; 3.49% and 4.00%; 0.42% and 0.43%, respectively.

During the second annual cycle, the vertical distributions of the dipteran fauna were $56x10^2/m^2$ (litter) and $16x10^2/m^2$ (0-10 cm). These densities in percentages, when calculated vertically among themselves, were 77.78% (litter) and 22.22% (0-

Table XLV. Showing the total number and percentages of Diptera in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total Insecta

d : Percentages in total "Other Arthropods"

e : Percentages in total soil fauna

Table XLVI. Showing the total number and percentages of Coleoptera in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total Insecta

d : Percentages in total "Other Arthropods"

e : Percentages in total soil fauna

TABLE XLV

INSECTA (ORDER)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Diptera	FOREST	LITTER	60 (±12.42)	68.18	6.97	3.49	0.42	56 (±11.68)	77.78	7.61	3.83	0.37
		0 - 10cm	28 (±6.87)	31.82	7.07	4.00	0.43	16 (±6.65)	22.22	2.69	1.71	0.23
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	88 (±8.45)	-	5.26	3.06	0.4	72 (±6.99)	-	4.01	2.49	0.31
	JHUM	0 - 10cm	24 (±8.01)	100	6.19	5.08	0.68	16 (±4.80)	100	6.25	4.12	0.44
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	24 (±8.01)	-	3.17	2.68	0.54	16 (±4.80)	-	2.00	1.65	0.32

TABLE XLVI

INSECTA (ORDER)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Coleoptera	FOREST	LITTER	56 (±12.02)	51.85	6.51	3.26	0.39	72 (±12.38)	60.00	9.78	4.93	0.47
		0 - 10cm	28 (±5.42)	25.93	7.07	4.00	0.43	20 (±7.82)	16.67	3.36	2.14	0.29
		10 - 20cm	24 (±6.01)	22.22	7.41	6.59	2.00	24 (±3.89)	20.00	10.35	9.38	2.03
		20 - 30cm	-	-	-	-	-	4 (±3.08)	3.33	2.0	1.96	1.68
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	108 (±11.92)	-	6.46	3.76	0.48	120 (±11.19)	-	6.68	4.15	0.51
	JHUM	0 - 10cm	24 (±8.86)	60.00	6.19	5.08	0.68	16 (±3.94)	36.36	6.25	4.12	0.44
		10 - 20cm	12 (±3.70)	30.00	5.17	4.17	1.61	16 (±5.43)	36.36	4.59	4.13	1.46
		20 - 30cm	4 (±1.22)	10.00	4.76	4.76	3.33	8 (±3.08)	18.18	10.00	10.00	7.14
		30 - 40cm	-	-	-	-	-	4 (±1.22)	9.10	3.45	3.45	3.45
		TOTAL	40 (±12.44)	-	5.29	4.46	0.91	44 (±9.25)	-	5.50	4.53	0.88

10 cm). Further, Diptera formed 7.61% (litter) and 2.69% (0-10 cm) of Insecta; 3.83% (litter) and 1.71% (0-10 cm) of arthropods other than Collembola and Acarina; 0.37% (litter) and 0.23% (0-10 cm) of total fauna of the forest system.

From the jhum soil, the dipteran fauna recorded for the first annual cycle were $24x10^2/m^2$, being 3.17% of Insecta, 2.68% of 'other arthropods' and 0.54% of total jhum soil fauna. With an annual density of $16x10^2/m^2$ during the second annual cycle, the dipteran fauna constituted 2.00% of Insecta, 1.65% of 'other arthropods' and 0.32% of total jhum soil fauna.

In relation to the vertical distributions, the dipterans were recorded from the 0-10 cm layer of the jhum soil only. At this layer, Diptera formed 6.19% of Insecta, 5.08% of 'other arthropods' and 0.68% of total jhum soil fauna of the layer, during the first annual cycle. In the second annual cycle, Diptera made up 6.25% of Insecta, 4.12% of 'other arthropods' and 0.44% of total jhum soil fauna.

a.4. Coleoptera

Table XLVI represents the percentages of Coleoptera among the different categories of the fauna and their densities in the forest and jhum soils during the two annual cycles of investigation. The first annual cycle densities of Coleoptera in the forest were $108x10^2/m^2$ and constituted 6.46% of Insecta, 3.76% of 'other arthropods' and 0.48% of total forest soil fauna. With an annual density of $120x10^2/m^2$ during the second annual cycle, Coleoptera formed 6.68% of Insecta, 4.15% of 'other

arthropods' and 0.51% of the total soil fauna of the forest system during the second annual cycle.

The vertical distributions of coleopteran fauna in terms of their annual densities were $56x10^2/m^2$ (litter), $28x10^2/m^2$ and $24x10^2/m^2$ (10-20 cm) during the first annual cycle. The percentage distributions of this group, vertically and among themselves, were 51.85% (litter), 25.93% (0-10 cm) and 22.22% (10-20 cm). Further, Coleoptera made up 6.51% (litter), 7.07% (0-10 cm) and 7.41% (10-20 cm) of Insecta; 3.26% (litter), 4.00% (0-10 cm) and 6.59% (10-20 cm) of arthropods other than Collembola and Acarina; 0.39% (litter), 0.43% (0-10 cm) and 2.00% (10-20 cm) of total forest soil fauna of the respective layers.

The annual densities of Coleoptera at different layers of the forest soils during the second annual cycle were recorded to be $72x10^2/m^2$ (litter), $20x10^2/m^2$ (0-10 cm), $24x10^2/m^2$ (10-20 cm) and $4x10^2/m^2$ (20-30 cm). These densities, among themselves vertically, were calculated to be 60.00% at the litter, 16.67% at 0-10 cm, 20.00% at 10-20 cm and 3.33% at 20-30 cm soil depth. It was also seen that in different layers Coleoptera formed 9.78% (litter), 3.36% (0-10 cm), 10.35% (10-20 cm) and 2.00% (20-30 cm) of Insecta; 4.93% (litter), 2.14% (0-10 cm), 9.38% (10-20 cm) and 1.96% (20-30 cm) of 'other arthropods' ; 0.47% (litter), 0.29% (0-10 cm), 2.03% (10-20 cm) and 1.68% (20-30 cm) of total forest soil fauna.

In the jhum soil, the annual density of Coleoptera was only $40x10^2/m^2$ during the first annual cycle. This density formed 5.29% of Insecta, 4.46% of 'other arthropods' and 0.91% of

total soil fauna of the jhum system. During the second annual cycle, the coleopteran annual density reached to $44x10^2/m^2$, constituting 5.50% of Insecta, 4.53% of 'other arthropods' and only 0.88% of total jhum soil fauna.

The vertical densities of Coleoptera during the first annual cycle were $24x10^2/m^2$ (0-10 cm), $12x10^2/m^2$ (10-20 cm) and $4x10^2/m^2$ (20-30 cm). These vertical densities in percentages, among themselves vertically, were 60.00% (0-10 cm), 30.00 (10-20 cm) and 10.00% (20-30 cm). In different layers of the jhum soil, Coleoptera formed 6.19% (0-10 cm), 5.17% (10-20 cm) and 4.76% (20-30 cm) of Insecta; 5.08% (0-10 cm), 4.17% (10-20 cm) and 4.76% (20-30 cm) of 'other arthropods'; 0.68% (0-10 cm), 1.61% (10-20 cm) and 3.33% (20-30 cm) of total jhum soil fauna.

The vertical distributions of Coleoptera in the jhum soil during the second annual cycle were $16x10^2/m^2$ (0-10 cm), $16x10^2/m^2$ (10-20 cm), $8x10^2/m^2$ (20-30 cm) and $4x10^2/m^2$ (30-40 cm). The percentages of these densities, among themselves vertically, were 36.36% (0-10 cm), 36.36% (10-20 cm), 18.18% (20-30 cm) and 9.10% (30-40 cm). Further, Coleoptera constituted only 6.25% (0-10 cm), 4.59% (10-20 cm), 10.00% (20-30 cm) and 3.45% (30-40 cm) of Insecta; 4.12% (0-10 cm), 4.13% (10-20 cm), 10.00 % (20-30 cm) and 3.45% (30-40 cm) of 'other arthropods'; 0.44% (0-10 cm), 1.46% (10-20 cm), 7.14% (20-30 cm) and 3.45% (30-40 cm) of total jhum soil fauna.

a.5. Hymenoptera

In the present study, the family Formicidae of the order Hymenoptera were the most abundant group of the arthropods other than Collembola and Acarina, in both the forest and jhum systems. The two annual cycle densities of Formicidae (Hymenoptera) and their percentages among different categories of the fauna are represented in Table XLVII. In the forest and during the first annual cycle, Formicidae were $624x10^2/m^2$ in terms of annual density, and formed 37.32% of Insecta, 21.70% of 'other arthropods' and 2.80% of total forest soil fauna. With an annual density of $692x10^2/m^2$ during the second annual cycle, Formicidae made up 38.53% of Insecta, 23.93% of 'other arthropods' and 2.94% of total forest soil fauna.

The vertical distributions of Hymenoptera (Formicidae) in relation to its annual densities were $272x10^2/m^2$ (litter), $116x10^2/m^2$ (0-10 cm), $160x10^2/m^2$ (10-20 cm), $32x10^2/m^2$ (20-30 cm) and $44x10^2/m^2$ (30-40 cm) during the first annual cycle of investigation. Vertically and among themselves, the percentage distributions of these fauna were 43.59% (litter), 18.59% (0-10 cm), 25.64% (10-20 cm), 5.13% (20-30 cm) and 7.05% (30-40 cm). Further, this group of Hymenoptera formed 31.63% (litter), 29.30% (0-10 cm), 49.38% (10-20 cm), 66.67% (20-30 cm) and 100.0% (30-40 cm) of Insecta; 15.81% (litter), 16.57% (0-10 cm), 43.96% (10-20 cm), 66.67% (20-30 cm) and 100.0% (30-40 cm) of 'other arthropods'; 1.89% (litter), 1.77% (0-10 cm), 13.33% (10-20 cm), 42.11% (20-30 cm) and 100.0% (30-40 cm) of total soil fauna of the forest system.

The vertical densities of Hymenoptera (Formicidae) in different layers of the forest soil during the second annual cycle were $120x10^2/m^2$ (litter), $264x10^2/m^2$ (0-10 cm), $120x10^2/m^2$ (10-20 cm), $152x10^2/m^2$ (20-30 cm) and $36x10^2/m^2$ (30-40 cm). These densities in percentages, among themselves vertically, were 17.34% (litter), 38.15% (0-10 cm), 17.34% (10-20 cm), 21.97% (20-30 cm) and 5.20% (30-40 cm). It was also observed that Formicidae made up 16.30% (litter), 44.29% (0-10 cm), 51.72% (10-20 cm), 77.60% (20-30 cm) and 100.0% (30-40 cm) of Insecta ; 8.22% (litter), 28.20% (0-10 cm), 46.87% (10-20 cm), 74.52% (20-30 cm) and 100.0% (30-40 cm) of 'other arthropods'; 0.79% (litter), 3.84% (0-10 cm), 10.13% (10-20 cm), 63.33% (20-30 cm) and 100.0% (30-40 cm) of total forest soil fauna.

In the jhum soil too, the Formicidae of the order Hymenoptera were the most abundant group of the arthropods other than Collembola and Acarina. During the first annual cycle, the annual density of Formicidae was $468x10^2/m^2$, forming 61.90% of Insecta, 52.23% of 'other arthropods' and 10.63% of total jhum soil fauna. The annual density for the second annual cycle was $484x10^2/m^2$ and among different faunal categories, Formicidae formed 60.50% of Insecta, 49.79% of 'other arthropods' and 9.69% of total jhum soil fauna.

The vertical densities of Formicidae (Hymenoptera) in the jhum soil during the first annual cycle were $208x10^2/m^2$ (0-10 cm), $144x10^2/m^2$ (10-20 cm), $64x10^2/m^2$ (20-30 cm) and $52x10^2/m^2$ (30-40 cm). Among themselves vertically, the percentages of these densities were 44.44% (0-10 cm), 30.77% (10-20 cm), 13.68%

Table XLVII. Showing the total number and percentages of Hymenoptera (Formicidae) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses
b : Percentages among themselves
c : Percentages in total Insecta
d : Percentages in total "Other Arthropods"
e : Percentages in total soil fauna

Table XLVIII. Showing the total number and percentages of Isoptera in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses
b : Percentages among themselves
c : Percentages in total Insecta
d : Percentages in total "Other Arthropods"
e : Percentages in total soil fauna

TABLE XLVII

INSECTA (ORDER)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Hymenoptera	FOREST	LITTER	272 (±48.92)	43.59	31.63	15.81	1.89	120 (±23.16)	17.34	16.30	8.22	0.79
		0 - 10cm	116 (±22.89)	18.59	29.30	16.57	1.77	264 (±66.74)	38.15	44.29	28.20	3.84
		10 - 20cm	160 (±19.51)	25.64	49.38	43.96	13.33	120 (±33.35)	17.34	51.72	46.87	10.13
		20 - 30cm	32 (±11.44)	5.13	66.67	66.67	42.11	152 (±26.86)	21.97	77.60	74.52	63.33
		30 - 40cm	44 (±11.11)	7.05	100.0	100.0	100.0	36 (±7.15)	5.20	100.0	100.0	100.0
		TOTAL	624 (±65.37)	-	37.32	21.70	2.8	692 (±127.33)	-	38.53	23.93	2.94
	JHUM	0 - 10cm	208 (±20.18)	44.44	53.61	44.07	5.85	120 (±18.72)	24.79	46.88	30.93	3.28
		10 - 20cm	144 (±19.68)	30.77	62.07	50.00	19.35	224 (±64.82)	46.28	64.37	57.73	20.36
		20 - 30cm	64 (±17.64)	13.68	76.19	76.19	53.34	32 (±11.29)	6.61	40.00	40.00	28.58
		30 - 40cm	52 (±12.87)	11.11	100.0	100.0	100.0	108 (±9.53)	22.32	93.10	93.10	93.10
		TOTAL	468 (±12.29)	-	61.9	52.23	10.63	484 (±62.34)	-	60.5	49.79	9.69

TABLE XLVIII

INSECTA (ORDER)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Isoptera	FOREST	LITTER	-	-	-	-	-	180 (±14.12)	77.59	24.46	12.33	1.18
		0 - 10cm	40 (±10.21)	66.67	10.10	5.72	0.61	20 (±4.56)	8.62	3.36	2.14	0.29
		10 - 20cm	20 (±6.39)	33.33	6.17	5.49	1.67	12 (±2.71)	5.17	5.17	4.69	1.01
		20 - 30cm	-	-	-	-	-	20 (±7.53)	8.62	10.20	9.80	8.33
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	60 (±8.65)	-	3.58	2.09	0.27	232 (±24.80)	-	12.92	8.02	0.99
	JHUM	0 - 10cm	-	-	-	-	-	-	-	-	-	-
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	28 (±2.97)	100	35.00	35.00	25.00
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	-	-	-	-	-	28 (±2.97)	-	3.5	2.88	0.56

(20-30 cm) and 11.11% (30-40 cm). Among the different faunal categories of different layers, Formicidae (Hymenoptera) constituted 53.61% (0-10 cm), 62.07% (10-20 cm), 76.19% (20-30 cm) and 100.0% (30-40 cm) of Insecta; 44.07% (0-10 cm), 50.00% (10-20 cm), 76.19% (20-30 cm) and 100.0% (30-40 cm) of 'other arthropods'; 5.85% (0-10 cm), 19.35% (10-20 cm), 53.34% (20-30 cm) and 100.0% (30-40 cm) of total jhum soil fauna.

The vertical distributions of this group of fauna in relation to its second annual cycle densities were $120x10^2/m^2$ (0-10 cm), $224x10^2/m^2$ (10-20 cm), $32x10^2/m^2$ (20-30 cm) and $108x10^2/m^2$ (30-40 cm). The percentage distributions of the group, vertically among themselves, were 24.79% (0-10 cm), 46.28% (10-20 cm), 6.61% (20-30 cm) and 22.32% (30-40 cm). Further, Formicidae formed 46.88% (0-10 cm), 64.37% (10-20 cm), 40.00% (20-30 cm) and 93.10% (30-40 cm) of Insecta; 30.93% (0-10 cm), 57.73% (10-20 cm), 40.00% (20-30 cm) and 93.10% (30-40 cm) of 'other arthropods'; 3.28% (0-10 cm), 20.36% (10-20 cm), 28.58% (20-30 cm) and 93.10% (30-40 cm) of total jhum soil fauna.

a.6. Isoptera

Annual densities and percentage data of Isoptera among different categories of the forest and jhum soil fauna are represented in the Table XLVIII. During the first annual cycle the annual densities of Isoptera were $60x10^2/m^2$. These densities made up 3.58% of Insecta, 2.09% of 'other arthropods' and 0.27% of total forest soil fauna. With an annual density of $232x10^2/m^2$ during the second annual cycle, Isoptera constituted

as much as 12.92% of Insecta, 8.02% of 'other arthropods' and 0.99% of total soil fauna of the forest system.

During the first annual cycle, Isoptera did not occur at the litter and beyond the 20 cm soil depth. Hence, the vertical distributions were limited to the 0-10 cm ($40x10^2/m^2$) and 10-20 cm ($20x10^2/m^2$) soil layers. Percentage distributions, among themselves vertically were 66.67% (0-10 cm) and 33.33% (10-20 cm). The group formed 10.10% (0-10 cm) and 6.17% (10-20 cm) of Insecta; 5.72% (0-10 cm) and 5.49% (10-20 cm) of 'other arthropods'; 0.61% (0-10 cm) and 1.67% (10-20 cm) of total forest soil fauna of the respective layer.

The vertical densities during the second annual cycle were $180x10^2/m^2$ (litter), $20x10^2/m^2$ (0-10 cm), $12x10^2/m^2$ (10-20 cm) and $20x10^2/m^2$ (20-30 cm). Among themselves vertically, the percentage distributions of Isoptera were 77.59% (litter),8.62% (0-10 cm), 5.17% (10-20 cm) and 8.62% (20-30 cm). Further, the group made up 24.46% (litter), 3.36% (0-10 cm), 5.17% (10-20 cm) and 10.20% (20-30 cm) of Insecta; 12.33% (litter), 2.14% (0-10 cm), 4.69% (10-20 cm) and 9.80% (20-30 cm) of 'other arthropods'; 1.18% (litter), 0.29% (0-10 cm), 1.01% (10-20 cm) and 8.33% (20-30 cm) of total forest soil fauna.

From the jhum soil, no isopteran fauna were recovered during the first annual cycle of investigation. The second annual cycle density was $28x10^2/m^2$, constituting 3.50% of Insecta, 2.88% of 'other arthropods' and 0.56% of total soil fauna of the jhum system.

In relation to its vertical distribution, the group

were recovered only from the 20-30 cm soil depth during the second annual cycle. At this layer, the group formed 35.00% of Insecta, 35.00% of 'other arthropods' and 25.00% of total jhum soil fauna of the layer.

a.7. Orthoptera

Table XLIX shows the two annual cycle densities of Orthoptera and their percentage compositions among different categories of soil fauna. The forest soil had a total density of $32x10^2/m^2$ during the first annual cycle. This density formed 1.92% of Insecta, 1.11% of 'other arthropods' and 0.14% of total fauna of the forest soil. The second annual cycle density was $24x10^2/m^2$ and formed 1.34% of Insecta, 0.83% of 'other arthropods' and 0.10% of total forest soil fauna.

The group occurred at the litter ($28x10^2/m^2$) and 0-10 cm ($4x10^2/m^2$) layer of the forest soil during the first annual cycle. Vertically among themselves, these densities were 87.50% (litter) and 12.50% (0-10 cm). Further, the group constituted 3.26% (litter) and 1.01% (0-10 cm) of Insecta; 1.63% (litter) and 0.57% (0-10 cm) of 'other arthropods'; 0.19% (litter) and 0.06% (0-10 cm) of total forest soil fauna.

The vertical densities of the fauna during the second annual cycle were $12x10^2/m^2$ each at the litter and 0-10 cm layer. Vertically among themselves, the group formed 50.00% each at both the layers. Orthoptera also calculated 1.63% (litter) and 2.01% (0-10 cm) of Insecta; 0.82% (litter) and 1.28% (0-10 cm) of 'other arthropods' and 0.08% (litter) and 0.17% (0-10 cm) of total forest soil fauna.

Table XLIX. Showing the total number and percentages of Orthoptera in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total Insecta

d : Percentages in total "Other Arthropods"

e : Percentages in total soil fauna

Table L. Showing the total number and percentages of Dermaptera in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total Insecta

d : Percentages in total "Other Arthropods"

e : Percentages in total soil fauna

TABLE XLIX

INSECTA (ORDER)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Orthoptera	FOREST	LITTER	28 (±6.56)	87.50	3.26	1.63	0.19	12 (±5.00)	50.00	1.63	0.82	0.08
		0 - 10cm	4 (±1.73)	12.50	1.01	0.57	0.06	12 (±4.38)	50.00	2.01	1.28	0.17
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	32 (±5.03)	-	1.92	1.11	0.14	24 (±7.45)	-	1.34	0.83	0.10
	JHUM	0 - 10cm	-	-	-	-	-	8 (±3.81)	40.00	3.12	2.06	0.22
		10 - 20cm	-	-	-	-	-	8 (±1.78)	40.00	2.30	2.06	0.73
		20 - 30cm	-	-	-	-	-	4 (±1.73)	20.00	5.00	5.00	3.57
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	-	-	-	-	-	20 (±6.22)	-	2.5	2.06	0.4

TABLE L

INSECTA (ORDER)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Dermaptera	FOREST	LITTER	28 (±5.37)	87.50	3.26	1.63	0.19	20 (±1.78)	62.50	2.72	1.37	0.13
		0 - 10cm	4 (±5.37)	12.50	1.01	0.57	0.06	12 (±4.26)	37.50	2.01	1.28	0.17
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	32 (±4.88)	-	1.92	1.11	0.14	32 (±4.24)	-	1.78	1.11	0.14
	JHUM	0 - 10cm	4 (±2.04)	33.33	1.03	0.85	0.11	4 (±1.47)	50.00	1.56	1.03	0.11
		10 - 20cm	8 (±2.65)	66.67	3.45	2.78	1.08	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	4 (±0.82)	50.00	3.45	3.45	3.45
		TOTAL	12 (±3.76)	-	1.59	1.34	0.27	8 (±1.87)	-	1.0	0.82	0.16

In the jhum soil, no Orthoptera could be encountered during the first annual cycle of present investigation. However, in the second annual cycle, the orthopteran density were observed to be $20x10^2/m^2$. This density constituted 2.50% of Insecta, 2.06% of 'other arthropods' and 0.40% of total jhum soil fauna.

The vertical densities during the second annual cycle were $8x10^2/m^2$ (0-10 cm), $8x10^2/m^2$ (10-20 cm) and $4x10^2/m^2$ (20-30 cm). Vertically among themselves, the percentage distributions of the group were 40.00% each at 0-10 cm and 10-20 cm, and 20.00 % at 20-30 cm soil layer. In different layers of the jhum soil, the group were observed to be 3.12% (0-10 cm), 2.30% (10-20 cm) and 5.00% (20-30 cm) of Insecta; 2.06% (0-10 cm), 2.06% (10-20 cm) and 5.00% (20-30 cm) of arthropods other than Collembola and Acarina; 0.22% (0-10 cm), 0.73% (10-20 cm) and 3.57% (20-30 cm) of total jhum soil fauna.

a.8. Dermaptera

Annual population density data of Dermaptera for two annual cycles and their percentages among different groups of the fauna are shown in the Table L. The forest soil had a total dermapteran count of $32x10^2/m^2$ during the first annual cycle. The percentage compositions of Dermaptera were 1.92% of Insecta, 1.11% of 'other arthropods' and 0.14% of total forest soil fauna. The second annual cycle density was also $32x10^2/m^2$, comprising 1.78% of Insecta, 1.11% of 'other arthropods' and 0.14% of total forest soil fauna.

The vertical distributions of Dermaptera were limited

to the litter ($28x10^2/m^2$) and 0-10 cm ($4x10^2/m^2$) soil depth of the forest, during the first annual cycle. The group were distributed as 87.50% (litter) and 12.50% (0-10 cm) , among themselves and vertically. Of the total Insecta, other arthropods and total forest soil fauna, Dermaptera constituted respectively 3.26%, 1.63% and 0.19% at the litter layer; 1.01%, 0.57% and 0.06% at 0-10 cm soil layer.

The vertical densities of the second annual cycle were $20x10^2/m^2$ (litter) and $12x10^2/m^2$ (0-10 cm). Vertically among themselves, Dermaptera had the percentage distributions of 62.50 % at the litter and 37.50% at 0-10 cm soil layer. Further, the group formed 2.72% (litter) and 2.01% (0-10 cm) of Insecta; 1.37% (litter) and 1.28% (0-10 cm) of 'other arthropods'; 0.13% (litter) and 0.17% (0-10 cm) of total forest soil fauna.

In the jhum soil, the dermapteran density for the first annual cycle was $12x10^2/m^2$ and constituted 1.59% of Insecta, 1.34% of 'other arthropods' and 0.27% of total jhum soil fauna. During the second annual cycle, Dermaptera decreased marginally over the first annual cycle. The density during this period was $8x10^2/m^2$, forming 1.00% of Insecta, 0.82% of 'other arthropods' and 0.16% of total jhum soil fauna.

In relation to its vertical distributions, Dermaptera were distributed at 0-10 cm ($4x10^2/m^2$) and 10-20 cm ($8x10^2/m^2$) of the jhum soil during the first annual cycle. Vertically among themselves, this group were distributed as 33.33% at the litter and 66.67% at 0-10 cm soil layer. Dermaptera also formed 1.03% (0-10 cm) and 3.45% (10-20 cm) of Insecta; 0.85% (0-10 cm)

and 2.78% (10-20 cm) of 'other arthropods'; 0.11% (0-10 cm) and 1.08% (10-20 cm) of total jhum soil fauna.

During the second annual cycle, Dermaptera occurred at 0-10 cm and 30-40 cm soil layers of the jhum system. The densities in both the layers were $4x10^2/m^2$ each and vertically among themselves constituted 50.00% each. Of the Insecta, other arthropods and total jhum soil fauna, this group respectively formed 1.56%, 1.03% and 0.11% at 0-10 cm soil layer. However, at 30-40 cm depth, Dermaptera made up 3.45% of each of the Insecta, total arthropods other than Collembola and Acarina and total jhum soil fauna.

a.9. Hemiptera

The two annual variations of the hemipteran populations and their percentage compositions among different categories of the fauna are represented in Table LI. During the first annual cycle, the hemipterans were $32x10^2/m^2$ in the forest system. They formed 1.92% of Insecta, 1.11% of 'other arthropods' and 0.14% of total forest soil fauna. With an annual density of $28x10^2/m^2$ during the second annual cycle, the group constituted 1.56% of Insecta, 0.97% of 'other arthropods' and 0.12% of total forest soil fauna.

The vertical densities of Hemiptera in the forest system were $28x10^2/m^2$ (litter) and $4x10^2/m^2$ (0-10 cm) during the first annual cycle. Vertically among themselves, the percentage distributions of the group were 87.50% (litter) and 12.50% (0-10 cm). At the litter layer, the group formed 3.26% of Insecta,

Table LI. Showing the total number and percentages of Hemiptera in the forest system and in its different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total Insecta

d : Percentages in total "Other Arthropods"

e : Percentages in total soil fauna

Table LII. Showing the total number and percentages of Psocoptera in the forest system and in its different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total Insecta

d : Percentages in total "Other Arthropods"

e : Percentages in total soil fauna

TABLE LI

INSECTA (ORDER)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Hemiptera	FOREST	LITTER	28 (±4.02)	87.50	3.26	1.63	0.19	20 (±2.68)	71.43	2.72	1.37	0.13
		0 - 10cm	4 (±1.73)	12.50	1.01	0.57	0.06	8 (±1.78)	28.57	1.34	0.85	0.12
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	32 (±2.68)	-	1.92	1.11	0.14	28 (±2.92)	-	1.56	0.97	0.12
	JHUM	0 - 10cm	-	-	-	-	-	-	-	-	-	-
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	-	-	-	-	-	-	-	-	-	-

TABLE LII

INSECTA (ORDER)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Psocoptera	FOREST	LITTER	24 (±6.57)	66.67	2.79	1.39	0.17	16 (±5.05)	80.00	2.18	1.10	0.11
		0 - 10cm	12 (±0.94)	33.33	3.03	1.71	0.18	4 (±1.22)	20.00	0.67	0.43	0.06
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	36 (±6.65)	-	2.15	1.25	0.16	20 (±3.94)	-	1.11	0.69	0.08
	JHUM	0 - 10cm	-	-	-	-	-	-	-	-	-	-
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	-	-	-	-	-	-	-	-	-	-

1.63% of 'other arthropods' and 0.19% of total litter fauna. At 0-10 cm soil depth, the group constituted only 1.01% of Insecta, 0.57% of 'other arthropods' and 0.06% of total forest soil fauna of the layer.

The vertical densities of the second annual cycle were $20x10^2/m^2$ (litter) and $8x10^2/m^2$ (0-10 cm). Their percentage distributions, among themselves vertically, were 71.43% (litter) and 28.57% (0-10 cm). Of the total Insecta, other arthropods and total forest fauna, the percentages of Hemiptera were respectively, 2.72%, 1.37% and 0.13% at the litter layer; 1.34%, 0.85% and 0.12% at the 0-10 cm soil layer.

However, the hemipteran fauna were totally absent in the jhum soil during the period of the present investigation.

a.10. Psocoptera

Table LII represents the population density and percentage data of Psocoptera for the two annual cycles. In the forest soil, the annual density of Psocoptera for the first annual cycle was $36x10^2/m^2$. The group comprised 2.15% of Insecta, 1.25% of other arthropods and 0.16% of total soil fauna of the forest system. The second annual cycle density of the fauna was reduced to $20x10^2/m^2$ and made up 1.11% of Insecta, 0.69% of arthropods other than Collembola and Acarina, and 0.08% of total forest soil fauna.

In relation to its vertical distributions, the group were observed only at the litter and 0-10 cm layers of the forest during both the annual cycle of investigation. During the

first annual cycle, the vertical annual densities were seen to be $24x10^2/m^2$ at the litter regime and $12x10^2/m^2$ at the 0-10 cm soil depth. These densities in percentages but among themselves vertically were 66.67% (litter) and 33.33% (0-10 cm). The group also formed 2.79% (litter) and 3.03% (0-10 cm) of total insect fauna; 1.39% (litter) and 1.71% (0-10 cm) of 'other arthropods'; 0.17% (litter) and 0.18% (0-10 cm) of total forest soil fauna.

During the second annual cycle, the densities of Psocoptera at the litter and 0-10 cm soil layer were $16x10^2/m^2$ and $4x10^2/m^2$, respectively. Vertically among themselves, the group's percentage distributions varied from 80.00% at the litter regime to 20.00% at 0-10 cm soil layer. Psocoptera further constituted 2.18% (litter) and 0.67% (0-10 cm) of Insecta; 1.10% (litter) and 0.43% (0-10 cm) of 'other arthropods'; 0.11% (litter) and 0.06% (0-10 cm) of total forest soil fauna.

In the jhum soil, no psocopteran fauna were encountered either during the first and second annual cycles of the present investigation.

a.11. Insect larvae

Throughout the period of the present study, the larval and immature stages of various groups of insects constituted a sizable quantity of the soil fauna in both the forest and jhym systems. Their annual population density data for two annual cycles and percentages among different categories of the soil fauna are represented in Table LIII. During the first annual cycle, the total density of insect larvae in the forest soil was

$396x10^2/m^2$. The larvae formed 23.68% of Insecta, 13.77% of 'other arthropods' and 1.78% of total soil fauna of the forest system. Total number of larvae, however, showed a marginal decline ($300x10^2/m^2$) during the second annual cycle, and constituted 16.70% of Insecta, 10.37% of 'other arthropods' and 1.28% of total forest soil fauna.

The vertical densities of insect larvae in the forest during the first annual cycle were $172x10^2/m^2$ (litter), $104x10^2/m^2$ (0-10 cm), $104x10^2/m^2$ (10-20 cm) and $16x10^2/m^2$ (20-30 cm). The percentage distributions, among themselves vertically, were 43.44% (litter), 26.26% (0-10 cm), 26.26% (10-20 cm) and 4.04% (20-30 cm). Further, insect larvae formed 20.00% (litter), 26.26 % (0-10 cm), 32.10% (10-20 cm) and 33.33% (20-30 cm) of Insecta; 10.00% (litter), 14.86% (0-10 cm), 28.57% (10-20 cm) and 33.33% (20-30 cm) of 'other arthropods'; 1.19% (litter), 1.58% (0-10 cm), 8.67% (10-20 cm) and 21.05% (20-30 cm) of total forest soil fauna.

The vertical densities of the larvae during the second annual cycle of investigation were $72x10^2/m^2$ (litter), $156x10^2/m^2$ (0-10 cm), $52x10^2/m^2$ (10-20 cm) and $20x10^2/m^2$ (20-30 cm). Vertically among themselves, the larvae were 24.00% (litter), 52.00% (0-10 cm), 17.33% (10-20 cm) and 6.67% (20-30 cm). It was also observed that the larvae constituted 9.78% (litter), 26.17% (0-10 cm), 22.41% (10-20 cm) and 10.20% (20-30 cm) of Insecta; 4.93% (litter), 16.66% (0-10 cm), 20.31% (10-20 cm) and 9.80% (20-30 cm) of 'other arthropods'; 0.47% (litter), 2.27% (0-10 cm), 4.39% (10-20 cm) and 8.33% (20-30 cm) of total forest soil fauna.

In the jhum soil, the larvae of insects constituted 19.57%, 16.52% and 3.36%, respectively of Insecta, 'other arthropods' and total jhum soil fauna during the first annual cycle. The numerical values of these percentages were $148x10^2/m^2$. With an annual density of $136x10^2/m^2$ during the second annual cycle, the insect larvae made up 17.00% of Insecta, 13.99% of 'other arthropods' and 2.73% of total jhum soil fauna.

The vertical densities of the larvae during the first annual cycle were $68x10^2/m^2$ (0-10 cm), $64x10^2/m^2$ (10-20 cm) and $16x10^2/m^2$ (20-30 cm). These densities in percentages and among themselves vertically were 45.95% (0-10 cm), 43.24% (10-20 cm) and 10.81% (20-30 cm). The larvae also made up 17.52% (0-10 cm), 27.59% (10-20 cm) and 19.05% (20-30 cm) of Insecta; 14.41% (0-10 cm), 22.22% (10-20 cm) and 19.05% (20-30 cm) of 'other arthropods'; 1.91% (0-10 cm), 8.60% (10-20 cm) and 13.33% (20-30 cm) of total jhum soil fauna.

In the second annual cycle, the larvae recorded the annual densities of $48x10^2/m^2$ at 0-10 cm, $80x10^2/m^2$ at 10-20 cm and $8x10^2/m^2$ at 20-30 cm. These distributions in percentages and among themselves vertically were 35.30% (0-10 cm), 58.82% (10-20 cm) and 5.88% (20-30 cm). Of the total Insecta, the larvae formed 18.75% (0-10 cm), 22.99% (10-20 cm) and 10.00% (20-30 cm). Among the total 'other arthropods', the larvae constituted 12.38% (0-10 cm), 20.62% (10-20 cm) and 10.00% (20-30 cm). Of total fauna of the jhum soil, the larval percentages at 0-10 cm, 10-20 cm and 20-30 cm were respectively 1.31%, 7.27% and 7.14%.

Table LIII. Showing the total number and percentages of Insect larvae in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total Insecta

d : Percentages in total "Other Arthropods"

e : Percentages in total soil fauna

Table LIV. Showing the total number and percentages of Myriapoda in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total "Other Arthropods"

d : Percentages in total soil fauna

TABLE LIII

INSECTA (ORDER)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Insect larvae	FOREST	LITTER	172 (±24.13)	43.44	20.00	10.00	1.19	72 (±6.00)	24.00	9,78	4.93	0.47
		0 - 10cm	104 (±20.67)	26.26	26.26	14.86	1.58	156 (±39.34)	52.00	26.17	16.66	2.27
		10 - 20cm	104 (±12.09)	26.26	32.10	28.57	8.67	52 (±15.67)	17.33	22.41	20.31	4.39
		20 - 30cm	16 (±6.14)	4.04	33.33	33.33	21.05	20 (±5.60)	6.67	10.20	9.80	8.33
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	396 (±39.51)	-	23.68	13.77	1.78	300 (±33.84)	-	16.7	10.37	1.28
	JHUM	0 - 10cm	68 (±14.70)	45.95	17.52	14.41	1.91	48 (±11.84)	35.30	18.75	12.38	1.31
		10 - 20cm	64 (±10.54)	43.24	27.59	22.22	8.60	80 (±10.11)	58.82	22.99	20.62	7.27
		20 - 30cm	16 (±5.40)	10.81	19.05	19.05	13.33	8 (±1.08)	5.88	10.00	10.00	7.14
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	148 (±25.27)	-	19.57	16.52	3.36	136 (±21.87)	-	17.0	13.99	2.73

TABLE LIV

ARTHROPODA (CLASS)	SITES	LAYERS	FIRST ANNUAL CYCLE				SECOND ANNUAL CYCLE			
			a	b	c	d	a	b	c	d
Myriapoda	FOREST	LITTER	348 (±30.60)	65.91	20.23	2.41	252 (±24.54)	54.31	17.26	1.66
		0 - 10cm	152 (±9.16)	28.79	21.70	2.32	184 (±10.78)	39.66	19.66	2.67
		10 - 20cm	28 (±5.87)	5.30	7.69	2.33	20 (±6.18)	4.31	7.81	1.70
		20 - 30cm	-	-	-	-	8 (±0.41)	1.72	3.92	3.33
		30 - 40cm	-	-	-	-	-	-	-	-
		TOTAL	528 (±28.04)	100.0	18.36	2.37	464 (±35.24)	100.0	16.04	1.97
	JHUM	0 - 10cm	40 (±4.42)	50.00	8.48	1.15	64 (±15.67)	72.73	16.49	1.75
		10 - 20cm	40 (±9.62)	50.00	13.89	5.35	24 (±5.02)	27.27	6.19	2.16
		20 - 30cm	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-
		TOTAL	80 (±13.64)	100.0	8.93	1.82	88 (±20.24)	100.0	9.05	1.76

b. Class Myriapoda

Table LIV shows the two annual cycle densities of Myriapoda and their percentages among the different faunal categories of the forest and jhum systems. In the forest, the myriapods were $528x10^2/m^2$ during the first annual cycle. The group constituted 18.36% of arthropods other than Collembola and Acarina and 2.37% of total forest soil fauna. With an annual density of $464x10^2/m^2$ during the second annual cycle, the myriapods formed 16.04% and 1.97%, respectively of the arthropods other than Collembola and Acarina, and total forest soil fauna.

The vertical distributions of Myriapoda were $348x10^2/m^2$ (litter), $152x10^2/m^2$ (0-10 cm) and $28x10^2/m^2$ (10-20 cm). These densities in percentages were 65.91% at the litter regime, only 28.79% at 0-10 cm forest soil and 5.30% at the next layer of 10-20 cm during the first annual cycle. Further, Myriapoda formed 20.23% (litter), 21.70% (0-10 cm) and 7.69% (10-20 cm) of 'other arthropods'; 2.41% (litter), 2.32% (0-10 cm) and 2.33% (10-20 cm) of total forest soil fauna during the first annual cycle.

During the second annual cycle, the vertical densities of myriapods were $252x10^2/m^2$ (litter), $184x10^2/m^2$ (0-10 cm), $20x10^2/m^2$ (10-20 cm) and $8x10^2/m^2$ (20-30 cm). Vertically among themselves, Myriapoda formed 54.31% (litter), 39.66% (0-10 cm), 4.31% (10-20 cm) and 1.72% (20-30 cm). Of the total insect fauna, myriapods constituted 17.26% at the litter layer, 19.66% at 0-10 cm, 7.81% at 10-20 cm and 3.92% at 20-30 cm. Myriapoda also formed 1.66% (litter), 2.67% (0-10 cm), 1.70% (10-20 cm) and 3.33% (20-30 cm) of total forest soil fauna.

In the jhum soil, the myriapods were $80x10^2/m^2$ during the first annual cycle. This density made up 8.93% of 'Other arthropods' and 1.82% of total jhum soil fauna. The second annual cycle density reached to $88x10^2/m^2$, comprising 9.05% of 'other arthropods' and 1.76% of total fauna of the jhum system.

The vertical densities of Myriapoda in the jhum soil were $40x10^2/m^2$ each at 0-10 cm and 10-20 cm layer. Therefore, the percentage distributions were 50.00% each at 0-10 cm and 10-20 cm soil layers. Of the total 'other arthropods' and total jhum soil fauna, Myriapoda formed respectively 8.48% and 1.15% at 0-10 cm; 13.89% and 5.35% at 10-20 cm of the jhum soil.

During the second annual cycle, the vertical distributions of the group were $64x10^2/m^2$ (0-10 cm) and $24x10^2/m^2$ (10-20 cm). These densities in percentages, among themselves vertically were 72.73% at 0-10 cm and 27.27% at 10-20 cm. Further, Myriapoda formed 16.49% (0-10 cm) and 6.19% (10-20 cm) of 'other arthropods'; 1.75% (0-10 cm) and 2.16% (10-20 cm) of total jhum soil fauna.

The myriapods encountered in the present study fall under four orders, viz. Chilopoda, Diplopoda, Symphyla and Pauropoda.

b.1. Chilopoda

The two annual densities of centipedes (Chilopoda) and their percentages among the different categories of the soil organisms, during the first and second annual cycles, are shown in the Table LV. From the forest, the number of centipedes re-

covered for the first annual cycle was $64x10^2/m^2$. This density accounted for 12.12% of Myriapoda, 2.22% of arthropods other than Collembola and Acarina, and 0.29% of total forest soil fauna. The second annual cycle densities were $60x10^2/m^2$ and formed 12.93% of Myriapoda, 2.08% of 'other arthropods' and 0.25% of total forest soil fauna.

The vertical distributions of Chilopoda in the forest during the first annual cycle were $28x10^2/m^2$ (litter), $28x10^2/m^2$ (0-10 cm) and $8x10^2/m^2$ (10-20 cm). Among themselves vertically, these densities in percentages, were 43.75% (litter), 43.75% (0-10 cm) and 12.50% (10-20 cm). In different layers of the forest soil, the centipedes made up 8.05% (litter), 18.42% (0-10 cm) and 28.57% (10-20 cm) of Myriapoda; 1.63% (litter), 4.00% (0-10 cm) and 2.20% (10-20 cm) of 'other arthropods'; 0.19% (litter), 0.43% (0-10 cm) and 0.67% (10-20 cm) of total soil fauna of respective layers.

The vertical densities of the second annual cycle in the forest system were $32x10^2/m^2$ (litter), $24x10^2/m^2$ (0-10 cm) and $4x10^2/m^2$ (10-20 cm). The percentage distributions of the group, among themselves vertically, were 53.33% (litter), 40.00% (0-10 cm) and 6.67% (10-20 cm). Chilopoda also formed 12.10% (litter), 13.04% (0-10 cm) and 20.00% (10-20 cm) of Myriapoda; 2.19% (litter), 2.57% (0-10 cm) and 1.56% (10-20 cm) of 'other arthropods'; 0.21% (litter), 0.35% (0-10 cm) and 0.34% (10-20 cm) of total forest soil fauna.

From the jhum soil, the first annual cycle density of Chilopoda was only $20x10^2/m^2$, constituting 25.00% of Myria-

Table LV. Showing the total number and percentages of Chilopoda in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses
b : Percentages among themselves
c : Percentages in total Myriapoda
d : Percentages in total "Other Arthropods"
e : Percentages in total soil fauna

Table LVI. Showing the total number and percentages of Diplopoda in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses
b : Percentages among themselves
c : Percentages in total Myriapoda
d : Percentages in total "Other Arthropods"
e : Percentages in total soil fauna

TABLE LV

MYRIAPODA (ORDER)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Chilopoda	FOREST	LITTER	28 (±3.81)	43.75	8.05	1.63	0.19	32 (±6.10)	53.33	12.10	2.19	0.21
		0 - 10cm	28 (±6.23)	43.75	18.42	4.00	0.43	24 (±4.78)	40.00	13.04	2.57	0.35
		10 - 20cm	8 (±1.41)	12.50	28.57	2.20	0.67	4 (±0.41)	6.67	20.00	1.56	0.34
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	64 (±3.76)	-	12.12	2.22	0.29	60 (±11.02)	-	12.93	2.08	0.25
	JHUM	0 - 10cm	8 (±1.78)	40.00	20.0	1.70	0.22	16 (±5.07)	80.00	25.0	4.12	0.44
		10 - 20cm	12 (±2.04)	60.00	30.0	4.16	1.62	4 (±0.58)	20.00	16.67	1.03	0.36
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	20 (±2.45)	-	25.0	2.23	0.46	20 (±5.29)	-	22.73	2.06	0.4

TABLE LVI

MYRIAPODA (ORDER)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Diplopoda	FOREST	LITTER	20 (±6.18)	50.00	5.75	1.16	0.14	24 (±7.45)	60.00	9.52	1.64	0.16
		0 - 10cm	16 (±2.00)	40.00	10.53	2.29	0.24	12 (±2.16)	30.00	6.52	1.28	0.17
		10 - 20cm	4 (±2.27)	10.00	14.29	1.10	0.33	4 (±2.04)	10.00	20.0	1.56	0.34
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	40 (±5.37)	-	7.58	1.39	0.18	40 (±10.72)	-	8.62	1.38	0.17
	JHUM	0 - 10cm	12 (±1.68)	100.0	30.0	2.54	0.34	12 (±3.54)	100.0	18.75	3.09	0.33
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	12 (±1.68)	-	15.0	1.34	0.27	12 (±3.54)	-	13.64	1.23	0.24

poda, 2.23% of 'other arthropods' and 0.46% of total jhum soil fauna. The second annual cycle density was also $20x10^2/m^2$ but made up 22.73% of Myriapoda, 2.06% of 'other arthropods' and 0.40% of total jhum soil fauna.

The vertical densities of Chilopoda in the jhum soil were $8x10^2/m^2$ (0-10 cm) and $12x10^2/m^2$ (10-20 cm) during the first annual cycle. These densities in percentages and among themselves vertically were 40.00% and 60.00%, respectively at 0-10 cm and 10-20 cm. Further, in different layers of the jhum soil, Chilopoda constituted 20.00% (0-10 cm) and 30.00% (10-20 cm) of Myriapoda; 1.70% (0-10 cm) and 4.16% (10-20 cm) of 'other arthropods'; 0.22% (0-10 cm) and 1.62% (10-20 cm) of total jhum soil fauna of the respective layer.

During the second annual cycle, the vertical distributions of Chilopoda in relation to its annual densities, were $16x10^2/m^2$ (0-10 cm) and only $4x10^2/m^2$ (10-20 cm). Vertically among themselves, the percentage distributions were 80.00% (0-10 cm) and 20.00% (10-20 cm). The group also formed 25.00% (0-10 cm) and 16.67% (10-20 cm) of Myriapoda; 4.12% (0-10 cm) and 1.03% (10-20 cm) of arthropods other than Collembola and Acarina; 0.44% (0-10 cm) and 0.36% (10-20 cm) of total soil fauna of the jhum system.

b.2. Diplopoda

The two annual variations in the densities of Diplopoda and their percentage constituents among the different faunal categories are represented in the Table LVI. Thus, the density

of Diplopoda in the total forest system and during the first annual cycle was $40x10^2/m^2$. The group also formed 7.58% of Myriapoda, 1.39% of arthropods other than Collembola and Acarina and 0.18% of total forest soil fauna. The diplopod density for the second annual cycle was also as much as the first, but constituted 8.62% of Myriapoda, 1.38% of 'other arthropods' and only 0.17% of total fauna of the forest system.

The vertical densities of Diplopoda during the first annual cycle were $20x10^2/m^2$ (litter), $16x10^2/m^2$ (0-10 cm) and $4x10^2/m^2$ (10-20 cm). Vertically among themselves, the vertical distributions of the group in percentage were 50.00%, 40.00% and 10.00%, respectively in the litter, 0-10 cm and 10-20 cm. In different layers of the forest system, Diplopoda constituted 5.75% (litter), 10.53% (0-10 cm) and 14.29% (10-20 cm) of Myriapoda; 1.16% (litter), 2.29% (0-10 cm) and 1.10% (10-20 cm) of arthropods other than Collembola and Acarina; 0.14% (litter), 0.24% (0-10 cm) and 0.33% (10-20 cm) of total soil fauna of the forest system.

The vertical distributions of Diplopoda in terms of annual densities during the second annual cycle were $24x10^2/m^2$ (litter), $12x10^2/m^2$ (0-10 cm) and $4x10^2/m^2$ (10-20 cm). Vertically among themselves, the group were 60.00% (litter), 30.00% (0-10 cm) and 10.00% (10-20 cm). The group also formed 9.52% (litter), 6.52% (0-10 cm) and 20.00% (10-20 cm) of Myriapoda; 1.64% (litter), 1.28% (0-10 cm) and 1.56% (10-20 cm) of arthropods other than Collembola and Acarina; 0.16% (litter), 0.17% (0-10 cm) and 0.34% (10-20 cm) of total forest soil fauna.

The number of diplopods recovered from the jhum soil was poorer than the forest system. The first annual cycle density was $12x10^2/m^2$, comprising 15.00% of Myriapoda, 1.34% of arthropods other than Collembola and Acarina, and 0.27% of total jhum soil fauna. The second annual cycle density was also as much as the first, but during this period the group constituted 13.64% of Myriapoda, 1.23% of 'other arthropods' and 0.24% of total jhum soil fauna.

In the present study, the diplopods were recovered only from the 0-10 cm layer of the jhum soil. At this layer and during the first annual cycle, the group formed 30.00% of Myriapoda, 2.54% of 'other arthropods' and 0.34% of total jhum soil fauna of the layer. In the second annual cycle, the group were 18.75% of Myriapoda, 3.09% of 'other arthropods' and 0.33% of total jhum soil fauna.

b.3. Symphyla

The symphylids were, by far, the most abundant myriapods of the present study. Their two annual densities and percentages among the various faunal categories of the forest and jhum systems are illustrated in the Table LVII. The total density of Symphyla in the forest, upto the depth of 40 cm and inclusive of litter, was $364x10^2/m^2$ for the first annual cycle. The group comprised 68.94% of Myriapoda, 12.66% of 'other arthropods' and 1.63% of total forest soil fauna. With an annual density of $320x10^2/m^2$ during the second annual cycle, Symphyla constituted 68.97% of Myriapoda, 11.07% of 'other arthropods' and 1.36% of total forest soil fauna.

The vertical densities of Symphyla during the first annual cycle were $260x10^2/m^2$ (litter), $88x10^2/m^2$ (0-10 cm) and $16x10^2/m^2$ (10-20 cm). The percentage distributions, vertically and among themselves, were 71.43% (litter), 24.17% (0-10 cm) and 4.40% (10-20 cm). Of the total Myriapoda, total other arthropods and total forest soil fauna, the percentage compositions of Symphyla were respectively 74.71%, 15.12% and 1.80% at the litter layer; 57.89%, 12.57% and 1.34% at 0-10 cm; 57.14%, 4.39% and 1.33% at 10-20 cm layer of the forest soil.

The vertical densities of the symphylid fauna during the second annual cycle were $168x10^2/m^2$ (litter), $132x10^2/m^2$ (0-10 cm), $12x10^2/m^2$ (10-20 cm) and $8x10^2/m^2$ (20-30 cm). Vertically and among themselves, the percentage distributions of the fauna were 52.50% (litter), 41.25% (0-10 cm), 3.75% (10-20 cm) and 2.50% (20-30 cm). Of the total Myriapoda, the symphylids formed 66.67% (litter), 71.74% (0-10 cm), 60.00% (10-20 cm) and 100.0% (20-30 cm). Among the total other arthropods, the symphylids constituted 11.51% (litter), 14.10% (0-10 cm), 4.69% (10-20 cm) and 3.92% (20-30 cm). Of the total fauna of the forest soil, symphylids contributed 1.10% (litter), 1.92% (0-10 cm), 1.01% (10-20 cm) and 3.33% (20-30 cm).

As compared to the forest system, the symphylids were far too less in abundance in the jhum system. The first annual cycle density was only $48x10^2/m^2$, comprising 60.00% of Myriapoda, 5.36% of 'other arthropods' and 1.09% of total jhum soil fauna. With a density of $56x10^2/m^2$ during the second annual cycle, Symphyla formed 63.63% of Myriapoda, 5.76% of 'other arthropods' and 1.13% of total fauna of the jhum system.

Table LVII. Showing the total number and percentages of Symphyla in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses
b : Percentages among themselves
c : Percentages in total Myriapoda
d : Percentages in total "Other Arthropods"
e : Percentages in total soil fauna

Table LVIII. Showing the total number and percentages of Pauropoda in the forest system and in its different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses
b : Percentages among themselves
c : Percentages in total Myriapoda
d : Percentages in total "Other Arthropods"
e : Percentages in total soil fauna

TABLE LVII

MYRIAPODA (ORDER)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Symphyla	FOREST	LITTER	260 (±40.91)	71.43	74.71	15.12	1.80	168 (±24.53)	52.50	66.67	11.51	1.10
		0 - 10cm	88 (±9.16)	24.17	57.89	12.57	1.34	132 (±7.45)	41.25	71.74	14.10	1.92
		10 - 20cm	16 (±6.94)	4.40	57.14	4.39	1.33	12 (±4.42)	3.75	60.00	4.69	1.01
		20 - 30cm	-	-	-	-	-	8 (±0.41)	2.50	100.0	5.92	3.33
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	364 (±31.68)	-	68.94	12.66	1.63	320 (±28.03)	-	68.97	11.07	1.36
	JHUM	0 - 10cm	20 (±2.74)	41.67	50.0	4.24	0.56	36 (±11.21)	64.29	56.25	9.28	0.98
		10 - 20cm	28 (±7.82)	58.33	70.0	9.72	3.76	20 (±5.34)	35.71	83.33	5.16	1.82
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	48 (±10.14)	-	60.0	5.36	1.09	56 (±16.00)	-	63.63	5.76	1.13

TABLE LVIII

MYRIAPODA (ORDER)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Pauropoda	FOREST	LITTER	40 (±6.76)	66.67	11.49	2.32	0.28	28 (±4.45)	63.64	11.11	1.92	0.18
		0 - 10cm	20 (±3.34)	33.33	13.16	2.86	0.31	16 (±2.16)	36.36	8.7	1.71	0.23
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	60 (±7.38)	-	11.36	2.09	0.27	44 (±6.07)	-	9.48	1.52	0.19
	JHUM	0 - 10cm	-	-	-	-	-	-	-	-	-	-
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	-	-	-	-	-	-	-	-	-	-

The vertical densities of Symphyla in the jhum soils during the first annual cycle were $20x10^2/m^2$ (0-10 cm) and $28x10^2/m^2$ (10-20 cm). The percentage distributions of the symphylid fauna in percentages, among themselves vertically, were 41.67% (0-10 cm) and 58.33% (10-20 cm). Of the total Myriapoda, other arthropods and total jhum soil fauna, the percentage contributions of symphylids were respectively 50.00%, 4.24% and 0.56% at 0-10 cm layer; 70.00%, 9.72% and 3.76% at 10-20 cm layer of the jhum soil during the first annual cycle.

The second annual cycle vertical densities varied from $36x10^2/m^2$ at 0-10 cm to $20x10^2/m^2$ at 10-20 cm depth. These densities in percentages were 56.25% (0-10 cm) and 35.71% (10-20 cm). Of the Myriapoda, other arthropods and total jhum soil fauna, Symphyla formed 56.25%, 9.28% and 0.98% at 0-10 cm soil depth; 83.33%, 5.16% and 1.82% at 10-20 cm layer.

b.4. Pauropoda

As shown in the Table LVIII, the pauropods were encountered in the forest system but not in the jhum. The first annual cycle density of Pauropoda in the forest system amounted to $60x10^2/m^2$ and comprised 11.36% of Myriapoda, 2.09% of other arthropods and 0.27% of total forest soil fauna. With an annual density of $44x10^2/m^2$, Pauropoda constituted 9.48% of Myriapoda, 1.52% of other arthropods and 0.19% of total forest soil fauna.

The first annual cycle vertical densities of Pauropoda in the forest system were $40x10^2/m^2$ (litter) and $20x10^2/m^2$ (0-10 cm). These densities in percentages, vertically among

themselves, were 66.67% at the litter and 33.33% at 0-10 cm of the forest soil. Of the Myriapoda, 'other arthropods' and total forest soil fauna, the pauropods formed 11.49%, 2.32% and 0.28% in the litter layer; 13.16%, 2.86% and 0.31% at 0-10 cm layer, respectively.

In the second annual cycle, the vertical densities of Pauropoda in terms of annual totals were $28x10^2/m^2$ in the litter layer and only $16x10^2/m^2$ in the 0-10 cm layer of the forest soil. Vertically and among themselves, the percentage distributions of Pauropoda were 63.64% (litter) and 36.36% (0-10 cm). Further, in the litter layer, Pauropoda formed 11.11% of Myriapoda, 1.92% of 'other arthropods' and 0.18% of total fauna of the litter layer. At 0-10 cm soil depth, Pauropoda constituted 8.70% of Myriapoda, 1.71% of 'other arthropods' and 0.23% of total forest soil fauna of the layer.

As stated earlier, no pauropod fauna occurred in the jhum system during the period of present investigation.

c. Class Arachnida

The arachnids (Table LIX), other than Acarina, encountered during the period of present investigation belonged to the orders Araneida, Pseudoscorpionida and others. The arachnids in the forest system constituted 17.80% ($512x10^2/m^2$) and 16.88% ($488x10^2/m^2$) of arthropods other than Collembola and Acarina during the first and second annual cycles, respectively. However, of the total soil fauna of the forest system, the arachnids comrised only 2.29% and 2.08%, respectively for the first and second annual cycles.

The first annual cycle vertical densities of Arachnida in different layers of the forest system were $376x10^2/m^2$ (litter), $124x10^2/m^2$ (0-10 cm) and $12x10^2/m^2$ (10-20 cm). The percentage distributions of the group, among themselves vertically, were 73.44% (litter), 24.22% (0-10 cm) and 2.34% (10-20 cm). Of the total 'other arthropods' and total forest soil fauna, Arachnida contributed respectively 21.86% and 2.61% in the litter layer; 17.70% and 1.89% at 0-10 cm; 3.30% and 1.00% at 10-20 cm.

During the second annual cycle, the annual densities of the group were $364x10^2/m^2$ in the litter, $120x10^2/m^2$ at 0-10 and only $4x10^2/m^2$ in the next layer of 10-20 cm. Vertically and among themselves, the Arachnida were in the orders of 74.59% , 24.59% and 0.82%, respectively at litter, 0-10 cm and 10-20 cm layers of the forest soil. Further, the group made up 24.93% (litter), 12.82% (0-10 cm) and 1.56% (10-20 cm) of 'other arthropods'; 2.40% (litter), 1.75% (0-10 cm) and 0.34% (10-20 cm) of total forest soil fauna of respective layer.

In the jhum system, the first annual cycle density of the arachnids was $60x10^2/m^2$, forming 6.70% of 'other arthropods' and 1.36% of total fauna of the jhum system. The second annual cycle density reached to $84x10^2/m^2$ and made up 8.64% of 'other arthropods' and 1.68% of total jhum soil fauna.

During the first annual cycle, the arachnids were confined in the vertical layers of 0-10 cm ($44x10^2/m^2$) and 10-20 cm ($16x10^2/m^2$). Their percentage distributions, among themselves vertically, varied from 73.33% at 0-10 cm layer to 26.67% at 10-20 cm layer. Of the total 'other arthropods' and total jhum soil

Table LIX. Showing the total number and percentages of Arachnida in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total "Other Arthropods"

d : Percentages in total soil fauna

Table LX. Showing the total number and percentages of Araneida (including arachnids other than Pseudoscorpionida) in the forest and jhum systems and in their different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses

b : Percentages among themselves

c : Percentages in total Arachnida

d : Percentages in total "Other Arthropods"

e : Percentages in total soil fauna

TABLE LIX

ARTHROPODA (CLASS)	SITES	LAYERS	FIRST ANNUAL CYCLE				SECOND ANNUAL CYCLE			
			a	b	c	d	a	b	c	d
Arachnida	FOREST	LITTER	376 (±74.69)	73.44	21.86	2.61	364 (±93.11)	74.59	24,93	2.40
		0 - 10cm	124 (±21.27)	24.22	17.70	1.89	120 (±11.70)	24.59	12.82	1.75
		10 - 20cm	12 (±2.35)	2.34	3.30	1.00	4 (±1.47)	0.82	1.56	0.34
		20 - 30cm	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-
		TOTAL	512 (±64.30)	100.0	17.80	2.29	488 (±95.18)	100.0	16.88	2.08
	JHUM	0 - 10cm	44 (±8.55)	73.33	9.32	1.27	68 (±13.08)	80.95	17.53	1.86
		10 - 20cm	16 (±3.49)	26.67	5.56	2.14	16 (±2.27)	19.05	4.12	1.44
		20 - 30cm	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-
		TOTAL	60 (±11.40)	100.0	6.70	1.36	84 (±14.12)	100.0	8.64	1.68

TABLE LX

ARACHNIDA (ORDER)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Araneida	FOREST	LITTER	368 (±75.12)	74.19	97.87	21.40	2.55	360 (±93.89)	74.38	98.90	24.66	2.37
		0 - 10cm	116 (±20.99)	23.39	93.55	16.57	1.77	120 (±11.70)	24.79	100.0	12.82	1.75
		10 - 20cm	12 (±2.35)	2.42	100.0	3.3	1.0	4 (±1.47)	0.38	100.0	1.56	0.34
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	496 (±65.59)	-	96.87	17.25	2.22	484 (±95.81)	-	99.18	16.73	2.06
	JHUM	0 - 10cm	44 (±8.55)	73.33	100.0	9.32	1.24	68 (±13.08)	80.95	100.0	17.53	1.86
		10 - 20cm	16 (±3.49)	26.67	100.0	5.56	2.15	16 (±2.27)	19.05	100.0	4.12	1.45
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	60 (±11.41)	-	100.0	6.70	1.36	84 (±14.12)	-	100.0	8.64	1.68

fauna, the arachnids were respectively 9.32% and 1.27% at 0-10 cm layer; 5.56% and 2.14% at 10-20 cm layer of the jhum soil.

The second annual cycle vertical densities ranged from $68x10^2/m^2$ at 0-10 cm to $16x10^2/m^2$ at 10-20 cm. Among themselves vertically, the arachnids were 80.95% (0-10 cm) and 19.05% (10-20 cm). Further, the group formed 17.53% (0-10 cm) and 4.12% (10-20 cm) of 'other arthropods'; 1.86% (0-10 cm) and 1.44% (10-20 cm) of total jhum soil fauna.

c.1. Araneida and other arachnids

Table LX shows the two annual cycle densities of Araneida and other arachnids (other than Pseudoscorpionida and Acarina) and their percentages among the different categories of the forest and jhum soil fauna. In the forest system, the density of these arachnids during the first annual cycle of present investigation was $498x10^2/m^2$. This category of fauna formed 96.87% of Class Arachnida, 17.25% of 'other arthropods' and 2.22% of total forest soil fauna. With an annual density of as much as $484x10^2/m^2$ during the second annual cycle, these arachnids constituted as high as 99.18% of Arachnida, 16.73% of arthropods other than Collembola and Acarina and 2.06% of total forest soil fauna.

The vertical densities of these arachnids in the forest during the first annual cycle were $368x10^2/m^2$ (litter), $116x10^2/m^2$ (0-10 cm) and $12x10^2/m^2$ (10-20 cm). Among themselves vertically, these arachnids had the percentage distributions of 74.19% (litter), 23.39% (0-10 cm) and 2.42% (10-20 cm). Of

the total Arachnida, 'other arthropods' and total forest soil fauna, these arachnids formed respectively 97.87%, 21.40% and 2.55% in the litter layer; 93.55%, 16.57% and 1.77% at 0-10 cm layer; 100.0%, 3.30% and 1.00% at 10-20 cm layer.

In the second annual cycle, the vertical distributions of the fauna in terms of annual densities, were $360x10^2/m^2$ (litter), $120x10^2/m^2$ (0-10 cm) and $4x10^2/m^2$ (10-20 cm). Among themselves vertically, the faunal percentage distributions were 74.38% (litter), 24.79% (0-10 cm) and 0.38% (10-20 cm). Further these arachnids constituted 98.90% (litter), 100.0% (0-10 cm) and 100.0% (10-20 cm) of Arachnida; 24.66% (litter), 12.82% (0-10 cm) and 1.56% (10-20 cm) of 'other arthropods'; 2.37% (litter), 1.75% (0-10 cm) and 0.34% (10-20 cm) of total soil fauna of the forest.

During the first annual cycle, the total density of Araneida and other arachnids (other than Pseudoscorpionida and Acarina) extracted from the jhum soil were $60x10^2/m^2$, forming 100.0% of Arachnida, 6.70% of 'other arthropods' and 1.36% of total soil fauna of the jhum system. The density of the second annual cycle was $84x10^2/m^2$. During this period too, these fauna were the only Arachnida in the jhum system, but among the 'other arthropods' and total jhum soil fauna, these arachnids formed 8.64% and 1.68%, respectively.

The vertical densities of these arachnids in different layers of the jhum soil during the first annual cycle were $44x10^2/m^2$ and $16x10^2/m^2$ respectively at 0-10 cm and 10-20 cm layers. Vertically among themselves, their percentage distributi-

ons were 73.33% (0-10 cm) and 26.67% (10-20 cm). Of the total 'other arthropods' and total jhum soil fauna of different layers, these arachnids constituted respectively 9.32% and 1.24% at 0-10 cm; 5.56% and 2.15% at 10-20 cm.

In the second annual cycle, the densities of the fauna were $68x10^2/m^2$ at 0-10 cm and $16x10^2/m^2$ at 10-20 cm. The faunal vertical distributions among themselves were 80.95% (0-10 cm) and 19.05% (10-20 cm). The percentage estimates amongst the 'other arthropods' and total jhum soil fauna were respectively 17.53% and 1.86% at 0-10 cm; 4.12% and 1.45% at 10-20 cm soil layer.

c.2. Pseudoscorpionida

The order Pseudoscorpionida (Table LXI) were one of the smallest groups of soil-dwelling organisms. Their density, in the litter and soil regimes of the forest was only $16x10^2/m^2$ during the first annual cycle. They formed 3.13% of Arachnida, 0.56% of 'other arthropods' and 0.07% of total forest soil fauna. The second annual cycle density was only $4x10^2/m^2$, forming 0.82% of Arachnida, 0.14% of 'other arthropods' and 0.02% of total forest soil fauna.

The vertical densities of Pseudoscorpionida in the forest soil during the first annual cycle were $8x10^2/m^2$ each at litter and 0-10 cm soil layer. Thus, the fauna were 50.00% each in the litter and 0-10 cm layer, when calculated among themselves vertically. Of the total Arachnida, 'other arthropods' and total forest soil fauna, Pseudoscorpionida formed respectively

Table LXI. Showing the total number and percentage of Pseudoscorpionida in the forest system and in its different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses
b : Percentages among themselves
c : Percentages in total Arachnida
d : Percentages in total "Other Arthropods"
e : Percentages in total soil fauna

Table LXII. Showing the total number and percentages of Isopoda (Crustacea) in the forest system and in its different layers during the two annual cycles of study.

a : Numbers, standard error in parentheses
b : Percentages among themselves
c : Percentages in total Crustacea
d : Percentages in total "Other Arthropods"
e : Percentages in total soil fauna

TABLE LXI

ARACHNIDA (ORDER)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Pseudo-scorpionida	FOREST	LITTER	8 (±0.91)	50.00	2.13	0.46	0.06	4 (±1.58)	100.0	1.1	0.27	0.02
		0 - 10cm	8 (±0.71)	50.00	6.45	1.14	0.12	-	-	-	-	-
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	16 (±1.47)	-	3.13	0.56	0.07	4 (±1.58)	-	0.82	0.14	0.02
	JHUM	0 - 10cm	-	-	-	-	-	-	-	-	-	-
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	-	-	-	-	-	-	-	-	-	-

TABLE LXII

CRUSTACEA (ORDER)	SITES	LAYERS	FIRST ANNUAL CYCLE					SECOND ANNUAL CYCLE				
			a	b	c	d	e	a	b	c	d	e
Isopoda	FOREST	LITTER	136 (±20.80)	82.93	100.0	7.91	0.94	108 (±13.83)	75.00	100.0	7.40	0-71
		0 - 10cm	28 (±4.14)	17.07	100.0	4.0	0.43	36 (±9.05)	25.00	100.0	3.85	0.52
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	164 (±24.58)	-	100.0	5.7	0.74	144 (±15.74)	-	100.0	4.98	0.61
	JHUM	0 - 10cm	-	-	-	-	-	-	-	-	-	-
		10 - 20cm	-	-	-	-	-	-	-	-	-	-
		20 - 30cm	-	-	-	-	-	-	-	-	-	-
		30 - 40cm	-	-	-	-	-	-	-	-	-	-
		TOTAL	-	-	-	-	-	-	-	-	-	-

2.13%, 0.46% and 0.06% in the litter layer; 6.45%, 1.14% and 0.12% at 0-10 cm depth of the forest soil.

In the second annual cycle, the group occurred only in the litter layer and had an annual density of $4x10^2/m^2$. During this period Pseudoscorpionida formed 1.10% of Arachnida, 0.27% of 'other arthropods' and 0.02% of total forest soil fauna of the layer.

A conspicuous feature was the total absence of Pseudoscorpionida in the jhum system throughout the period of present investigation.

d. Class Crustacea

This group of soil arthropod was represented by a single order, viz. Isopoda during the period of present investigation.

d.1. Isopoda

Table LXII illustrates the annual densities of Isopoda and their percentages among the different faunal categories of the forest and jhum systems. In the forest system, the annual densities of Isopoda during the first annual cycle totalled $164x10^2/m^2$, forming 5.70% of 'other arthropods' and 0.74% of total forest soil fauna. The second annual cycle density was $144x10^2/m^2$ and formed 4.98% of 'other arthropods' and 0.61% of total forest soil fauna.

The vertical densities of isopods during the first annual cycle were $136x10^2/m^2$ (litter) and $28x10^2/m^2$ (0-10 cm).

Among themselves vertically, the isopods formed 82.93% in the litter and 17.07% at 0-10 cm soil layer. Of the total 'other arthropods' and total forest soil fauna, Isopoda constituted respectively 7.91% and 0.94% at the litter layer; 4.00% and 0.43% at 0-10 cm soil layer.

The second annual cycle vertical densities of Isopoda in different layers of the forest system were $108x10^2/m^2$ (litter) and $36x10^2/m^2$ (0-10 cm). Vertically and among themselves, the faunal percentage distributions were 75.00% and 25.00%, respectively at the litter layer and 0-10 cm soil layer. Further, the group formed 7.40% (litter) and 3.85% (0-10 cm) of 'other arthropods'; 0.71% (litter) and 0.52% (0-10 cm) of total forest soil fauna.

However, surprisingly enough, not a single isopod could be isolated from the jhum system, during the present period of investigation.

4.2.2. Seasonal variations

4.2.2.1. Total soil fauna

Fig. 12 illustrates the total soil fauna of the forest and jhum systems and Fig. 13, that of the profile distributions for the two years of study period. During the first annual cycle the forest soil comprising litter and upto 40 cm soil depth showed $2417x10^2/m^2$ individuals in July 1980. This was maximum while minimum which occurred in December 1980 amounted to $1070x10^2/m^2$. In terms of the seasonal densities in different profiles of the forest system, the litter layer had $1562x10^2/m^2$ (October 1980) as maximum and $647x10^2/m^2$ (December 1980) as minimum. The forest soil layer at 0-10 cm revealed $798x10^2/m^2$ (July 1980) as maximum and $327x10^2/m^2$ (January 1981) as minimum densities. At 10-20 cm soil depth, maximum number was seen in July 1980 ($324x10^2/m^2$) and minimum in February 1981 ($120x10^2/m^2$). At 20-30 cm and 30-40 cm soil depths, the individuals tended to decline rapidly in that the maximum values ranged from $28x10^2/m^2$ (August 1980) to a complete absence in several months of the study period and $24x10^2/m^2$ (September 1980) to nil occurrence for a number of months, respectively.

In the second annual cycle, the total fauna of the forest system amounted to $2527x10^2/m^2$ (August 1981) as maximum and $1002x10^2/m^2$ (December 1981) as minimum. In the litter layer the maximum individuals were found in July 1981 ($1610x10^2/m^2$) and minimum in December 1981 ($599x10^2/m^2$). At 0-10 cm layer, the maximum number ($722x10^2/m^2$) occurred in August 1981 and the minimum ($321x10^2/m^2$) in November 1981. The next layer (10-20 cm) of

Fig. 12. Showing the seasonal fluctuations of the total soil fauna (litter, 0-40 cm in the forest; 0-40 cm in the jhum) for two annual cycles.

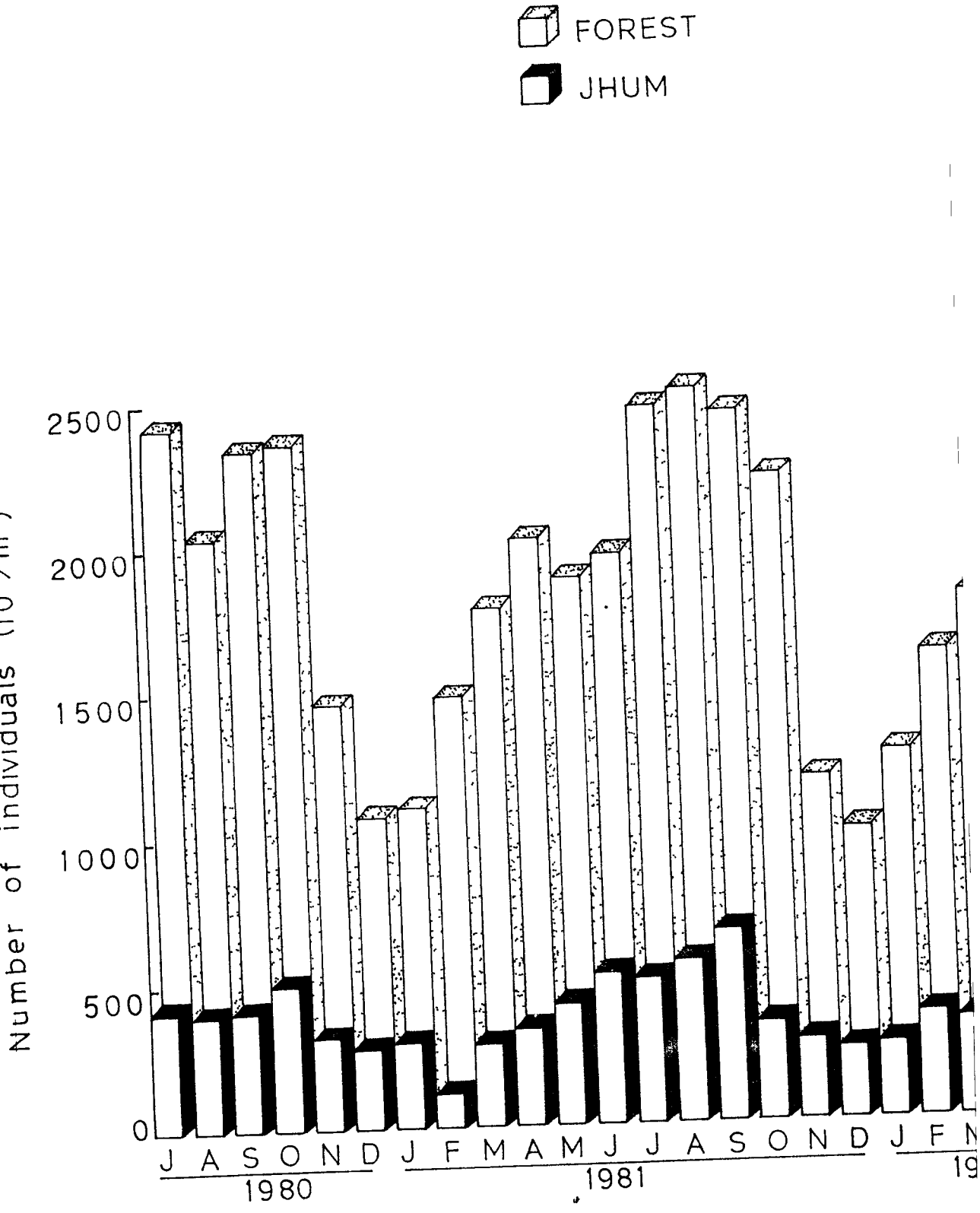

FOREST
JHUM
Number of individuals ($10^2/m^2$)
2500
2000
1500
1000
500
0
J A S O N D J F M A M J J A S O N D J F N
1980
1981
19

Fig 12

Fig. 13. Showing the seasonal fluctuations of the total soil fauna in the different layers of the forest and jhum systems for two annual cycles.

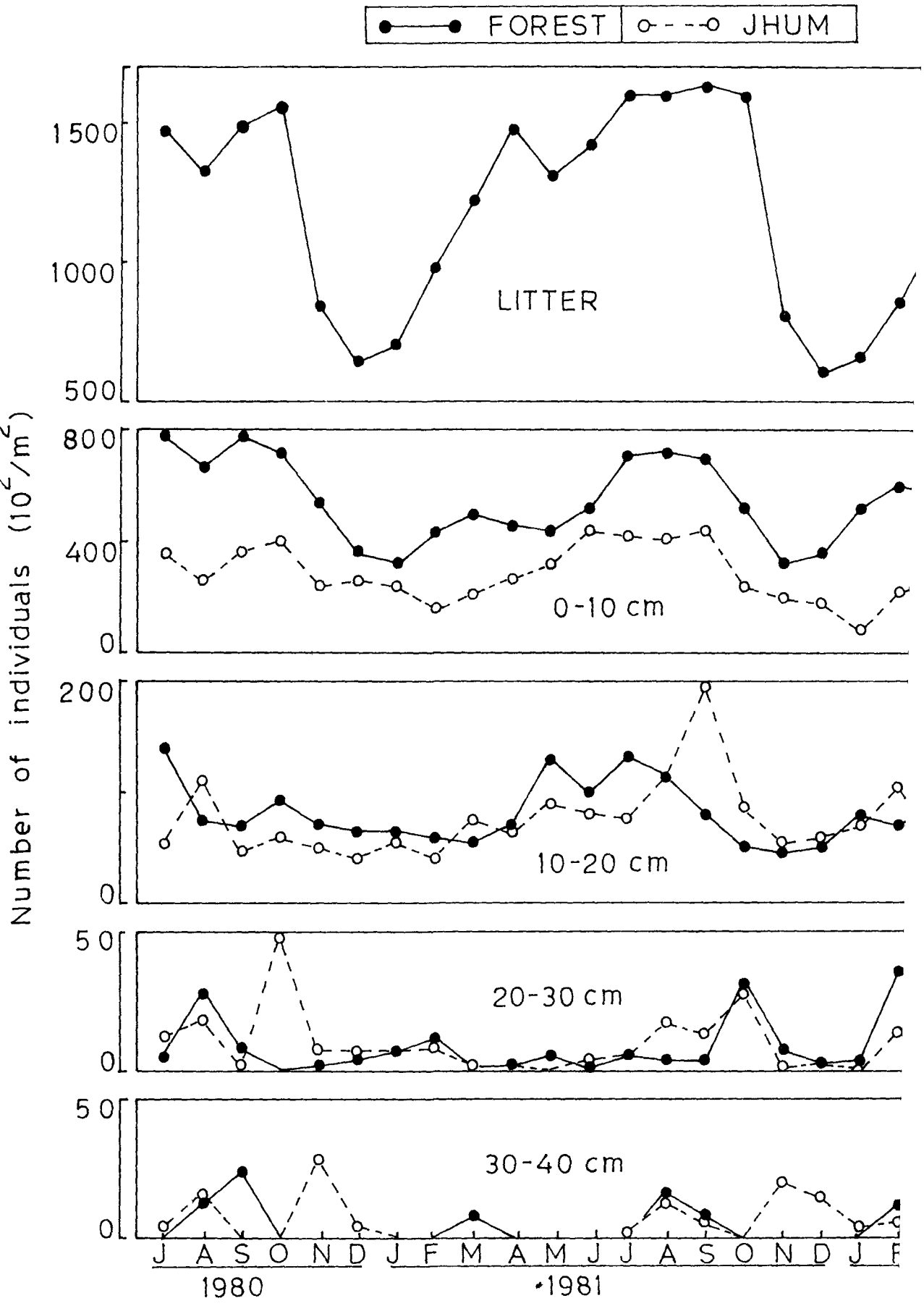

FOREST
JHUM
Number of individuals ($10^2/m^2$)
1500
1000
500
LITTER
800
400
0
0-10 cm
200
0
10-20 cm
50
0
20-30 cm
50
0
30-40 cm
J A S O N D J F M A M J J A S O N D J F
1980
1981

Fig 13

the forest soil showed $484x10^2/m^2$ (July 1981) individuals as maximum and $100x10^2/m^2$ (February 1982) as minimum. At 20-30 cm soil depth, the values ranged from $88x10^2/m^2$ (August 1981) being maximum to complete absence in several months. At 30-40 cm soil layer a similar pattern followed with $16x10^2/m^2$ individuals as maximum (August 1981) and no individuals in several months of the study period as shown in the figure (Fig. 13).

During the first annual cycle, the jhum system (0-40 cm) had the seasonal total faunal densities of $121x10^2/m^2$ (February 1981) as minimum and $524x10^2/m^2$ (June 1982) as maximum. At 0-10 cm soil layer, the monthly total faunal densities ranged from $161x10^2/m^2$ in February 1981 to $442x10^2/m^2$ in June 1981. The next jhum soil layer (10-20 cm) recorded maximum densities in August 1980 ($103x10^2/m^2$) and minimum in December 1980 ($40x10^2$ per m^2). The third layer (20-30 cm) had a maximum density of $48x10^2/m^2$ in October 1980 and nil in May 1981. At 30-40 cm soil depth, the densities ranged from nil occurrence in several months (as shown in Fig. 13) to a maximum of only $28x10^2/m^2$ in November 1980.

The monthly population densities of the second annual cycle for the total jhum system (0-40 cm) ranged from a minimum of $252x10^2/m^2$ (December 1981) to a maximum of $652x10^2/m^2$ (September 1981). The maximum-minimum densities of the soil fauna in different depths were $432x10^2/m^2$ (September 1981) and $76x10^2/m^2$ (January 1982) at 0-10 cm; $199x10^2/m^2$ (September 1981) and $46x10^2/m^2$ (March 1982) at 10-20 cm; $27x10^2/m^2$ (October 1981) and $1x10^2/m^2$ (November-December 1981) at 20-30; $48x10^2/m^2$ (April) and total absence in October and March, respectively.

4.2.2.2. Collembola

Fig. 14 illustrates the seasonal population dynamics of Collembola in the different layers and total systems of the forest and jhum soils during the two years of investigation. Thus, in the total system of the forest, Collembola were maximum during July for both the annual cycles, being $1296x10^2/m^2$ in the first annual cycle and $1443x10^2/m^2$ in the second annual cycle. Minimum densities were in January 1981 ($529x10^2/m^2$) of the first annual cycle and in December 1981 ($491x10^2/m^2$) of the second annual cycle.

In the total system of the jhum soils, the minimum-maximum densities of Collembola ranged from $59x10^2/m^2$ in January 1981 to $160x10^2/m^2$ in June 1981. The second annual cycle showed a maximum density of $204x10^2/m^2$ in July 1981 and a minimum of $61x10^2/m^2$ in February 1982.

During the first annual cycle, the different layers of the forest soils had the maximum-minimum densities of Collembola as $906x10^2/m^2$ (July 1980) and $397x10^2/m^2$ (December 1980) in the litter layer and $336x10^2/m^2$ (July 1980) and $72x10^2/m^2$ (February 1981) at 0-10 cm layer of the forest soil, respectively. In the next layer (10-20 cm), the seasonal densities ranged from $12x10^2/m^2$ (November 1980 & February 1981) to $64x10^2/m^2$(May 1981). In the 20-30 cm layer, Collembola showed a peak density of only $5x10^2/m^2$ in May 1981 but were totally absent in several months of the study period (Fig. 14).

During the second annual cycle, the litter layer had a maximum density of $997x10^2/m^2$ in July 1981 and a minimum of

Fig. 14. Showing the seasonal fluctuations of Collembola in the total systems of the forest and jhum and in their different layers for two annual cycles (Vertical lines show the standard error).

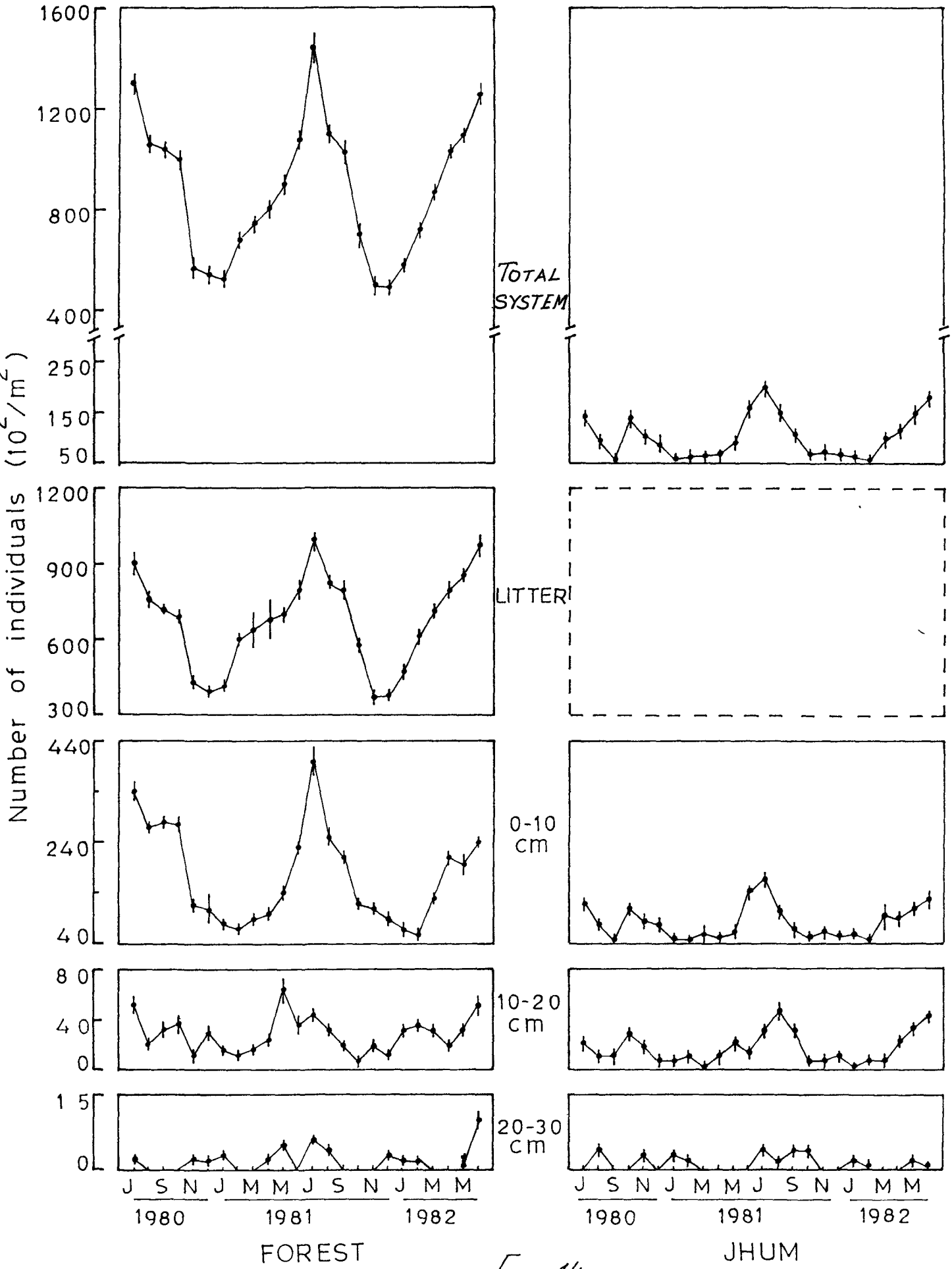

1600
1200
800
400
250
150
50
TOTAL SYSTEM
Number of individuals ($10^2/m^2$)
1200
900
600
300
LITTER
440
240
40
0-10 cm
80
40
0
10-20 cm
15
0
20-30 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
J S N J M M J S N J M M
1980
1981
1982
JHUM

Fig. 14

$373x10^2/m^2$ in November 1980. The maximum-minimum densities of Collembola at 0-10 cm soil depth were $396x10^2/m^2$ (July 1981) and $64x10^2/m^2$ (February 1982), respectively. At 10-20 cm soil layer, the soil faunal densities ranged from a minimum of $8x10^2/m^2$ (October 1981) to a maximum of $48x10^2/m^2$ (June 1982). In several months of the investigation period, Collembola were totally absent at 20-30 cm depth, although maximum density of the layer was observed in June 1982 ($10x10^2/m^2$).

In the jhum soils and during the first annual cycle, its 0-10 cm layer exhibited a density of $48x10^2/m^2$ in January-February 1981 as minimum to $144x10^2/m^2$ in June 1981 as maximum. The next soil depth (10-20 cm) showed a maximum density of $28x10^2/m^2$ in October 1980 and a minimum of $4x10^2/m^2$ in March 1981. At 20-30 cm soil depth, a peak was reached in August 1980 ($4x10^2/m^2$), but were totally absent in several months of the first annual cycle, as shown in the figure.

During the second annual cycle, the collembolan densities for the 0-10 cm layer were $168x10^2/m^2$ (July 1981) as maximum and $52x10^2/m^2$ (February 1982) as minimum. At 10-20 cm depth the collembolan densities were maximum in August 1981 ($48x10^2/m^2$) and minimum in January 1982 ($4x10^2/m^2$). The third layer (20-30 cm) recorded a maximum density of $4x10^2/m^2$ but were totally absent in several months of the second annual cycle of investigation.

In addition to the above, the monthly population dynamics of Collembola have been described family-wise, viz. Hypogastruridae, Poduridae, Isotomidae, Entomobryidae, Sminthuridae and Neelidae.

a. Family Hypogastruridae

The seasonal population dynamics of Hypogastruridae, which occurred only at the litter layer of the forest, are illustrated in the Fig. 15. The population densities of Hypogastruridae ranged from $2x10^2/m^2$ (November 1980) to $14x10^2/m^2$ (April 1981) and 2x10 /m (November 1980) to $10x10^2/m^2$ (February 1982) during the first and second annual cycles, respectively.

b. Family Poduridae

Fig. 16 illustrates the monthly population densities of Poduridae during the two annual cycles of investigation. The group occurred only at the litter layer of the forest and the densities ranged from nil occurrence in the winter months to maximum in the summer months. Thus, Poduridae were totally absent in the months of December-January-February and were maximum in June-July ($12x10^2/m^2$) during the first annual cycle. The second annual cycle had a maximum density of $16x10^2/m^2$ in July 1981 and nil in January 1982.

c. Family Isotomidae

The monthly population densities of Isotomidae in different layers of the forest and jhum soils during the two years of present investigation are illustrated in Fig. 17. In the forest during the first annual cycle, the densities of Isotomidae in the litter layer were maximum in July 1980 ($625x10^2/m^2$) and minimum in December 1980 ($315x10^2/m^2$). At 0-10 cm layer, the maximum-minimum densities were respectively $266x10^2/m^2$ in July

Fig. 15. Showing the seasonal fluctuations of the family Hypogastruridae (Collembola : Insecta) in the litter layer of the forest system for two annual cycles (Vertical lines show the standard error).

Fig. 16. Showing the seasonal fluctuations of the family Poduridae (Collembola : Insecta) in the litter layer of the forest system for two annual cycles (Vertical lines show the standard error).

Fig. 15

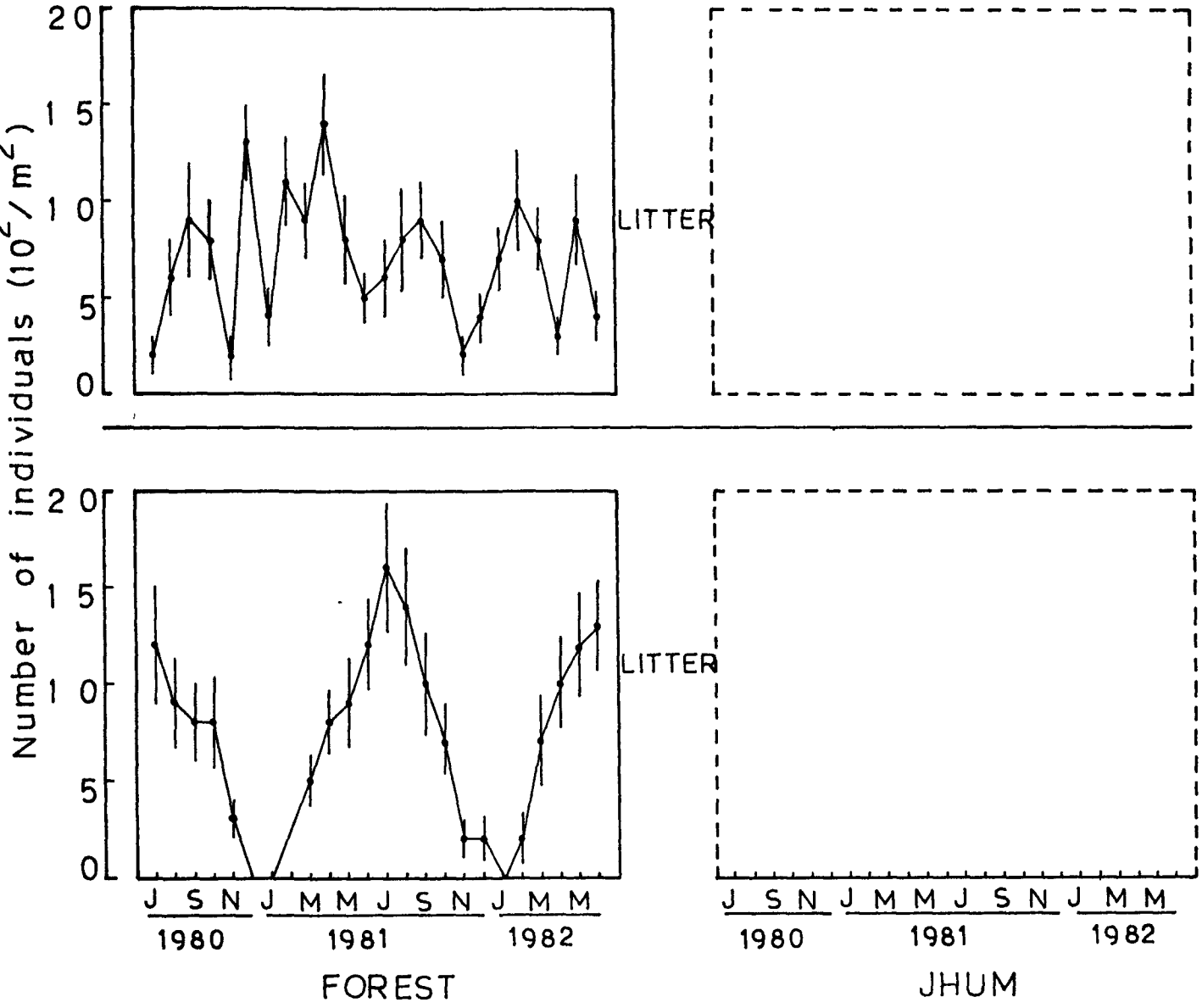

Number of individuals ($10^2/m^2$)
20
15
10
5
0
LITTER
LITTER
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 16

1980 and $64x10^2/m^2$ in February 1981. At 10-20 cm layer, the densities ranged from $10x10^2/m^2$ (February 1981) to $60x10^2/m^2$ (May 1981). In the next soil depth (20-30 cm), a peak was recorded in May 1981 with a density of $5x10^2/m^2$, but were totally absent in several months of the first annual cycle.

During the second annual cycle, the litter layer had a maximum density of $720x10^2/m^2$ in July 1981 and a minimum of $286x10^2/m^2$ in November 1981. The densities of Isotomidae at 0-10 cm soil depth were maximum in July 1981 ($319x10^2/m^2$) and minimum in February 1982 ($56x10^2/m^2$). In the next layer (10-20 cm) the densities ranged from a minimum of $7x10^2/m^2$ in October 1981 to a maximum of $41x10^2/m^2$ in June 1982. At 20-30 cm soil layer, the isotomids were absent in several months of the second annual cycle, as seen in the figure, although a maximum density of $10x10^2/m^2$ occurred in June 1982.

In the jhum soil, the monthly population densities of Isotomidae for the first annual cycle ranged from $39x10^2/m^2$(September 1980) to $127x10^2/m^2$ (June 1981) at 0-10 cm; $4x10^2/m^2$(March 1981) to $28x10^2/m^2$ (October 1980) at 10-20 cm as minima and maxima, respectively. In the next layer (20-30 cm), maximum density of Isotomidae was recorded in August 1980 ($4x10^2/m^2$), although these collembolans were totally absent in most of the months of the first annual cycle, as illustrated in the figure.

During the second annual cycle, the 0-10 cm layer of the jhum soil had a maximum density of $142x10^2/m^2$ in July 1981 and a minimum of $42x10^2/m^2$ in October 1981. At 10-20 cm layer, maximum density was recorded in August 1981 ($48x10^2/m^2$) and mi-

Fig. 17. Showing the seasonal fluctuations of the family Isotomidae (Collembola : Insecta) in the different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

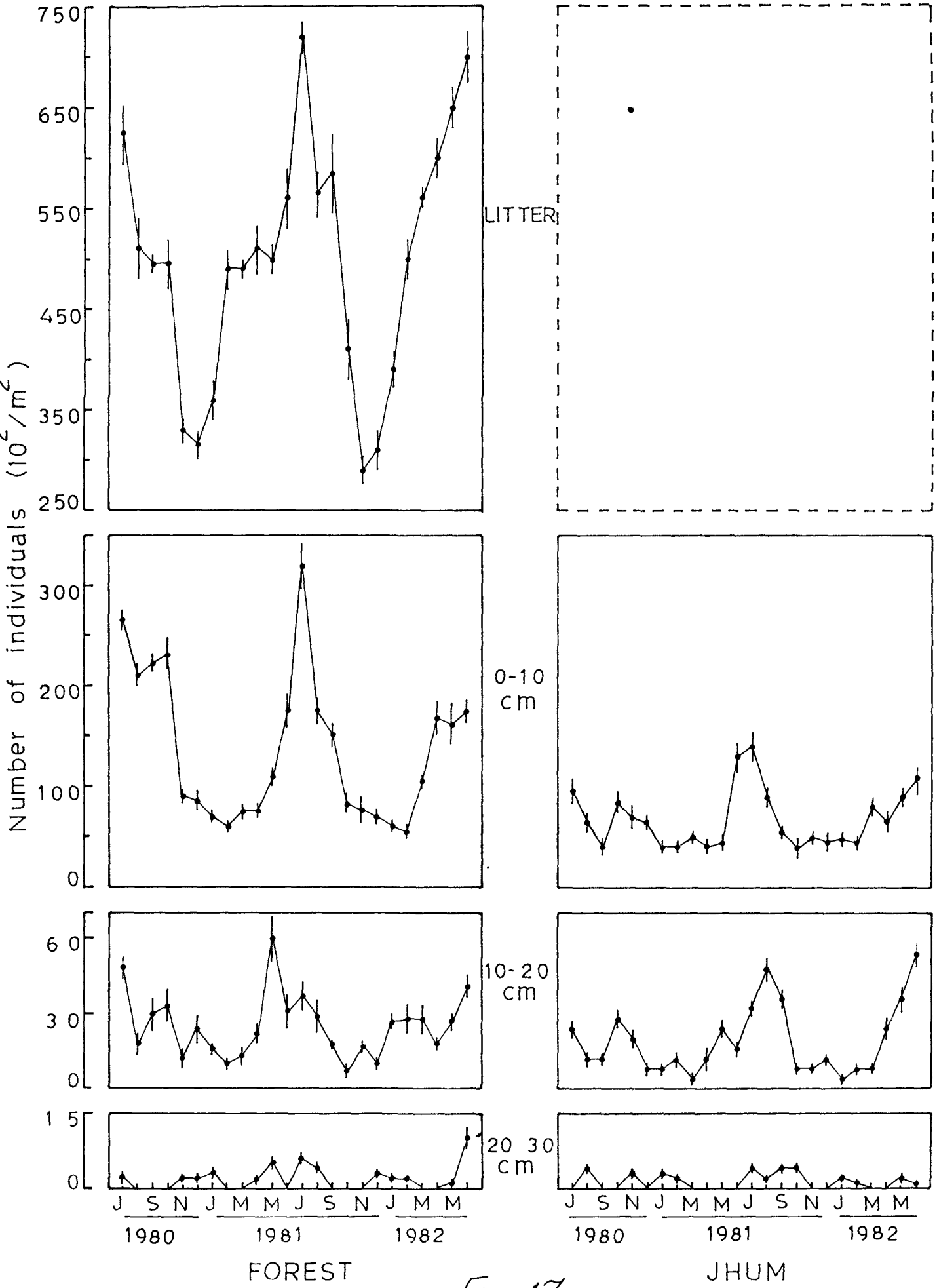

750
650
550
450
350
250
LITTER
Number of individuals ($10^2/m^2$)
300
200
100
0
0-10 cm
6 0
3 0
0
10-20 cm
1 5
0
20 30 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 17

nimum in January 1982 ($4x10^2/m^2$). In the next layer (20-30 cm), the isotomids were absent during the months of November-December & March-April, although maximum densities ($4x10^2/m^2$) were observed in the months of July, September & October of the second annual cycle.

Further, the population dynamics of the following species of Isotomidae are described from the forest and jhum systems.

c.1. Isotoma (Desoria) trispinata MacGillivray

Fig. 18 illustrates the population dynamics of Isotoma (Desoria) trispinata in the forest and jhum study sites for two annual cycles. In the first annual cycle, at the litter layer of the forest, the maximum population density was seen in July 1980 ($507x10^2/m^2$) and minimum in December 1980 ($271x10^2/m^2$). The population trend at the different soil layers of the forest tended to show variations. At 0-10 cm soil depth, the maximum population density was $220x10^2/m^2$ (July 1980) and the minimum $57x10^2/m^2$ (February 1981). The next soil layer (10-20 cm) revealed a maximum of the population ($48x10^2/m^2$) in May 1981 and a minimum ($8x10^2/m^2$) in March 1981. In the 20-30 cm soil layer the population did not show seasonal dynamism in that the species were totally absent in several months of the investigation period, while maximum occurred in May 1981 ($5x10^2/m^2$).

In the second annual cycle, the litter layer showed a maximum population in July 1981 being $612x10^2/m^2$ and minimum in November 1981, recording $246x10^2/m^2$. The maximum and minimum po-

Fig. 18. Showing the seasonal fluctuations of Isotoma (Desoria) trispinata MacGillivray (Collembola: Isotomidae) in the different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

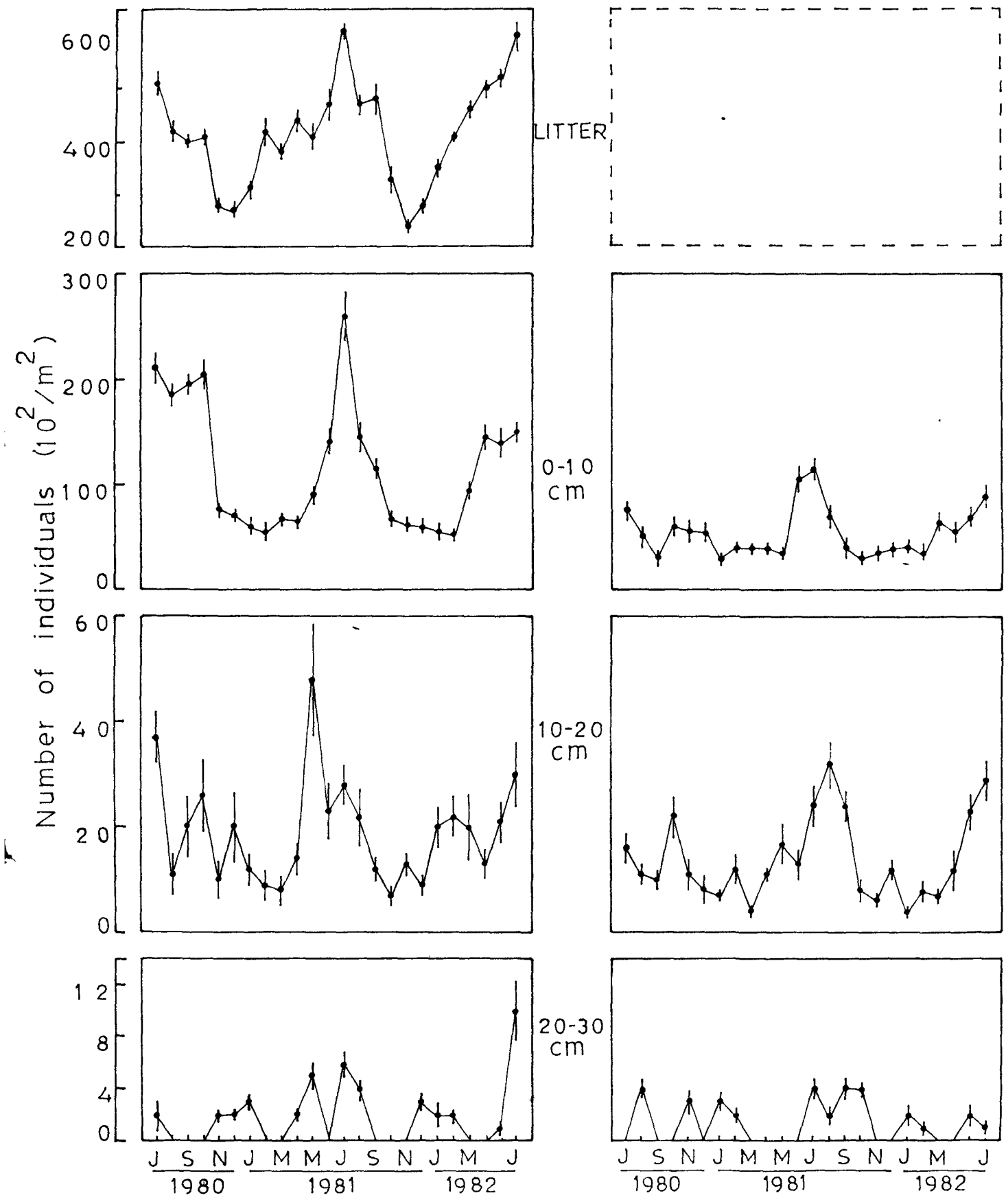

600
400
200
LITTER
300
200
100
0
0-10 cm
60
40
20
0
10-20 cm
12
8
4
0
20-30 cm
Number of individuals (10²/m²)
J S N J M M J S N J M J
1980
1981
1982
FOREST
JHUM

Fig. 18

pulation densities at 0-10 cm soil layer were $262x10^2/m^2$ in July 1981 and $52x10^2/m^2$ in February 1982, respectively. In the next soil depth (10-20 cm), the maximum number of individuals observed were $30x10^2/m^2$ (June 1982) and the minimum $7x10^2/m^2$ (October 1981). The maximum population of $10x10^2/m^2$ in June was clearly observed but the populations' total absence occurred in several months of the second annual cycle at 20-30 cm soil profile, as indicated in the figure.

In the jhum system, the 0-10 cm soil layer had a maximum of $105x10^2/m^2$ individuals of Isotoma (Desoria) trispinata in June 1981 and a minimum of $32x10^2/m^2$ in September 1980 during the first annual cycle. The maximum and minimum number of individuals at the soil profile of 10-20 cm were respectively $22x10^2/m^2$ (October 1980) and $4x10^2/m^2$ (March 1981), while at 20-30 cm layer the maximum occurred in August 1980 ($4x10^2/m^2$) but recorded a total absence in the months of September, October and December 1980 and from March to June 1981.

During the second annual cycle of investigation, the population dynamics of Isotoma (Desoria) trispinata in terms of maximum densities were $115x10^2/m^2$ in July 1981 (0-10 cm), $32x10^2/m^2$ in August 1981 (10-20 cm) and $4x10^2/m^2$ in several months (20-30 cm). The minimum densities for the different profiles were $34x10^2/m^2$ (October 1981) at 0-10 cm layer, $4x10^2/m^2$ (January 1982) at 10-20 cm layer and total absence in the months of November-December 1981 & March-April 1982 at 20-30 cm profile of the jhum soil.

c.2. Cryptopygus thermophilus Axelson

The seasonal population densities of Cryptopygus thermophilus occurring in the first and second annual cycles of the forest and jhum soils are represented in Fig. 19. At the litter layer, in the first annual cycle, July 1980 showed the maximum population density of $105x10^2/m^2$, while the minimum occurred in December 1980 with $29x10^2/m^2$ individuals. In the forest soil, the maximum number of individuals was recorded in July 1980 ($20x10^2/m^2$) and the minimum in February 1981 ($2x10^2/m^2$) for the 0-10 cm profile. In the 10-20 cm soil depth, the species population ranged from a maximum of $8x10^2/m^2$ (May 1981) to a complete absence in the months of November 1980 and February 1981.

During the second annual cycle, the litter layer had a maximum of $98x10^2/m^2$ individuals (July 1981) and a minimum of $18x10^2/m^2$ individuals (January 1982). In the forest soil layers of 0-10 cm and 10-20 cm, the maximum and minimum population densities were respectively $24x10^2/m^2$ (July 1981) and $1x10^2/m^2$ (February 1982) for the former and $6x10^2/m^2$ (July 1981 & June 1982) and nil population (October 1981) for the latter.

This species of Collembola also inhabited the jhum soils during both the years of investigation. In the first annual cycle, they were present at 0-10 cm and 10-20 cm soil layers, respectively having maximum populations of $8x10^2/m^2$ (October 1980) and $4x10^2/m^2$ (July 1980 & June 1981), and with minimum population densities of $2x10^2/m^2$ (February & April 1981) and a total absence (December 1980 & February-March 1981).

Fig. 19. Showing the seasonal fluctuations of Cryptopygus thermophilus Axelson (Collembola : Isotomidae) in the different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

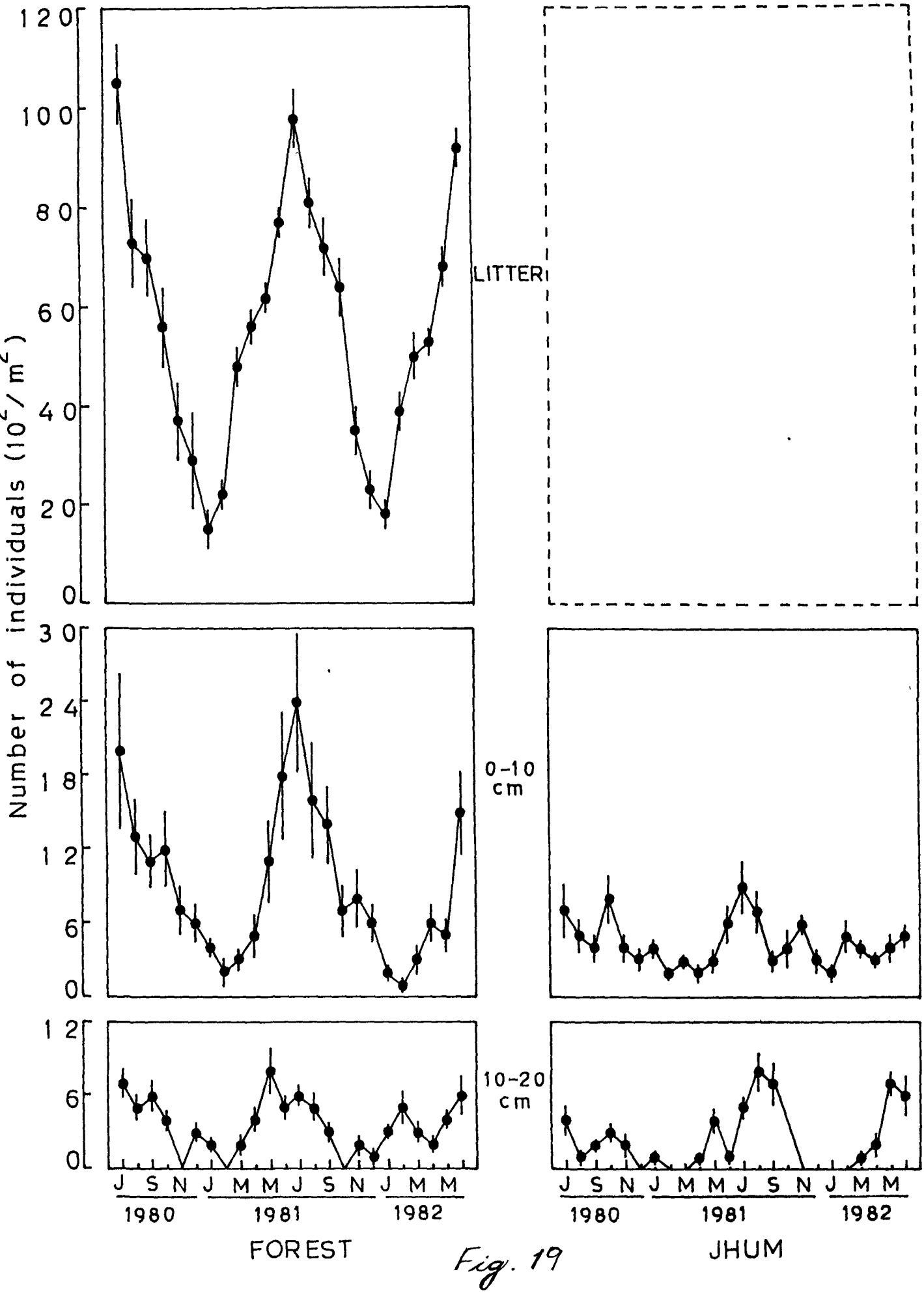

Number of individuals ($10^2/m^2$)
120
100
80
60
40
20
0
LITTER
30
24
18
12
6
0
0-10 cm
12
6
0
10-20 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
J S N J M M J S N J M M
1980
1981
1982
JHUM

Fig. 19

During the second annual cycle, Cryptopygus thermophilus were also found to occur within the profiles of 0-10 cm and 10-20 cm. For the first depth, the maximum and minimum numbers were respectively $9x10^2/m^2$ in July 1981 and $2x10^2/m^2$ in January 1982. For the next layer (10-20 cm), the maximum density occurred in the month of August 1981 ($8x10^2/m^2$) but were totally absent in several months of the study period.

c.3. Other isotomids

Fig. 20 indicates the seasonality of 'other isotomids' in different layers of the forest and jhum soils during the two annual cycles of investigation. During the first annual cycle, the litter layer of the forest depicted a maximum population of $57x10^2/m^2$ (March 1981) and a minimum of $6x10^2/m^2$ (November 1980). The 0-10 cm soil profile had maximum individuals in July 1980 with $26x10^2/m^2$ and minimum in February 1981 with $5x10^2/m^2$, while the next layer (10-20 cm) showed a maximum of $4x10^2/m^2$ in July 1980 and $1x10^2/m^2$ as minimum in December 1980 and February 1981.

In the second annual cycle the maximum and minimum populations occurred in May 1982 ($59x10^2/m^2$) and November 1981 ($5x10^2/m^2$) respectively in the litter layer. The 0-10 cm layer of the forest recorded a maximum of $33x10^2/m^2$ individuals in July 1981 while a minimum of $3x10^2/m^2$ individuals were present in February 1982. Further, the forest soil profile at 10-20 cm had $5x10^2/m^2$ individuals of population in March and June 1982 as maximum but were absent in October and December 1981.

The jhum soil during the first annual cycle displayed

Fig. 20. Showing the seasonal fluctuations of "other isotomids" in the different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

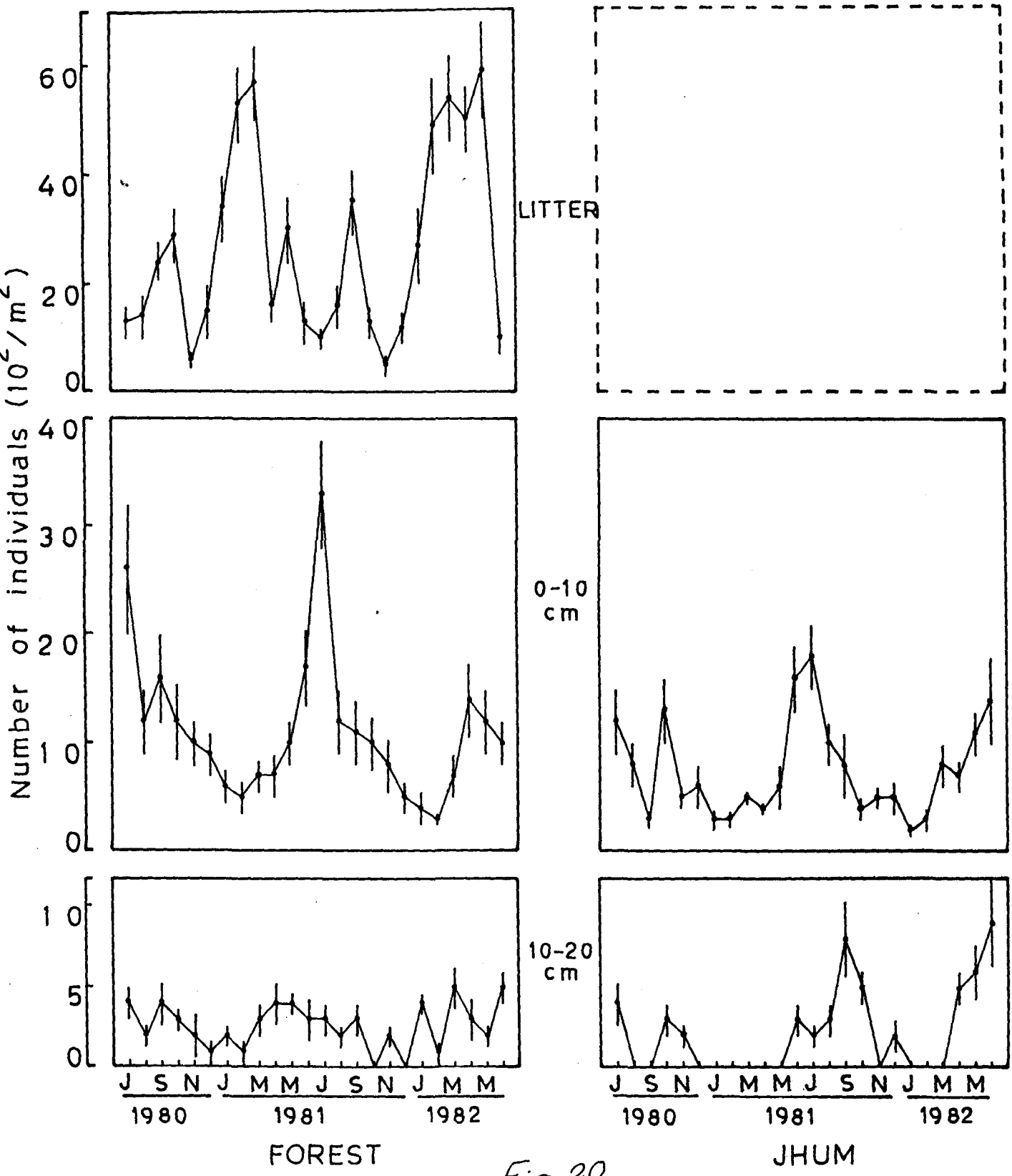

Number of individuals ($10^2/m^2$)
60
40
20
0
LITTER
40
30
20
10
0
0-10 cm
10
5
0
10-20 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
J S N J M M J S N J M M
1980
1981
1982
JHUM

Fig. 20

a maximum of $16x10^2/m^2$ in June 1981 and a minimum of $3x10^2/m^2$ in September 1980, January & February 1981 at 0-10 cm soil profile. In the next soil profile (10-20 cm), the seasonality of this collembolan group ranged from a maximum of $4x10^2/m^2$ in July 1980 to a complete absence in August, September and December 1980.

The second annual cycle of the jhum soil at 0-10 cm recorded $18x10^2/m^2$ individuals in July 1981 as maximum and only $2x10^2/m^2$ in January 1982 as minimum. At 10-20 cm, the month of June 1982 had a maximum population of $9x10^2/m^2$ individuals. Moreover quite a number of the months did not record anu individual of 'other isotomids' as shown in the figure.

d. Family Entomobryidae

The monthly population dynamics of the family Entomobryidae in the forest and jhum systems are represented in the Fig. 21. During the first annual cycle, the litter layer of the forest had a maximum population density of $156x10^2/m^2$ in July 1980 and a minimum of $45x10^2/m^2$ in December 1980. The maximum-minimum densities in the 0-10 cm layer were $46x10^2/m^2$ (August 1980) and $7x10^2/m^2$ (February 1981), respectively. In the 10-20 cm soil profile, the entomobryids were maximum in June 1981 ($5x10^2/m^2$) but showed non-occurrence in November 1980 and January 1981.

In the second annual cycle, the litter layer exhibited a peak of $156x10^2/m^2$ individuals in July 1981 and a minimum of $41x10^2/m^2$ in December 1980. Maximum-minimum densities of entomo-

Fig. 21. Showing the seasonal fluctuations of the family Entomobryidae (Collembola : Insecta) in the different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

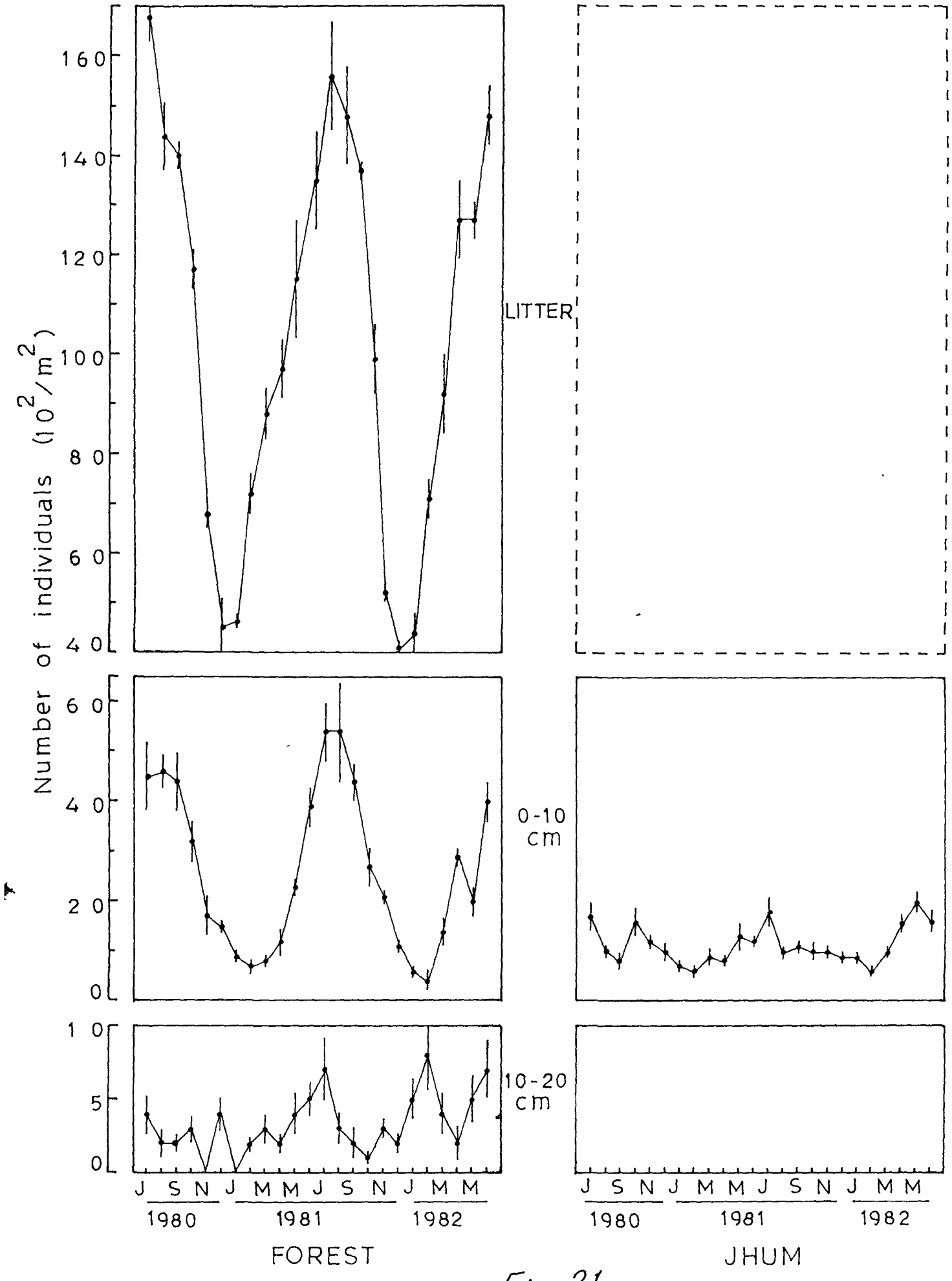

Number of individuals ($10^2/m^2$)
160
140
120
100
80
60
40
LITTER
60
40
20
0
0-10 cm
10
5
0
10-20 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 21

bryids at 0-10 cm layer were $54x10^2/m^2$ (July-August 1981) and $4x10^2/m^2$ (February 1982), respectively. In the next profile (10-20 cm), the density ranged from a minimum of $1x10^2/m^2$ in October 1981 to a maximum of $8x10^2/m^2$ in February 1982.

In the jhum soil, the entomobryids occurred only within the profile of 0-10 cm. Thus, in the first annual cycle, the densities were maximum in July 1980 ($17x10^2/m^2$) and minimum in February 1981 ($6x10^2/m^2$). The second annual cycle densities ranged from a minimum of $6x10^2/m^2$ in February 1982 to a maximum of $20x10^2/m^2$ in May 1982.

The seasonal variations of the different species or genera of Entomobryidae have been described from the forest and jhum systems, as below.

d.1. Dicranocentrus singularis Mari Mutt & Bhattacharjee

The population dynamics of Dicranocentrus singularis is given in Fig. 22 which occurred apparently only in the forest soil during the first and second annual cycles of study. In the first annual cycle, the litter layer exhibited a maximum population of $18x10^2/m^2$ (July 1980) and a minimum population of $4x10^2/m^2$ (December 1980). The forest soil at 0-10 cm depth had a maximum density ($4x10^2/m^2$) in June 1981. In the months of August 1980 and May 1981, the population had $2x10^2/m^2$ individuals each, while the rest of the months recorded no individuals at all.

The litter layer of the second annual cycle showed $17x10^2/m^2$ individuals in August 1981 being maximum, and only

Fig. 22. Showing the seasonal fluctuations of Dicranocentrus singularis Mari Mutt & Bhattacharjee (Collembola : Entomobryidae) in the litter and 0-10 cm layers of the forest system for two annual cycles. (Vertical lines show the standard error).

Fig. 23. Showing the seasonal fluctuations of Dicranocentrus fraternus Mari Mutt & Bhattacharjee (Collembola : Entomobryidae) in the different layers of the forest system and only in 0-10 cm layer of the jhum soil for two annual cycles. (Vertical lines show the standard error).

Fig. 22

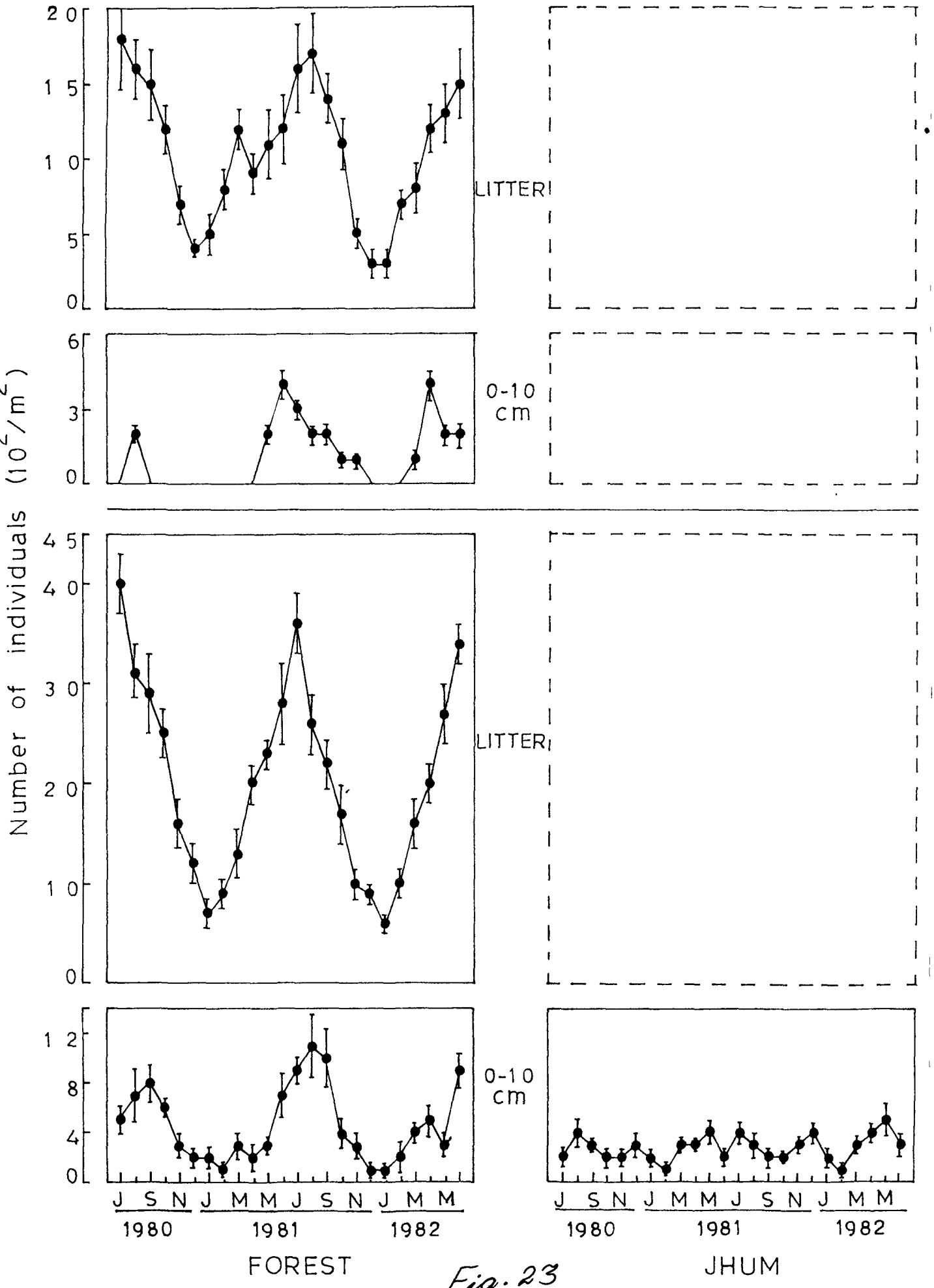

Number of individuals ($10^2/m^2$)
20
15
10
5
0
LITTER
6
3
0
0-10 cm
45
40
30
20
10
0
LITTER
12
8
4
0
0-10 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
J S N J M M J S N J M M
1980
1981
1982
JHUM

Fig. 23

$3x10^2/m^2$ individuals in December 1981 and January 1982 as minimum. The forest soil at 0-10 cm soil depth had $4x10^2/m^2$ population in April 1982 as the maximum and with no individuals occurring in December 1981 and January-February 1982.

The jhum system did not contain any individuals of Dicranocentrus singularis during the two annual cycles o present investigation.

d.2. Dicranocentrus fraternus Mari Mutt & Bhattacharjee

The population dynamics of Dicranocentrus fraternus in the forest and jhum systems for the two annual cycles are illustrated in Fig. 23. During the first annual cycle, the peak population density for the litter layer was in July 1980 ($40x10^2/m^2$) and the least in January 1981 ($7x10^2/m^2$). At 0-10 cm soil depth, the species had a maximum population of $8x10^2/m^2$ in September 1980 and a minimum of $1x10^2/m^2$ in February 1981.

In the second annual cycle, the population peak occurred in July 1981, being $36x10^2/m^2$. The least density for the same layer was recorded in January 1982 ($6x10^2/m^2$). For the 0-10 cm soil layer in the forest the month of August 1981 showed a maximum of $11x10^2/m^2$ individual, while the minimum occurred in December-January, being only $1x10^2/m^2$ individuals.

The jhum system under study was populated only at 0-10 cm profile. In the first annual cycle, the maximum density was $4x10^2/m^2$ in August 1980 and May 1981, and the minimum in February 1981 ($1x10^2/m^2$). The second annual cycle revealed $5x10^2/m^2$ as maximum in May 1982 and $1x10^2/m^2$ as minimum in February 1982.

d.3. Entomobrya sp.

Fig. 24 depicts the monthly population densities of Entomobrya sp. in different layers of the forest and jhum soils of the investigation period. During the first annual cycle, the litter layer had a maximum density of $30x10^2/m^2$ in September 1980 and a minimum of $6x10^2/m^2$ in January 1981. At 0-10 cm depth of the soil, the maximum-minimum densities were in July 1980 ($21x10^2/m^2$) and March 1981 ($2x10^2/m^2$), respectively.

In the second annual cycle, the maximum-minimum population densities accounted $28x10^2/m^2$ individuals in August 1981 and $9x10^2/m^2$ in January 1982 respectively at the litter layer. The 0-10 cm soil depth had a maximum population density in July 1981 ($19x10^2/m^2$) and a minimum in February 1982 ($1x10^2/m^2$).

In the jhum system and at its 0-10 cm profile, Entomobrya sp. recorded a maximum density in July 1980 with $8x10^2/m^2$ individuals and minimum in February & April 1981 ($2x10^2/m^2$) of the first annual cycle. The population densities of the second annual cycle ranged from $2x10^2/m^2$ minimal in several months (as seen in the figure) to $7x10^2/m^2$ as maximal in May 1982.

d.4. Lepidocyrtus sp.

As illustrated in the Fig. 25, the litter had a maximum population density of Lepidocyrtus sp. in July 1980 ($19x10^2/m^2$) and minimum in December 1980 and March 1981 ($2x10^2/m^2$) during the first annual cycle. The second annual cycle densities ranged from $2x10^2/m^2$ as minimum in December 1981 to $16x10^2/m^2$ as maximum in May 1982.

Fig. 24. Showing the seasonal fluctuations of Entomobrya (Collembola : Entomobryidae) in the different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

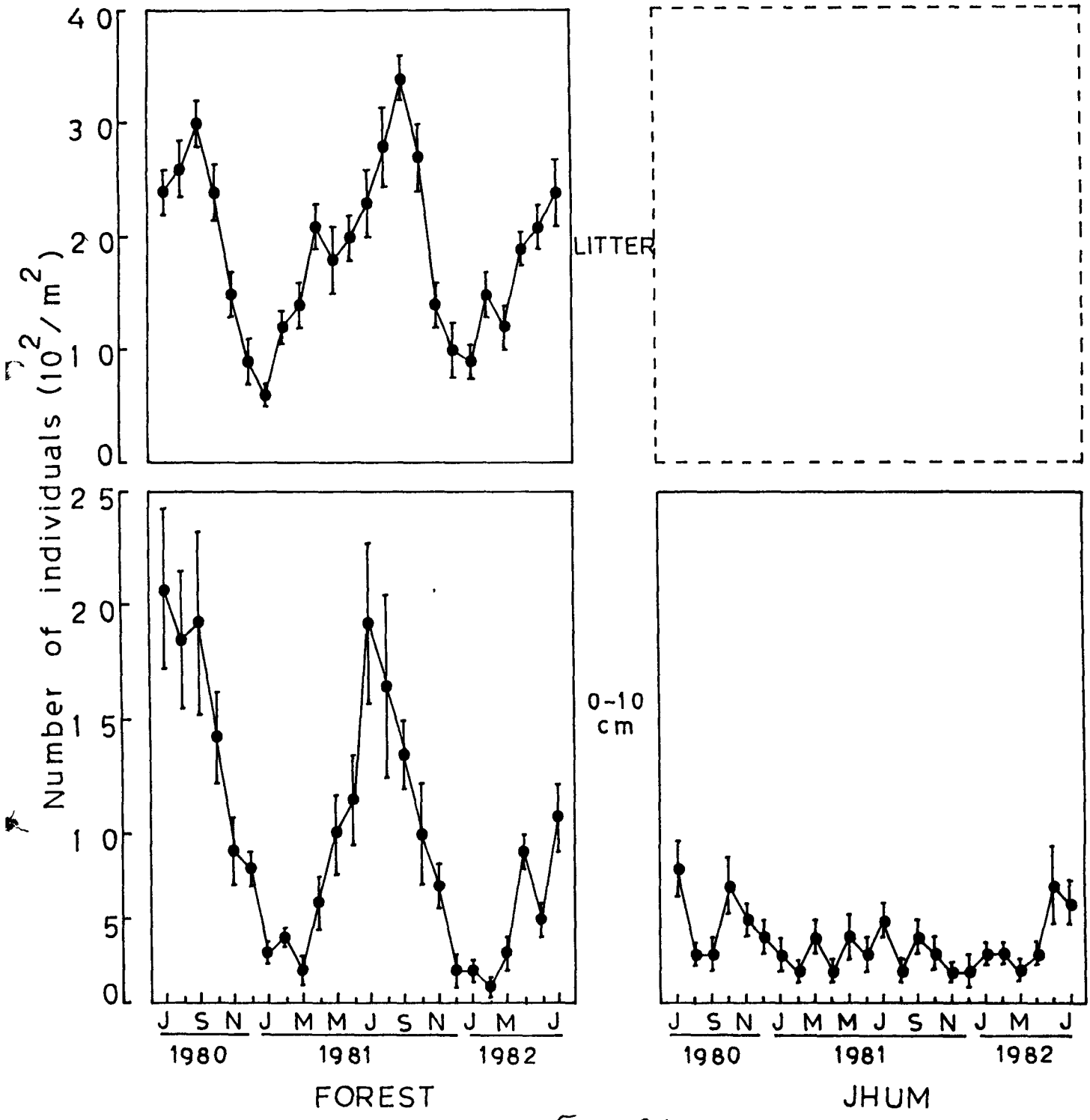

Number of individuals ($10^2/m^2$)
40
30
20
10
0
LITTER
25
20
15
10
5
0
0-10 cm
J S N J M M J S N J M J
1980
1981
1982
FOREST
JHUM

Fig. 24

Fig. 25. Showing the seasonal fluctuations of Lepidocyrtus (Collembola : Entomobryidae) in the litter layer of the forest for two annual cycles. (Vertical lines show the standard error).

Fig. 26. Showing the seasonal fluctuations of Salina sp. (Collembola : Entomobryidae) in the different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

Fig. 25

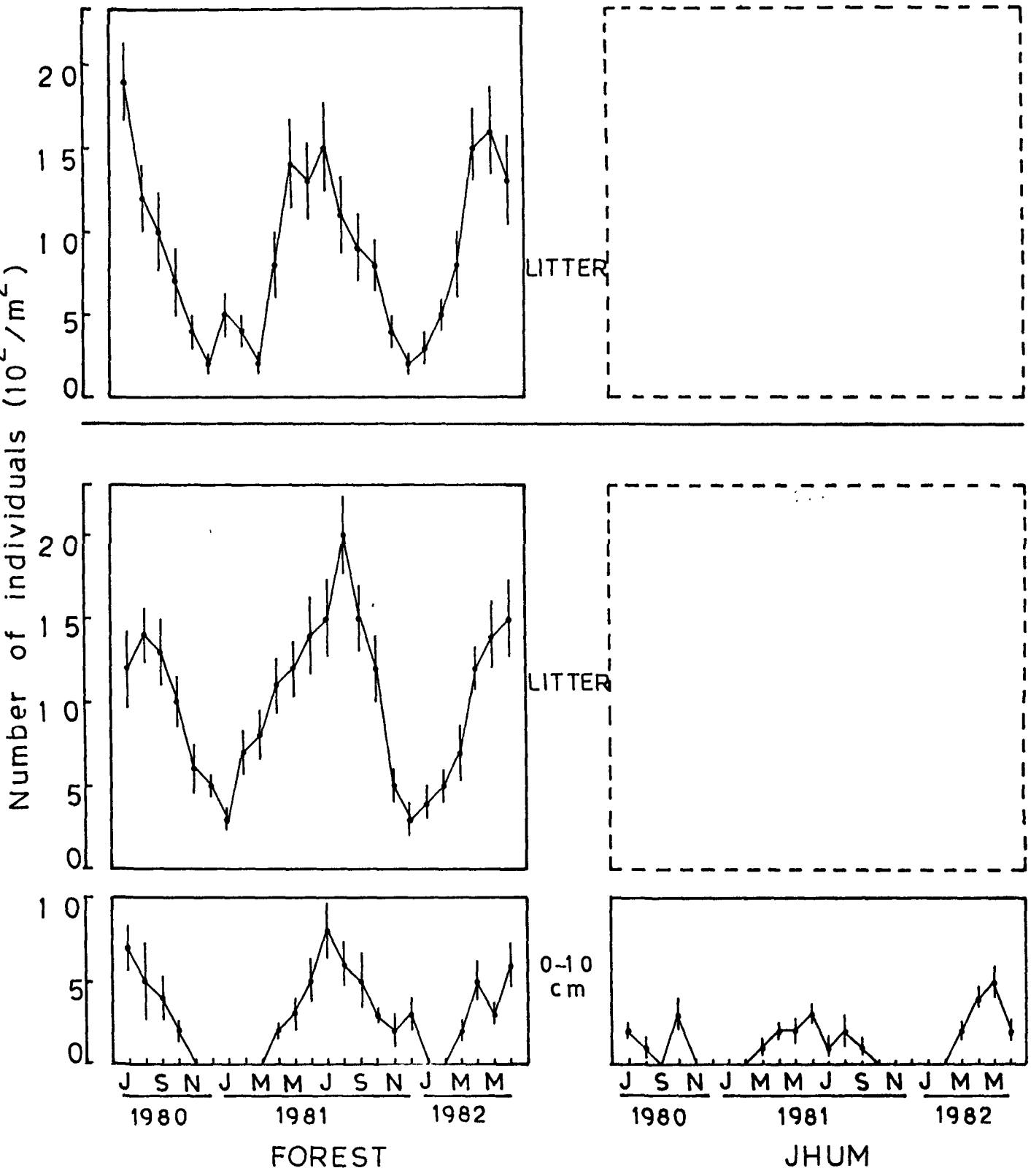

Number of individuals ($10^2/m^2$)
20
15
10
5
0
LITTER
LITTER
10
5
0
0-10 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 26

d.5. Salina sp.

The seasonal population dynamics of Salina sp. in different layers of the forest and jhum soils are illustrated in the Fig. 26. In the litter layer, Salina sp. showed maximum densities of $14x10^2/m^2$ each in August 1980 and June 1981. Minimum population density for the same period (first annual cycle) was in January 1981 ($3x10^2/m^2$). Further, the maximum-minimum densities for the second annual cycle in the litter layer were respectively in August 1981 ($20x10^2/m^2$) and December 1981 ($3x10^2/m^2$).

As seen in the figure, the 0-10 cm layer of the forest soil had maximum densities of $7x10^2/m^2$ (July 1980) and $8x10^2/m^2$ (July 1981), during the first and second annual cycles, respectively. Further, the winter months of the investigation period recorded non-occurrence of Salina sp. at this layer.

At 0-10 cm layer of the jhum soil, Salina sp. showed maximum population densities of $3x10^2/m^2$ (October 1980) and $5x10^2/m^2$ (April 1982) during the first and second annual cycles, respectively. In several months of the investigation period, the species were, however, totally absent at this layer of the jhum soil, as seen in the figure.

d.6. Isotobryoides sp.

Fig. 27 represents the monthly population dynamics of this collembolan species in the litter layer. The maximum and minimum densities of the first annual cycle were $13x10^2/m^2$ (July 1980) and $3x10^2/m^2$ (December 1980), respectively. The second annual cycle densities ranged from $3x10^2/m^2$ (November 1981) to $14x10^2/m^2$ (June 1982).

Fig. 27. Showing the seasonal fluctuations of Isotobryoides sp. (Collembola : Entomobryidae) in the litter layer of the forest system for two annual cycles. (Vertical lines show the standard error).

Fig. 28. Showing the seasonal fluctuations of Seira sp. (Collembola : Entomobryidae) in the litter layer of the forest for two annual cycles. (Vertical lines show the standard error).

Fig. 27

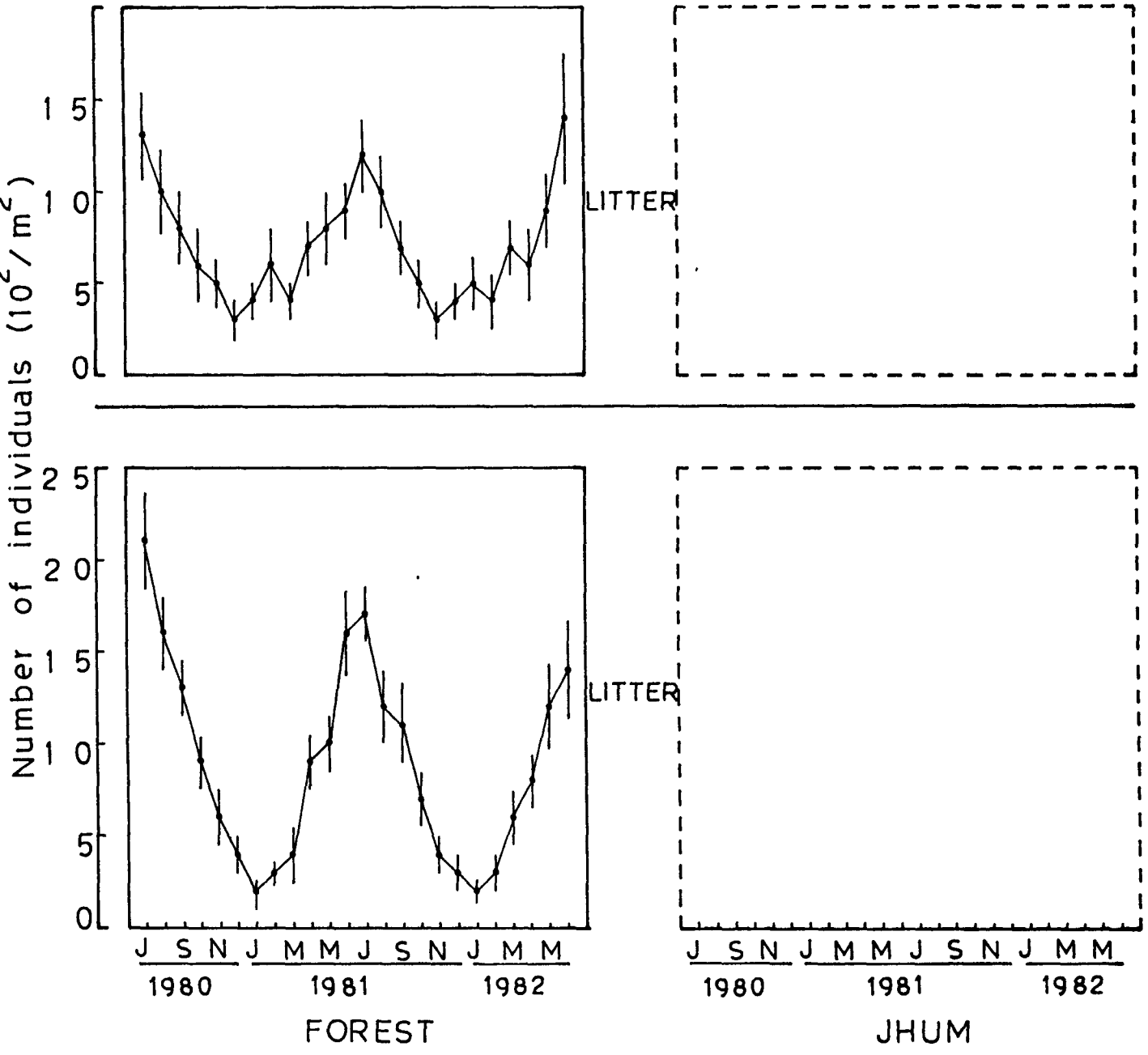

Number of individuals ($10^2/m^2$)
15
10
5
0
LITTER
25
20
15
10
5
0
LITTER
J S N J M M J S N J M M
1980
1981
1982
FOREST
J S N J M M J S N J M M
1980
1981
1982
JHUM

Fig. 28

d.7. Seira sp.

This group of Collembola occurred only in the litter layer of the forest (Fig. 28). The population densities of the first and second annual cycles were maximum in July, being $21x10^2/m^2$ and $17x10^2/m^2$, respectively. Further, the two annual cycles had equal values of minimum densities in January, being $2x10^2/m^2$ individuals only.

d.8. Metacoelura sp.

Fig. 29 illustrates the seasonal population dynamics of Metacoelura sp. in different layers of the forest and jhum soils. During the first annual cycle and in the litter layer, the population densities of Metacoelura sp. ranged from a minimum $2x10^2/m^2$ in January 1981 to a maximum of $18x10^2/m^2$ in June 1981. The maximum-minimum densities of the second annual cycle were $22x10^2/m^2$ (August 1981) and $3x10^2/m^2$ (January 1982), respectively.

In the 0-10 cm profile of the forest soil, the densities of the population were maximum in August and minimum in February, true for both the annual cycle. Thus, the maximum and minimum densities were respectively $14x10^2/m^2$ and $2x10^2/m^2$ during the first annual cycle (April also recorded minimum density for this period); $18x10^2/m^2$ and $2x10^2/m^2$ during the second annual cycle.

In the jhum soil of 0-10 cm profile showed maximum ($5x10^2/m^2$) and minimum ($2x10^2/m^2$) population densities of Metacoelura sp. in different months of the first annual cycle, as

Fig. 29. Showing the seasonal fluctuations of Metacoelura sp. (Collembola : Entomobryidae) in the different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

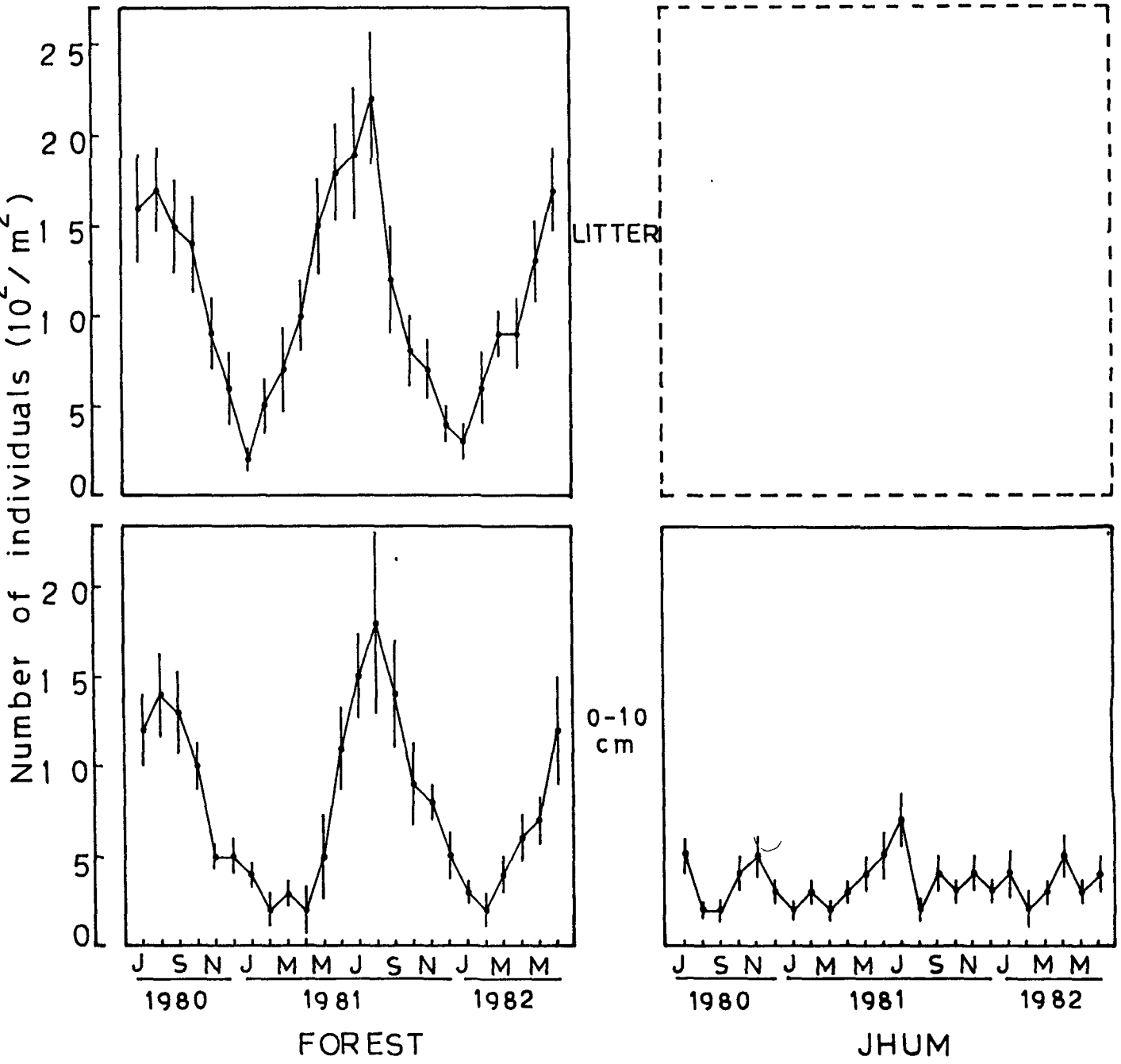

Number of individuals ($10^2/m^2$)
25
20
15
10
5
0
LITTER
0-10 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 29

depicted in the figure. During the second annual cycle, the same layer of the jhum soil recorded a maximum population density of $7x10^2/m^2$ in July 1981 and a minimum of $2x10^2/m^2$ in August 1981 and February 1982.

d.9. Other entomobryids

The seasonal population dynamics of "other entomobryids" from different layers of the forest soil are illustrated in the Fig. 30. In the litter layer of the forest system, as seen in the figure, the "other entomobryids" did not occur during the winter months of the investigation period. The maximum population densities for the first and second annual cycles were respectively $24x10^2/m^2$ in March 1981 and $26x10^2/m^2$ in April 1982.

At 10-20 cm profile of the forest soil the "other entomobryids" showed a maximum density of $5x10^2/m^2$ in June 1981 and a total absence in November and January of the first annual cycle. The population densities of the second annual cycle ranged from $1x10^2/m^2$ (October 1981) to $8x10^2/m^2$ (February 1982). The "other entomobryids" were not recovered from 0-10 cm layer of the forest soil, nor from the jhum system.

Fig. 30. Showing the seasonal fluctuations of "other entomobryids" in different layers of the forest system for two annual cycles. (Vertical lines show the standard error).

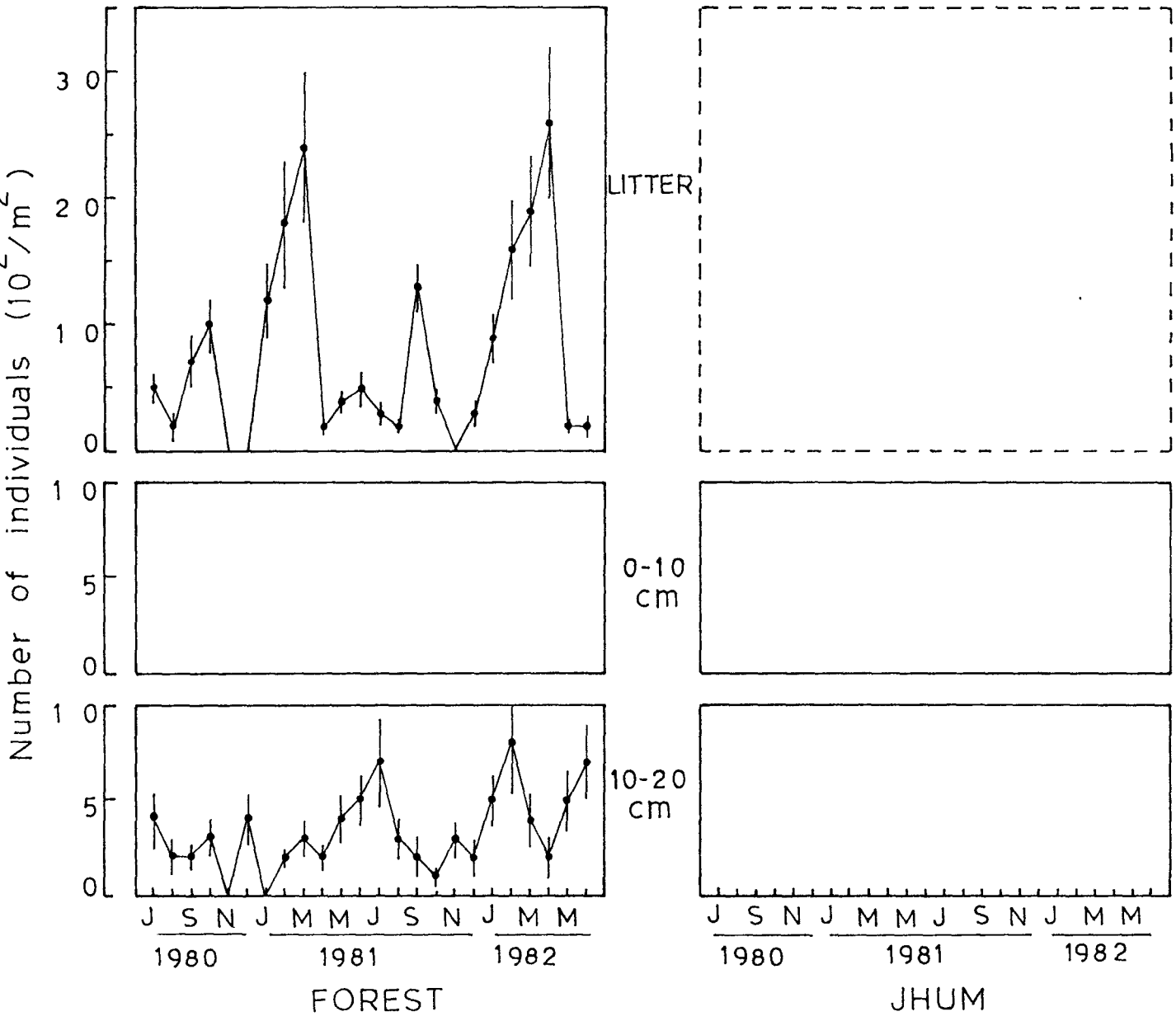

Number of individuals ($10^2/m^2$)
30
20
10
0
10
5
0
10
5
0
LITTER
0-10 cm
10-20 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 30

e. Family Sminthuridae

Fig. 31 illustrates the seasonal variations in the population dynamics of the family Sminthuridae in the different layers of the forest and jhum soils. The densities of sminthurids in the litter layer were maximum in August and minimum in January, true for both the annual cycles. Thus, the densities were respectively $58x10^2/m^2$ and $11x10^2/m^2$ during the first annual cycle, and $56x10^2/m^2$ and $12x10^2/m^2$ during the second annual cycle.

At 0-10 cm layer of the forest soil, sminthurids were maximum in July 1980 ($14x10^2/m^2$) and recorded a total absence in February 1981 of the first annual cycle. The second annual cycle densities varied from a minimum of $1x10^2/m^2$ in February 1982 to a maximum of $15x10^2/m^2$ in June 1982.

In the jhum system, the sminthurid collembolans occurred only in the soil profile of 0-10 cm. For the first annual cycle, the peak was observed in July, August and October 1980 ($5x10^2/m^2$) but were totally absent in February 1981. The second annual cycle recorded a minimum density of $1x10^2/m^2$ (December & February 1982) and a maximum of $6x10^2/m^2$ (March, April & June 1982).

Family Sminthuridae had two species, viz. Sminthurinus bimaculatus Axelson and Sphaeridia cornuta Murphy. The population dynamics of these collembolan species are described, both from the forest and jhum systems.

Fig. 31. Showing the seasonal fluctuations of the family Sminthuridae (Collembola : Insecta) in the different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

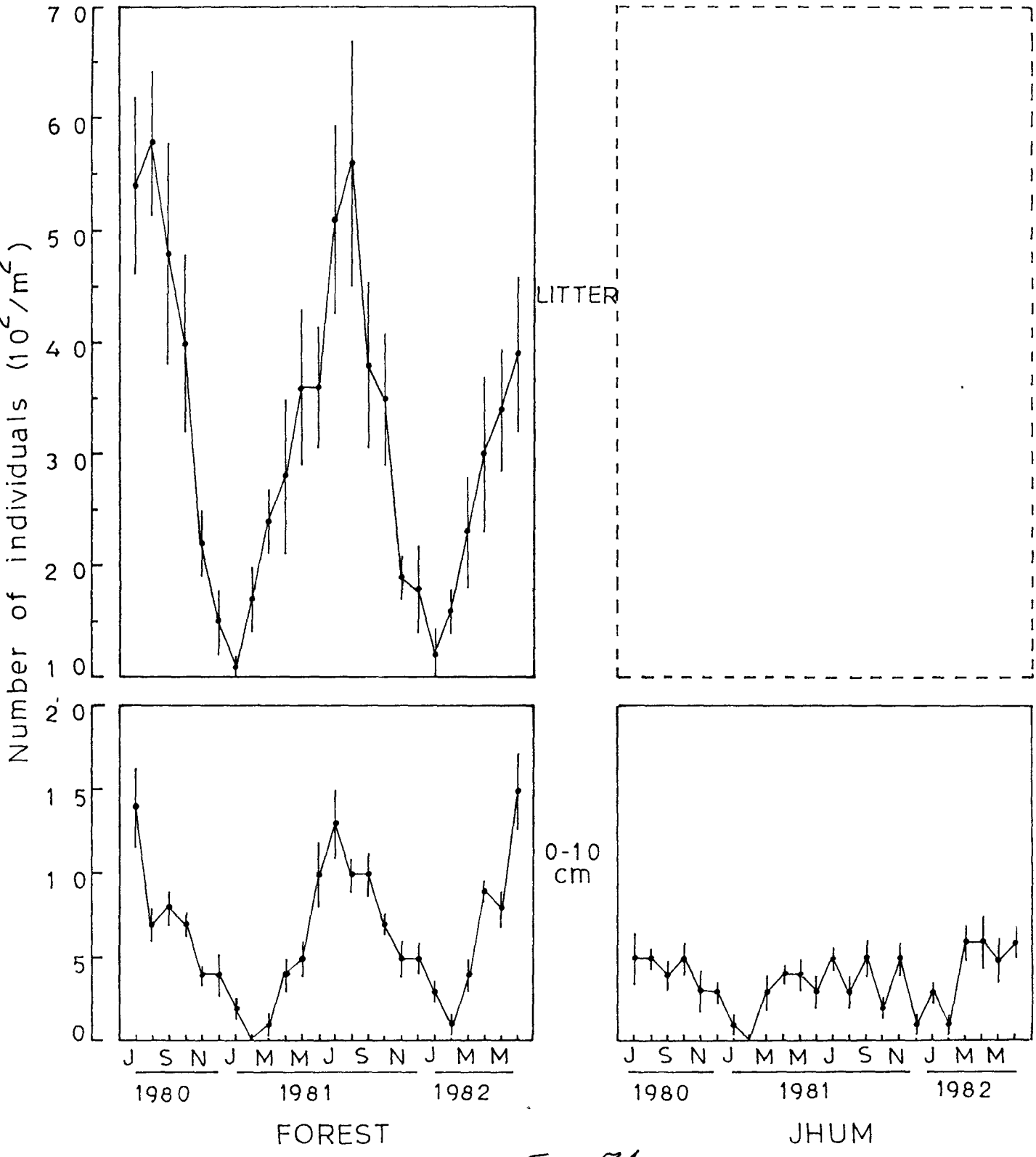

Number of individuals ($10^2/m^2$)
7 0
6 0
5 0
4 0
3 0
2 0
1 0
LITTER
2 0
1 5
1 0
5
0
0-10 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 31

e.1. Sphaeridia cornuta Murphy

Fig. 32 represents the seasonal population densities of this species in different layers of the forest and jhum soils. In the litter layer, the population densities were maximum and minimum during August and January, respectively, true for both the annual cycles. Thus, the densities were $43x10^2/m^2$ and $6x10^2/m^2$ during the first annual cycle; and were $40x10^2/m^2$ and $8x10^2/m^2$ during the second annual cycle.

At 0-10 cm layer of the forest soil, the maximum number of the species occurred in July 1980 ($8x10^2/m^2$) and a total absence in February 1981 during the first annual cycle. The monthly densities of the second annual cycle ranged from $1x10^2/m^2$ in February 1982 to $8x10^2/m^2$ in June 1982.

At 0-10 cm depth of the jhum soil, the species were absent during January-February of the first annual cycle and December and February of the second annual cycle. Maximum densities were $3x10^2/m^2$ (August & October 1980) and $4x10^2/m^2$ (April 1982), respectively, for the first and second annual cycles.

e.2. Sminthurinus bimaculatus Axelson

The seasonal population dynamics of this species of Collembola are illustrated in the Fig. 33. During the first annual cycle, the litter layer of the forest had a maximum population density of $16x10^2/m^2$ in July 1980 and a minimum of only $4x10^2/m^2$ in December 1980. At 0-10 cm layer, maximum density was also observed in July 1980 ($6x10^2/m^2$) but the species showed complete absence in February-March 1981.

Fig. 32. Showing the seasonal fluctuations of Sphaeridia cornuta Murphy (Collembola : Sminthuridae) in the different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

Fig. 33. Showing the seasonal fluctuations of Sminthurinus bimaculatus Axelson (Collembola : Sminthuridae) in the different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

Fig. 32

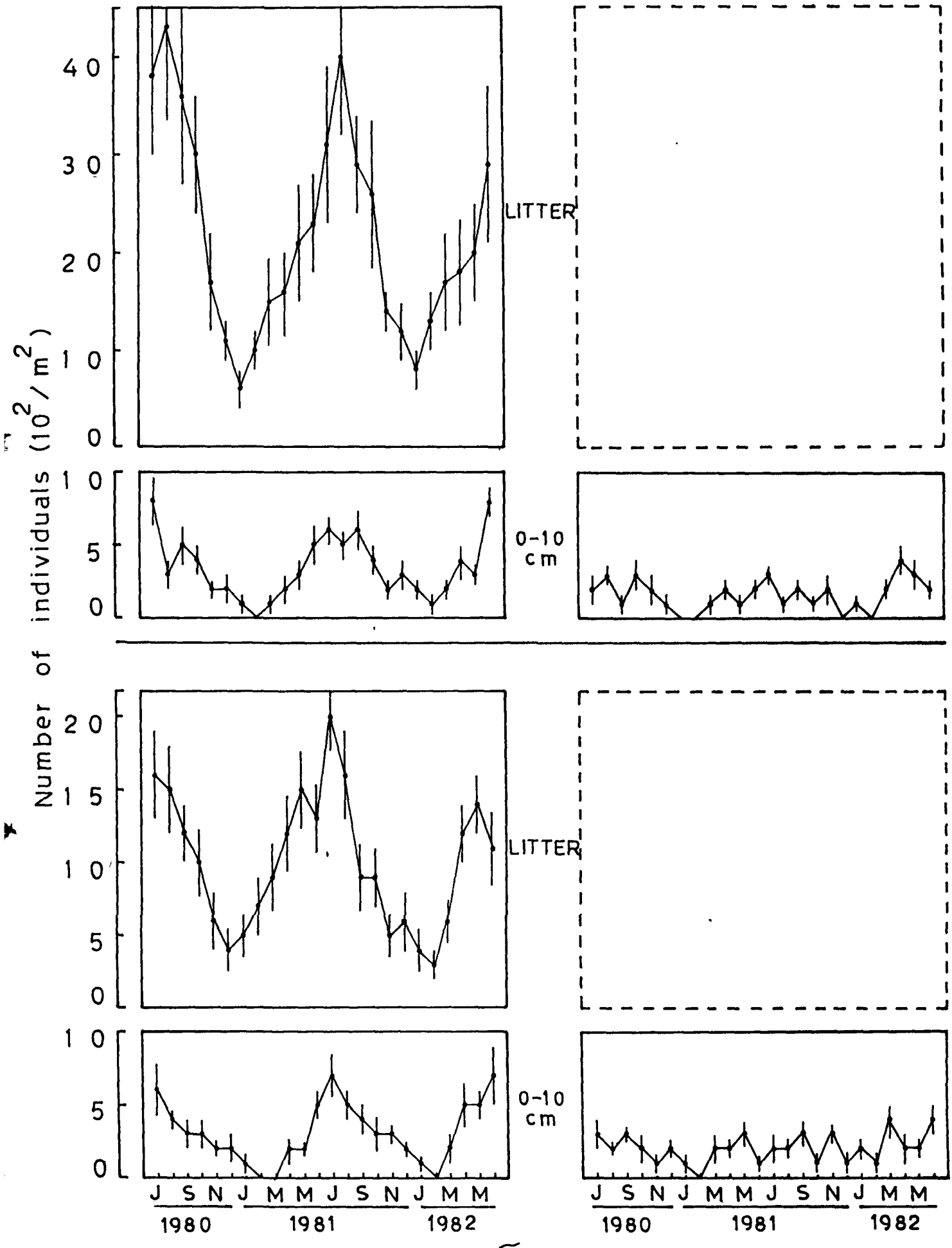

Number of individuals ($10^2/m^2$)
40
30
20
10
0
LITTER
10
5
0
0-10 cm
20
15
10
5
0
LITTER
10
5
0
0-10 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 33

During the second annual cycle, the litter layer had $20x10^2/m^2$ (July 1980) as maximum and $3x10^2/m^2$ (February 1981) as minimum. The species, at 0-10 cm layer, were absent in February 1982, but showed maximum densities in July 1981 and June 1982 ($7x10^2/m^2$).

The population densities of Sminthurinus bimaculatus at 0-10 cm layer of the jhum soil ranged from a nil occurrence in February 1981 to a maximum of $3x10^2/m^2$ in July, September and May of the first annual cycle. The second annual cycle densities varied from a minimum of $1x10^2/m^2$ (October, December and February) to a maximum of $4x10^2/m^2$ (March and June).

f. Family Neelidae

This family was represented by a single species, viz. Megalothorax minimus Willem in both the forest and jhum systems (Fig. 34). During the first annual cycle, the maximum and minimum densities were respectively $60x10^2/m^2$ (June 1981) and $7x10^2$ per m^2 (January 1981) in the litter layer; $11x10^2/m^2$ (July 1980) and $1x10^2/m^2$ (February 1981) at 0-10 cm soil layer.

In the second annual cycle, the minimum-maximum densities were respectively $8x10^2/m^2$ (December 1981) and $68x10^2/m^2$ (June 1982) in the litter layer; $2x10^2/m^2$ (January-February 1982) and $10x10^2/m^2$ (June-July) in the 0-10 cm soil profile.

At 0-10 cm layer of the jhum soil, the population densities varied from nil occurrence in January-February 1981 to a maximum of only $3x10^2/m^2$ in May 1981. The species were absent in December and February but rose to a maximum of $4x10^2/m^2$ in April 1982 during the second annual cycle.

Fig. 34. Showing the seasonal fluctuations of Megalothorax minimus Willem (Collembola : Neelidae) in the different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

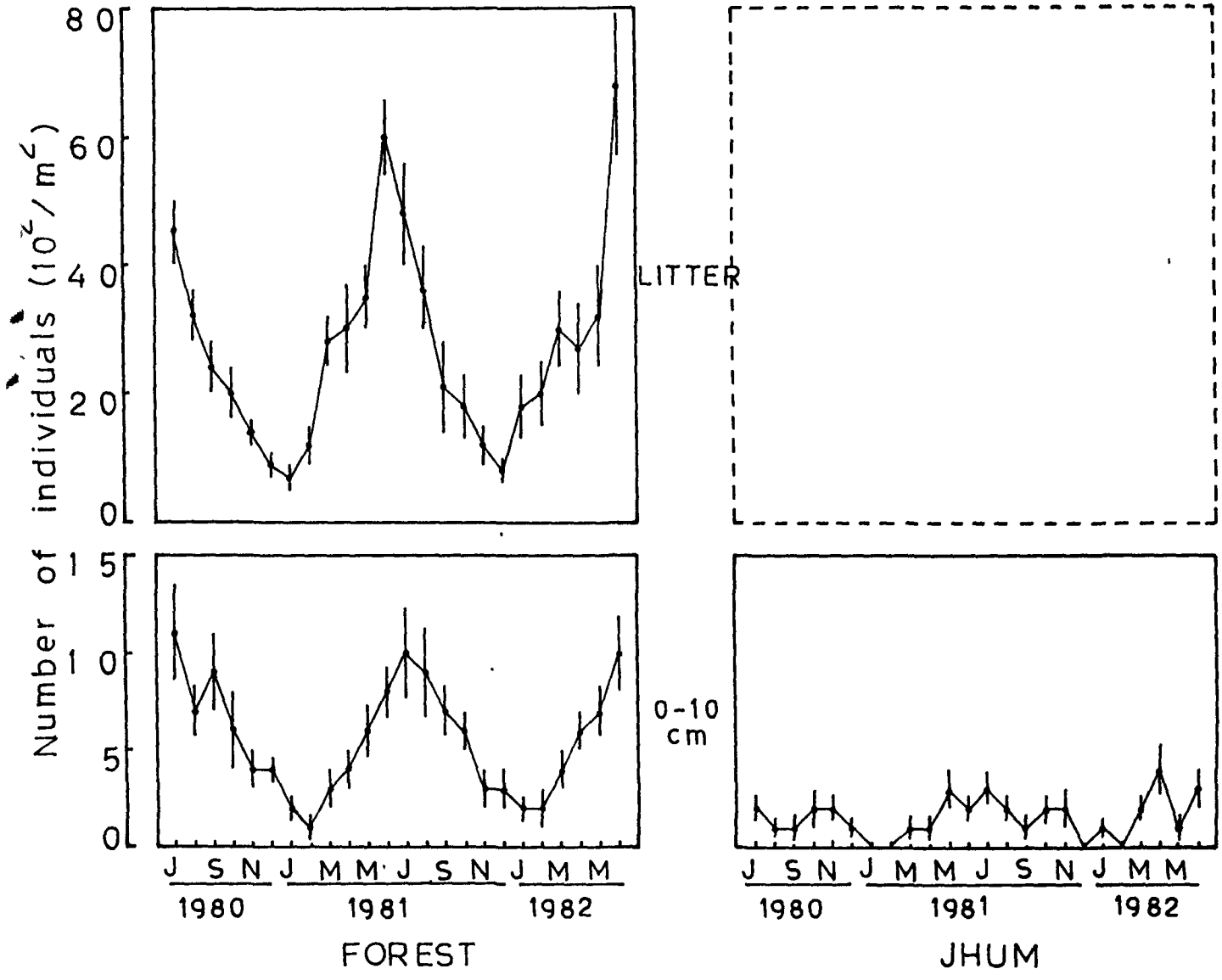

Number of individuals ($10^2/m^2$)
80
60
40
20
0
LITTER
15
10
5
0
0-10 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 34

4.2.2.3. Acarina

Fig. 35 illustrates the population dynamics of Acarina in the total system and different soil layers of the forest and jhum soils. During the first annual cycle, the population dynamics of the total acari in the forest system showed a peak of $1193x10^2/m^2$ individuals in October 1980 and the least in December 1980 ($380x10^2/m^2$). The minimum and maximum densities of acari in the litter layer were also observed in the same months, being $138x10^2/m^2$ and $753x10^2/m^2$, respectively. For the different layers of the forest soil, the maximum and minimum population densities were respectively $404x10^2/m^2$ (September 1980) and $204x10^2/m^2$ (January 1981) at 0-10 cm; $72x10^2/m^2$ (July 1980) and $24x10^2/m^2$ (March 1981) at 10-20 cm soil profile. In the next layer (20-30 cm), the acari did not exhibit a consistency of monthly occurrence so much so that in several months (as seen in the figure) they were totally absent and a peak population density was observed in January 1981, being $4x10^2/m^2$.

During the second annual cycle, the minimum and maximum population densities of acari were respectively $373x10^2/m^2$ (December 1981) and $1207x10^2/m^2$ (September 1981) for the total system of the forest; $110x10^2/m^2$ (January 1982) and $898x10^2/m^2$ (October 1982) in the litter layer; $152x10^2/m^2$ (November 1981) and $442x10^2/m^2$ (February 1982) at 0-10 cm soil layer; $24x10^2/m^2$ (November 1981) and $79x10^2/m^2$ (August 1981) at 10-20 cm soil depth. The acari of the second annual cycle at 20-30 cm exhibited similar pattern of population dynamism in that they were totally absent in several months and the maximum density recorded was only $4x10^2/m^2$ in September 1981.

Fig. 35. Showing the seasonal fluctuations of Acarina in the total systems of the forest and jhum, and in their different layers for two annual cycles. (Vertical lines show the standard error).

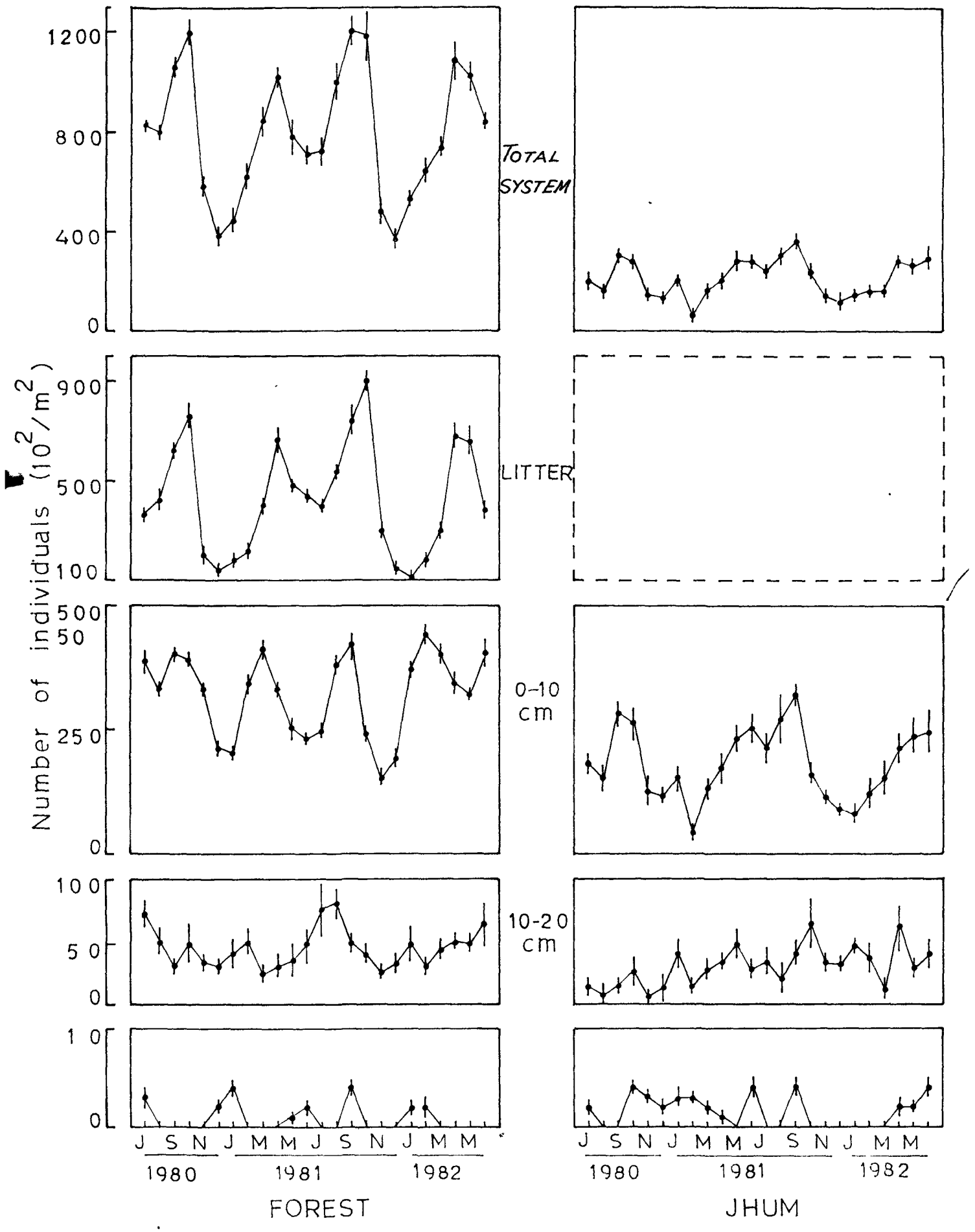

1200
800
400
0
TOTAL SYSTEM
900
500
100
LITTER
Number of individuals ($10^2/m^2$)
500
50
250
0
0-10 cm
100
50
0
10-20 cm
10
0
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 35

In the jhum soil of the first annual cycle, the acari showed a minimum population density of $62x10^2/m^2$ (February 1981) and a maximum of $292x10^2/m^2$ (September 1980) for the total system. The 0-10 cm layer of the jhum soil had a minimum density of $43x10^2/m^2$ in February 1981 and a maximum of $276x10^2/m^2$ in September 1980. The next layer (10-20 cm) showed a range of $8x10^2/m^2$ (August and November 1980) to $48x10^2/m^2$ (May 1980). At 20-30 cm layer, acari were absent in the months of August-September 1980 & May 1981, and a maximum of $4x10^2/m^2$ were seen during October 1980 and June 1981.

In the second annual cycle, the monthly population densities of Acarina varied from a minimum of $124x10^2/m^2$ (December 1981) to a maximum of $368x10^2/m^2$ (September 1981) for the total system of the jhum. The 0-10 cm soil layer had a maximum density of $324x10^2/m^2$ in September 1981 and a minimum of $84x10^2/m^2$ in January 1982. The next layer (10-20 cm) showed a range of $12x10^2/m^2$ in March 1982 to $66x10^2/m^2$ in October 1981 as minimum and maximum, respectively. At 20-30 cm layer of the jhum soil, the acari exhibited a peak population density of $4x10^2/m^2$ during September 1981 and June 1982. However, the mites were absent in most months of the second annual cycle, as could be seen in the figure.

Further, the monthly population dynamics of the acari of the forest and jhum systems have been studied under the following sub-orders, viz. Astigmata, Prostigmata, Mesostigmata and Cryptostigmata (Oribatida), and their families, genera or species, wherever possible.

a. Sub-order Astigmata

Fig. 36 illustrates the seasonal variations of Astigmata in different layers of the forest and jhum soils during the two annual cycles of investigation. Thus, during the first annual cycle, at the litter layer of the forest, the maximum population density of astigmatid mites was seen in June 1981 and minimum in January 1981, being $22x10^2/m^2$ and $4x10^2/m^2$, respectively. At 0-10 cm soil depth, the mites were maximum ($9x10^2/m^2$) in November 1980 but were totally absent during the months of January-February and April-May of the first annual cycle.

In the second annual cycle, the monthly population densities of Astigmata, in the litter layer, ranged from a minimum of $5x10^2/m^2$ (January 1982) to a maximum of $20x10^2/m^2$ (June 1982). At 0-10 cm layer of the forest soil, the astigmatid mites showed non-occurrence in the months of November, February and May with a peak in January 1982 ($8x10^2/m^2$).

In the jhum soil, Astigmata were recovered only at its 0-10 cm depth. A peak monthly population density of $10x10^2/m^2$ was seen in two different months (September & May 1981) of the first annual cycle. The month of February 1981 of the same cycle did not record any individuals of Astigmata. During the second annual cycle, Astigmata ranged from nil population in November 1981 to $13x10^2/m^2$ in May 1982.

b. Sub-order Prostigmata

Fig. 37 represents the seasonal population variations of prostigmatid mites in different layers of the forest and jhum

Fig. 36. Showing the seasonal fluctuations of Astigmata (Acarina) in the different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

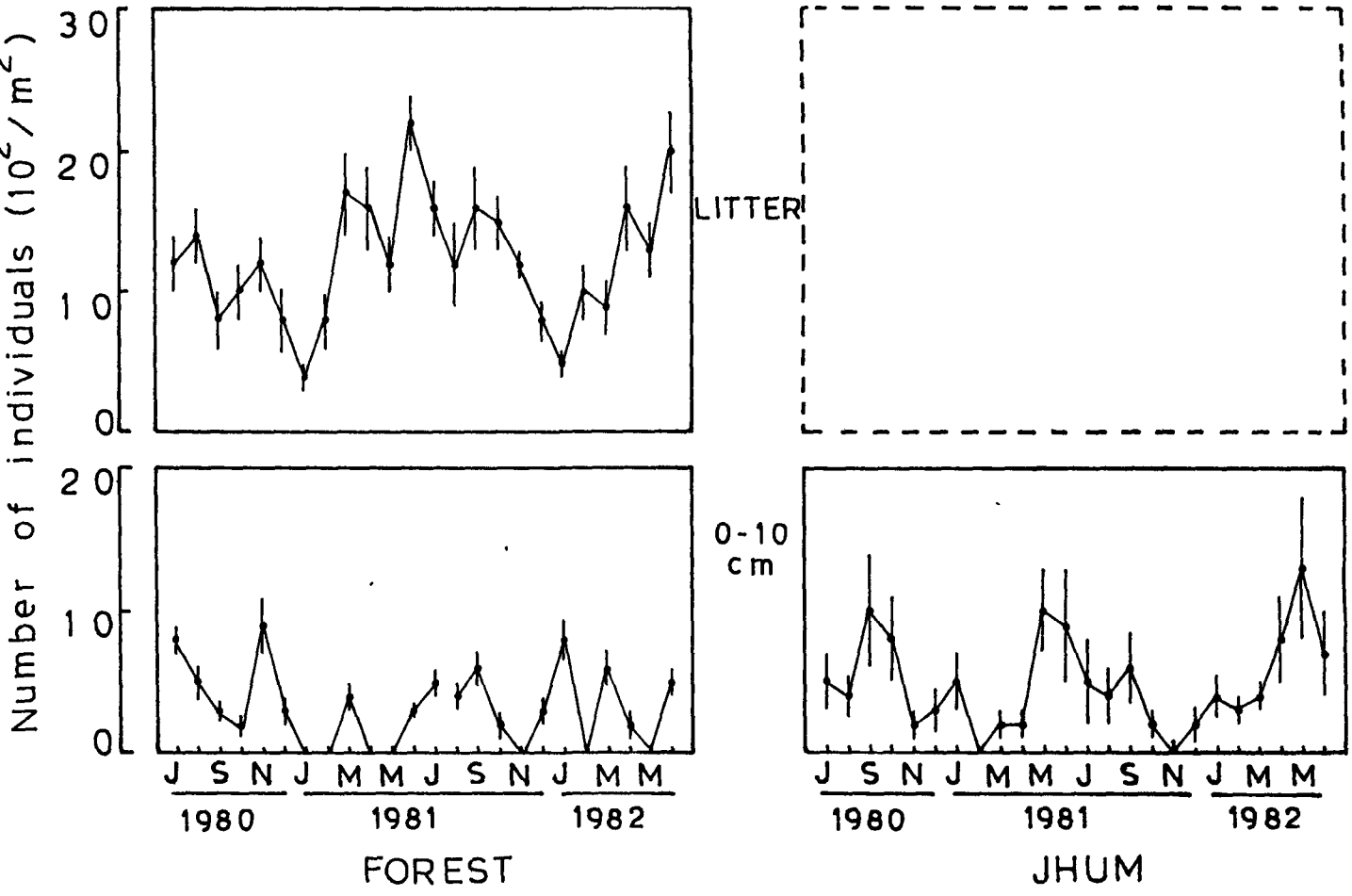

Number of individuals ($10^2/m^2$)
30
20
10
0
LITTER
20
10
0
0-10 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 36

soils during the first and second annual cycles. Thus, the litter layer of the first annual cycle showed the lowest population density of $18x10^2/m^2$ in December 1980 and a peak rise in April 1981 ($152x10^2/m^2$). The 0-10 cm soil depth had a range of $25x10^2/m^2$ in December 1980 to $103x10^2/m^2$ in October 1980. The next layer (10-20 cm) showed a minimum of $8x10^2/m^2$ in March 1981 to a maximum of $39x10^2/m^2$ in July 1980.

During the second annual cycle, the litter layer manifested a minimum population density of Prostigmata in January 1982 ($16x10^2/m^2$) and a maximum in October 1981 ($162x10^2/m^2$). At 0-10 cm layer, the population density ranged from $20x10^2/m^2$ in December 1981 to $121x10^2/m^2$ in January 1982. In the next layer of the soil (10-20 cm), November 1981 showed minimum density of $9x10^2/m^2$ and August 1981 as maximum ($46x10^2/m^2$).

At the 0-10 cm layer of the jhum soil, the population density of prostigmatid mites ranged from a minimum of $8x10^2/m^2$ in February 1981 to a maximum of $164x10^2/m^2$ in October 1980 during the first annual cycle. The population density at 0-10 cm layer of the jhum soil were minimum in November 1980 ($4x10^2/m^2$) and maximum in January 1981 ($28x10^2/m^2$).

In the second annual cycle, the 0-10 cm profile of the jhum soil had a maximum population density of $160x10^2/m^2$ in September 1981 and a minimum of $36x10^2/m^2$ in December 1981. The next soil profile (10-20 cm) recorded a minimum population density of $6x10^2/m^2$ during March 1982 and a maximum of $33x10^2/m^2$ in April 1982.

Fig. 37. Showing the seasonal fluctuations of Prostigmata (Acarina) in the different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

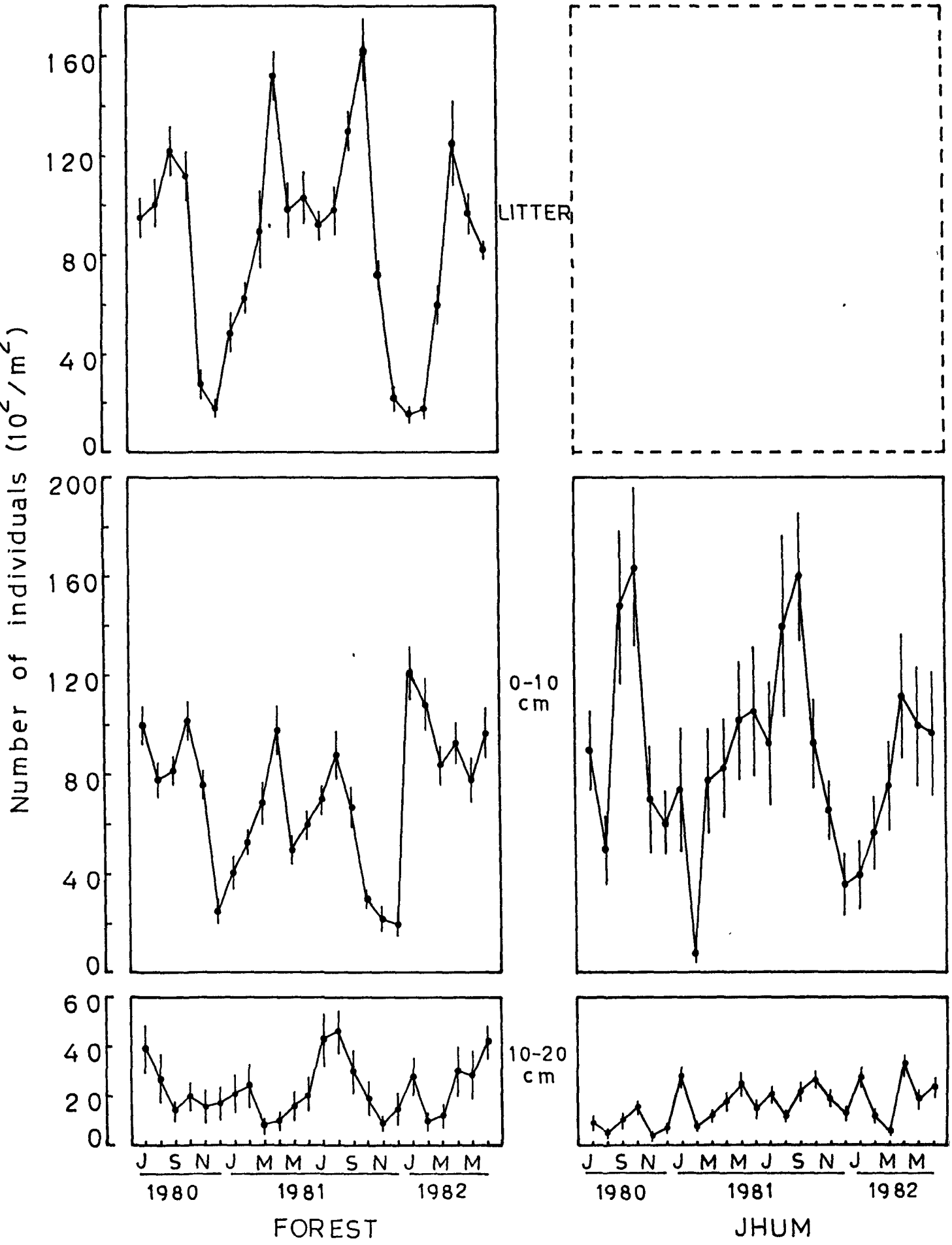

Number of individuals ($10^2/m^2$)
160
120
80
40
0
LITTER
200
160
120
80
40
0
0-10 cm
60
40
20
0
10-20 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 37

c. Sub-order Mesostigmata

Fig. 38 shows the seasonal changes of mesostigmatid mites in different layers of the forest and jhum soils. During the first annual cycle, the litter layer had a maximum population density of $97x10^2/m^2$ in October 1980 and a minimum in January 1981 ($19x10^2/m^2$). At 0-10 cm, the upper and lower limits of fluctuations were $34x10^2/m^2$ (April 1981) and $14x10^2/m^2$ (December 1980), respectively. The next layer's (10-20 cm) population fluctuations ranged from a minimum of $15x10^2/m^2$ in December 1980 to a maximum of $28x10^2/m^2$ in October 1980. As seen from the graph, maximum density of Mesostigmata at 20-30 cm layer was in January 1981 ($4x10^2/m^2$) but several months of the investigation period recorded non-occurrence of these mites at this depth.

In the second annual cycle, the minimum and maximum densities of the population fluctuated within the values of, respectively, $11x10^2/m^2$ (January 1982) and $110x10^2/m^2$ (October 1981) in the litter layer; $12x10^2/m^2$ (December 1981) and $39x10^2/m^2$ (September 1981 and April 1982) in the 0-10 cm soil profile; $15x10^2/m^2$ (November 1981) and $32x10^2/m^2$ (July 1981 and March 1982) in the 10-20 cm soil layer. Although the mesostigmatid mites were totally absent in most of the months at 20-30 cm soil depth, a density of $4x10^2/m^2$ in September 1981 was observed as maximum for this layer.

In the jhum soil and during the first annual cycle, the 0-10 cm soil depth showed a maximum density of Mesostigmata in May 1981 ($39x10^2/m^2$) and a minimum in February 1981 ($15x10^2/m^2$). The next layer (10-20 cm) exhibited a range of $3x10^2/m^2$ in

Fig. 38. Showing the seasonal fluctuations of Mesostigmata (Acarina) in different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

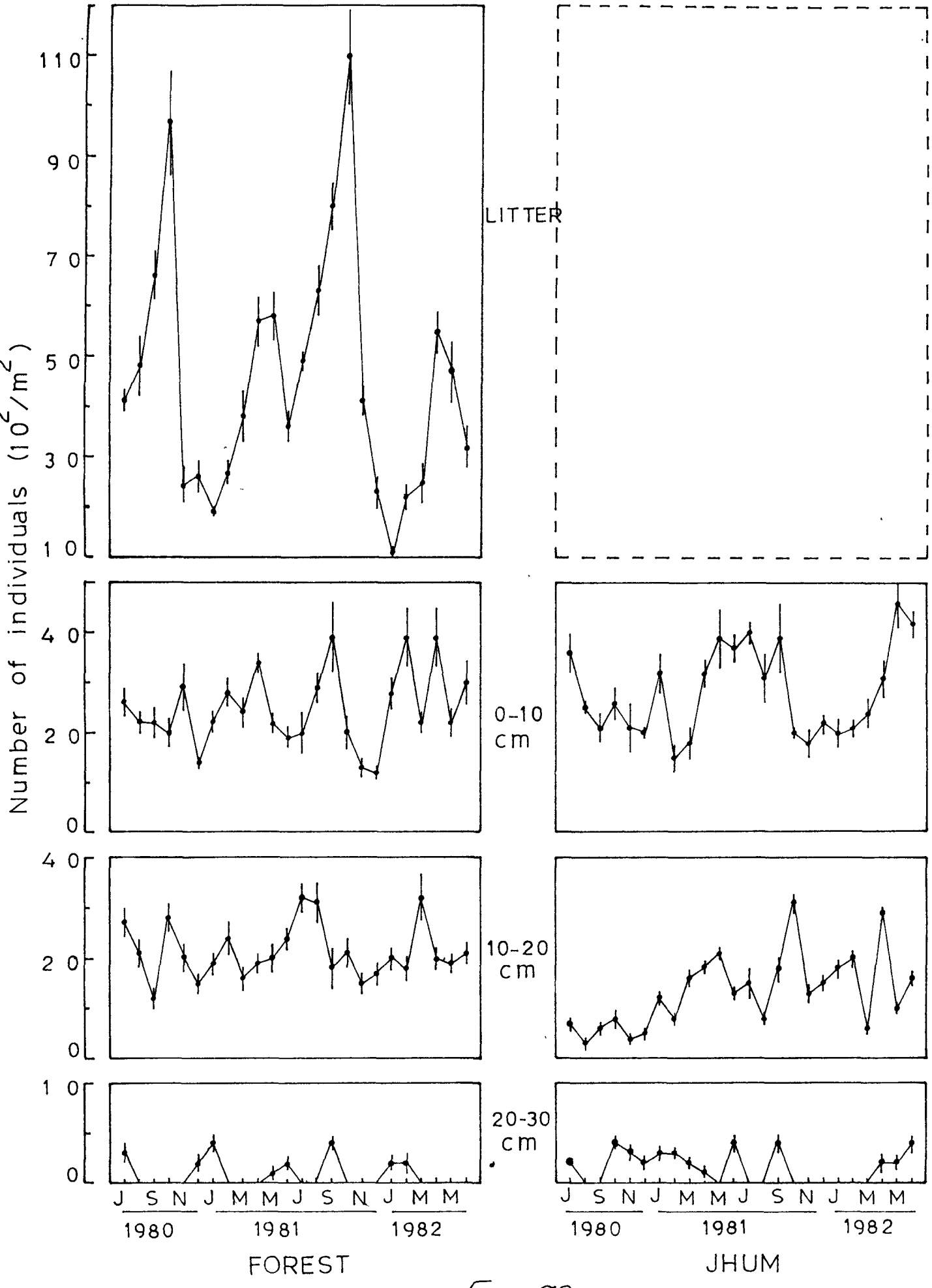

Number of individuals ($10^2/m^2$)
110
90
70
50
30
10
LITTER
40
20
0
0-10 cm
40
20
0
10-20 cm
10
0
20-30 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 38

August 1980 to $21x10^2/m^2$ in May 1981. At 20-30 cm layer, the mites were totally absent during the months of August-September 1980 and May 1981; maximum density of the layer was $4x10^2/m^2$ in the months of October 1980 and June 1981.

In the second annual cycle, the 0-10 cm soil depth had a maximum population density of $46x10^2/m^2$ in May 1982 and a minimum of $18x10^2/m^2$ in November 1981. At 10-20 cm, the ranges were $6x10^2/m^2$ (March 1982) and $36x10^2/m^2$ (October 1981) as the minimum and maximum densities, respectively. The next layer (20-30 cm) had a maximum density of $4x10^2/m^2$ in September 1981 and June 1982, although most of the months of the second annual cycle showed non-occurrence of the mites at this layer of the jhum soil.

The seasonal population dynamics of one species of mesostigmatid mite, viz. Parasitus diviortus Athias-Henriot has been worked out. All the other unidentified mites of Mesostigmata has been described under the category "other misostigmatid mites" in the present study.

c.1. Parasitus diviortus Athias-Henriot

Fig. 39 illustrates the monthly population variations of Parasitus diviortus in different layers of the forest and jhum soils. In the forest, during the first annual cycle, the maximum and minimum population densities of the species were $37x10^2/m^2$ (October 1980) and $7x10^2/m^2$ (January 1981) in the litter layer; $17x10^2/m^2$ (November 1980) and $6x10^2/m^2$ (July 1980) in the 0-10 cm soil profile; $24x10^2/m^2$ (February and June 1981)

and $15x10^2/m^2$ (December 1980) at 10-20 cm layer; $4x10^2/m^2$ (January 1981) and total absence in several months at 20-30 cm soil layer, respectively.

During the second annual cycle, the densities of the species ranged from $5x10^2/m^2$ in January 1982 to $31x10^2/m^2$ in October 1981 for the litter layer. At 0-10 cm soil depth, this species ranged from $5x10^2/m^2$ (November 1981) as minimum to $21x10^2/m^2$ (February 1982) as maximum. The next layer (10-20 cm) had a minimum density of $15x10^2/m^2$ in November 1981 and a maximum of $24x10^2/m^2$ in March 1982. Although, as seen in the graph, the mites were absent in most of the months at 20-30 cm soil depth, a maximum density of 4x10 /m was apparent during September 1981.

In the jhum soil, during the first annual cycle, the 0-10 cm profile of the soil showed a maximum density of the species in April 1981 ($18x10^2/m^2$) and a minimum in January 1981 ($4x10^2/m^2$). At 10-20 cm soil depth, the monthly population fluctuations ranged from a minimum of $2x10^2/m^2$ (August and December 1980) to a maximum of $10x10^2/m^2$ (April 1981). The next layer (20-30 cm) showed a peak in October 1980 and June 1981 ($4x10^2/m^2$) but were absent in few of the months.

In the second annual cycle, the 0-10 cm layer of the jhum soil had a maximum population density of $19x10^2/m^2$ in September 1981 and minimum of $6x10^2/m^2$ in February 1982. The ranges for 10-20 cm were $2x10^2/m^2$ (March 1982) to $10x10^2/m^2$ (October 1981). The third layer (20-30 cm) showed maximum of $4x10^2/m^2$ individuals, but were totally absent in several months of the second annual cycle.

Fig. 39. Showing the seasonal fluctuations of Parasitus diviortus Athias-Henriot (Mesostigmata : Acarina) in the different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

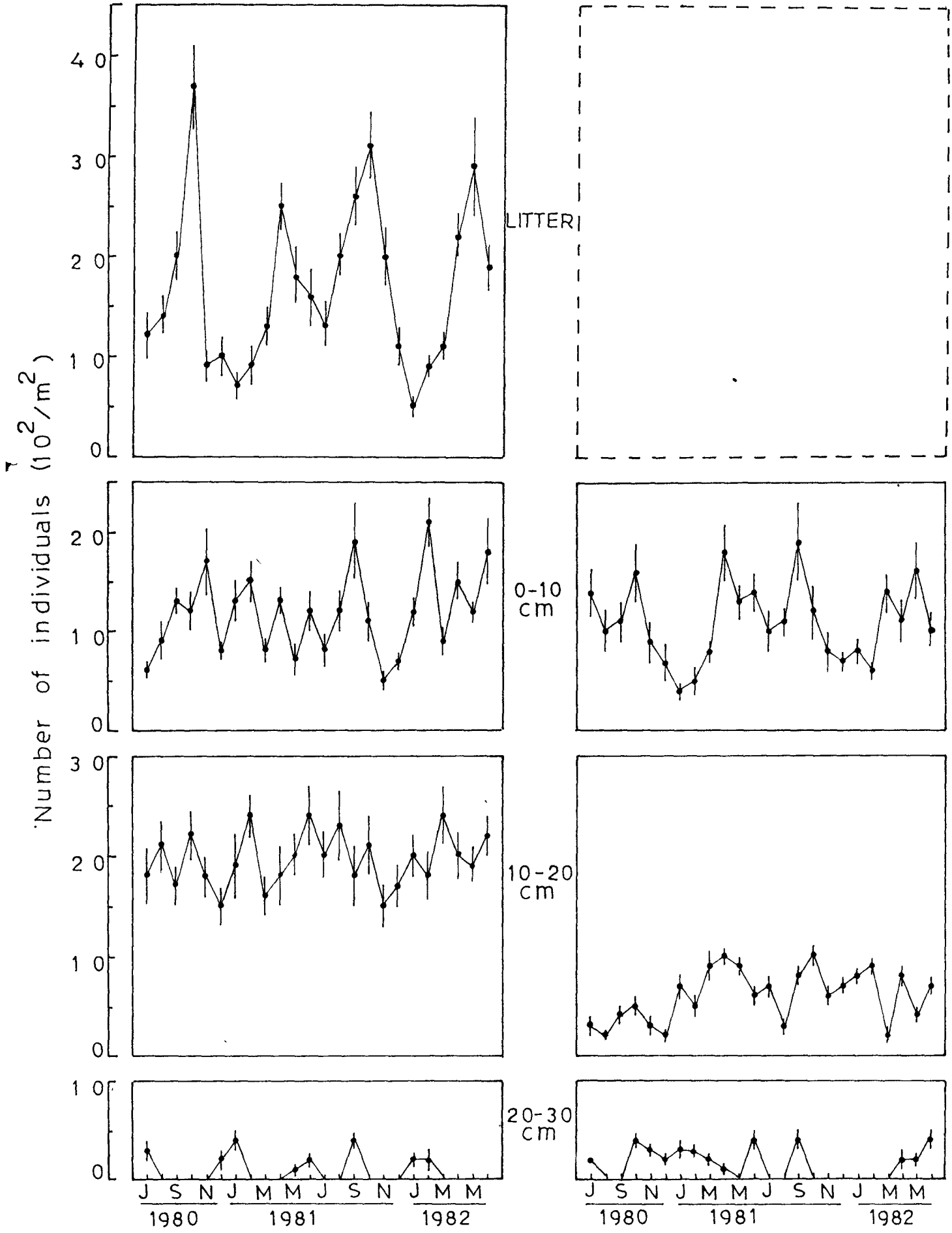

Number of individuals ($10^2/m^2$)
LITTER
0-10 cm
10-20 cm
20-30 cm
J S N J M M J S N J M M
1980
1981
1982

Fig. 39

c.2. Other mesostigmatid mites

Fig. 40 illustrates the monthly population densities of these mites in different layers of the forest and jhum soils for two annual cycles. In the forest during the first annual cycle, the litter layer recorded a minimum of these mites in January 1981 ($12x10^2/m^2$) and maximum in October 1980 ($60x10^2/m^2$). The 0-10 cm layer had a range of $6x10^2/m^2$ (December 1980) to $21x10^2/m^2$ (April 1981), as the minimum and maximum densities, respectively. The next layer (10-20 cm) had a maximum density of $9x10^2/m^2$ in July 1980 and a total absence for several months of the investigation period, as indicated in the figure.

In the second annual cycle, the population densities of these mites at the litter layer showed a range of $6x10^2/m^2$ (January 1982) as minimum to $79x10^2/m^2$ (October 1981) as maximum. The densities at 0-10 cm depth ranged from $5x10^2/m^2$ in December 1981 to $24x10^2/m^2$ in April 1982. At 20-30 cm layer, the mites were maximum in July 1981 ($12x10^2/m^2$) but were totally absent in most of the months of the investigation period.

At 0-10 cm layer of the jhum soil, the first annual cycle revealed a density-range of $10x10^2/m^2$ in few of the months to $28x10^2/m^2$ in January 1981. These mites were maximum in May 1981 ($12x10^2/m^2$) and minimum during August and November 1980 ($1x10^2/m^2$) at 10-20 cm layer of the jhum soil.

The maximum and minimum population densities of these mites during the second annual cycle were respectively $32x10^2/m^2$ (June 1982) and $8x10^2/m^2$ (October 1981) at 0-10 cm layer of the soil; $26x10^2/m^2$ (October 1981) and $4x10^2/m^2$ (March 1982) at 10-20 cm soil profile of the jhum.

Fig. 40. Showing the seasonal fluctuations of "other mesostigmatid mites" in the different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

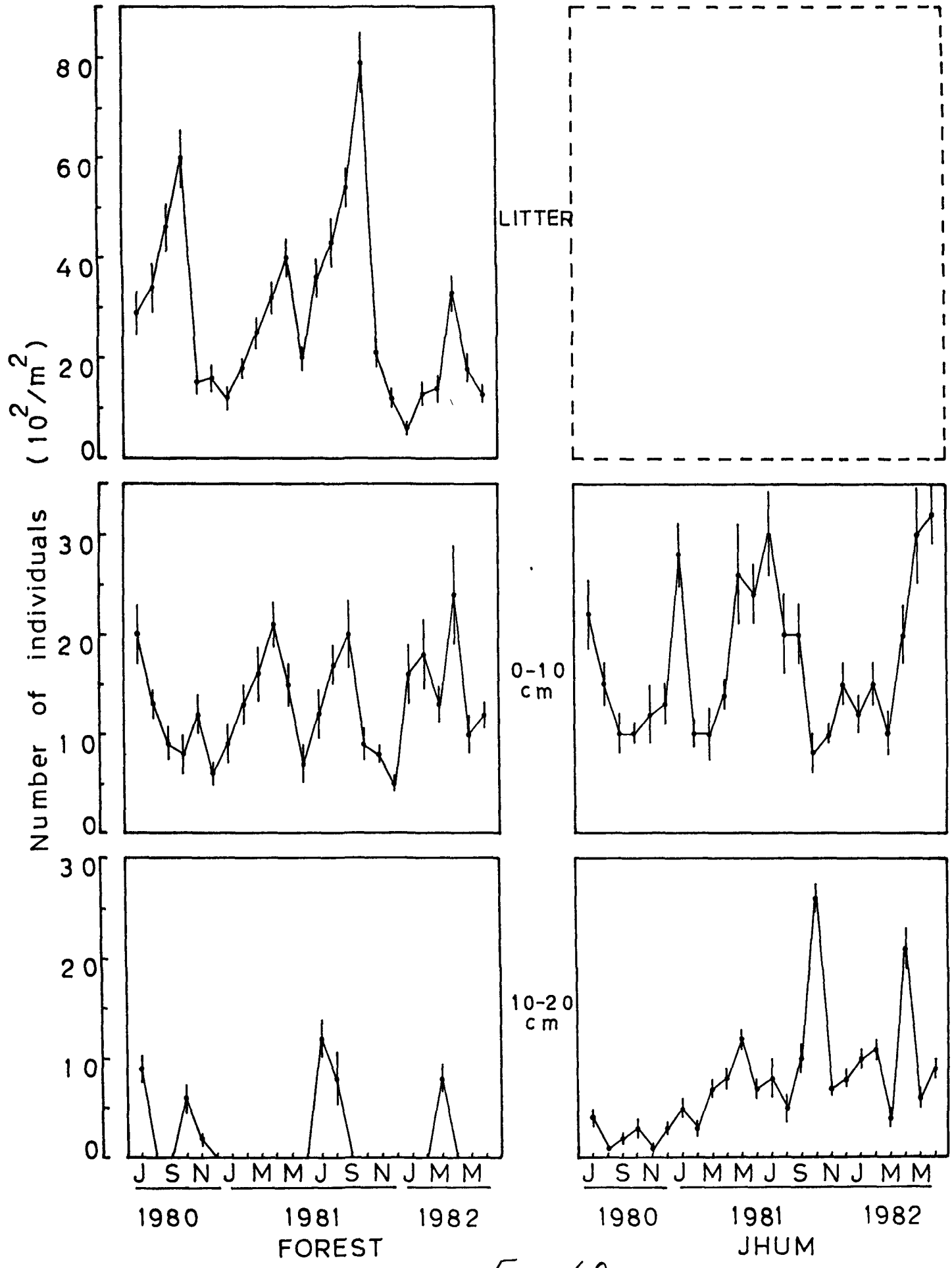

LITTER
0-10 cm
10-20 cm
Number of individuals (10²/m²)
0
10
20
30
40
60
80
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 40

d. Sub-order Cryptostigmata

The seasonal variations of the cryptostigmatid or oribatid mites in different profiles of the forest and jhum soils are illustrated in the Fig. 41. In the forest during the first annual cycle, the densities of Cryptostigmata at the litter layer ranged from a minimum of $86x10^2/m^2$ in December 1980 to a maximum of $534x10^2/m^2$ in October 1980. At 0-10 cm soil layer, this sub-order varied from $141x10^2/m^2$ (January 1981) to $297x10^2/m^2$ (September 1980). The next depth (10-20 cm) was very poorly populated by these mites, being only $6x10^2/m^2$ (July 1980) as maximum. Nil occurrences in most of the months of investigation was observed as seen in the figure.

In the second annual cycle, the densities of Cryptostigmata at the litter layer showed a minimum of $78x10^2/m^2$ in January 1982 and a maximum of $611x10^2/m^2$ in October 1981. The densities at 0-10 cm layer varied from $117x10^2/m^2$ (November 1981) to $308x10^2/m^2$ (September 1981). At 10-20 cm soil depth, only the months of July 1981 ($1x10^2/m^2$) and August 1981 ($2x10^2/m^2$) had the populations of these mites, whereas the remaining months recorded nil.

In the jhum soil during the first annual cycle, the 0-10 cm profile recorded a maximum population density of $96x10^2/m^2$ in September 1980 and a minimum of $20x10^2/m^2$ in February 1981. At 10-20 cm layer, these mites were recorded only in May 1981 ($2x10^2/m^2$) but were totally absent during the remaining months.

During the second annual cycle, the seasonality of these mites in terms of monthly densities ranged from $20x10^2/m^2$

Fig. 41. Showing the seasonal fluctuations of Cryptostigmata or oribatid mites (Acarina) in the different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

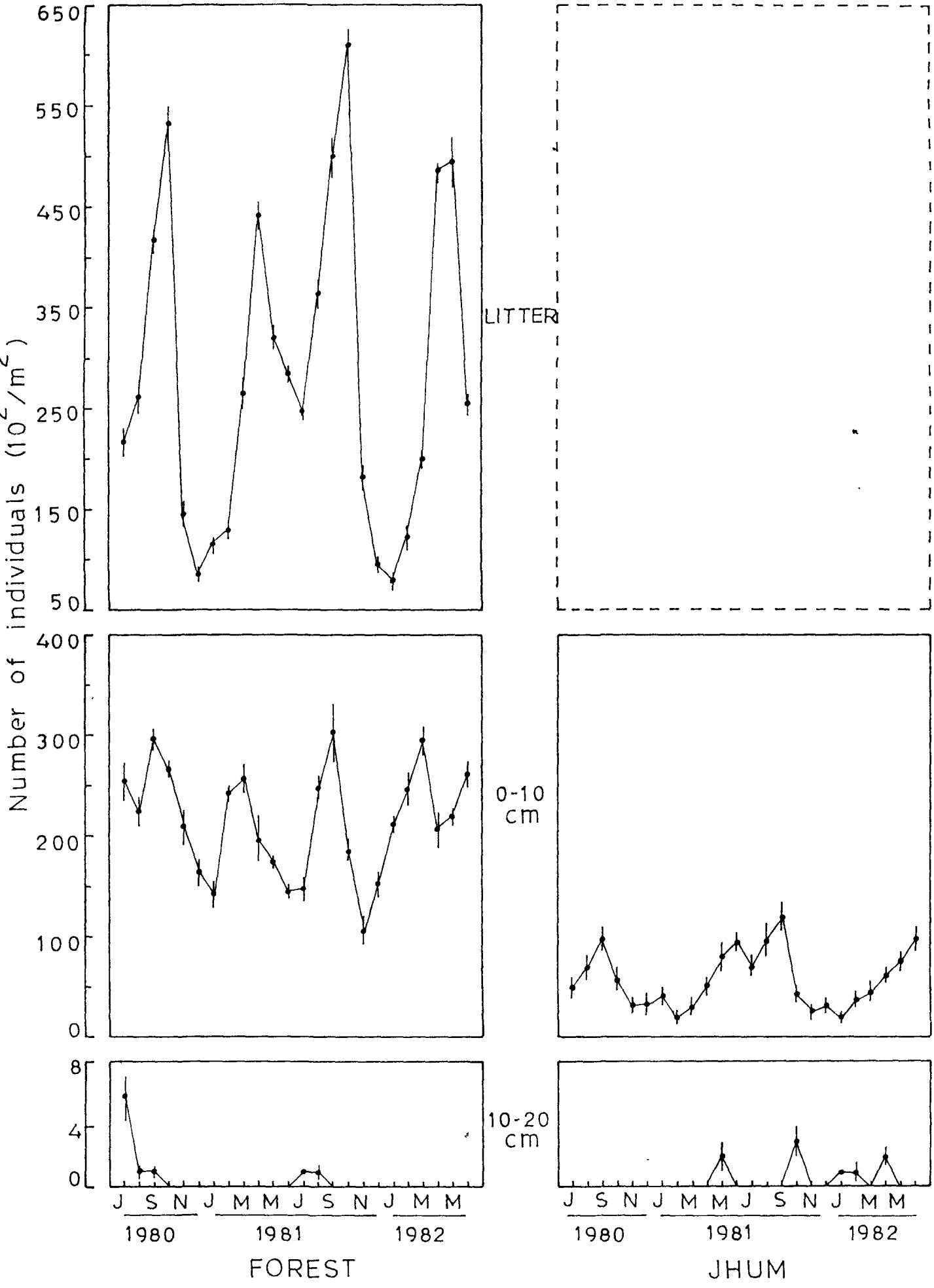

650
550
450
350
250
150
50
LITTER
Number of individuals ($10^2/m^2$)
400
300
200
100
0
0-10 cm
8
4
0
10-20 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 41

(January 1982) to 119x10^2/m^2 (September 1981) at 0-10 cm layer of the jhum soil. The ranges at 10-20 cm layer were 3x10^2/m^2 (October 1981) as maximum to total absence in several months of the investigation period, as depicted in the figure.

Cryptostigmata encountered in the present investigation have been described at family/genera/species level wherever identified for their seasonality.

d.1. Rhysotritia ardua Koch

The monthly densities of the species in the different profiles of the forest and jhum soils are represented in the Fig. 42. In the forest during the first annual cycle, the litter layer had a maximum population density these mites in October 1980 (103x10^2/m^2) and a minimum in December 1980 (10x10^2/m^2). The variations at 0-10 cm soil depth were 12x10^2/m^2 in April 1981 to 48x10^2/m^2 in September 1980.

During the second annual cycle, the maximum and minimum densities were respectively 112x10^2/m^2 (October 1981) and 8x10^2/m^2 (December 1981) for the litter layer; 50x10^2/m^2 (September 1981) and 13x10^2/m^2 (April 1982) for the 0-10 cm soil profile of the forest.

At 0-10 cm layer of the jhum soil, minimum population densities of Rhysotritia ardua were seen during the months of November and February of the first annual cycle, and December-January of the second annual cycle. The densities for these months were only 2x10^2/m^2. Maximum densities of 19x10^2/m^2 and 22x10^2/m^2 were seen during September of the first annual cycle and second annual cycles, respectively.

Fig. 42. Showing the seasonal fluctuations of Rhysotritia ardua Koch (Cryptostigmata : Acarina) in different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

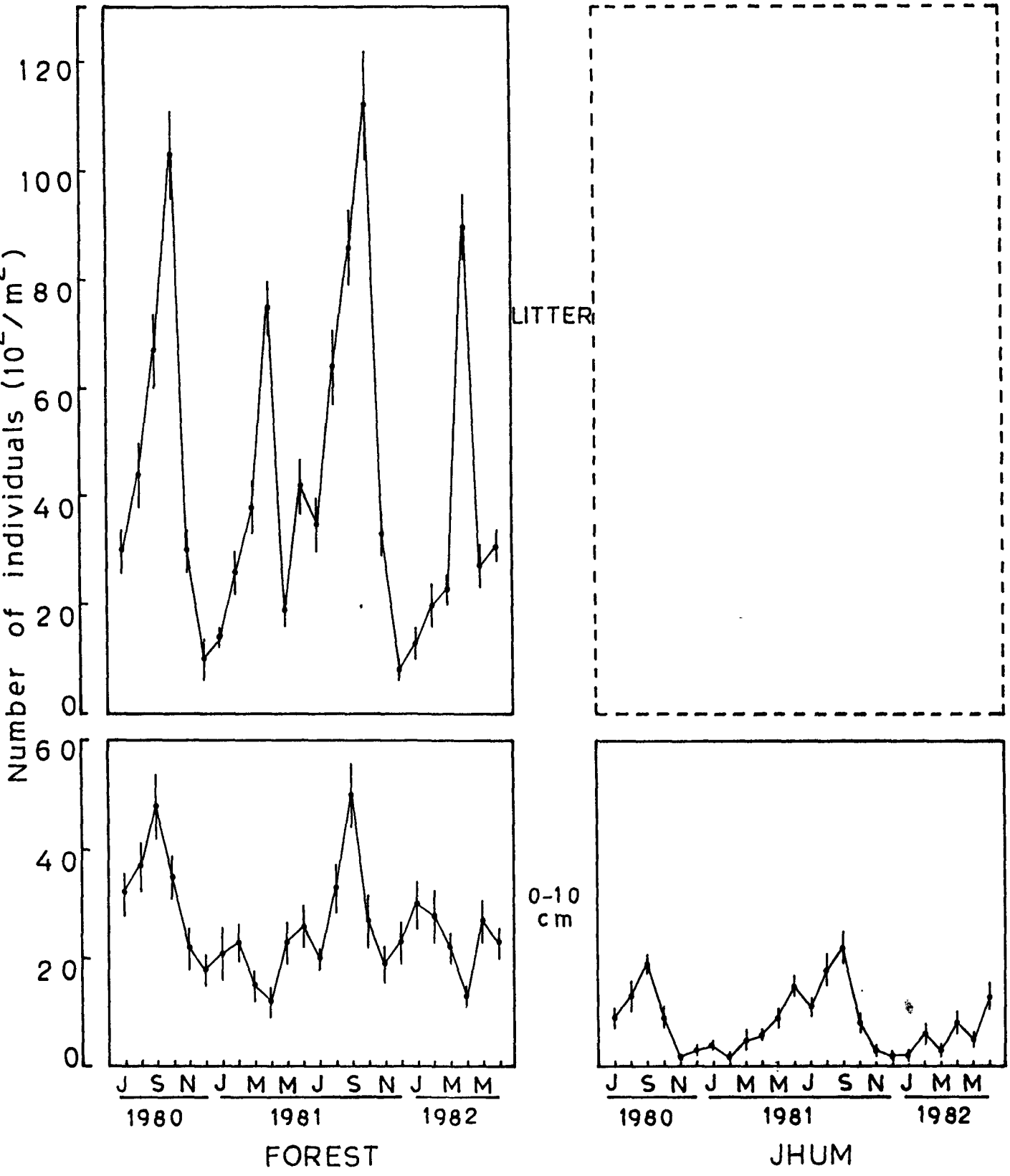

Number of individuals ($10^2/m^2$)
120
100
80
60
40
20
0
LITTER
60
40
20
0
0-10 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 42

d.2. Euphthiracarus sp.

Fig. 43 illustrates the population dynamics of these mites in different layers of the forest and jhum soils. In the litter layer during the first annual cycle, the mites were maximum ($32x10^2/m^2$) in October 1980 and minimum ($6x10^2/m^2$) in December 1980. The densities of these mites at 0-10 cm ranged from a minimum of $3x10^2/m^2$ in June 1981 to a maximum of $19x10^2/m^2$ in March 1981.

The second annual cycle density of the mites in the litter layer ranged from a minimum of $7x10^2/m^2$ in July 1981 to a maximum of $24x10^2/m^2$ in April 1982. At 0-10 cm layer, the minimum and maximum ranges were $6x10^2/m^2$ and $18x10^2/m^2$ in July and March, respectively.

In the 0-10 cm profile of the jhum soil, the maximum population densities of these mites were recorded in September and April ($4x10^2/m^2$) of the first annual cycle and during June 1982 ($5x10^2/m^2$) of the second annual cycle. However, as seen in the figure, these mites were totally absent in several months of both the annual cycles.

d.3. Mesotritia sp.

As shown in Fig. 44, the litter layer showed a maximum density of Mesotritia sp. in October 1980 ($69x10^2/m^2$) and a minimum of $11x10^2/m^2$ in December 1980, during the first annual cycle. The highest and the lowest densities for the 0-10 cm layer were respectively $43x10^2/m^2$ (March 1981) and $12x10^2/m^2$ (June 1981) during the same period of investigation.

Fig. 43. Showing the seasonal fluctuations of Euphthiracarus sp. (Cryptostigmata : Acarina) in different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

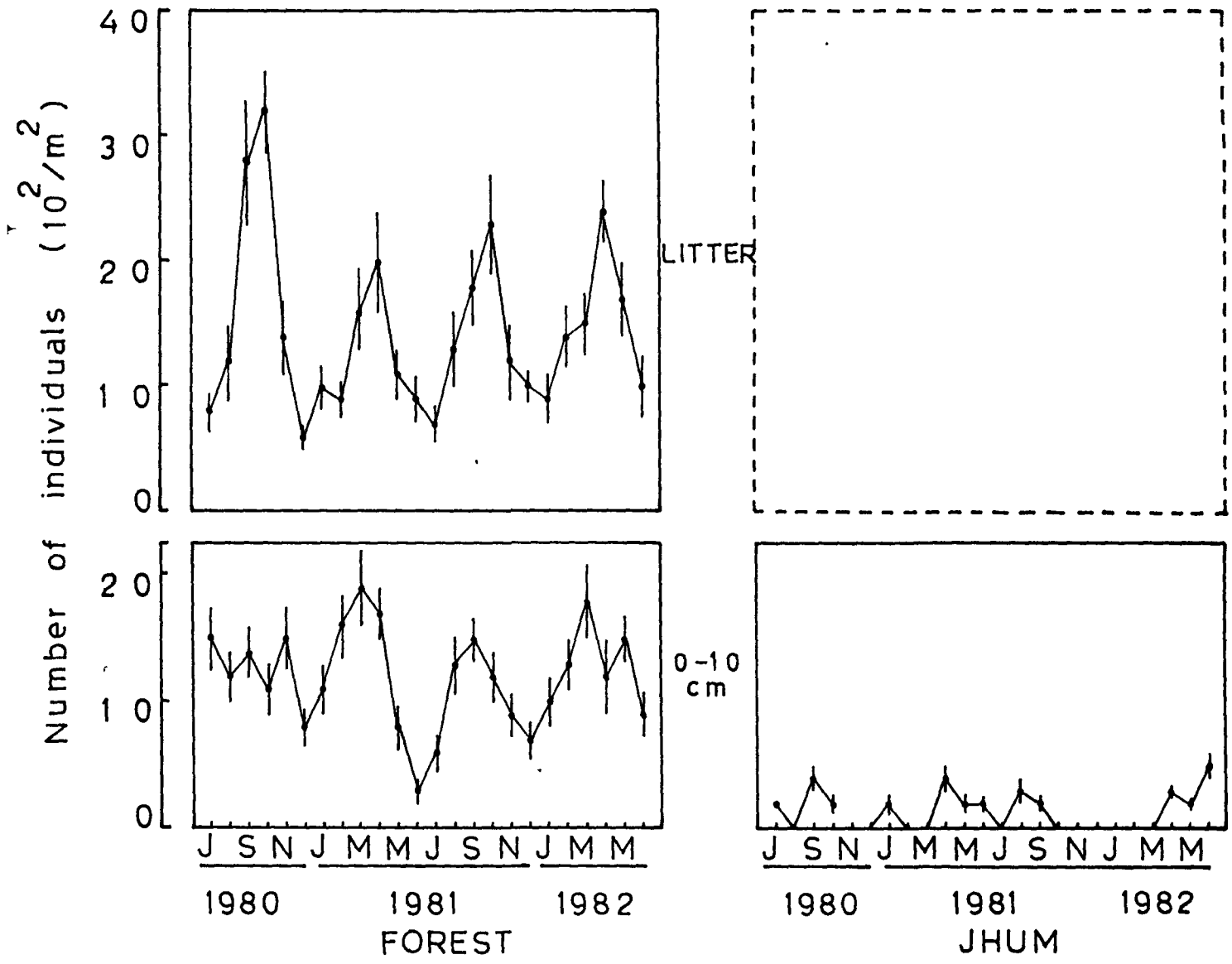

Number of individuals (10²/m²)
40
30
20
10
0
LITTER
20
10
0
0-10 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
J S N J M M J S N J M M
1980
1981
1982
JHUM

Fig. 43

Fig. 44. Showing the seasonal fluctuations of Meso-tritia sp. (Cryptostigmata : Acarina) in different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

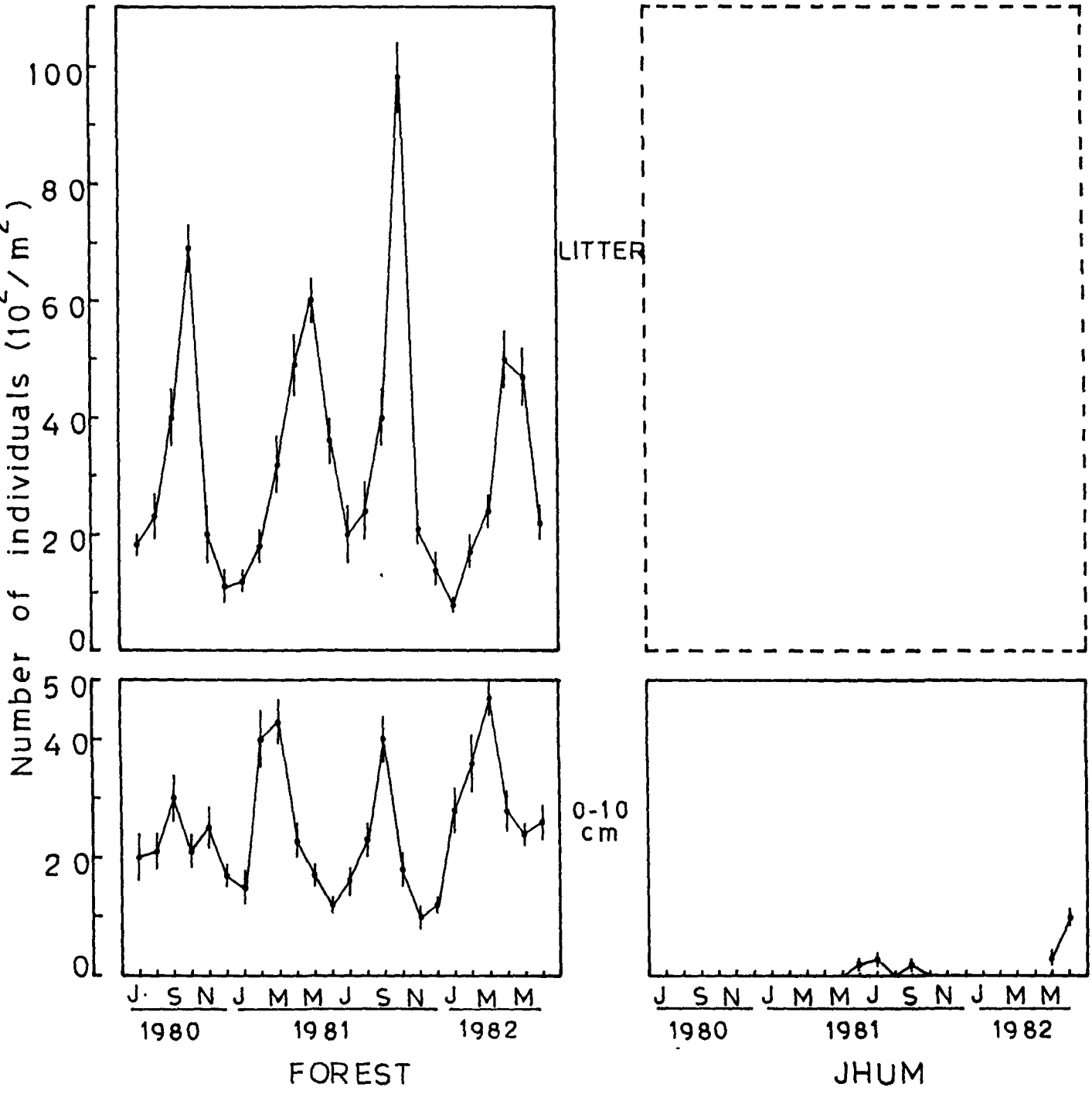

Number of individuals ($10^2/m^2$)
100
80
60
40
20
0
LITTER
50
40
20
0
0-10 cm
J· S N J M M J S N J M M
1980
1981
1982
FOREST
J S N J M M J S N J M M
1980
1981
1982
JHUM

Fig. 44

The second annual cycle densities at the litter layer varied from a maximum of $98x10^2/m^2$ in October 1981 to a minimum of $8x10^2/m^2$ in January 1982. The highest and the lowest values for the 0-10 cm profile were $47x10^2/m^2$ (March 1982) and $10x10^2/m^2$ (November 1981), respectively.

In the jhum system, as illustrated in the figure, most of the months of the investigation period recorded non-occurrence of Mesotritia sp. at its 0-10 cm layer. However, maximum densities of the first and second annual cycles were respectively 3x10 /m (June 1981) and 10x10 /m (June 1982).

d.4. Galumna sp.

During the first annual cycle, the litter layer of the forest exhibited $7x10^2/m^2$ (December 1980) as minimum and $54x10^2/m^2$ (April 1981) as maximum densities (Fig. 45) of Galumna sp. These mites were the least in number during January 1981 ($18x10^2/m^2$) with a peak in October 1980 ($42x10^2/m^2$) at 0-10 cm profile.

The maximum and minimum population densities for the second annual cycle were respectively $78x10^2/m^2$ (September 1981) and $7x10^2/m^2$ (January 1982) in the litter layer; $40x10^2/m^2$ (March 1982) and $11x10^2/m^2$ (November 1981) in the 0-10 cm depth.

At 0-10 cm profile of the jhum soil, the months of September and November respectively recorded the maximum and minimum population densities. These values recorded in densities were $23x10^2/m^2$ and $4x10^2/m^2$ during the first annual cycle; $29x10^2/m^2$ and $2x10^2/m^2$ during the second annual cycle.

Fig. 45. Showing the seasonal fluctuations of Galumna sp. (Cryptostigmata : Acarina) in different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

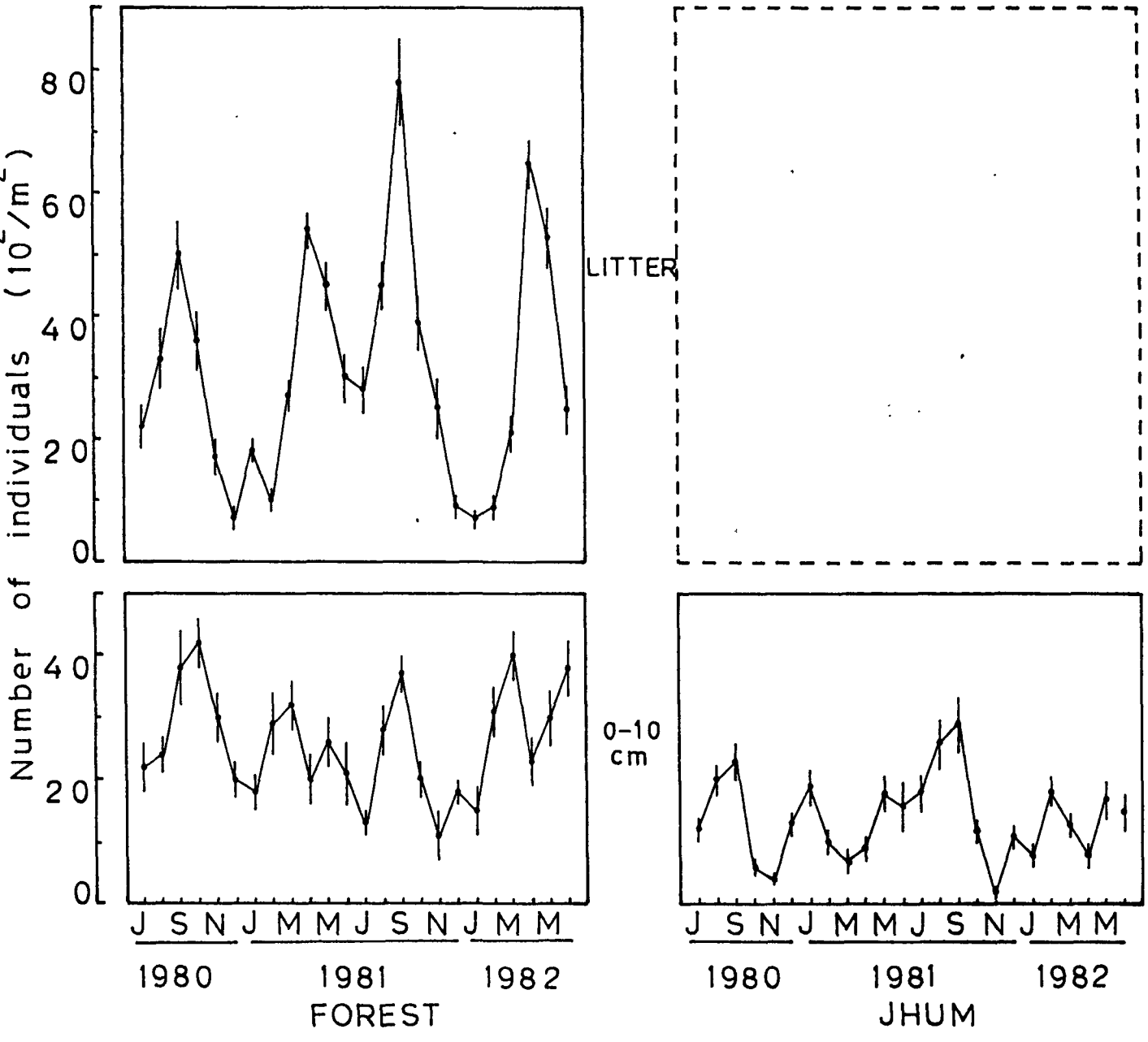

Number of individuals ($10^2/m^2$)
80
60
40
20
0
LITTER
40
20
0
0-10 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
J S N J M M J S N J M M
1980
1981
1982
JHUM

Fig. 45

d.5. Neoribates sp.

Fig. 46 illustrates the monthly population densities of Neoribates sp. in different layers of the forest and jhum soils for two annual cycles. In the forest during the first annual cycle, the litter layer had a minimum population density of $10x10^2/m^2$ in November 1980 and a maximum of $95x10^2/m^2$ in April 1981. At 0-10 cm layer, while the month of September 1980 recorded maximum density ($50x10^2/m^2$), minimum was observed in May 1981 ($12x10^2/m^2$). At 10-20 cm layer of the forest soil, the mites were recorded only in July 1980 ($2x10^2/m^2$) during the first annual cycle.

In the second annual cycle, the litter layer recorded a maximum density of $108x10^2/m^2$ (October 1981) and a minimum of $11x10^2/m^2$ (December 1981). Neoribates sp. at 0-10 cm layer were maximum during the months of September, March and June ($46x10^2/m^2$) and minimum in November 1981 ($9x10^2/m^2$).

At 0-10 cm layer of the jhum soil, these mites were maximum in densities during September, true for both the annual cycle. The densities were $31x10^2/m^2$ and $38x10^2/m^2$ for the first and second annual cycles, respectively. The minimum densities were $5x10^2/m^2$ (February 1981) during the first annual cycle and $4x10^2/m^2$ (January 1982) during the second annual cycle.

d.6. Dolicheremaeus sp.

The monthly population seasonality of Dolicheremaeus sp. in different profiles of the forest and jhum soils are represented in the Fig. 47. During the first annual cycle, the

Fig. 46. Showing the seasonal fluctuations of Neoribates sp. (Cryptostigmata : Acarina) in different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

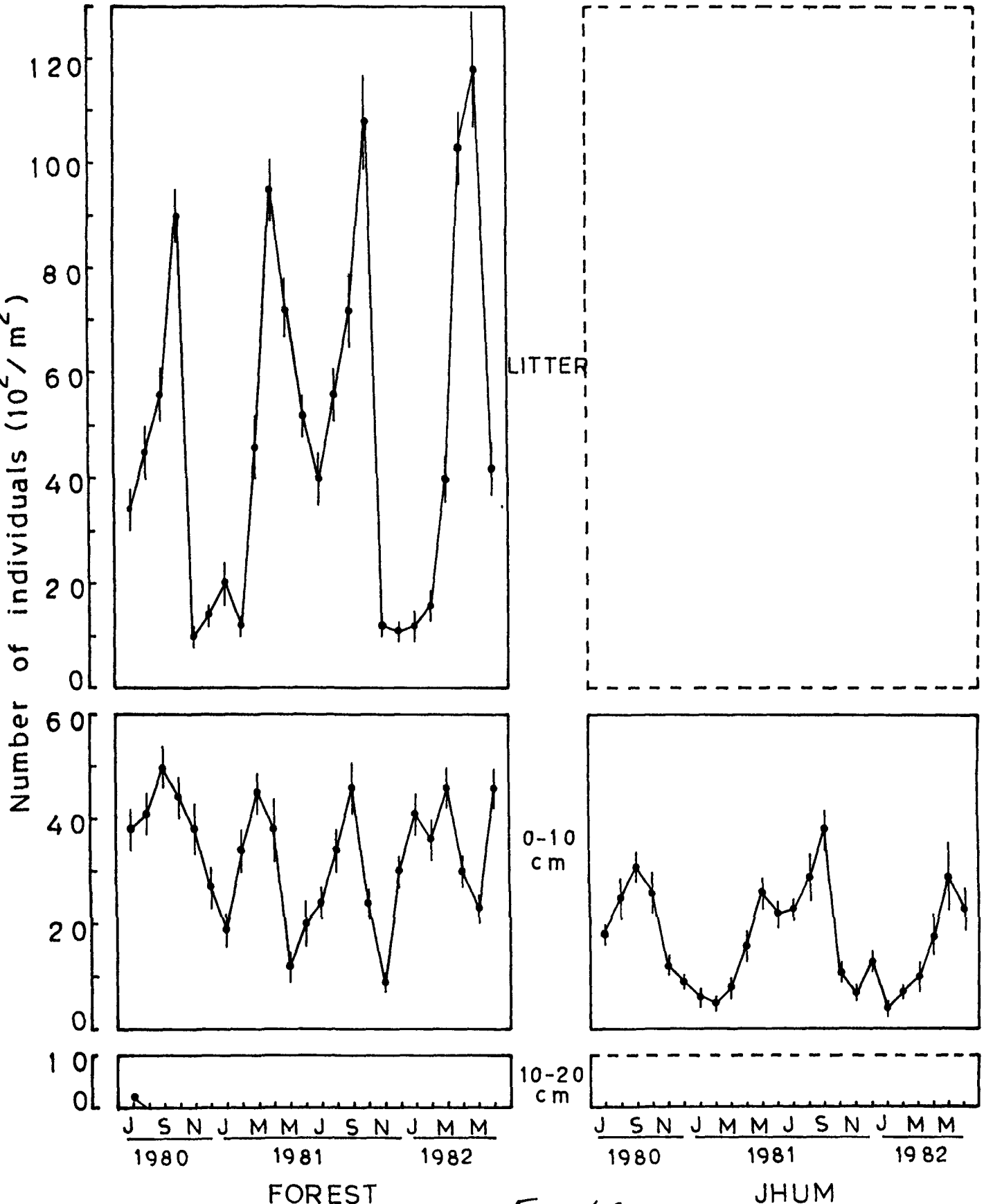

Number of individuals ($10^2/m^2$)
120
100
80
60
40
20
0
LITTER
60
40
20
0
0-10 cm
10
0
10-20 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 46

Fig. 47. Showing the seasonal fluctuations of Dolicheremaeus sp. (Cryptostigmata : Acarina) in different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

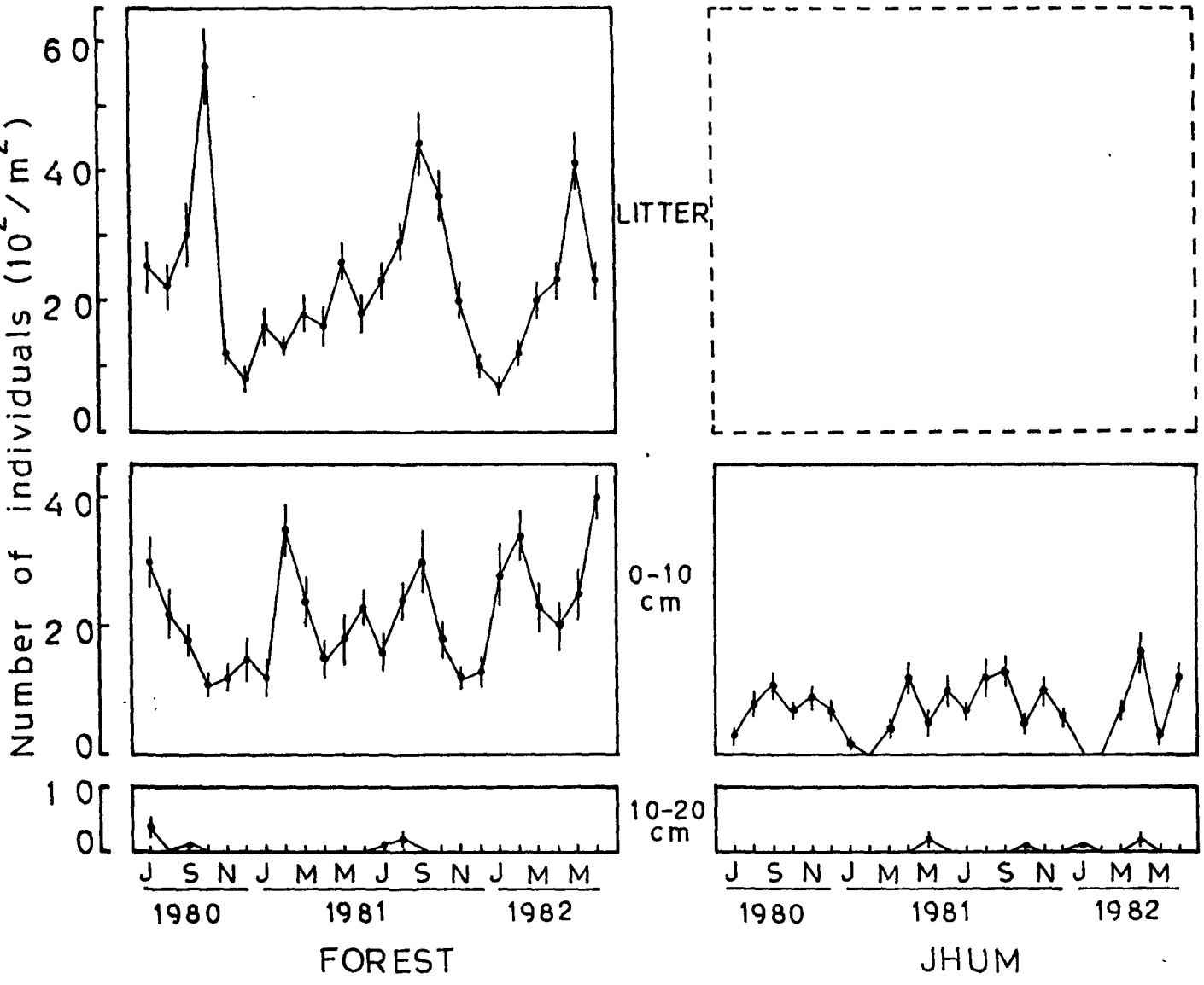

Number of individuals ($10^2/m^2$)
60
40
20
0
LITTER
40
20
0
0-10 cm
10
0
10-20 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 47

litter layer of the forest exhibited a maximum population density of $56x10^2/m^2$ in October 1980 and a minimum of $8x10^2/m^2$ in December 1980. The 0-10 cm layer showed a range of $11x10^2/m^2$ in October 1980 to $35x10^2/m^2$ in February 1981. At 10-20 cm soil layer, the mites occurred only in the months of July 1980 ($4x10^2/m^2$) and September 1980 ($1x10^2/m^2$).

During the second annual cycle, the litter layer had a maximum population density of $44x10^2/m^2$ (September 1981) and a minimum of $7x10^2/m^2$ (January 1982). The soil layer at 0-10 cm depth showed a minimum of $12x10^2/m^2$ in November 1981 and a maximum of $40x10^2/m^2$ during June 1982.

At 0-10 cm depth of the jhum soil, Dolicheremaeus sp. were maximum in density during April of both the annual cycles. The number of individuals were $12x10^2/m^2$ and $16x10^2/m^2$ respectively during the first and second annual cycles. However, the mites were totally absent during February of the first annual cycle and January-February of the second annual cycle. At 10-20 cm depth, the maximum densities ($2x10^2/m^2$) were during May 1981 and April 1982 of the first and second annual cycles, respectively, although the mites were not recorded throughout the investigation period, as evident from the figure.

d.7. Eremobelba sp.

Fig. 48 illustrates the monthly variations of the population densities of Eremobelba sp. from the forest and jhum systems for two annual cycles. During the first annual cycle, these mites at the litter layer of the forest were highest in

Fig. 48. Showing the seasonal fluctuations of Eremobelba sp. (Cryptostigmata : Acarina) in different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

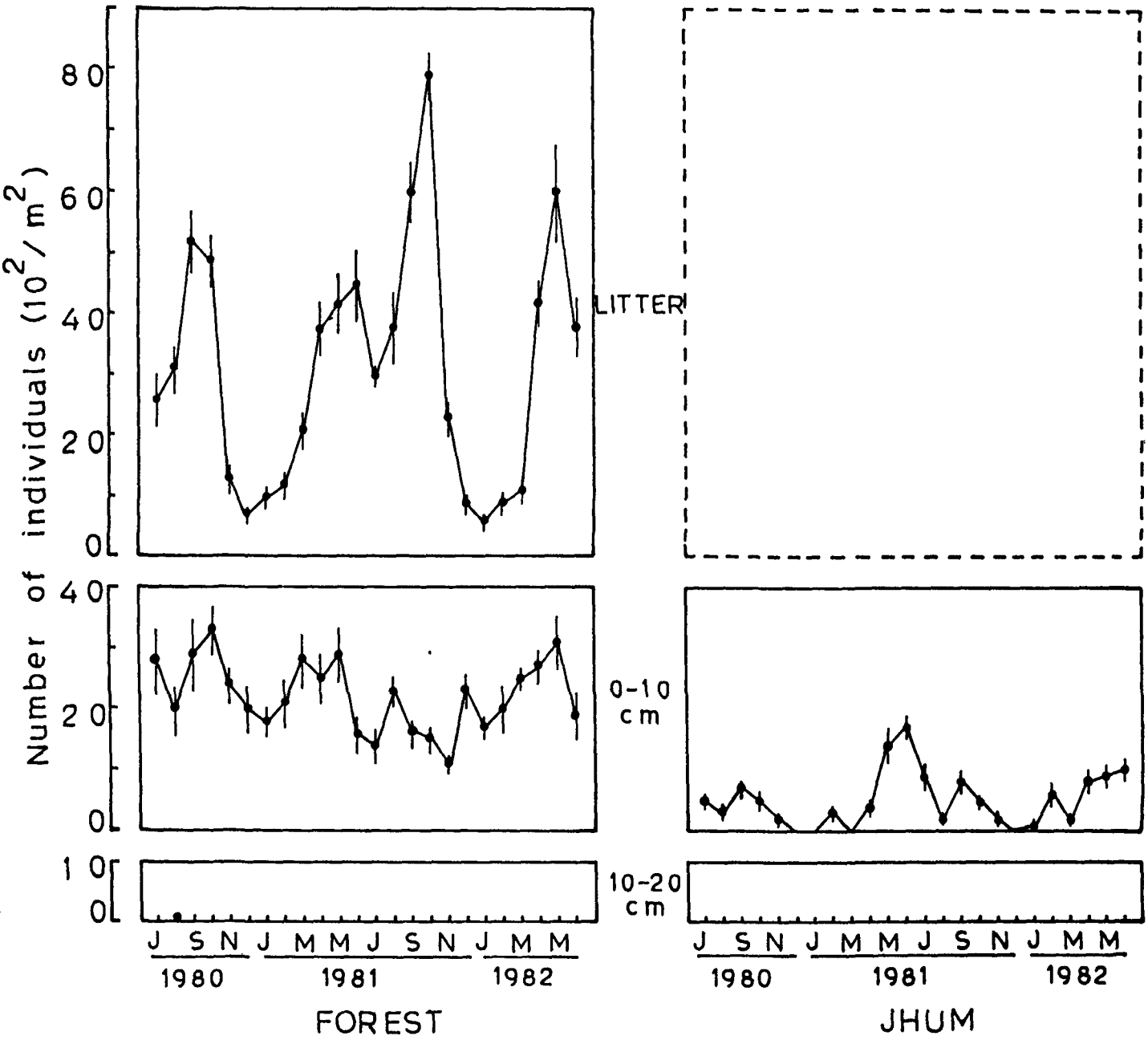

Number of individuals ($10^2/m^2$)
80
60
40
20
0
LITTER
40
20
0
0-10 cm
10
0
10-20 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 48

number in September 1980 ($52x10^2/m^2$) and the least during December 1980 ($7x10^2/m^2$). The forest soil profile at 0-10 cm recorded a maximum density of $33x10^2/m^2$ in October 1980 and a minimum of $16x10^2/m^2$ in June 1981. At 10-20 cm layer, the mites occurred only in August 1980 ($1x10^2/m^2$) but were totally absent during the remaining months of the investigation period.

In the second annual cycle, the litter layer had a maximum population density of $79x10^2/m^2$ in October 1981 and a minimum of $7x10^2/m^2$ in January 1982. The densities of the mites at 0-10 cm layer ranged from a minimum of $11x10^2/m^2$ (November 1981) to a maximum of $27x10^2/m^2$ (April 1982).

At 0-10 cm profile of the jhum soil, Eremobelba sp. were maximum in June, true for both the annual cycles. Thus, the numbers for the first and second annual cycles were respectively $17x10^2/m^2$ and $10x10^2/m^2$. However, the mites showed non-occurrence at this depth during December, January and March of the first annual cycle and only December of the second annual cycle.

d.8. Brachychthonius sp.

The graphical illustrations in Fig. 49 represents the seasonal densities of Brachychthonius sp. in different profiles of the forest and jhum systems. During the first annual cycle, the litter layer of the forest showed maximum density in April 1981 ($20x10^2/m^2$) and minimum in June 1981 ($3x10^2/m^2$). The densities at 0-10 cm layer were $17x10^2/m^2$ as maximum during September 1980 and $7x10^2/m^2$ as minimum during the month of June 1981.

Fig. 49. Showing the seasonal fluctuations of Brachychthonius sp. (Cryptostigmata : Acarina) in different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

Fig. 50. Showing the seasonal fluctuations of Suctobelba sp. (Cryptostigmata : Acarina) in the different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

Fig. 49

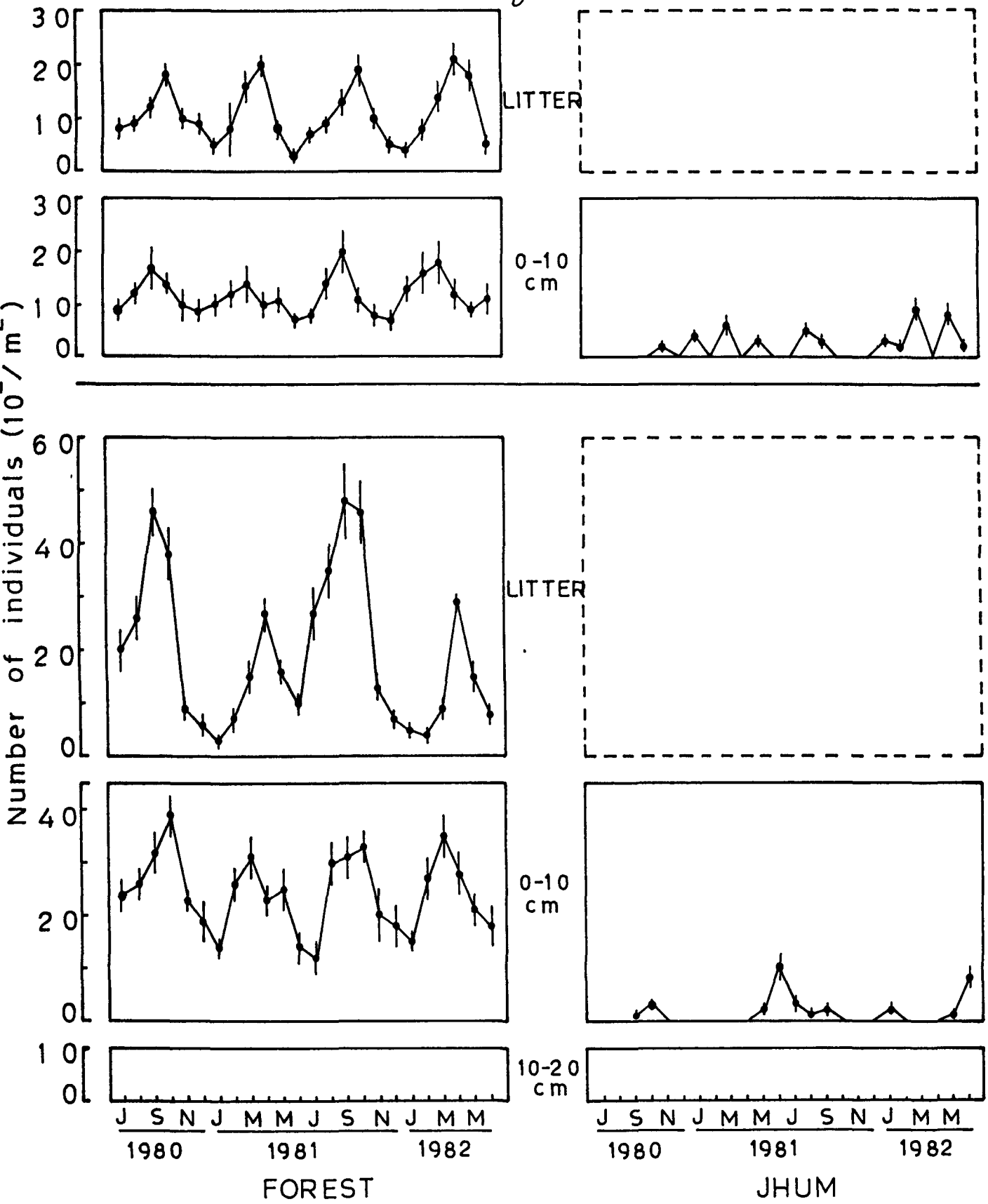

Number of individuals ($10^2/m^2$)
LITTER
0-10 cm
10-20 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 50

During the second annual cycle, the lowest and the highest densities of these mites were in January 1982 ($4x10^2/m^2$) and April 1982 ($21x10^2/m^2$), respectively in the litter layer. At 0-10 cm layer, these ranges were $7x10^2/m^2$ in December 1981 and $20x10^2/m^2$ in September 1981, respectively.

In the jhum system and at its 0-10 cm soil profile, the peak densities of these mites were recorded in March, true for both the annual cycles. Thus, these numbers were $6x10^2/m^2$ and $9x10^2/m^2$ during the first and second annual cycles, respectively. However, as seen in the figure, the species/genera were totally absent in several months of the study period.

d.9. Suctobelba sp.

Fig. 50 represents the population seasonality of Suctobelba sp. in different layers of the forest and jhum soils during the two annual cycles of investigation. In the forest during the first annual cycle, the maximum and minimum population densities of these mites were respectively $46x10^2/m^2$ (September 1980) and $3x10^2/m^2$ (January 1981) in the litter layer; $39x10^2/m^2$ (October 1980) and $14x10^2/m^2$ (January and June 1981) in the 0-10 cm profile of the forest soil.

In the second annual cycle, the population peaks and lowest densities were respectively $48x10^2/m^2$ (September 1981) and $4x10^2/m^2$ (February 1982) for the litter layer; $35x10^2/m^2$ (March 1982) and $12x10^2/m^2$ (July 1981) for the 0-10 cm forest soil profile.

At 0-10 cm layer of the jhum soil, maximum densities

of these mites were in June, being $10x10^2/m^2$ for the first and $8x10^2/m^2$ for the second annual cycle. At 10-20 cm soil depth, these mites were recorded only during October 1981 ($2x10^2/m^2$) and February 1982 ($1x10^2/m^2$) of the entire study period.

d.10. Uropodidae

The litter recorded $2x10^2/m^2$ individuals of Uropodidae as minimum during several months of the study period (Fig. 51). Maximum densities were in April, being $16x10^2/m^2$ for the first and $12x10^2/m^2$ for the second annual cycle. At 0-10 cm depth of the soil, maximum densities were in September ($8x10^2/m^2$ for the first annual cycle; $10x10^2/m^2$ for the second annual cycle). The winter months did not record any Uropodidae. These were also totally absent in the jhum system.

d.11. Other Oribatid mites

These were recorded only from the forest system in the present study (Fig. 52). During the first annual cycle, the maximum and minimum densities were respectively $35x10^2/m^2$ (June 1981) and $4x10^2/m^2$ (December 1980) in the litter layer, and $32x10^2/m^2$ (July 1980) and $2x10^2/m^2$ (June 1981) in the 0-10 cm soil profile. In the second annual cycle, the population fluctuations in the litter layer ranged from $4x10^2/m^2$ in January 1982 to $93x10^2/m^2$ in May 1982. At 0-10 cm layer, the fluctuations were $4x10^2/m^2$ in October 1981 to $28x10^2/m^2$ in June 1982.

Fig. 51. Showing the seasonal population fluctuations of Uropodidae (Cryptostigmata : Acarina) in two different layers of the forest system for two annual cycles. (Vertical lines show the standard error).

Fig. 52. Showing the seasonal population fluctuations of "other oribatid mites" in two different layers of the forest system for two annual cycles. (Vertical lines show the standard error).

Fig. 51

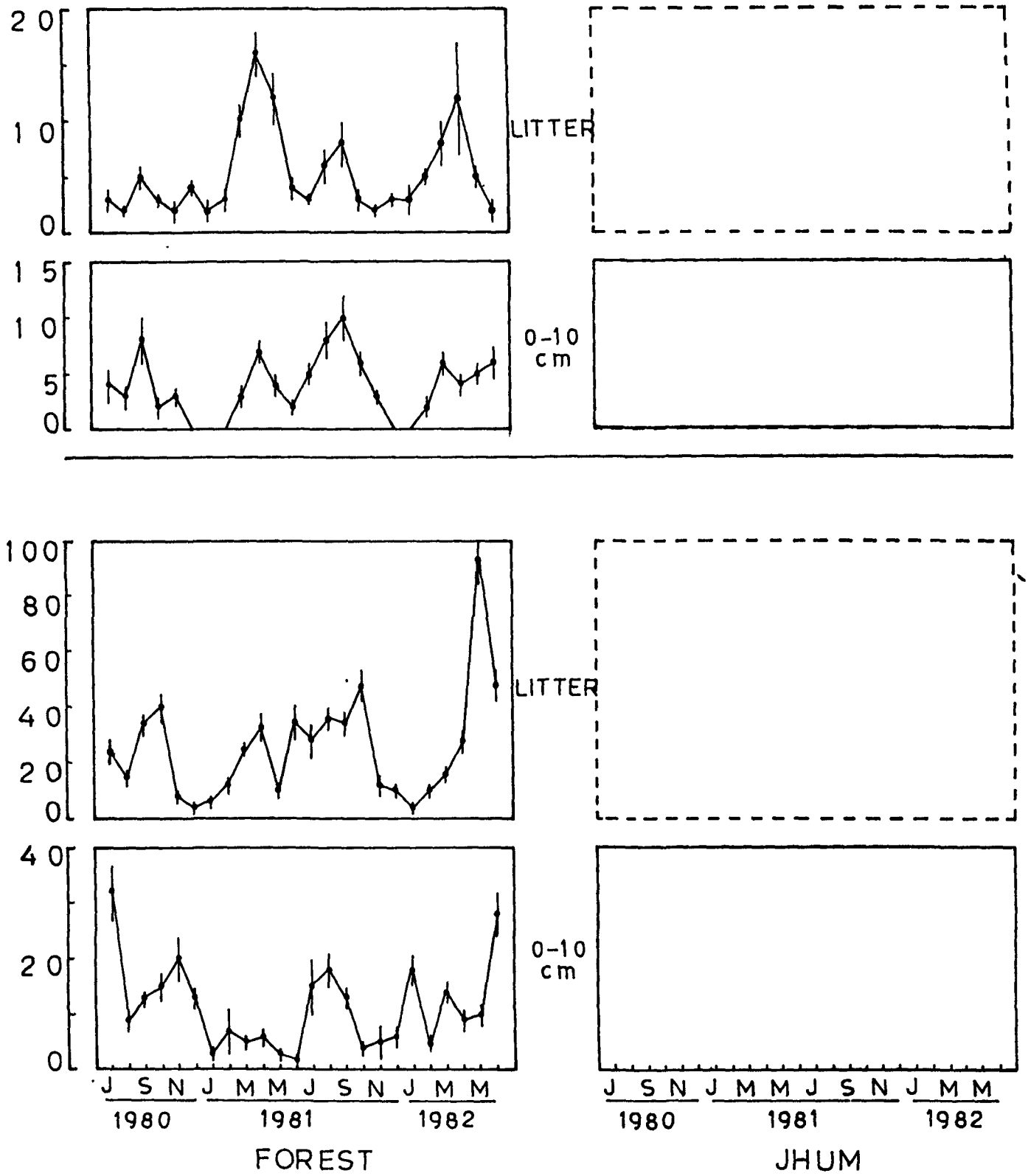

20
10
0
LITTER
15
10
5
0
0-10
cm
100
80
60
40
20
0
LITTER
40
20
0
0-10
cm
J S N J M M J S N J M M
1980 1981 1982
FOREST
J S N J M M J S N J M M
1980 1981 1982
JHUM

Fig. 52

4.2.2.4. Other arthropods

Fig. 53 represents the seasonal densities of "Other arthropods" (other than Collembola and Acarina) in the forest and jhum systems. During the first annual cycle, the forest system had maximum densities of "other arthropods" in November 1980 ($316x10^2/m^2$) and minimum in January 1981 ($132x10^2/m^2$). Total densities of "other arthropods" during the second annual cycle were maximum in August 1981 ($418x10^2/m^2$) and minimum in May 1982 ($114x10^2/m^2$).

In the total system of the jhum, maximum-minimum densities of "other arthropods" were respectively $151x10^2/m^2$ (August 1980) and $74x10^2/m^2$ (November 1980) during the first annual cycle; $172x10^2/m^2$ (September 1981) and $42x10^2/m^2$ (June 1982) during the second annual cycle.

In different layers of the forest and jhum soils, "other arthropods" showed variable densities in different months. Thus, during the first annual cycle, the litter layer had a maximum density of $202x10^2/m^2$ in July 1980 and a minimum of $85x10^2/m^2$ in January 1981. The maximum and minimum densities of "other arthropods" in the 0-10 cm soil profile were respectively during September 1980 ($91x10^2/m^2$) and December 1980 ($37x10^2/m^2$). In the next layer (10-20 cm), the densities ranged from nil occurrence in February 1981 to a maximum of $27x10^2/m^2$ in May 1981. Maximum densities of the populations at 20-30 cm and 30-40 cm soil depths were respectively $28x10^2/m^2$ (August 1980) and $24x10^2/m^2$ (September 1980). In both the layers, "other arthropods" were absent during several months, as shown in the figure.

During the second annual cycle, the litter layer showed population peak during August 1981 ($232x10^2/m^2$) and minimum in December 1981 ($66x10^2/m^2$). The maximum and minimum densities at 0-10 cm depth were $161x10^2/m^2$ (October 1981) and $36x10^2/m^2$ (May 1982), respectively. At 10-20 cm layer, the "other arthropods" were absent during January 1982 but reached to a peak in September 1981 with $14x10^2/m^2$ individuals. Maximum densities at 20-30 cm and 30-40 cm soil layers were respectively $88x10^2/m^2$ and $16x10^2/m^2$, both occurring during the month of August of the second annual cycle.

The 0-10 cm layer of the jhum soil during the first annual cycle recorded a peak population density of $70x10^2/m^2$ in February 1981 and a minimum of $22x10^2/m^2$ in March 1981. In the next layer (10-20 cm), the highest ($83x10^2/m^2$) and the lowest ($4x10^2/m^2$) numbers of individuals were observed during the months of August 1980 and January 1981, respectively. The maximum densities at 20-30 cm and 30-40 cm were respectively $44x10^2/m^2$ (October 1980) and $28x10^2/m^2$ (November 198). However, during several months of the study period, the "other arthropods" were totally absent in both the layers.

In the second annual cycle, the densities at 0-10 cm ranged from $20x10^2/m^2$ (October 1981) to $56x10^2/m^2$ (February 1982). The number individuals were highest during September 1981 ($123x10^2/m^2$) and the least during July 1981 ($8x10^2/m^2$) for 10-20 cm soil profile. The peak densities at 20-30 cm and 30-40 cm were respectively $23x10^2/m^2$ (October 1981) and $48x10^2/m^2$ (April 1982). However, the "other arthropods" were absent during few months in both the 20-30 cm and 30-40 cm layers.

Fig. 53. Showing the seasonal fluctuations of "Other Arthropods" in the total systems of the forest and jhum systems, and in their different layers for two annual cycles. (Vertical lines show the standard error).

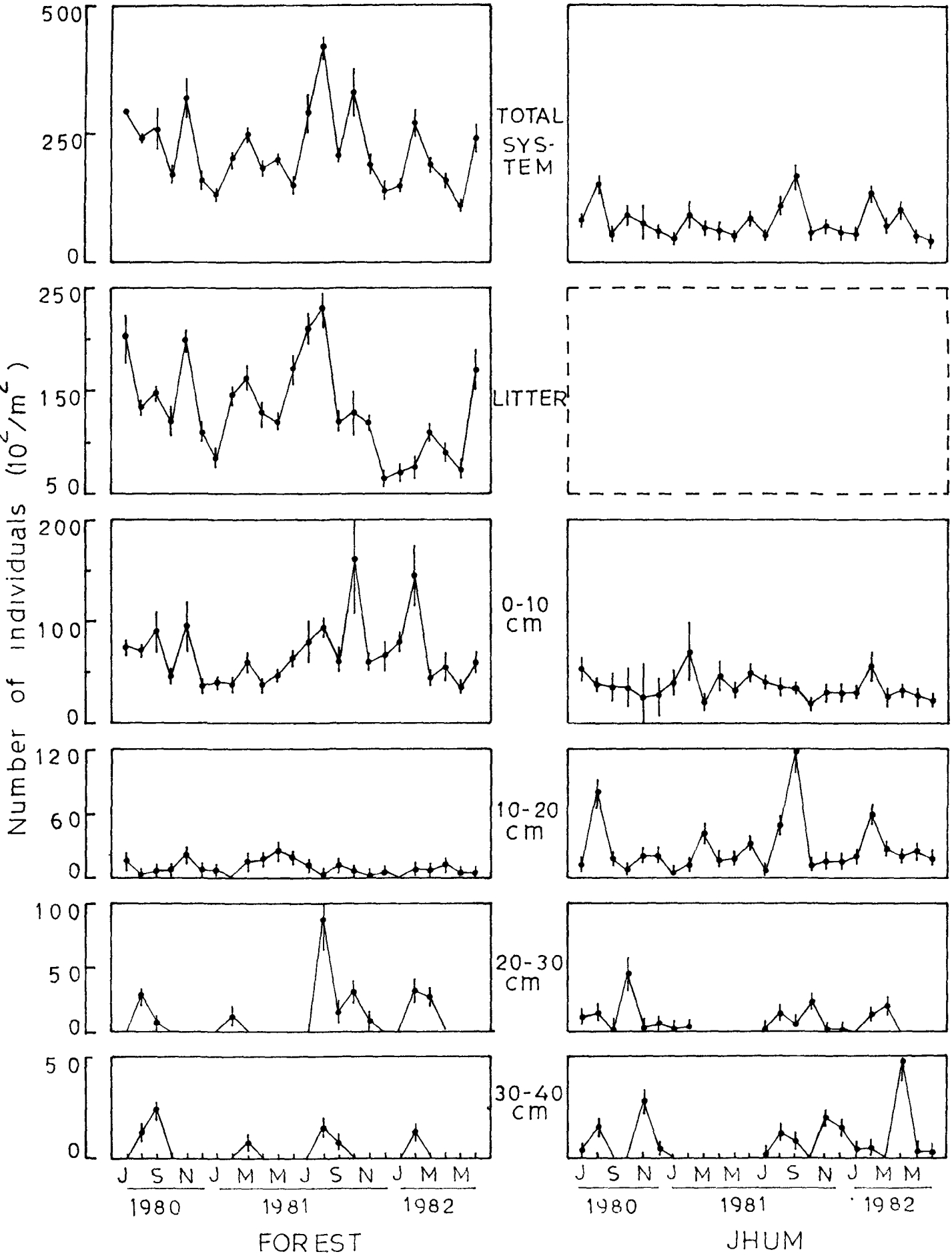

500
250
0
TOTAL SYS-TEM
250
150
50
LITTER
Number of individuals ($10^2/m^2$)
200
100
0
0-10 cm
120
60
0
10-20 cm
100
50
0
20-30 cm
50
0
30-40 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
J S N J M M J S N J M M
1980
1981
1982
JHUM

Fig. 53

The "other arthropods" were categorised into four classes, viz. Insecta, Myriapoda, Arachnida and Crustacea. The seasonal population dynamics of these arthropods and their orders are described below.

a. Class Insecta

Fig. 54 represents the monthly population dynamics of the insects recorded from the different layers of the forest and jhum soils for two annual cycles. During the first annual cycle, the maximum and minimum population densities of the insects were respectively $131x10^2/m^2$ (November 1980) and $49x10^2/m^2$ (May 1981) in the litter layer; $76x10^2/m^2$ (November 1980) and $12x10^2/m^2$ (May 1981) in the 0-10 cm soil profile; $104x10^2/m^2$ (February 1981) and $4x10^2/m^2$ (December 1980 and April 1981) in the 10-20 cm layer of the forest soil. In the next 20-30 cm and 30-40 cm layers, the maximum densities of Insecta were during the months of August 1980 ($28x10^2/m^2$) and September 1980 ($24x10^2/m^2$). However, the insects were totally absent in several months of the investigation period at both the layers of the forest soil.

In the second annual cycle, the litter layer had a maximum density of $95x10^2/m^2$ in August 1981 and June 1982, and a minimum of $40x10^2/m^2$ in February 1982. At 0-10 cm layer, the densities of the insects were maximum in October 1981 and minimum in May 1982, being $141x10^2/m^2$ and $10x10^2/m^2$, respectively. The next layer (10-20 cm) recorded a maximum population density of $68x10^2/m^2$ in December 1981 but showed a complete absence in January 1982. In the 20-30 cm and 30-40 cm soil profiles, the

Fig. 54. Showing the seasonal fluctuations of Insecta in different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

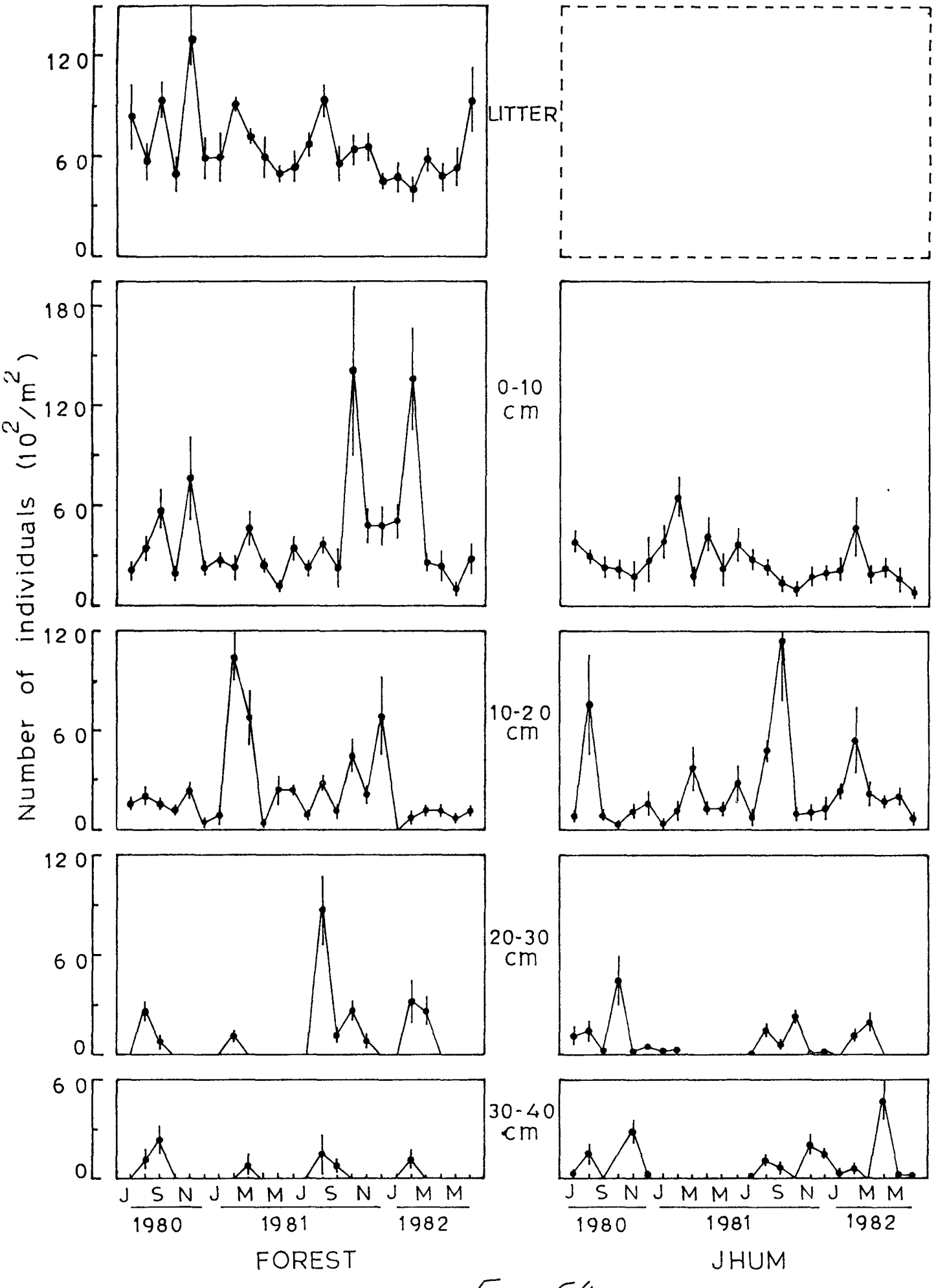

Number of individuals ($10^2/m^2$)
LITTER
0-10 cm
10-20 cm
20-30 cm
30-40 cm
120
60
0
180
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 54

maximum populations of insects were $88x10^2/m^2$ (August 1981) and $16x10^2/m^2$ (August 1981), respectively. However, as shown in the figure, the insects were absent in several months of the study period at both the layers.

For the jhum soil, the first annual cycle densities ranged from $18x10^2/m^2$ individuals (November 1980 & March 1981) to $66x10^2/m^2$ (February 1981) at its 0-10 cm profile. The next soil layer (10-20 cm) recorded maximum populations in August ($76x10^2/m^2$) and minimum in October and January ($4x10^2/m^2$). The 20-30 cm soil depth had a maximum population of $44x10^2/m^2$ during October 1980 and total absence during March to June of the first annual cycle. In the last layer (30-40 cm), although a maximum density of $28x10^2/m^2$ was recorded during November 1980, most of the months of the investigation period were devoid of insects (Fig. 54).

During the second annual cycle, the 0-10 cm layer of the jhum soil had a maximum population density of insects in February 1982 ($48x10^2/m^2$) and a minimum in June 1982 ($9x10^2/m^2$). At 10-20 cm layer, the population density ranged from $8x10^2/m^2$ (July 1981 & June 1982) to $116x10^2/m^2$ (September 1981). In the next layer (20-30 cm), population peak was in October 1981 ($23x10^2/m^2$) but the months of January, April, May and June showed total absence of these insects at this layer. In the last layer too, insects were absent in the months of October 1981 and March 1982, although April 1982 showed a peak ($48x10^2/m^2$).

The class Insecta had the following orders and are described for their population dynamics.

a.1. Diplura

Fig. 55 illustrates the seasonal population dynamics of Diplura in the different layers of forest and jhum soils for two annual cycles. Except in the litter layer, Diplura did not show monthly continuity of occurrence. Thus, in the litter layer, the population densities of Diplura ranged from $2x10^2/m^2$ (September 1980) to $12x10^2/m^2$ (December 1980) and $2x10^2/m^2$ (November & January) to $8x10^2/m^2$ (December 1980) during the first and second annual cycles, respectively.

At 0-10 cm depth of the forest soil, equal densities of $4x10^2/m^2$ as maximal were attained during September, November, February and May of the first annual cycle, and only June 1982 of the second annual cycle. However, Diplura did not occur during October, May and April of the first annual cycle and November, December and April of the second annual cycle.

The maximum population densities of Diplura at 10-20 cm soil layer of the forest were $8x10^2/m^2$ and $12x10^2/m^2$ in November of the first and second annual cycles, respectively. In numerous months of the investigation period this faunal group was, however, totally absent.

In the jhum soil, maximum densities of Diplura during the first and second annual cycles were respectively $2x10^2/m^2$ (November & June) and $5x10^2/m^2$ (June 1982) at 0-10 cm; $2x10^2/m^2$ (May 1981) and $3x10^2/m^2$ (February 1982) at 10-20 cm soil depth. However, Diplura did not occur in several months of the study period in both the profiles of the jhum soil as indicated in the figure.

Fig. 55. Showing the seasonal fluctuations of Diplura (Insecta) in the different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

Fig. 56. Showing the seasonal fluctuations of Protura (Insecta) in the different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

Fig. 55

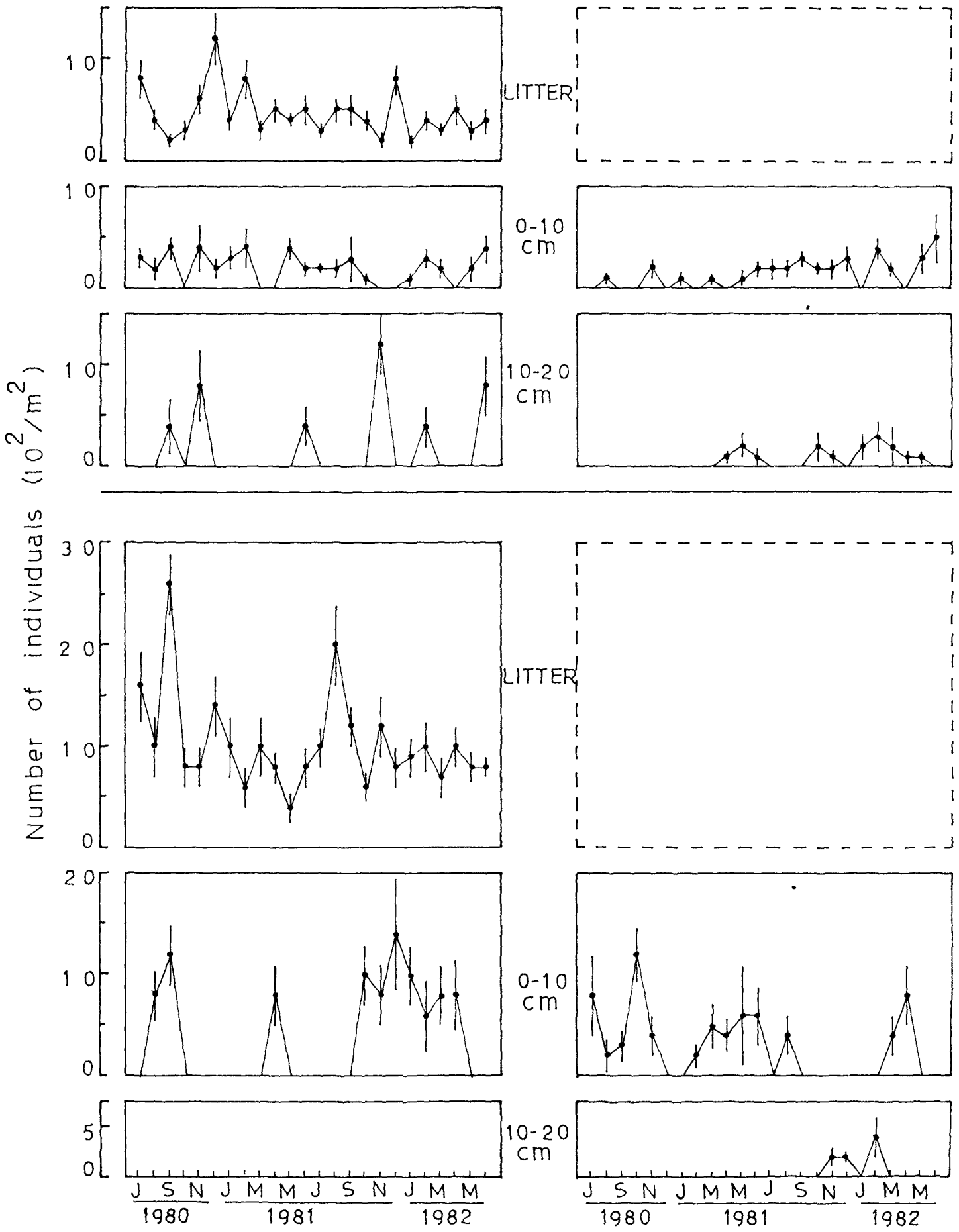

Number of individuals ($10^2/m^2$)
LITTER
0-10 cm
10-20 cm
LITTER
0-10 cm
10-20 cm
J S N J M M J S N J M M
1980
1981
1982

Fig. 56

a.2. Protura

The seasonal population dynamics of Protura in the forest and jhum soils are given in the Fig. 56. The highest and the lowest population fluctuations of Protura in the litter layer were respectively $26x10^2/m^2$ (September 1980) and $4x10^2/m^2$ (May 1981) during the first annual cycle; $20x10^2/m^2$ (August 1981) and $6x10^2/m^2$ (October 1981) during the second annual cycle.

At 0-10 cm layer of the forest soil, maximum densities of proturans for the first and second annual cycles were respectively $12x10^2/m^2$ (September 1980) and $14x10^2/m^2$ (December 1981). However, as shown in the figure, several months of both the annual cycles were devoid of proturans at this layer.

The population densities of the proturans at 0-10 cm profile of the jhum soil were maximum in October 1980 ($12x10^2/m^2$) of the first annual cycle and April 1982 ($8x10^2/m^2$) of the second annual cycle. Whereas, the proturans were absent only during the two winter months (December & January) of the first annual cycle, the second annual cycle recorded their absence in most of the months of the study period.

In the 10-20 cm profile of the jhum soil, the proturans were absent throughout the period of the first annual cycle. During the second annual cycle, the fauna occurred only in the months of November-December 1981 ($2x10^2/m^2$ each) and February 1982 ($4x10^2/m^2$). All the remaining months of the second annual cycle recorded nil population of Protura for this layer (10-20 cm) of the jhum soil.

a.3. Diptera

The population seasonality of Diptera from the forest and jhum soils are illustrated in the Fig. 57. In the litter layer, maximum population densities of Diptera were $12x10^2/m^2$, true for both the annual cycles. These densities were recorded in February 1981 and June 1982 of the first and second annual cycles, respectively. At 0-10 cm layer of the forest soil, dipteran populations were maximum ($8x10^2/m^2$) in February-March of the first annual cycle and November of the second annual cycle.

At 0-10 cm layer of the jhum soil, population peaks were observed during August and January of the first annual cycle and August and December of the second annual cycle. These densities were only $8x10^2/m^2$ individuals each. Further, in all the layers of the forest and jhum soil, dipteran population did not occur during each and every month of the investigation period, as shown in the figure.

a.4. Coleoptera

Fig. 58 illustrates the monthly population dynamics of Coleoptera in different soil layers of the forest and jhum for two annual cycles. During the first annual cycle, the maximum and minimum densities of Coleoptera in the litter layer were respectively $10x10^2/m^2$ (September 1980) and $1x10^2/m^2$ (November 1980). Maximum densities for 0-10 cm and 10-20 cm soil profiles were $8x10^2/m^2$ each. These densities were recorded during August and January at 0-10 cm layer, and during July at 10-20 cm soil depth.

During the second annual cycle, the litter layer had

Fig. 57. Showing the seasonal fluctuations of Diptera (Insecta) in different layers of the forest and jhum systems for two annual cycles. (Vertical lines show standard error).

Fig. 58. Showing the seasonal fluctuations of Coleoptera (Insecta) in different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

Fig. 57

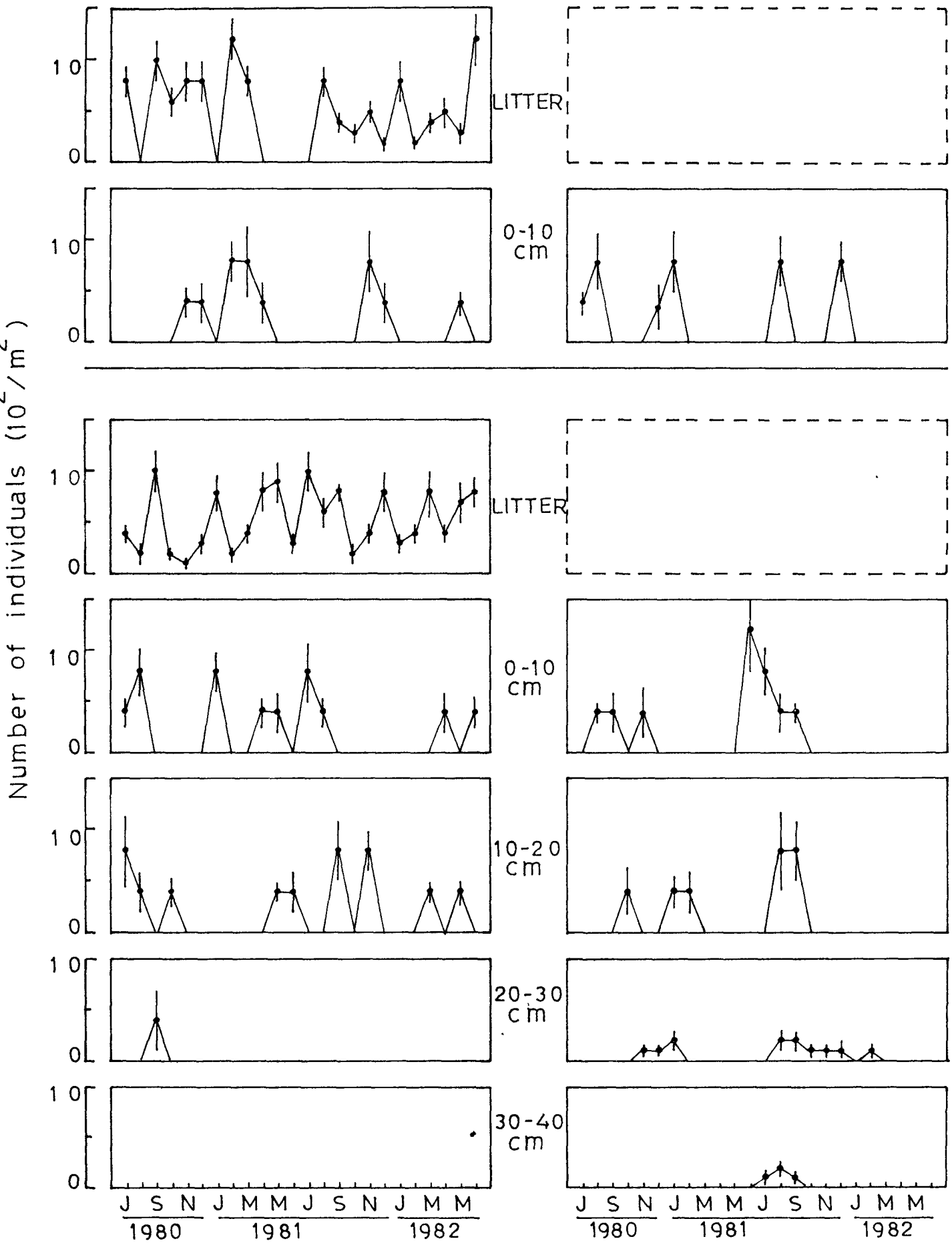

Number of individuals ($10^2/m^2$)
10
0
LITTER
0-10 cm
10-20 cm
20-30 cm
30-40 cm
J S N J M M J S N J M M
1980
1981
1982

Fig. 58

a maximum population density of $10x10^2/m^2$ in July 1981 and minimum of $2x10^2/m^2$ in October 1981. At 0-10 cm and 10-20 cm soil depths of the forest, the maximum coleopteran densities were $8x10^2/m^2$ each. Further, Coleoptera did not occur in several months of the study period in both the depths, as shown in the figure. At 20-30 cm profile, Coleoptera occurred only during September 1981 with a density of $4x10^2/m^2$.

In the jhum soil during the first annual cycle, the peak populations were $12x10^2/m^2$ (June 1981) at 0-10 cm; $4x10^2/m^2$ (October, January & February) at 10-20 cm and $2x10^2/m^2$ (January 1981) at 20-30 cm soil profile. The peak populations for the second annual cycle were $8x10^2/m^2$ (June 1981) at 0-10 cm layer; $8x10^2/m^2$ (August & September) at 10-20 cm; $2x10^2/m^2$ (August & September) at 20-30 cm layer. However, as shown in the figure, the fauna were not consistent in their occurrence throughout all the months of the study period.

a.5. Hymenoptera

Fig. 59 indicates the population dynamics of Hymenoptera (Formicidae), one of the abundant groups seen in the forest and jhum soil during the two years of investigation. In the first annual cycle the maximum and minimum population densities at the litter layer of the forest were $76x10^2/m^2$ (November 1980) and $3x10^2/m^2$ (January 1981). The forest soil at 0-10 cm showed $48x10^2/m^2$ as maximum in November 1980, while it recorded a nil population in several months. This pattern was followed for the subsequent layers, although maximum densities reached in certain

Fig. 59. Showing the seasonal fluctuations of Hymenoptera (Formicidae) in different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

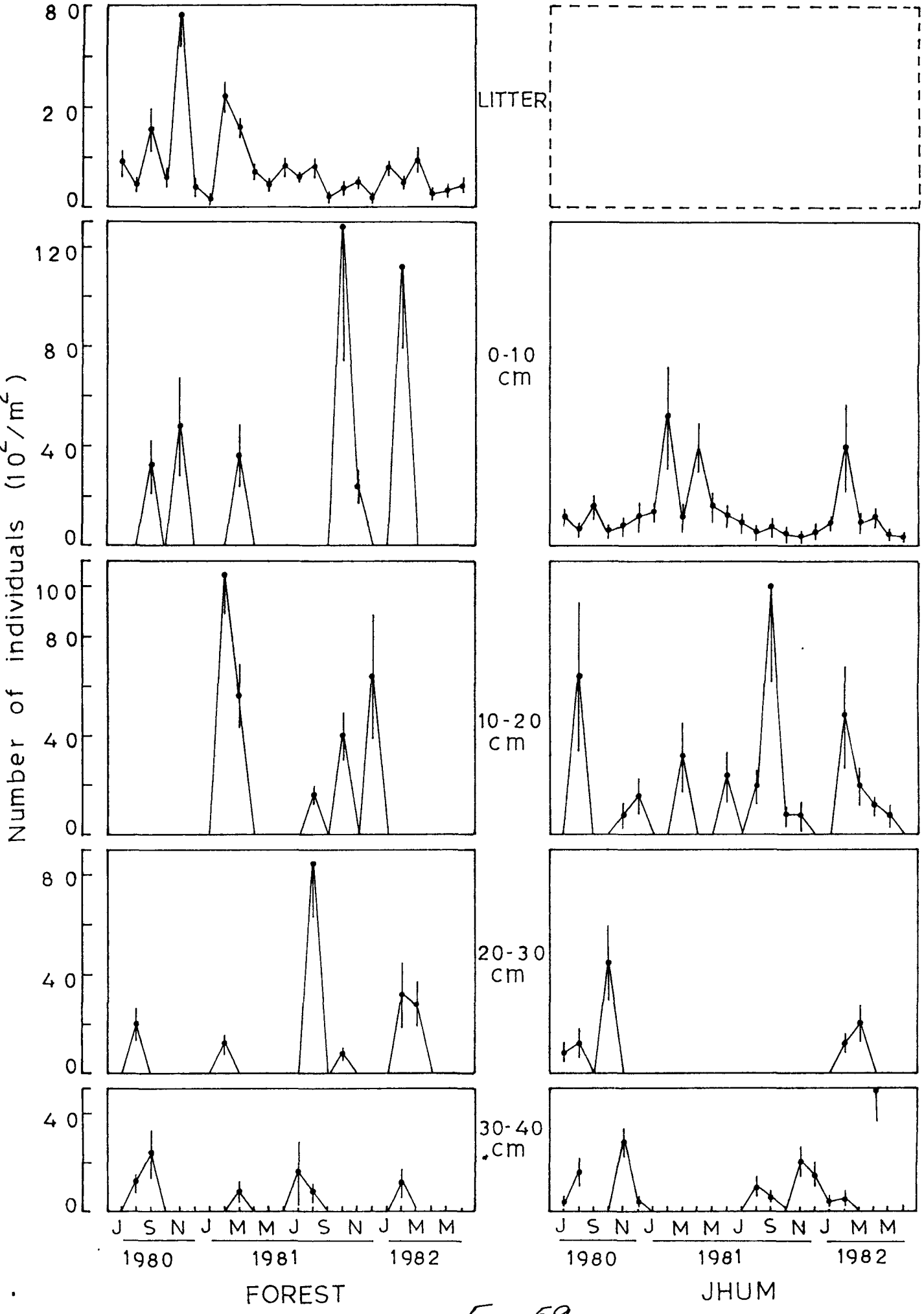

Number of individuals ($10^2/m^2$)
LITTER
0-10 cm
10-20 cm
20-30 cm
30-40 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 59

months for each layer, being $104x10^2/m^2$ in February 1982 for 10-20 cm layer; $20x10^2/m^2$ in August 1980 for 20-30 cm layer and $24x10^2/m^2$ in September 1980 for 30-40 cm soil layer.

The litter layer, during the second annual cycle, recorded $19x10^2/m^2$ individuals (March 1982) as maximum and $4x10^2/m^2$ (September & December 1981) as minimum. The forest soil layers at 0-10 cm, 10-20 cm, 20-30 cm and 30-40 cm showed peak populations respectively during October 1981 ($128x10^2/m^2$), December 1981 ($64x10^2/m^2$), August 1981 ($84x10^2/m^2$) and August 1981 ($16x10^2/m^2$). However, none of these layers displayed continuous occurrence of Formicidae throughout all the months of the second annual cycle.

In the jhum soil during the first annual cycle, the population densities at 0-10 cm depth ranged from a minimum of $6x10^2/m^2$ in November 1980 to a maximum of $52x10^2/m^2$ in February 1981. At 10-20 cm depth, the densities varied from nil population during several months to a maximum of $64x10^2/m^2$ in August 1980. In the next layer, maximum density rose to $44x10^2/m^2$ in October 1980 but were absent in most of the other months. In the last layer, November 1980 recorded a maximum population of $28x10^2/m^2$.

During the second annual cycle, the population densities of Formicidae at 0-10 cm layer ranged from $4x10^2/m^2$ (November & June) to $40x10^2/m^2$ in February 1982. Maximum population densities at 10-20 cm, 20-30 cm and 30-40 cm were respectively $100x10^2/m^2$ (September), $20x10^2/m^2$ (March) and $48x10^2/m^2$ (April). The ants were, however, absent in several months of the study period in all these layers.

a.6. Orthoptera

The graphical representations of orthopteran population densities as monthly averages from the forest and jhum soil are shown in the Fig. 60. In the litter layer, the maximum population densities were recorded in August 1980 ($5x10^2/m^2$) of the first annual cycle and May 1982 ($4x10^2/m^2$) of the second annual cycle. As depicted in the figure, several months of the study period did not record any orthopteran individual in the litter layer. At 0-10 cm layer, Orthoptera were recorded only during August month of the first annual cycle, and during August, March and April of the second annual cycle. The densities in all these months were $4x10^2/m^2$ individuals each.

At 0-10 cm depth of the jhum soil, orthopteran fauna were recorded only during November and December 1981 ($4x10^2/m^2$) of the second annual cycle. In the next layer (10-20 cm), these were encountered only during August and September ($4x10^2/m^2$) of the second annual cycle, also true for the 20-30 cm depth, being $2x10^2/m^2$ each in densities.

a.7. Dermaptera

Fig. 61 shows the monthly population densities of Dermaptera from the two systems studied for two years. During the first annual cycle, the populations ranged from nil in July, November, January and March to a peak of $6x10^2/m^2$ individuals in April 1981, for the litter layer. During the second annual cycle and in the same layer, the fauna were absent in November, December and February but rose to maximum densities in August and March ($4x10^2/m^2$). In the first forest soil profile (0-10 cm),

Fig. 60. Showing the seasonal fluctuations of Orthoptera (Insecta) in the different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

Fig. 61. Showing the seasonal fluctuations of Dermaptera (Insecta) in different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

Fig. 60

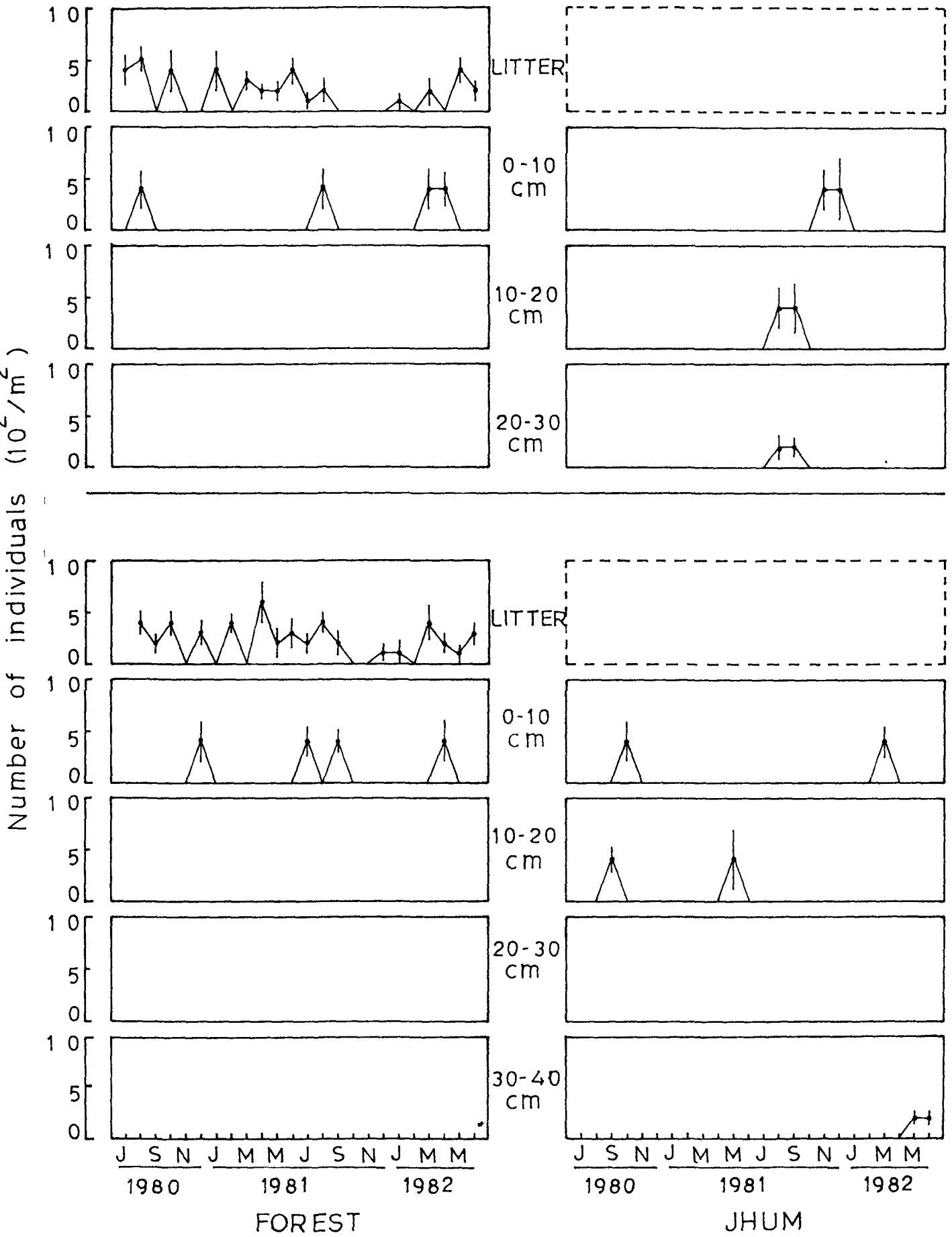

Number of individuals ($10^2/m^2$)
10
5
0
LITTER
0-10 cm
10-20 cm
20-30 cm
30-40 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 61

the maximum densities of Dermaptera were $4x10^2/m^2$, true for both the annual cycles. These densities were observed during December of the first annual cycle, and July, September and April of the second annual cycle.

At 0-10 cm depth of the jhum soil, Dermaptera occurred only during October 1980 of the first annual cycle and March of the second annual cycle, revealing densities of $4x10^2/m^2$ individuals each. At 10-20 cm depth, Dermaptera were recorded only during September and May of the first annual cycle, being $4x10^2/m^2$ in each month.

a.8. Hemiptera

Fig. 62 represents the monthly population dynamics of Hemiptera. In the litter layer, maximum densities were $6x10^2/m^2$, true for both the annual cycles (during September of the first annual cycle and August of the second annual cycle). However, these were not encountered in several months of both the annual cycles at the litter layer. The 0-10 cm layer recorded only during April of the first annual cycle, and September and March of the second annual cycle, being $4x10^2/m^2$ in each month. Further, Hemiptera were not recorded from the jhum soil during present investigation.

a.9. Psocoptera

As seen in the Fig. 63, this group of soil fauna also displayed discontinuous occurrences throughout the study period. In the litter layer, the peak populations were $7x10^2/m^2$ (August) for the first annual cycle, and $4x10^2/m^2$ (June) for the second

Fig. 62. Showing the seasonal fluctuations of Hemiptera (Insecta) in two different layers of forest system for two annual cycles. (Vertical lines show the standard error).

Fig. 63. Showing the seasonal fluctuations of Psocoptera (Insecta) in two different layers of the forest system for two annual cycles. (Vertical lines show the standard error).

Fig. 62

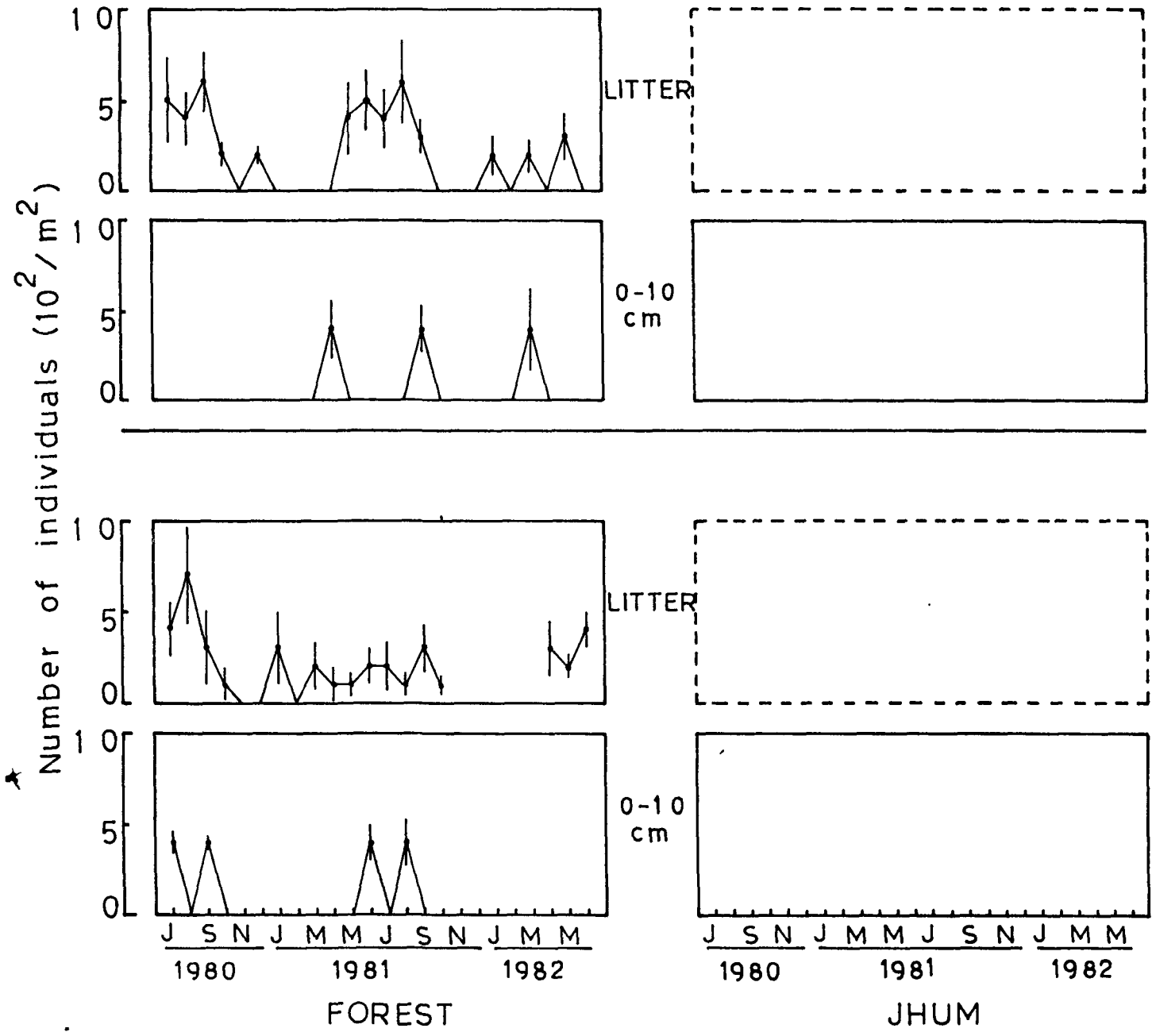

Number of individuals ($10^2/m^2$)
10
5
0
LITTER
0-10 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 63

annual cycle. At 0-10 cm layer of the forest soil, the fauna were seen only during July, September and June of the first annual cycle, and August of the second annual cycle, being $4x10^2/m^2$ in each month. Further, the jhum soil did not record any psocopteran individual during the entire study period.

a.10. Insect larvae

Fig. 64 reveals that the larvae of insects were fairly abundant in both the forest and jhum systems during the investigation period. During the first annual cycle, the maximum and minimum number of insect larvae were respectively $32x10^2/m^2$ (November 1980) and $4x10^2/m^2$ (September 1980) in the litter layer; $20x10^2/m^2$ (November 1980) and $2x10^2/m^2$ (March 1981) in the 0-10 cm soil profile; $20x10^2/m^2$ (May 1981) and nil occurrence in February 1981 at 10-20 cm layer. At 20-30 cm layer, the larvae occurred only during August and September of the first annual cycle, being $8x10^2/m^2$ in each month.

In the second annual cycle, the fluctuations of the numbers of insect larvae as the highest and the lowest densities were respectively $14x10^2/m^2$ (December 1981) and $2x10^2/m^2$ (February 1982) for the litter layer; $40x10^2/m^2$ (January 1982) and $2x10^2/m^2$ (October 1981) for the 0-10 cm profile; $12x10^2/m^2$ (April 1982) and total absence in August, November and January for the 10-20 cm soil layer. However, in the third layer of the soil profile (20-30 cm), the larvae occurred only during August 1981 ($4x10^2/m^2$), and September and November ($8x10^2/m^2$ each) of the second annual cycle.

Fig. 64. Showing the seasonal fluctuations of Insect larvae in different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

Fig. 65. Showing the seasonal fluctuations of Isoptera (Insecta) in different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

Fig. 64

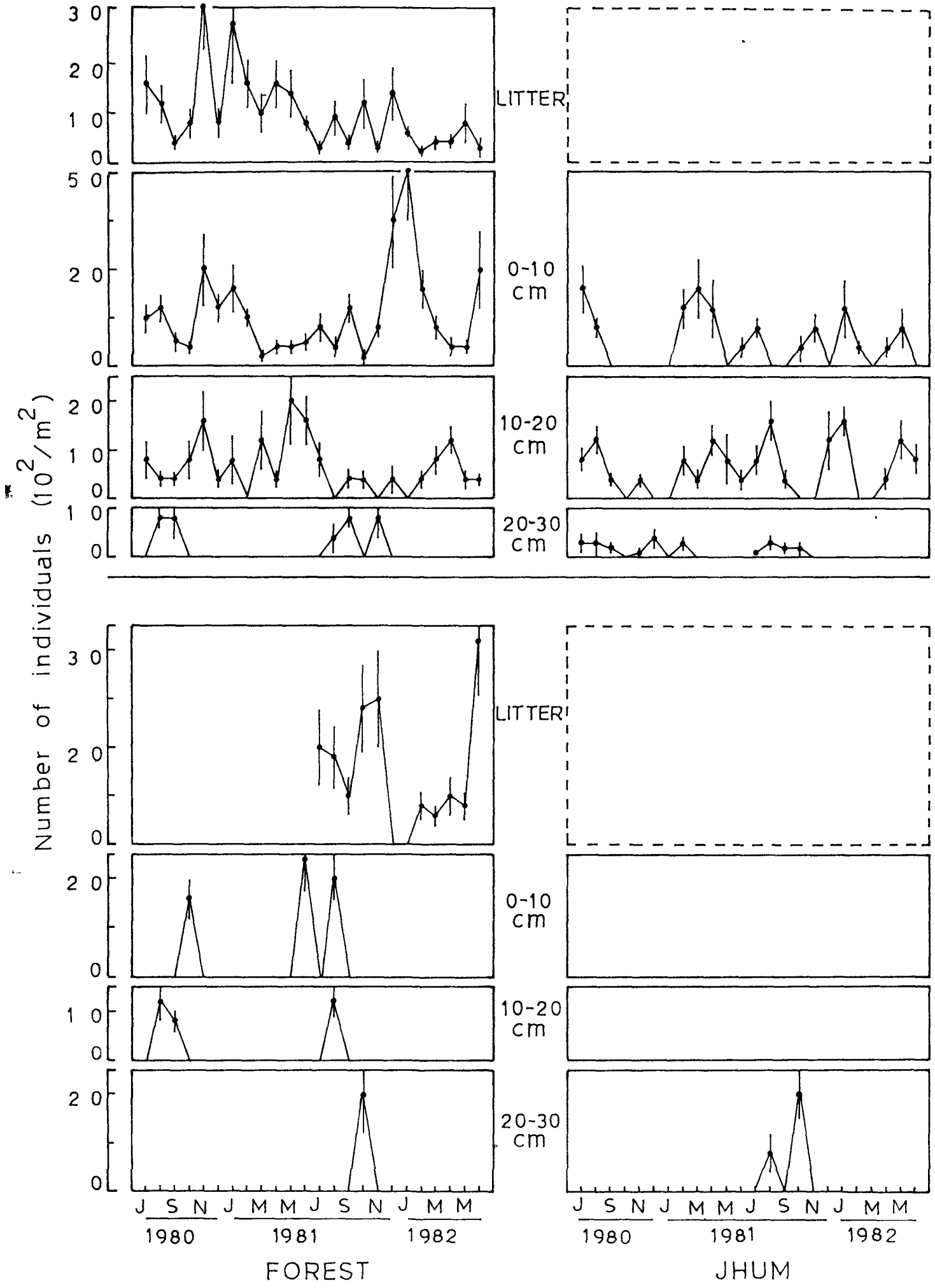

Number of individuals ($10^2/m^2$)
LITTER
0-10 cm
10-20 cm
20-30 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 65

In the jhum system, different months of the first and second annual cycles showed population peaks for different profiles, being respectively $16x10^2/m^2$ (July and January) and $12x10^2/m^2$ (January) in the 0-10 cm layer; $12x10^2/m^2$ (August and April) and $16x10^2/m^2$ (August and January) in the 10-20 cm layer; $4x10^2/m^2$ (December) and $3x10^2/m^2$ (August) in the 20-30 cm layer. In all the above layers of the jhum soil, the larval occurrences were not continuous in that they were absent in several months of the entire study period, as seen in the figure.

a.11. Isoptera

This group were totally absent in the litter layer during the first annual cycle (Fig. 65). However, in the second annual cycle, their population peak rose to $42x10^2/m^2$ in June, but again showing nil occurrence during winter months of December and January for the litter layer. At 0-10 cm layer, Isoptera occurred only during October ($16x10^2/m^2$) and June ($24x10^2/m^2$) of the first annual cycle, and August ($20x10^2/m^2$) of the second annual cycle. In the next layer (10-20 cm), this group were encountered only during August ($12x10^2/m^2$) and September ($8x10^2/m^2$) of the first annual cycle, and August ($12x10^2/m^2$) of the second annual cycle. At 20-30 cm layer, Isoptera were recorded only during October ($20x10^2/m^2$) of the second annual cycle.

In the jhum soil, as could be seen from the figure, Isoptera occurred only at its 20-30 cm during August ($8x10^2/m^2$) and October ($20x10^2/m^2$) of the second annual cycle. Thus, the group were absent from the jhum soil during the first annual cycle of present study.

b. Class Myriapoda

The monthly population densities of Myriapoda in different layers of the forest and jhum soils are shown in Fig.66. During the first annual cycle, the maximum and minimum populations were respectively $59x10^2/m^2$ (July 1980) and $11x10^2/m^2$ (January & May 1981) in the litter layer; $25x10^2/m^2$ (July 1980) and $6x10^2/m^2$ (December 1980) in the 0-10 cm profile. At 10-20 cm depth, the peak population was in April 1981 ($12x10^2/m^2$), with several months recording nil population.

During the second annual cycle, the population peaks and the minimum densities were respectively $40x10^2/m^2$ (August 1981) and 9x10 /m (December 1981) in the litter layer; $34x10^2/m^2$ (July 1981) and $4x10^2/m^2$ (February 1982) in the 0-10 cm layer of the forest soil. At 10-20 cm depth, the myriapods occurred irregularly, although maximum of $8x10^2/m^2$ was in September 1981. In the third layer of the soil (20-30 cm), this group were recorded only during September and October of the second annual cycle, being $4x10^2/m^2$ in each month.

In the jhum soil and at its 0-10 cm layer, maximum densities of myriapods for the first and second annual cycles were respectively $8x10^2/m^2$ (May & June 1981) and $12x10^2/m^2$ (September 1981). However, at this layer, the myriapods were absent during November, January and April of the first annual cycle, and February of the second annual cycle. At 10-20 cm, maximum densities were $8x10^2/m^2$ (September) for the first annual cycle and $5x10^2/m^2$ (April) for the second annual cycle, with several months showing nil population.

Fig. 66. Showing the seasonal fluctuations of Myriapoda in different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

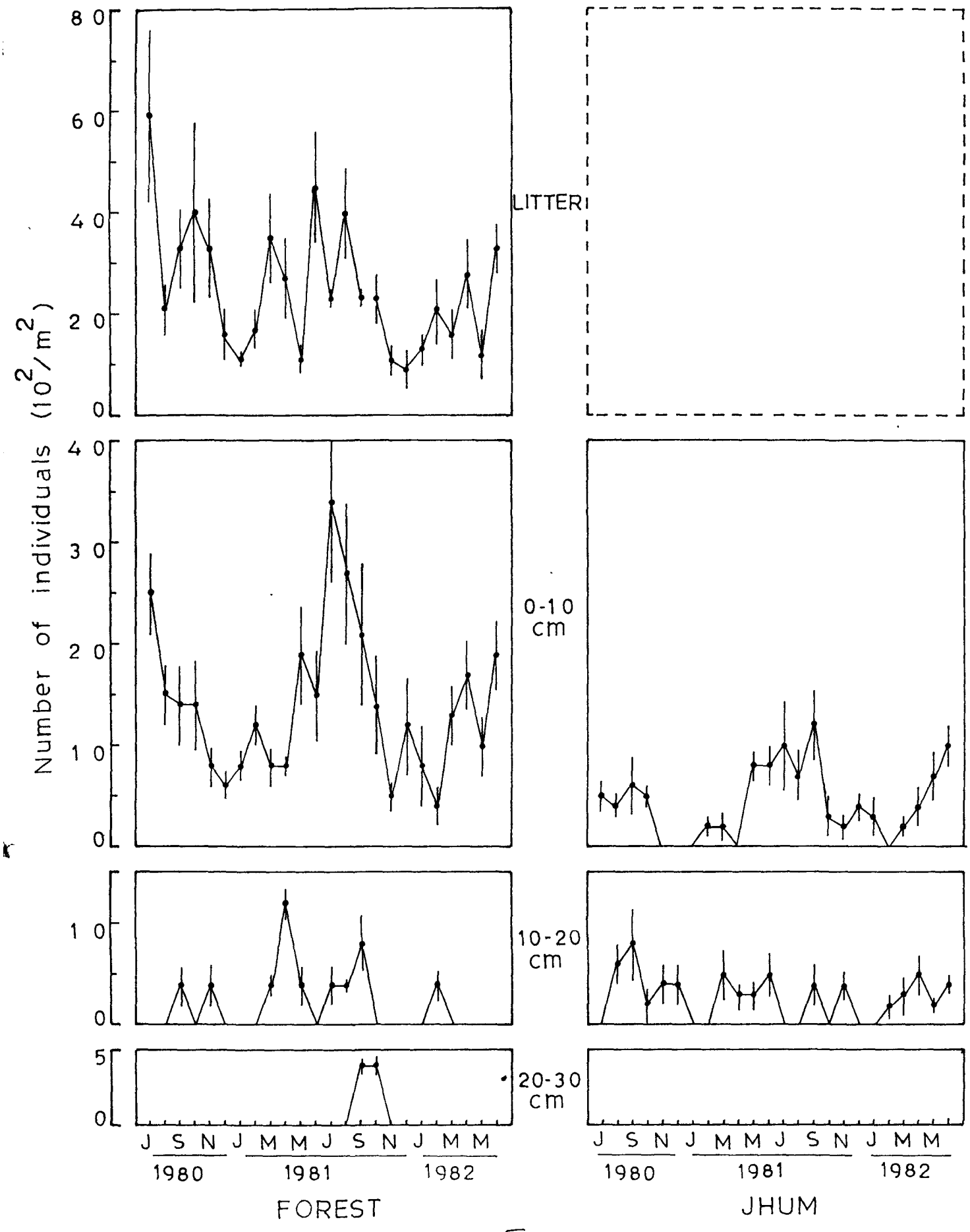

Number of individuals ($10^2/m^2$)
8 0
6 0
4 0
2 0
0
LITTER
4 0
3 0
2 0
1 0
0
0-10 cm
1 0
0
10-20 cm
5
0
20-30 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 66

b.1. Chilopoda

As shown in the Fig. 67, the maximum and minimum densities of Chilopoda in the litter layer were respectively $4x10^2/m^2$ (November & December) and $1x10^2/m^2$ (October, April & May) during the first annual cycle, and $5x10^2/m^2$ (July) and $1x10^2/m^2$ (March & May) during the second annual cycle. At 0-10 cm layer, maximum densities were $8x10^2/m^2$, true for both the annual cycles (February & May of the first and March of the second annual cycles), with a number of months showing nil population. At 10-20 cm profile, Chilopoda occurred only during March and April of the first annual cycle, and August of the second annual cycle, being $4x10^2/m^2$ in each month.

In the jhum soil, the maximum densities of this group during the first and second annual cycles were respectively $2x10^2/m^2$ (in a number of months) and $4x10^2/m^2$ (December 1981) in the 0-10 cm layer; $4x10^2/m^2$ (December) and $2x10^2/m^2$ (April & May) in the 10-20 cm profile. However, in both these layers the centipedes occurred irregularly, showing their absence in several months of the entire study period.

b.2. Diplopoda

In the forest, the maximum population densities (Fig. 68) of Diplopoda, during the first and second annual cycles were respectively $4x10^2/m^2$ (July, September & April) and $6x10^2/m^2$ (August) in the litter layer, with few of the months recording nil population. In the soil profiles (0-10 cm & 10-20 cm), the densities of Diplopoda were always $4x10^2/m^2$ (whenever they occurred), although most of the months recorded nil population.

Fig. 67. Showing the seasonal fluctuations of Chilopoda (Myriapoda) in different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

Fig. 68. Showing the seasonal fluctuations of Diplopoda (Myriapoda) in different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

Fig. 67

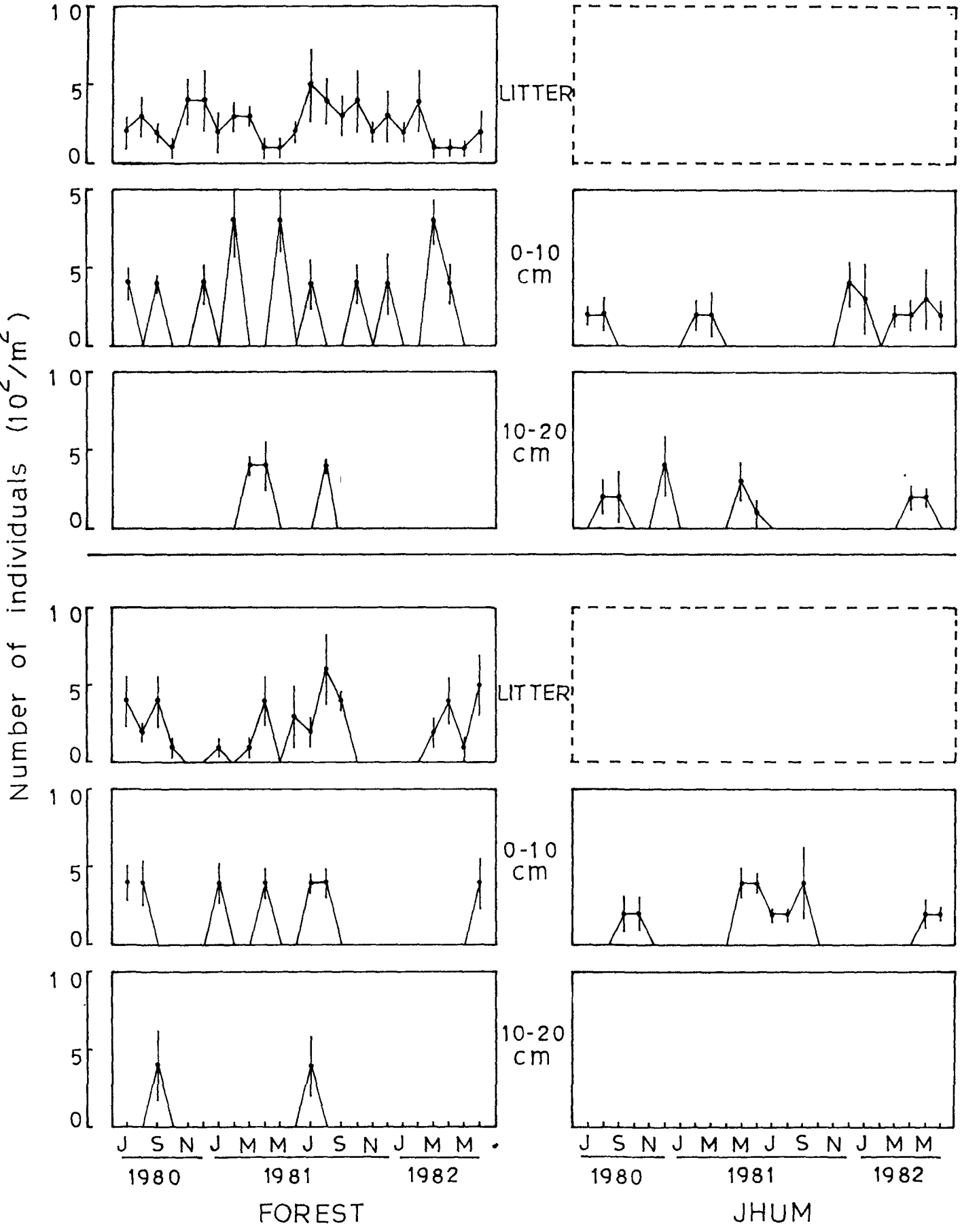

Number of individuals ($10^2/m^2$)
10
5
0
LITTER
0-10 cm
10-20 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 68

In the jhum soil, this group were recorded only at its 0-10 cm layer. Maximum densities were during May and June of the first annual cycle and September of the second annual cycle, being $4x10^2/m^2$ in each month. Both the annual cycles also revealed that this group were absent in most of the months.

b.3. Pauropoda

Fig. 69 reveals that Pauropoda occurred only in the forest system during the present investigation period. The maximum and minimum population densities in the litter layer were respectively $8x10^2/m^2$ (June 1981) and $1x10^2/m^2$ (November 1980) during the first annual cycle; $4x10^2/m^2$ (July & September 1981) and 1x10 /m (November 1981, February & March 1982) during the second annual cycle.

At 0-10 cm profile of the forest soil, Pauropoda were maximum in June 1981 ($7x10^2/m^2$) and July 1981 ($4x10^2/m^2$) respectively for the first and second annual cycles. However, this group were absent in several months of both the annual cycles.

b.4. Symphyla

Symphyla were the most numerous group of Mayriapods in both the systems (Fig. 70). During the first annual cycle, the maximum and minimum number of individuals were respectively $48x10^2/m^2$ (July 1980) and $4x10^2/m^2$ (January 1981) in the litter layer; $12x10^2/m^2$ (July & October 1980) and $2x10^2/m^2$ (December 1980) in the 0-10 cm soil layer; $8x10^2/m^2$ (April 1981) and non-occurrence in most of the months at 10-20 cm soil layer.

Fig. 69. Showing the seasonal fluctuations of Pauropoda (Myriapoda) in different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

Fig. 70. Showing the seasonal fluctuations of Symphyla (Myriapoda) in different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

Fig. 69

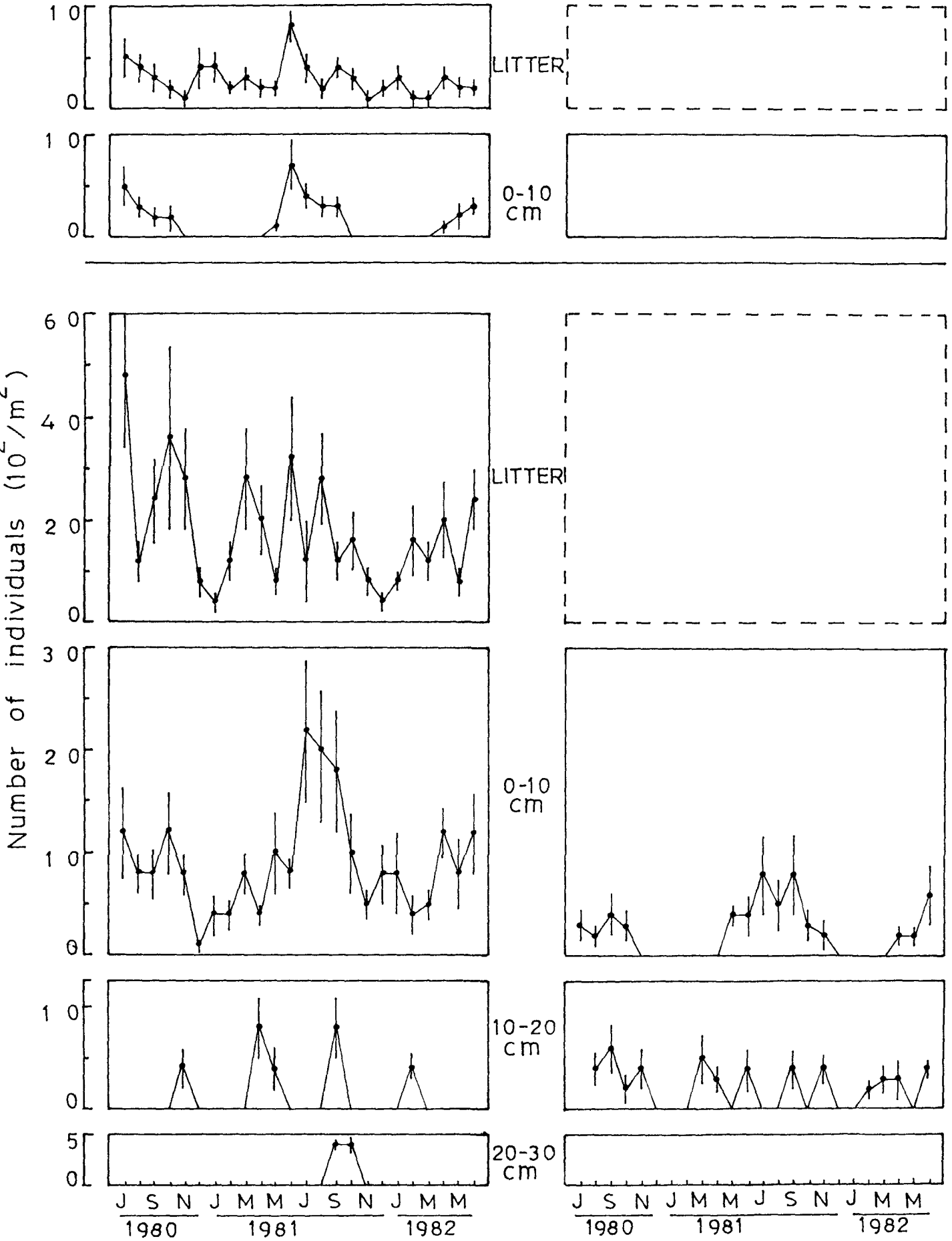

Number of individuals ($10^2/m^2$)
LITTER
0-10 cm
10-20 cm
20-30 cm
J S N J M M J S N J M M
1980
1981
1982

Fig. 70

During the second annual cycle, the maximum and minimum densities of Symphyla were respectively $28x10^2/m^2$ (August 1981) and $4x10^2/m^2$ (December 1981) in the litter layer; $22x10^2/m^2$ (July 1981) and $4x10^2/m^2$ (February 1982) in the 0-10 cm soil layer. At 10-20 cm depth, Symphyla occurred only during September 1981 ($8x10^2/m^2$) and February 1982 ($4x10^2/m^2$). In the next layer (20-30 cm), the symphylids were recorded only during September and October, being $4x10^2/m^2$ in each month.

In the jhum soil and at its 0-10 cm depth, maximum densities of Symphyla for the first and second annual cycles were respectively $4x10^2/m^2$ (September 1980 & May-June 1981) and $8x10^2/m^2$ (July & September 1981). At 10-20 cm layer, the peak populations were in September 1980 ($6x10^2/m^2$) of the first annual cycle and September, November and June ($4x10^2/m^2$ each) of the second annual cycle. However, in both the layers, the symhylids were absent in several months of the entire study period.

c. Class Arachnida

The maximum and minimum densities of this fauna (Fig. 71) during the first annual cycle were respectively $56x10^2/m^2$ (June) and $9x10^2/m^2$ (September) in the litter layer; $20x10^2/m^2$ (July) and $4x10^2/m^2$ (January & February) in the 0-10 cm layer; $4x10^2/m^2$ (June) and total absence in many of the months at 10-20 cm layer of the forest soil.

During the second annual cycle, the highest and the lowest number of individuals of arachnids were respectively $88x10^2/m^2$ (July) and $4x10^2/m^2$ (May) in the litter layer of the forest; $20x10^2/m^2$ (August 1981) and $4x10^2/m^2$ (October, February

Fig. 71. Showing the seasonal fluctuations of Arachnida in different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

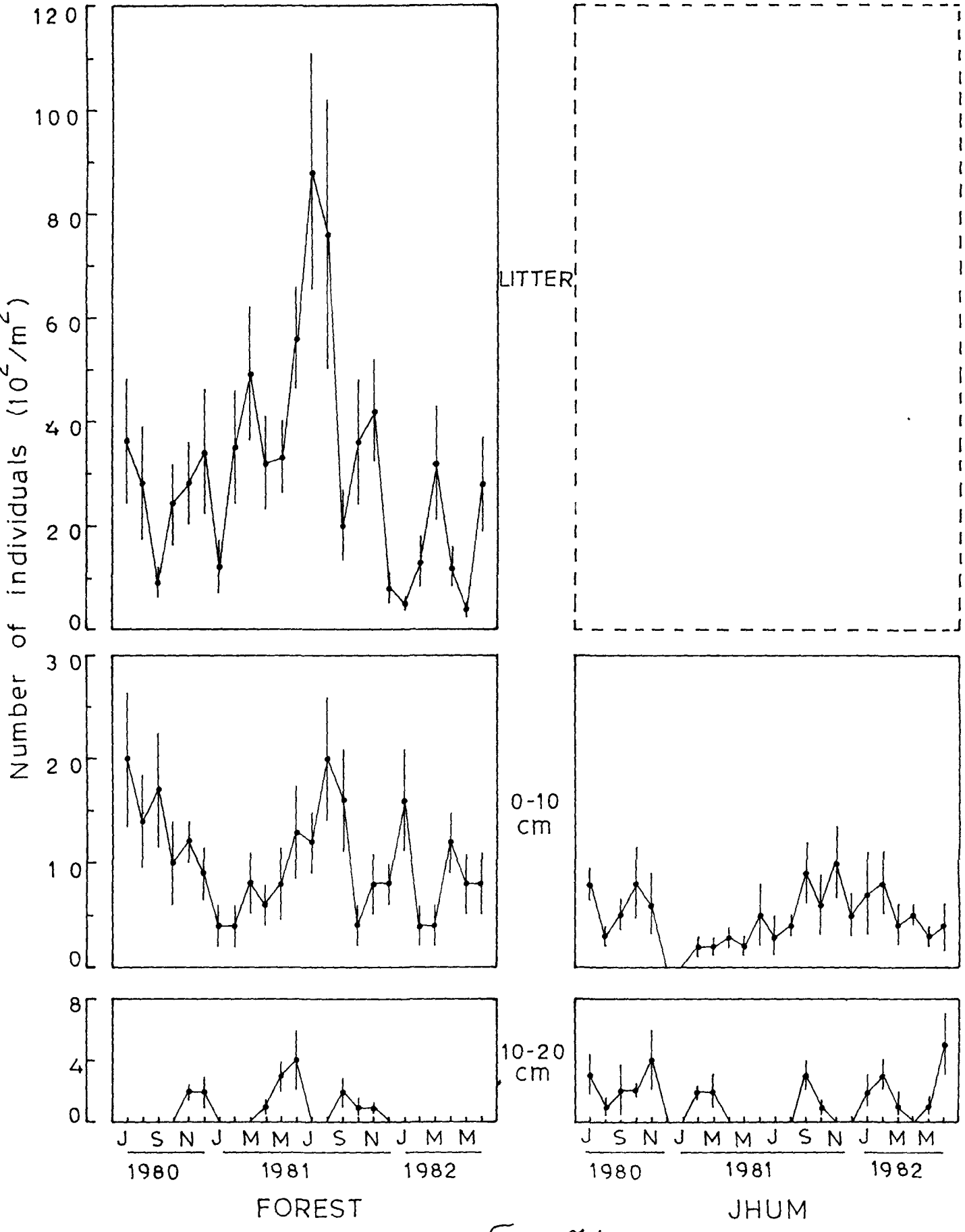

Number of individuals ($10^2/m^2$)
120
100
80
60
40
20
0
LITTER
30
20
10
0
0-10 cm
8
4
0
10-20 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 71

& March) in the 0-10 cm soil profile; $2x10^2/m^2$ (September) and nil population in most of the months at 10-20 cm layer of the forest soil.

In the jhum soil and at its 0-10 cm, the arachnids were totally absent during December and January of the first annual cycle (Fig. 71), although peak populations were in July and October ($8x10^2/m^2$ each). Maximum and minimum population densities for the second annual cycle were $10x10^2/m^2$ (November) and $3x10^2/m^2$ (July & May), respectively. At 10-20 cm profile, the peak populations recorded were $4x10^2/m^2$ (November 1980) and $5x10^2/m^2$ (June 1982) respectively during the first and second annual cycles. However, arachnids did not occur throughout all the months of the study period at this layer.

All the arachnids in the present study were identified into Pseudoscorpionida and Araneida. The latter, however, includes (for convenience) all the unidentifiable arachnids other than pseudoscorpions.

c.1. Pseudoscorpionida

This group were recorded only from the forest system during present investigation (Fig. 72). In the litter layer, maximum densities were only $3x10^2/m^2$ (February 1981) during the first annual cycle and $2x10^2/m^2$ (November 1981) during the second annual cycle. At 0-10 cm depth, Pseudoscorpionida were $2x10^2/m^2$ each during the months of August, October and April of the first annual cycle only. *However, in most of the months* of present investigation, the pseudoscorpions were absent.

Fig. 72. Showing the seasonal fluctuations of Pseudoscorpionida (Arachnida) in two different layers of the forest system for two annual cycles. (Vertical lines show the standard error).

Fig. 73. Showing the seasonal fluctuations of Araneida (including arachnids other than pseudoscorpiones) in different layers of the forest and jhum systems for two annual cycles. (Vertical lines show the standard error).

Fig. 72

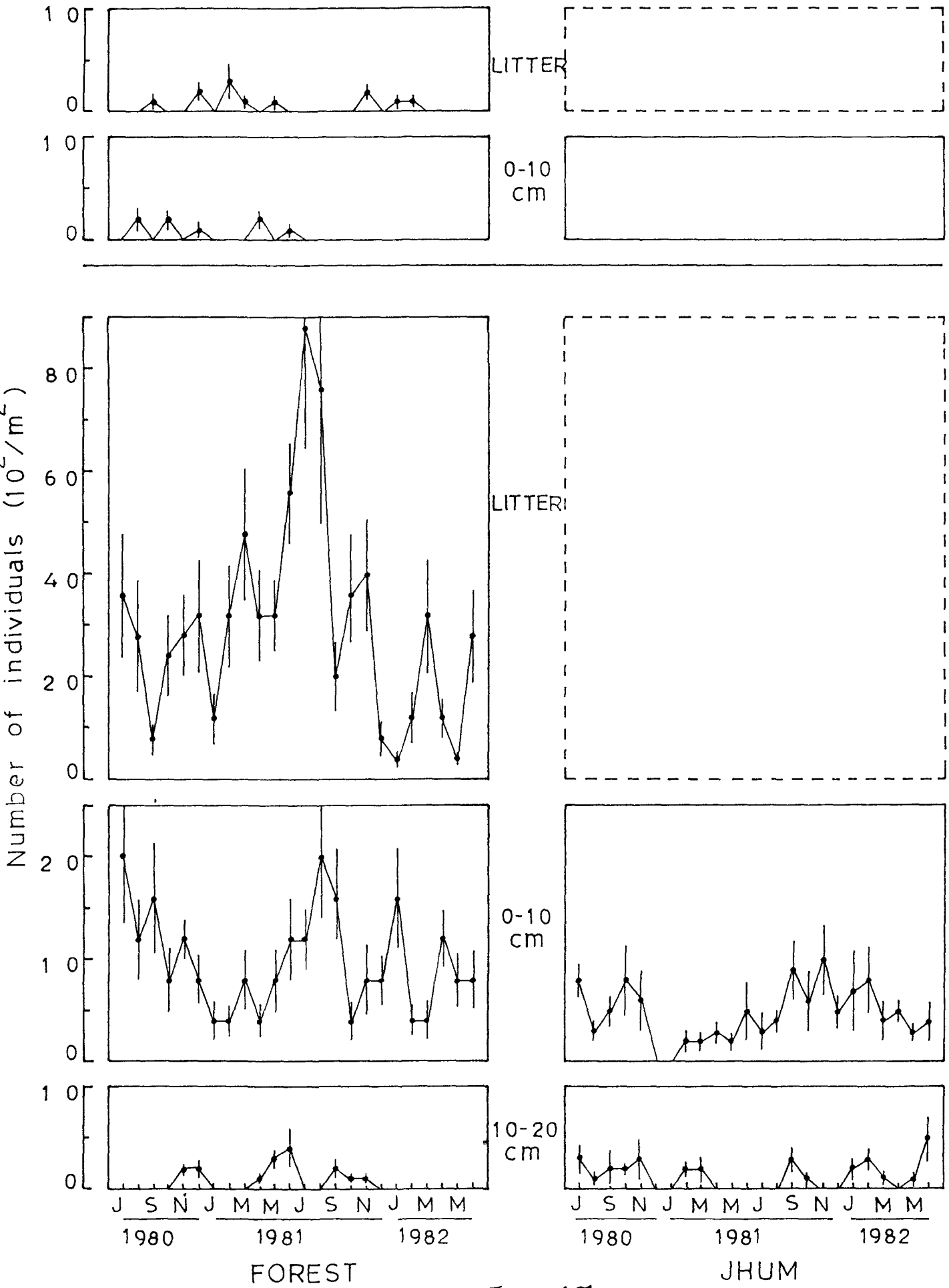

LITTER
0-10 cm
10-20 cm
Number of individuals ($10^2/m^2$)
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 73

c.2. Araneida

The seasonal population dynamics of Araneida (including arachnids other than pseudoscorpions) in different layers of the forest and jhum soil are shown in the Fig. 73. During the first annual cycle, the maximum and minimum populations of this group were respectively $56x10^2/m^2$ (June 1981) and $8x10^2/m^2$ (September 1980) for the litter layer; $20x10^2/m^2$ (July 1980) and $4x10^2/m^2$ (January, February & April 1981) for the 0-10 cm profile of the forest soil. In the 10-20 cm layer, the peak was seen in June 1981 ($4x10^2/m^2$), although the fauna were absent in several months of the first annual cycle.

During the second annual cycle, the population peaks occurred in July 1981 ($88x10^2/m^2$) and August 1981 ($20x10^2/m^2$), respectively in the litter and 0-10 cm soil layer. Minimum densities for these layers were $4x10^2/m^2$ (January & May) in the litter and $4x10^2/m^2$ (October, February & March) in the 0-10 cm layer. At 10-20 cm depth, Araneida occurred only during September 1981 ($2x10^2/m^2$) and October-November ($1x10^2/m^2$ each).

At 0-10 cm layer of the jhum soil, the maximum and minimum population densities of Araneida were respectively $8x10^2/m^2$ (July & October) and nil population (December & January) for the first annual cycle; $10x10^2/m^2$ (November 1981) and $3x10^2/m^2$ (July & May) for the second annual cycle. At 10-20 cm depth, the highest densities of the population for the first and second annual cycles were respectively $4x10^2/m^2$ (November) and $5x10^2/m^2$ (June). However, this group were totally absent in a number of the months of the second annual cycle.

d. Class Crustacea

This group was represented by a single order, viz. Isopoda, occurring only in the forest system.

d.1. Isopoda

As shown in the Fig. 74, during the first annual cycle, the litter layer recorded a maximum population density of $28x10^2/m^2$ in August 1980 and a minimum of $2x10^2/m^2$ in January and February 1981. Maximum and minimum population densities of the litter layer during the second annual cycle were $30x10^2/m^2$ in July 1981 and $2x10^2/m^2$ in November 1981 and February 1982, respectively.

At 0-10 cm layer of the forest soil, the monthly population densities of isopods were $8x10^2/m^2$ (July & August 1980) during the first annual cycle and $9x10^2/m^2$ (August 1981) during the second annual cycle. However, the isopods were totally absent during the winter months of both the annual cycles at this layer.

Further, this group of fauna were not encountered in the jhum system during the period of present investigation.

Fig. 74. Showing the seasonal fluctuations of Isopoda (Crustacea) in two different layers of the forest system for two annual cycles. (Vertical lines show the standard error).

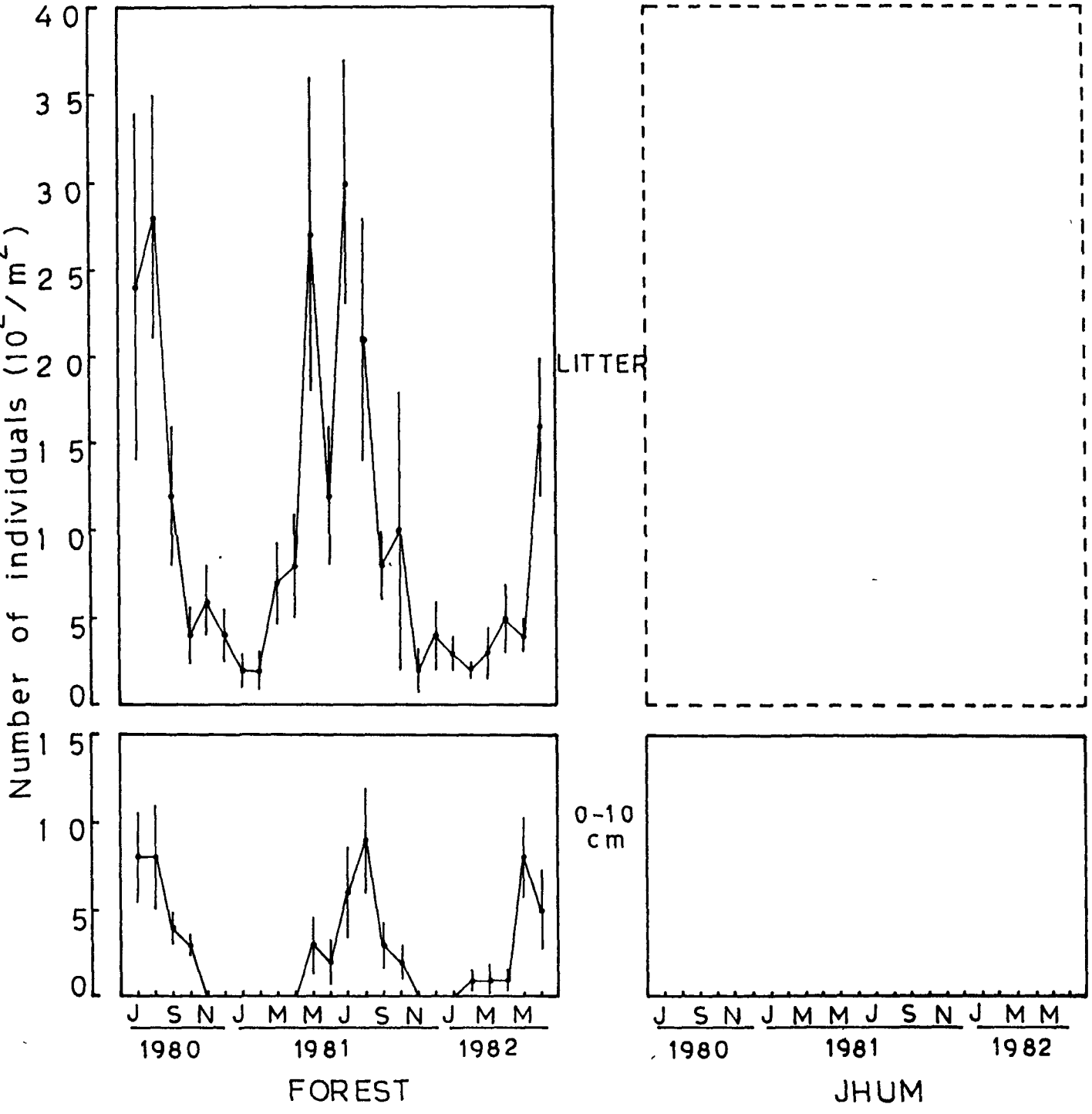

Number of individuals ($10^2/m^2$)
40
35
30
25
20
15
10
5
0
LITTER
15
10
5
0
0-10 cm
J S N J M M J S N J M M
1980
1981
1982
FOREST
JHUM

Fig. 74

4.2.3. Community analysis

Two faunal communities, viz. Collembola and Oribatid or Cryptostigmata (Acarina) were compared between the forest and jhum systems. This was done because it was only in these two major soil faunal groups that either generic or specific levels were possible to be identified in the present investigation. The species diversities and similarities of the communities were analysed using the different indices as described in the following text.

4.2.3.1. Collembolan species number and its diversity

The species number and the diversity indices of collembolan communities were studied for the total systems and the different layers of the forest and jhum soils.

On a general analysis, it was seen though the litter was not taken into consideration (except while comparing total of both the systems) in the forest system, while comparing between the systems or depth-wise, the largest number of species occurred in the litter layer, amounting to 17. However, in the 0-10 cm layer of the forest, there were only 11 species recorded, of which 10 were common also in the same layer of the jhum system. Dicranocentrus singularis was that species which was totally absent in the jhum system. The 6 species or group not recorded in the 0-10 cm layer of the forest were Poduridae, Hypogastruridae, Seira sp., Lepidocyrtus sp., Isotobryoides sp. and other entomobryids. These were absent not only in this layer of the forest or jhum system, but also in all the subsequent depths of both the systems. In the next 10-20 cm profile

there was a drastic fall of 4 species in the forest and only 3 in the jhum system. Of these, 3 were common (Isotoma (Desoria) trispinata, Cryptopygus thermophilus and other isotomids) to both the systems, while other entomobryids formed the 4th group in the forest system only. The 20-30 cm layer recorded only one species in both the forest and jhum systems, and that was Isotoma (Desoria) trispinata.

Forest and jhum soils : Total system

Fig. 75 shows the number of species and species diversity indices of collembolan communities in the total forest and jhum systems for two annual cycles. The number of species in the forest and jhum systems was 17 and 10, respectively. Of these, the family Poduridae was totally absent during December, January and February of the first annual cycle, and only January of the second annual cycle, while other entomobryids were absent during November of the first annual cycle only (in the forest system). In the jhum, of the 10 species that occurred, Salina was absent during September, November to February of the first annual cycle and October to February of the second annual cycle, Sphaeridia cornuta and Megalothorax minimus were absent during January and February of the first annual cycle,and December and February of the second annual cycle. Sminthurinus bimaculatus was absent during February of the first annual cycle only.

Margalef's indices in the total system of the forest were the least in July, true for both the annual cycles (5.140 and 5.064 respectively for the first and second annual cycles). Maximum values of the indices were seen in March 1981 (5.567)

Fig. 75. Showing the seasonal fluctuations in the number of species (S), Margalef's Index (D_a), Shannon-Wiener Index (H'), $H_{max'}$, Evenness Index (J') and Redundance values (R) of Collembola in the total systems of the forest and jhum for two annual cycles.

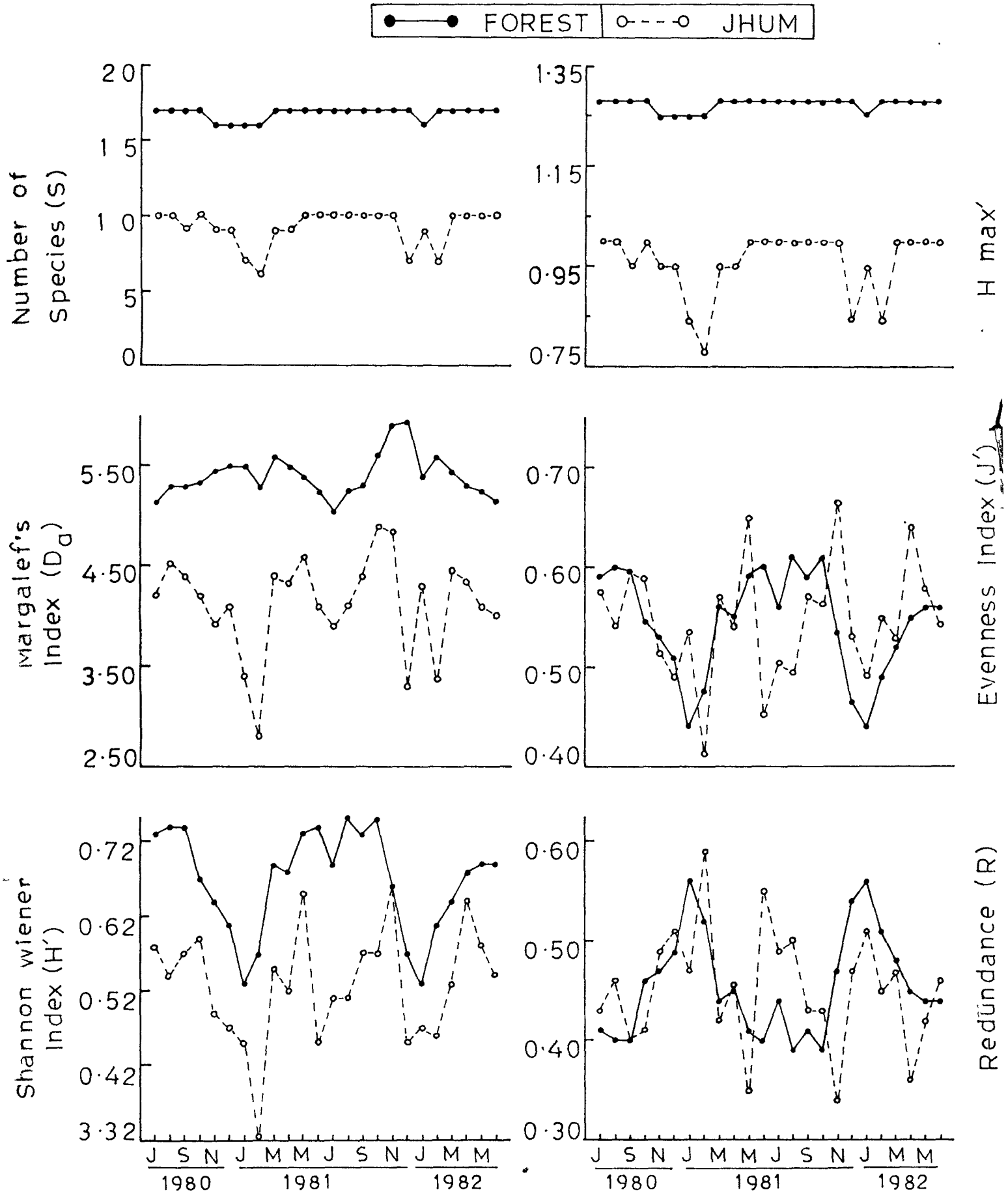

FOREST
JHUM
Number of Species (S)
H max'
Margalef's Index (D_d)
Evenness Index (J')
Shannon wiener Index (H')
Redundance (R)
20
15
10
5
0
1·35
1·15
0·95
0·75
5·50
4·50
3·50
2·50
0·70
0·60
0·50
0·40
0·72
0·62
0·52
0·42
3·32
0·60
0·50
0·40
0·30
J S N J M M J S N J M M
1980
1981
1982

Fig. 75

and December 1981 (5.946) during the first and second annual cycles, respectively. In the total system of the jhum, these values ranged from 2.789 (February 1981) to 4.628 (May 1981) during the first annual cycle, while the second annual cycle indices varied from 3.274 (December 1981) to 4.911 (October 1981).

Shannon's index of diversities in the forest system were seen minima in the month of January during both the first (0.532) and second (0.530) annual cycles. The maximum values of the indices were in August, true for both the annual cycles, being 0.738 for the first and 0.756 for the second annual cycles. In the jhum system, Shannon's index of diversities varied from 0.322 (February 1981) to 0.651 (May 1981) during the first annual cycle, while they ranged from 0.446 (December 1981) to 0.665 (November 1981) in the second annual cycle.

H_{max}, or maximum diversity values of collembolan species in the forest system were seen minima during the winter months of both the annual cycles. Thus, the index recorded as minimum during the first (November to February) and second (January) annual cycles, was 1.204. All the remaining months showed the H_{max}, as 1.230 in the forest system. Similar patterns of H_{max}, trends (winter minima and summer maxima) were observed in the jhum system for the collembolan species. Thus, the values ranged from 0.778 (February) to 1.000 (July, August, October, May & June) during the first annual cycle. The second annual cycle depicted a range of 0.845 in December and February to 1.000 for all the remaining months, except January 1982 (0.954).

The evenness values of the collembolan community in

the forest system were seen maxima in August and minima in January during the investigation period. These values were respectively 0.600 and 0.442 during the first annual cycle; 0.614 and 0.440 during the second annual cycle. In the jhum system, these values ranged from 0.414 (February 1981) to 0.651 (May 1981) during the first annual cycle; 0.493 (January 1982) to 0.665 (November 1981) during the second annual cycle.

The redundance values of the collembolan species in the forest system were minimum in August and maximum in January, true for both the annual cycles. Thus, the values ranged from 0.400 to 0.558 and 0.386 to 0.560 respectively during the first and second annual cycles. In the jhum system, the maximum and minimum redundance values were respectively 0.586 (February) and 0.349 (May 1981) during the first annual cycle; 0.507 (January) and 0.335 (November) during the second annual cycle.

Forest and jhum soils : 0-10 cm layer

Indices of collembolan species diversity from 0-10 cm layer of the forest and jhum soils for two annual cycles are represented in the Fig. 76. Of the 11 species which occurred in this layer of the forest, Dicranocentrus singularis was not recorded during July, September to April of the first annual cycle and December to February of the second annual cycle, while Salina, similarly did not occur during November to March of the first annual cycle,and January and February of the second annual cycle. Further, Sphaeridia cornuta was absent from the system during February of the first annual cycle, while Sminthurinus bimaculatus in February of both the annual cycles and March of

Fig. 76. Showing the seasonal fluctuations in the number of species (S), Margalef's Index (D_a), Shannon-Wiener Index (H'), $H_{max'}$, Evenness Index (J') and Redundance values (R) of Collembola in the 0-10 cm layer of the forest and jhum systems for two annual cycles.

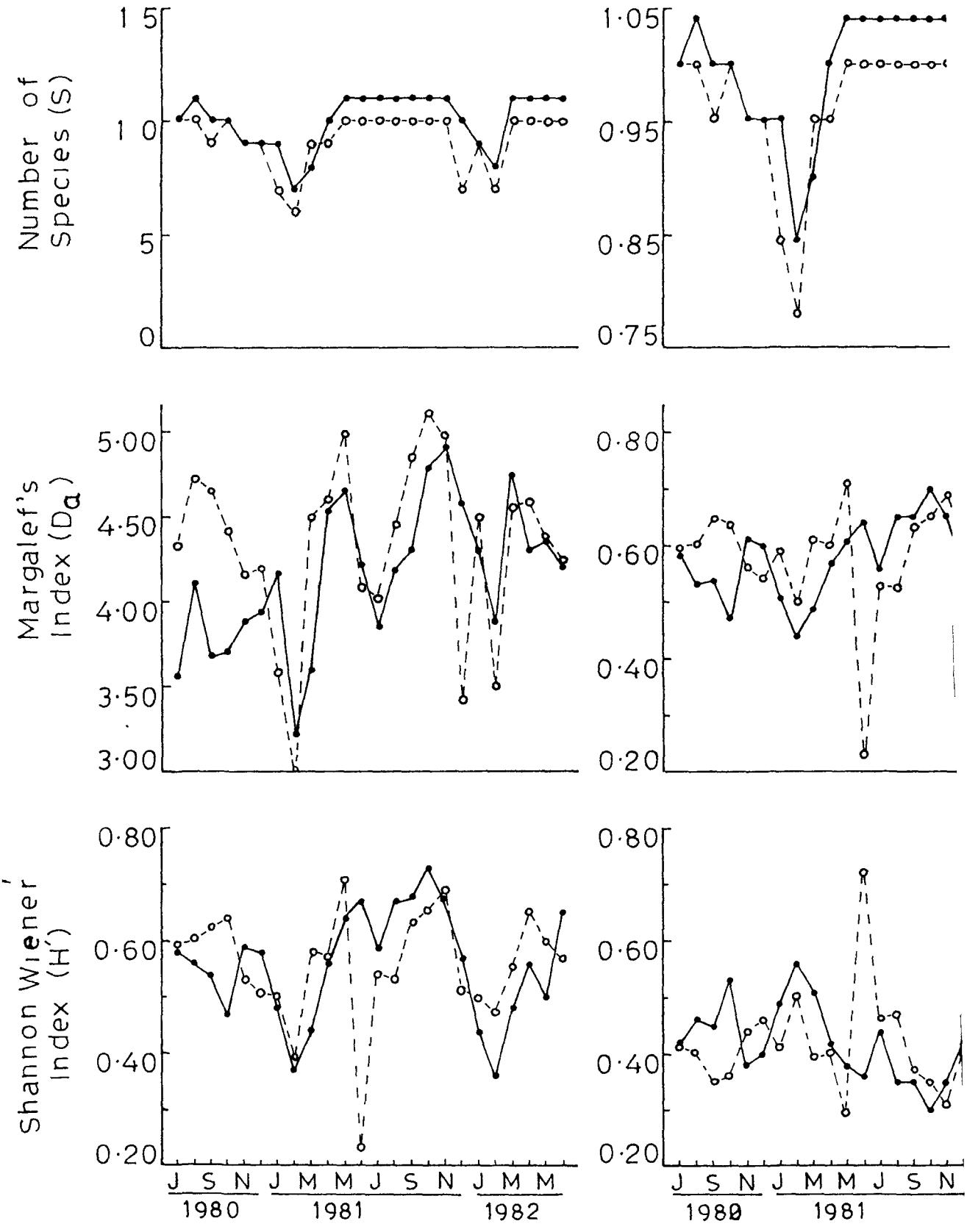

Number of Species (S)
1 5
1 0
5
0
1·05
0·95
0·85
0·75
Margalef's Index (Dα)
5·00
4·50
4·00
3·50
3·00
0·80
0·60
0·40
0·20
Shannon Wiener Index (H')
0·80
0·60
0·40
0·20
0·80
0·60
0·40
0·20
J S N J M M J S N J M M
1980 1981 1982
J S N J M M J S N
1980 1981

Fig. 76

the first annual cycle. Of the 10 species occurring in this layer of the jhum soil, once again Salina did not occur during September, November to February of the first annual cycle and October to February of the second annual cycle. Sphaeridia cornuta and Sminthurinus bimaculatus again followed the forest system in that the former did not occur in January and February of the first annual cycle, and December and February of the second annual cycle, while the latter was absent only in February of the first annual cycle. Moreover, Megalothorax minimus in the jhum soil did not occur in February of both the annual cycles, and January and December of the first and second annual cycles, respectively.

Margalef's indices in the 0-10 cm layer of the forest soil for the collembolan species ranged from 3.230 (February 1981) to 4.646 (May 1981) during the first annual cycle. In the second annual cycle, it was 3.849 in July 1981 as minimum and 4.917 in November 1981 as maximum values. In the jhum soil (0-10 cm), the collembolan species recorded values of 2.974 as minimum (February 1981) and 4.982 as maximum (May 1981). The index values ranged from 3.431 (December 1981) to 5.147 (October 1981) during the second annual cycle.

Shannon-Wiener index were the least in February, true for both the annual cycles, being 0.369 for the first and 0.361 for the second annual cycles. The indices were maximum in June (0.665) and October (0.729) during the first and second annual cycles, respectively. In the jhum soil (0-10 cm) too, the values were the least in February, being 0.388 during the first and 0.466 during the second annual cycle. The values were maximum

during May (0.709) of the first annual cycle and November 1981 (0.693) of the second annual cycle.

The H_{max}' values were the least in February, being 0.845 for the first and 0.903 for the second annual cycle. Maximum of 1.041 were recorded in a number of months of both the annual cycles, in the 0-10 cm layer of the forest soil. In the jhum soil, minimum H_{max}' were 0.778 (February) during the first annual cycle and 0.845 (December & February) during the second annual cycle. Further, different months of both the annual cycles showed H_{max}' values as 1.000.

The evenness values in the forest soil (0-10 cm) ranged from 0.437 (February) to 0.639 (June) during the first annual cycle and 0.400 (February) to 0.700 (October) during the second annual cycle. In the jhum soil for the corresponding layer, the minimum and maximum values were respectively 0.234 (June) and 0.709 (May) during the first annual cycle; 0.527 (August) and 0.769 (January) during the second annual cycle.

The redundance values were maximum in February for the forest (0-10 cm) soil, being 0.563 for the first and 0.600 for the second annual cycles. Minimum values were 0.361 (June) and 0.300 (October) for the first and second annual cycles, respectively. In the 0-10 cm layer of the jhum soil, the redundance values of the collembolan species were maximum during June 1981 (0.766) and August 1981 (0.473) of the first and second annual cycles, respectively. Minimum values were 0.291 in May 1981 of the first annual cycle and 0.231 in January 1982 of the second annual cycle.

Forest and jhum soils : 10-20 cm layer

Fig. 77 represents the diversity of indices for collembolan species in the 10-20 cm layer of the forest and jhum soils for two annual cycles. This layer showed drastic fall in number of collembolan species as mentioned earlier. Of the 4 species in the forest, Cryptopygus thermophilus was not recorded during November and February of the first annual cycle and October of the second annual cycle; other isotomids in October and December of the second annual cycle; other entomobryids in November and January of the first annual cycle. On a similar analysis the 3 species occurring in jhum, Cryptopygus thermophilus was not recorded in December, February and March of the first annual cycle and October to February of the second annual cycle; other isotomids was absent in August, September, December to April of the first annual cycle and November, January to March of the second annual cycle.

In the forest, the minimum and maximum values of Margalef's index were respectively 0.926 (November) and 2.491 (March) during the first annual cycle; 0.967 (October) and 2.305 (September, November & April) during the second annual cycle. In the jhum soil (10-20 cm), the peak values of the index were 1.660 (June) during the first annual cycle and 1.449 (April) during the second annual cycle. In a few months of both the annual cycles, the values for Margalef's index were zero.

Shannon-Wiener index values ranged from 0.196 (November) to 0.536 (March) in the forest soil during the first annual cycle; 0.164 (October) to 0.480 (September) during the second annual cycle. In the jhum soil, the index were maximum during

Fig. 77. Showing the seasonal fluctuations in the number of species (S), Margalef's Index (D_a), Shannon-Wiener Index (H'), $H_{max'}$, Evenness Index (J') and Redundance values (R) of Collembola in the 10-20 cm layer of the forest and jhum systems for two annual cycles.

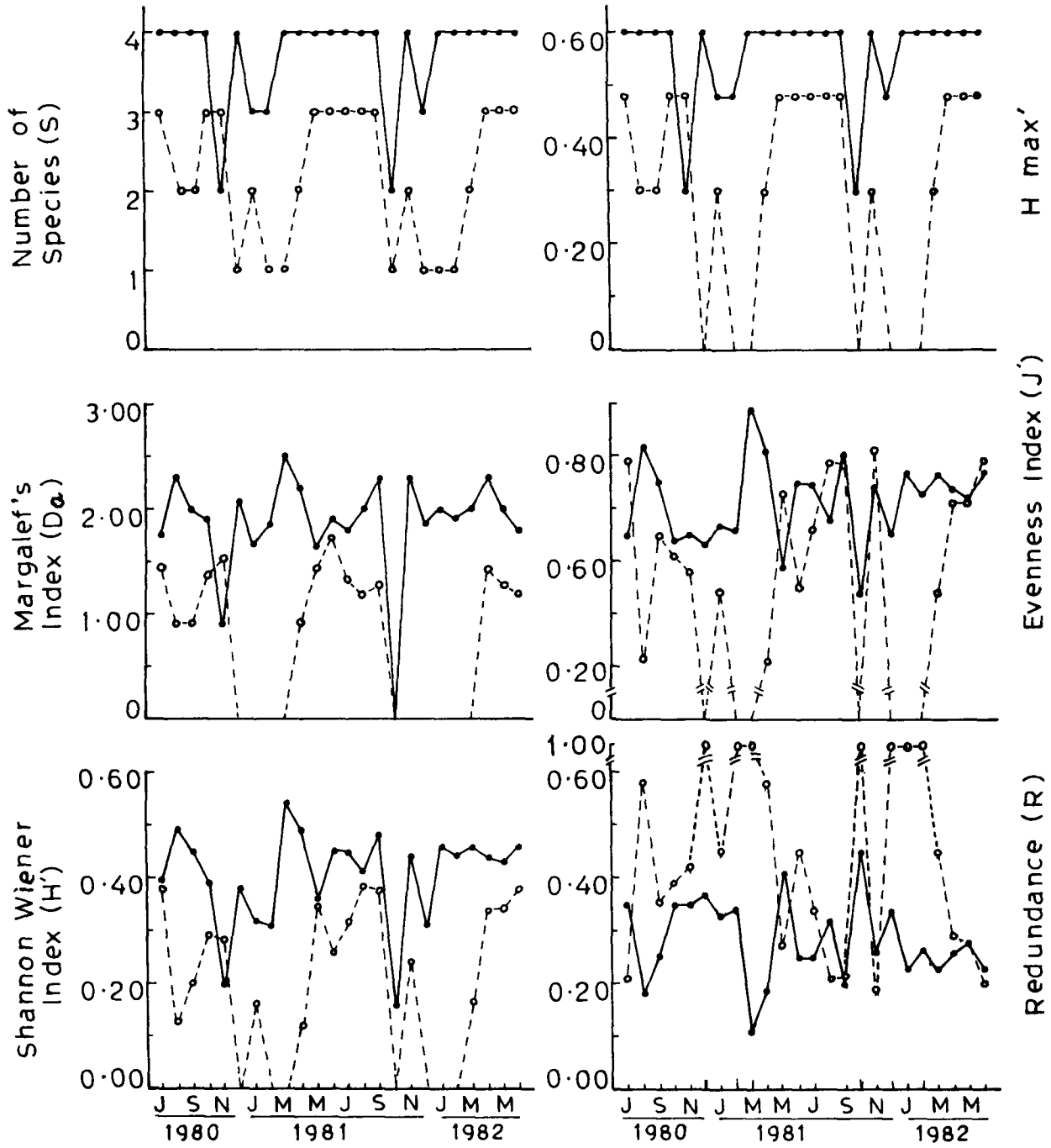

Number of Species (S)
H max'
Margalef's Index (Dα)
Evenness Index (J')
Shannon Wiener Index (H')
Redundance (R)
J S N J M M J S N J M M
1980 1981 1982

Fig. 77

July 1980 (0.377) of the first annual cycle and June 1982 of the second annual cycle (0.378).

In the 10-20 cm layer of the forest soil, the collembolan species revealed same values of $H_{max'}$ = 0.301 as minimum and $H_{max'}$ = 0.602 as maximum during the investigation period. Thus, during the first annual cycle, $H_{max'}$ was the least in November, while all the remaining months showed equal values of maximum $H_{max'}$ (except January & February, $H_{max'}$ = 0.447). In the second annual cycle, October revealed minimum $H_{max'}$ whereas all the remaining months (except December, $H_{max'}$ = 0.447) displayed uniform measures of maximum $H_{max'}$. In the jhum soil, both the annual cycles manifested same estimates of maximum diversity ($H_{max'}$ = 0.477) in different months as seen in the figure.

The evenness values of the collembolan species in the 10-20 cm layer of the forest ranged from 0.593 (May 1981) to 0.890 (March 1981) and 0.545 (October 1981) to 0.797 (September 1981) during the first and second annual cycles, respectively. Maximum evenness values of collembolan species in the jhum soil reached 0.790 (July 1980) and 0.792 (June 1982) respectively during the first and second annual cycles.

The redundance values of the collembolan species in the forest ranged from 0.110 (March 1981) to 0.407 (May 1981) during the first annual cycle. The values of the second annual cycle were all within the range of 0.203 (September 1981) to 0.455 (October 1981). In the jhum soil, the peak redundance values were 1.000 during December, February and March of the first

annual cycle and October, December, January and February of the second annual cycle. The least were during July (0.210) and November (0.188) of the first and second annual cycles, respectively.

Forest and jhum soils : 20-30 cm layer

In this layer, only *Isotoma* (*Desoria*) *trispinata* which occurred was also not available throughout the year of either of the annual cycle in both the systems. In the forest, the species were absent during August to October and February-March of the first annual cycle; September to November and March-April of the second annual cycle. Similarly, in the jhum soil, they were not recorded during several months of both the annual cycles.

Since this was the only species and that too occurring irregularly in either of the system, no calculations of their diversity indices nor any other, were performed for this layer.

4.2.3.2. Collembolan community similarity

The community similarities of Collembola of the forest and jhum systems were compared using the indices, viz. Sørensen's Coefficient of Community Similarity (Quotient of Similarity), Morisita's Index and Average Faunal Resemblance.

Forest and jhum soils : Total system

Fig. 78 represents the quantitative measures of similarity indices of collembolan community between the forest and jhum systems. Thus, Sørensen's quotient of similarity between

Fig. 78. Showing the seasonal fluctuations of the Average faunal resemblance (%), Morisita's Index (I_m) and Sørensen Coefficient of Similarity, CC_s (%) of Collembola between the total systems of the forest and jhum for two annual cycles.

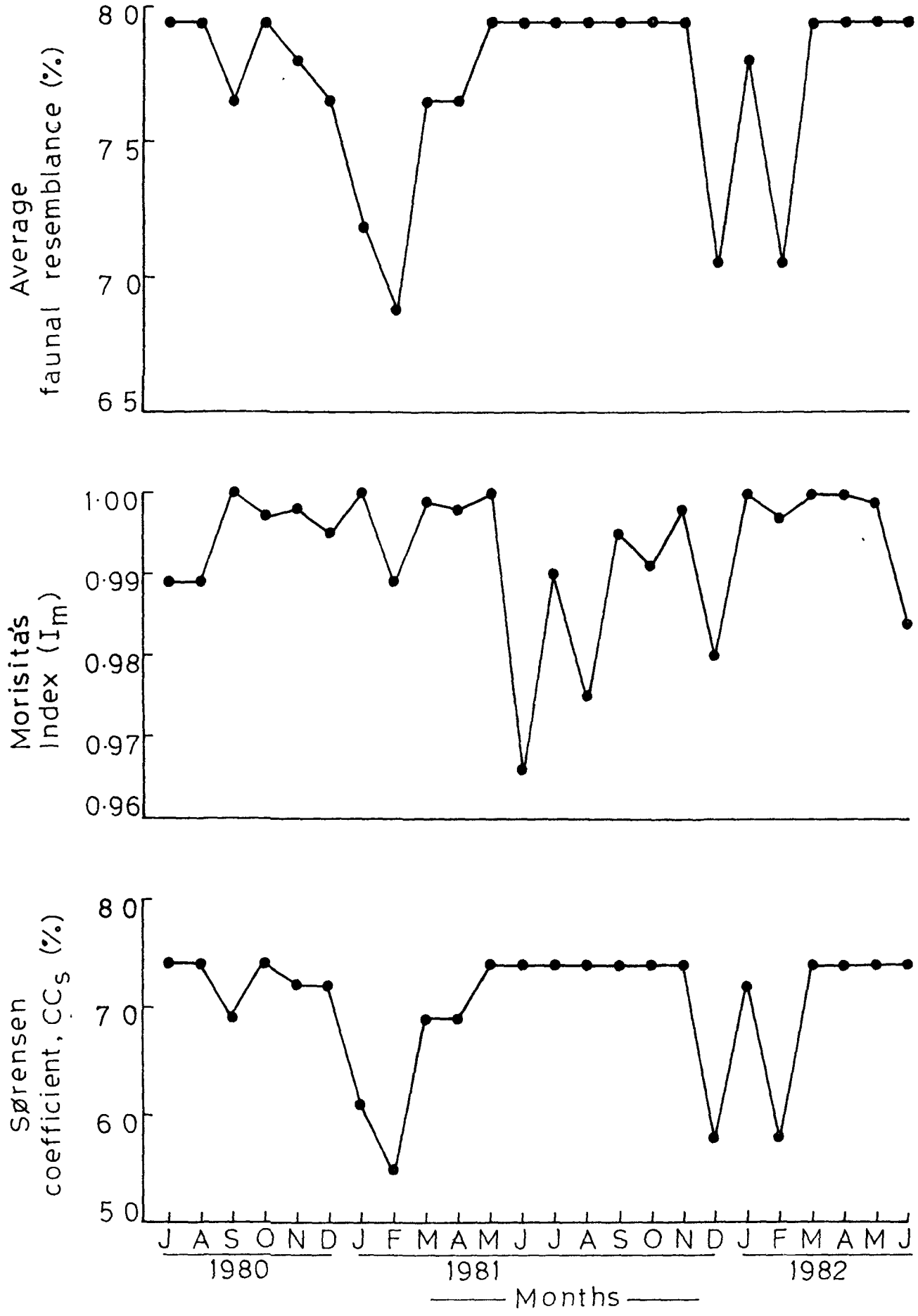

Average faunal resemblance (%)
8 0
7 5
7 0
6 5
Morisita's Index (I_m)
1·00
0·99
0·98
0·97
0·96
Sørensen coefficient, CC_S (%)
8 0
7 0
6 0
5 0
J A S O N D J F M A M J J A S O N D J F M A M J
1980
1981
1982
Months

Fig. 78

Collembola of total forest and jhum systems were the lowest in February 1981 (54.55%) of the first annual cycle; December 1981 and February 1982 (58.33%) of the second annual cycle. Further, the measure of similarity calculated was 74.07% as maximum in different months of the entire study period (Fig. 78).

Equal values of maximum Morisita's index (1.00) were recorded in the months of September, January and May of the first annual cycle; January, March and April of the second annual cycle. Minimum estimates of the index were 0.966 (June 1981) and 0.975 (August 1981) during the first and second annual cycles, respectively.

The average faunal resemblance of the collembolan community between the total forest and jhum systems were 79.41% as maximum in different months of the entire study period. However, minimal were recorded only in February 1981 (68.75%) of the first annual cycle; December and February (70.58%) of the second annual cycle.

Forest and jhum soils : 0-10 cm layer

The indices of collembolan community similarity between the 0-10 cm layer of the forest and jhum systems are illustrated in Fig. 79. During the first annual cycle, Sørensen's quotient of similarity ranged from 87.50% in January 1981 to 100.0% in different months of the period as observed in the figure. In the second annual cycle, the similarity value of the collembolan species ranged from 82.35% (December 1981) to 100.0% (January 1982).

Figs. 79 & 80. Showing the seasonal fluctuations of the Average faunal resemblance (%), Morisita's Index (I_m) and Sørensen Coefficient of Similarity, CC_s (%) of Collembola between the 0-10 cm layer (Fig. 79) and 10-20 cm layer (Fig. 80) of the forest and jhum systems for two annual cycles.

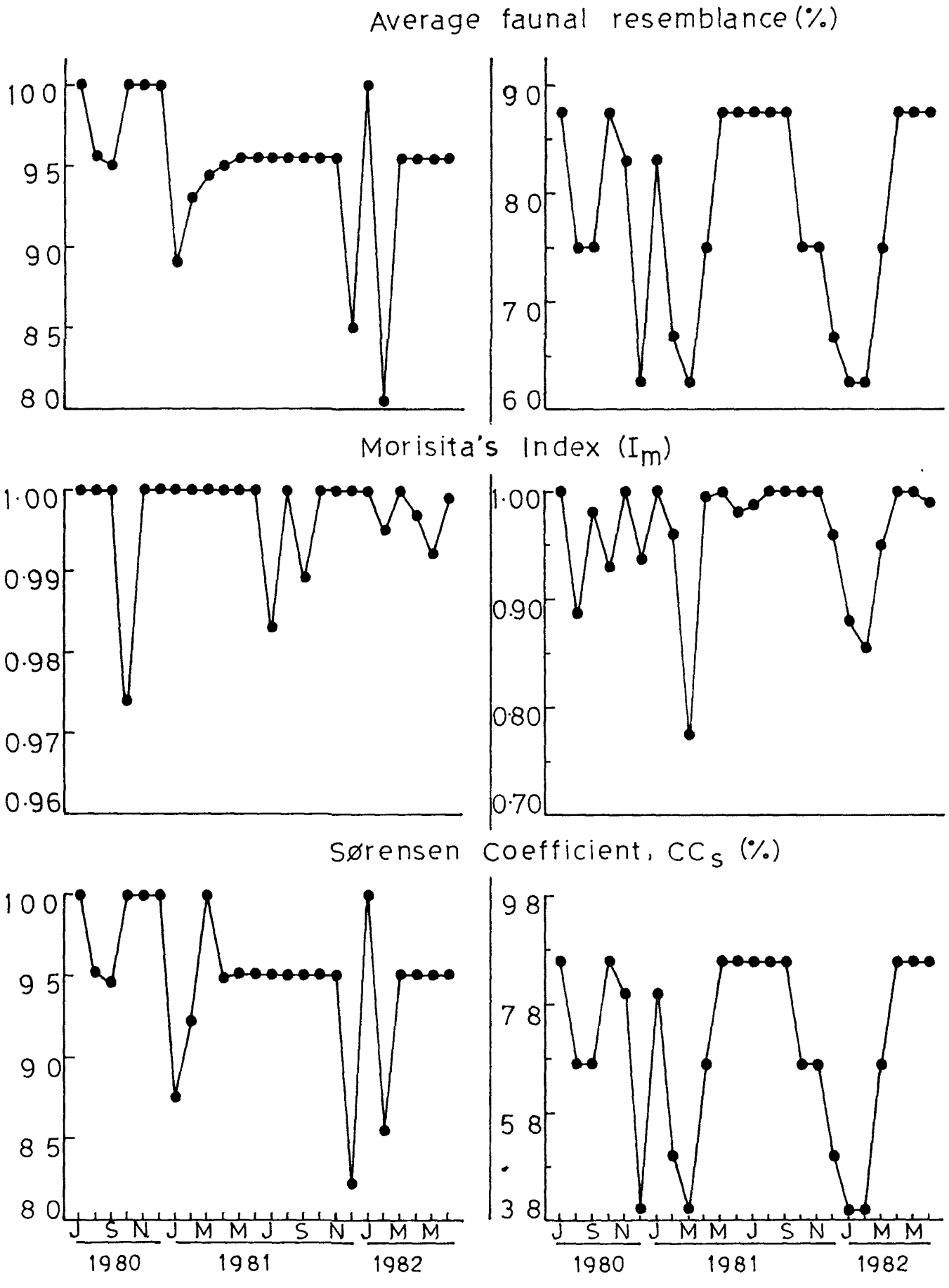

Average faunal resemblance (%)
100
95
90
85
80
90
80
70
60
Morisita's Index (I_m)
1·00
0·99
0·98
0·97
0·96
1·00
0·90
0·80
0·70
Sørensen Coefficient, CC_S (%)
100
95
90
85
80
98
78
58
38
J S N J M M J S N J M M
1980
1981
1982
J S N J M M J S N J M M
1980
1981
1982

Fig. 79

Fig. 80

Morisita's index were minimum during October 1980 (0.974) of the first annual cycle and August 1981 (0.989) of the second annual cycle. Maximum values were 1.000, in different months of the entire study period.

The average faunal resemblance ranged from 88.89% (January 1981) to 100.0% (July, October, November & December 1980) during the first annual cycle. In the second annual cycle, the values ranged from 80.36% in February 1982 to 100.0% in January 1982.

Forest and jhum soils : 10-20 cm layer

Sørensen's quotients were minimum (40.00%) during December and March of the first annual cycle; January and February of the second annual cycle. Maximum value was 85.71% in different months of both the annual cycles (Fig. 80).

Morisita's index were the least during March (0.774) of the first annual cycle and February (0.856) of the second annual cycle. Maximum value was 1.00 for Morisita's index in different months of both the annual cycles.

The average faunal resemblance were minimum (62.50%) during December and March of the first annual cycle; January and February of the second annual cycle. Further, different months of the total study period also recorded 87.50% as maximum average faunal resemblance, as seen in the figure.

4.2.3.3. Oribatid species number and diversity indices

The species number and the diversities of oribatid community were studied for the total system and 0-10 cm layer of the forest and jhum soil.

Like Collembola, on a similar analysis for oribatid (Cryptostigmata), it was seen that the largest number of species 11 occurred in the forest and 9 in the jhum (Fig. 81). The two species/group that were absent in the jhum were Uropodidae and other oribatids. Interestingly enough, the top 0-10 cm layer of both the forest and jhum had the same number of species (11 and 9, respectively) as for the total systems. However, there was drastic fall at 10-20 cm layer with only 3 and 1 species occurring in the first and second annual cycles respectively of the forest system, while only 1 and 2 species in the jhum system for the first and second annual cycles.

The next layer and subsequent did not have any of these oribatids in either of the systems.

Forest and jhum soils : Total system

Fig. 81 illustrates the indices of oribatid species diversities in the total system of the forest and jhum soils during the span of present investigation. Of the 11 species/group of oribatids, all occurred throughout both the annual cycles in the forest under study, while in the jhum system, of the 9 species that occurred, only Rhysotritia ardua, Galumna and Neoribates, similarly occurred throughout both the annual cycles. The other 6 species/group occurred very irregularly, with all of them mostly absent during the winter months.

Fig. 81. Showing the seasonal fluctuations of the number of species (S), Margalef's Index (D_a), Shannon-Wiener Index (H'), $H_{max'}$, Evenness Index (J') and Redundance values (R) of Cryptostigmata (Oribatid mites) in the total systems of the forest and jhum for two annual cycles.

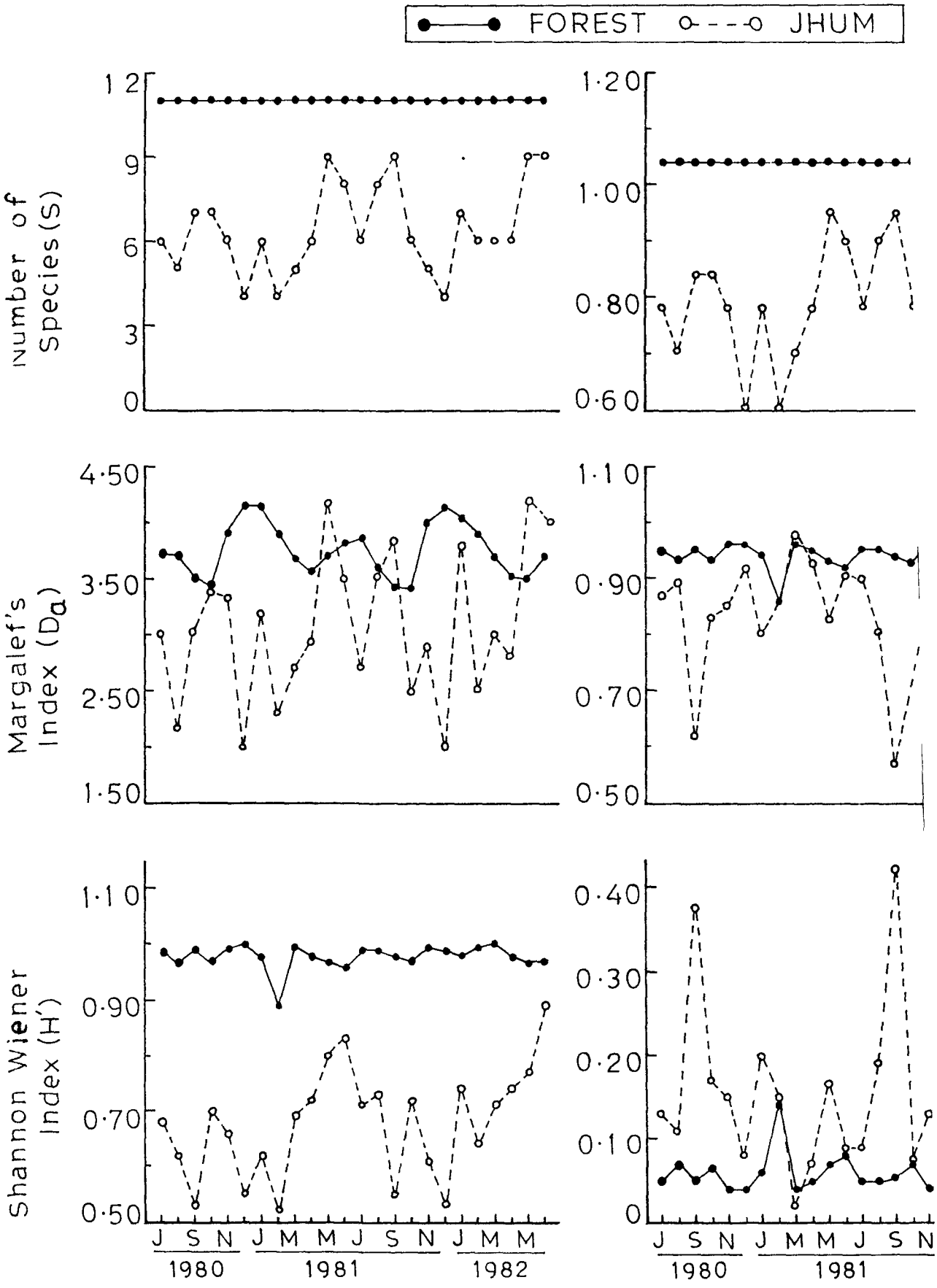

FOREST
JHUM
Number of Species (S)
Margalef's Index (D_a)
Shannon Wiener Index (H')
12
9
6
3
0
1·20
1·00
0·80
0·60
4·50
3·50
2·50
1·50
1·10
0·90
0·70
0·50
1·10
0·90
0·70
0·50
0·40
0·30
0·20
0·10
0
J S N J M M J S N J M M
1980 1981 1982
J S N J M M J S N
1980 1981

Fig. 81

In the forest, whereas the December months of both the annual cycles recorded maximum (4.164) values of Margalef's index, the minimum were observed during October (3.444) of the first annual cycle; September and October (3.438) of the second annual cycle. In the jhum soil, the value was the least in December (1.993), true for both the annual cycles. The maximum values of Margalef's index were seen in the months of May, being 4.168 during the first annual cycle and 4.240 during the second annual cycle.

Shannon-Wiener index were minimum during February 1981 (0.892) of the first annual cycle and October 1981 (0.967) of the second annual cycle, in the forest system. Maximum value was 1.00 each, being in December of the first annual cycle and March of the second annual cycle. In the jhum system, the minimum and maximum values were respectively 0.525 (February) and 0.826 (June) during the first annual cycle; 0.530 (December) and 0.892 (June) during the second annual cycle.

The oribatid species in the forest system showed a uniform estimate of maximum diversity ($H_{max'}$ = 1.041) throughout the period of present investigation. However, in the jhum system, the $H_{max'}$ for oribatid species ranged from 0.602 to 0.954 during the entire study period, as shown in the figure.

The evenness values for the forest system recorded 0.960 as maximum during December of the first and March of the second annual cycles. Minimum were in February 1981 (0.857) of the first and October 1981 (0.929) of the second annual cycles. In the jhum system, the evenness values ranged from 0.624 (Sep-

tember 1980) to 0.980 (March 1981) and 0.574 (September 1981) to 0.946 (April 1982) of the first and second annual cycles, respectively.

Redundance values were the least (0.040) during December 1980 of the first annual cycle and March 1982 of the second annual cycle. However, two different peaks were observed for the two annual cycles, being 0.143 (February 1981) for the first annual cycle and 0.071 (October 1981.) for the second annual cycle. In the jhum system, these values ranged from 0.020 (March 1981) to 0.376 (September 1980) during the first annual cycle; 0.054 (April 1982) to 0.426 (September 1981) during the second annual cycle.

Forest and jhum soils : 0-10 cm layer

The diversity indices of oribatid species in the 0-10 cm layer of the forest and jhum soils are illustrated in the Fig. 82. In this layer, in the forest system, except for Uropodidae which was not recorded during December to February of the first annual cycle, and December and January of the second annual cycle, all the others were found throughout the study period. In the jhum, however, of the 9 species/group, only 3 occurred throughout the year as for the total system, while others were predominantly absent during the winter months.

Margalef's index in the forest system (0-10 cm) ranged from 3.772 (February) to 4.620 (June) during the first annual cycle; 3.858 (January) to 4.835 (November) during the second annual cycle. In the jhum soil, the minimum value of Margalef's

Fig. 82. Showing the seasonal fluctuations of the number of species (S), Margalef's Index (D_a), Shannon-Wiener Index (H'), H_{max}', Evenness Index (J') and Redundance values (R) of Cryptostigmata (Oribatid mites) in the 0-10 cm layer of the forest and jhum systems for two annual cycles.

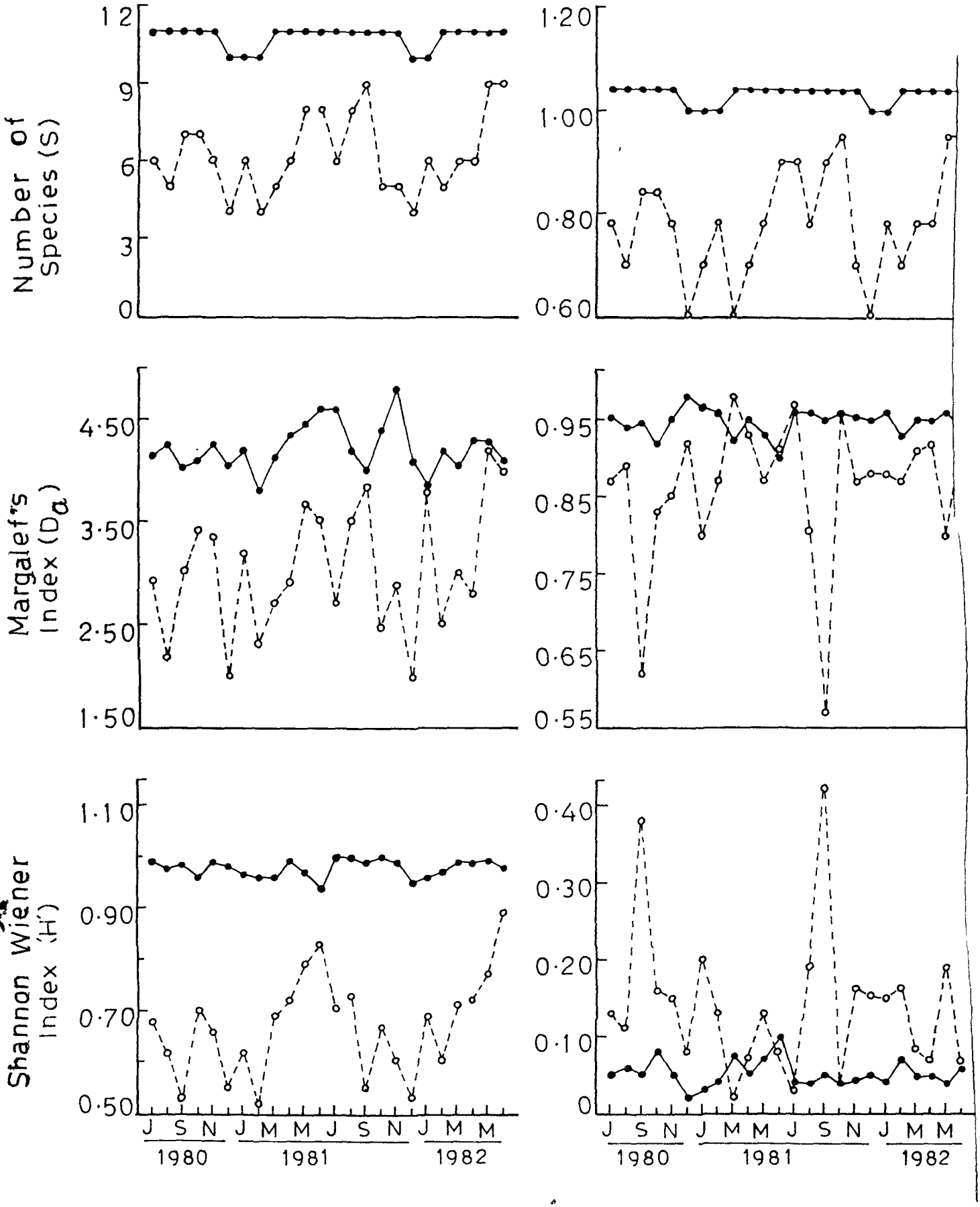

Number of Species (S)
12
9
6
3
0
1·20
1·00
0·80
0·60
Margalef's Index (D_α)
4·50
3·50
2·50
1·50
0·95
0·85
0·75
0·65
0·55
Shannon Wiener Index (H')
1·10
0·90
0·70
0·50
0·40
0·30
0·20
0·10
0
J S N J M M J S N J M M
1980
1981
1982

Fig. 82

index was 1.993 in December, true for both the annual cycles. The maximum values were in May, being 3.667 for the first annual cycle and 4.240 for the second annual cycle.

Shannon-Wiener index values in the forest soil were minimum in June (0.940) and maximum in July (0.993) during the first annual cycle. In the second annual cycle, the index was minimum in December (0.947) and maximum in the months of July, August and October, being 1.000 in each month. In the jhum soil, the values were maximum in June, being 0.826 for the first annual cycle and 0.892 for the second annual cycle. The index were the least in February of the first annual cycle (0.525) and December of the second annual cycle (0.530).

In the forest, the $H_{max'}$ values were 1.000 (in December, January & February of the first annual cycle; December & January of the second annual cycle) to 1.041 during the remaining months of both the annual cycles. In the jhum soil, equal values of minimum $H_{max'}$ (0.602) were recorded during December and February of the first annual cycle and only in December of the second annual cycle. Maximum $H_{max'}$ during the first and second annual cycles were respectively 0.903 (May & June) and 0.954 (September, May & June).

The evenness values in the forest ranged from 0.903 (June 1981) to 0.977 (November 1980) during the first annual cycle; 0.930 (February 1982) to 0.961 (January 1982) during the second annual cycle. In the jhum soil, the minimum and maximum evenness values were 0.624 (September 1980) and 0.983 (March 1981) respectively in the first annual cycle; 0.574 (September 1981) and 0.967 (July 1981) in the second annual cycle.

The redundance values of the oribatid species in the 0-10 cm layer of the forest soil ranged from 0.023 (December 1980) to 0.097 (June 1981) during the first annual cycle; 0.039 (January 1982) to 0.070 (February 1982) during the second annual cycle. These values in the jhum soil were 0.017 (March 1981) to 0.376 (September 1980) and 0.033 (July 1981) to 0.426 (September 1981) during the first and second annual cycles, respectively.

Forest and jhum soils : 10-20 cm layer

In this layer, even the 3 species which occurred in the forest did not occur throughout both the annual cycles. In the first annual cycle, all of them were present only in the months of July, August and September, while in the second annual cycle, the only one that was present in July and August was Dolicheremaeus sp.

In the jhum, the only 2 species that occurred were Dolicheremaeus and Suctobelba, the former being present only in May of the first annual cycle and October, January and April of the second annual cycle, while the latter only in second annual cycle and that too during two months, October and February.

No further analysis of diversities of these species were done due to very low number of species present and highly irregular occurrences.

4.2.3.4. Oribatid community similarity

As were used for Collembola, three indices, viz. Sørensen's Coefficient, Morisita's index and Average faunal resemblance were used to analyse the community similarity of oribatid in/between the forest and jhum soils as described below.

Forest and jhum soils : Total system

Fig. 83 illustrates the measures of similarity indices of oribatid community between the total systems of the forest and jhum. Thus, Sørensen's quotient of similarity index ranged from 53.33% as minimal to 90.00% as maximal throughout the study period. The months that showed minimum were in December and February, and maximum in May of the first annual cycle; minimum in December and maximum in September, May and June of the second annual cycle.

Morisita's index ranged from 0.525 (February 1981) to 0.920 (June 1981) during the first annual cycle; 0.530 (December 1981) to 0.923 (June 1982) of the second annual cycle.

The minimum and maximum values of the average faunal resemblance were respectively 68.18% and 90.91%, true for both the annual cycles. Thus, during the first annual cycle, minimum was seen in December 1980 and February 1981. The maximum values for the same annual cycle was observed in May 1981. In the second annual cycle, only the month of December 1981 showed minimum value of average faunal resemblance between the total system of the forest and jhum. Maximum was recorded in the months of September, May and June for the second annual cycle.

Figs. 83 & 84. Showing the seasonal fluctuations of the Average faunal resemblance (%), Morisita's Index (I_m) and Sørensen Coefficient of Similarity, CC_s (%) of Cryptostigmata (Oribatid mites) between the total systems of the forest and jhum (Fig. 83) and 0-10 cm layer of the forest and jhum systems (Fig. 84).

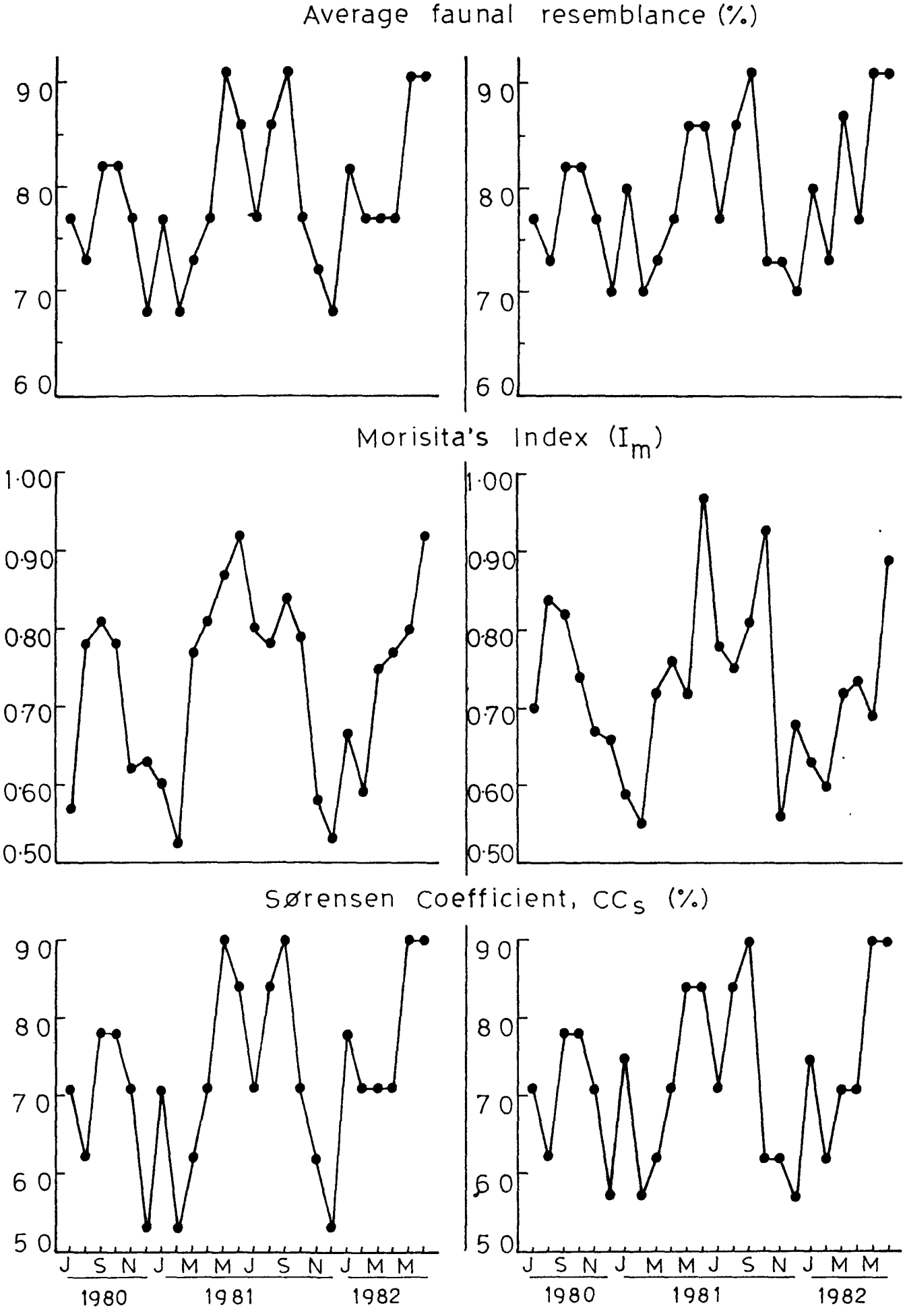

Average faunal resemblance (%)
9 0
8 0
7 0
6 0
Morisita's Index (I_m)
1·00
0·90
0·80
0·70
0·60
0·50
Sørensen Coefficient, CC_S (%)
9 0
8 0
7 0
6 0
5 0
J S N J M M J S N J M M
1980
1981
1982

Fig. 83

Fig. 84

Forest and jhum soils : 0-10 cm layer

The indices of oribatid community similarity in the 0-10 cm layer of the forest and jhum soils are represented in the Fig. 84. Sørensen's quotient of similarity were the least (57.14%) during December and February of the first annual cycle, and only December of the second annual cycle. However, maximum values of the first and second annual cycles were 84.21% (May & June) and 90.00% (September, May & June), respectively.

Morisita's index for the oribatid community exhibited a minimum of 0.552 in February 1981 to a maximum of 0.970 in June 1981 during the first annual cycle. In the second annual cycle, the ranges were 0.560 (November 1981) as minimum to 0.930 (October 1981) as maximum.

The average faunal resemblance were the least (70.00%) during December and February of the first annual cycle, and only during December of the second annual cycle. However, maximum values of average faunal resemblance were observed in May and June (86.36%) of the first annual cycle, and September, May and June (90.91%) of the second annual cycle.

5. DISCUSSION

The results of the present investigation, when totalled for the forest system, revealed nearly $22500 \times 10^2/m^2$ individuals of soil fauna for one annual cycle for all the layers under consideration, inclusive of litter and 0-40 cm soil depth. This was more or less true for the second annual cycle also. On a similar analysis, in contrast, the jhum system revealed about $4400 \times 10^2/m^2$ for the first annual cycle and nearly $5000 \times 10^2/m^2$ for the second annual cycle. It is seen, however, that the figures for the jhum system are those only of the soil layers of 0-40 cm, as the litter layer was completely absent. Therefore, a decrease of nearly 5 times in the total fauna of jhum system, as compared to the pine forest system, is observed. However, if one were to compare only the soil layer of 0-40 cm in both the forest and jhum systems, it is seen that nearly $8000 \times 10^2/m^2$ individuals of soil fauna was recorded in the forest soil and, therefore, a nearly 50% reduction is observed in the jhum soil.

On a depth-wise analysis, it was seen that nearly $6500\text{-}7000 \times 10^2/m^2$ soil fauna was seen in the 0-10 cm layer of the forest, while only $3500 \times 10^2/m^2$ was observed for the same layer in the jhum soil, again revealing about 50% reduction for the top soil layers. In the next layer of 10-20 cm, a density of nearly $1200 \times 10^2/m^2$ was observed in the forest system and $700\text{-}1000 \times 10^2/m^2$ in the jhum system, showing a negligible reduction in this layer in the latter. For the next two layers (20-30 cm and 30-40 cm), interestingly enough, there was a trend

in reverse between these two systems under consideration. An abundance of 75-240x$10^2/m^2$ soil fauna in the forest system and nearly 120x$10^2/m^2$ in the jhum system was observed for the 20-30 cm layer, while the 30-40 cm depth showed about 40x$10^2/m^2$ for the forest system and 50-100x$10^2/m^2$ for the jhum system, revealing even about 50% increase in the latter (during the second annual cycle), though the densities observed were far less.

This clearly indicates that a dense cover of litter in an undisturbed forest system enables in accumulation and aggregation of larger number of individuals in the top layers. In contrast, the jhum system, due probably to the highly disturbed nature of the top soil, enables the soil fauna, to probably migrate to deeper layer of less disturbance. This is obvious in the present study as there is certainly increase in the abundance in the lower soil layer in the jhum system as seen during the second year of investigation.

Soil zoologists generally agree that the most abundant soil inhabiting microarthropods are usually available near the surface upto the layer of 10 cm deep, characterized by adequate living space, favourable moisture condition, aeration rates and rich accumulation of organic debris (Weis-Fogh, 1948; Murphy, 1953; Haarløv, 1960; Hale, 1967; Wallwork, 1970). The effects of cultivation, fallowing, irrigation and other habitat disturbance associated with agriculture could only be compared probably to soil under natural conditions of semi-arid mediterranean type of climate or to the dry season in areas subject to drought which tend to favour development of sub-surface fauna

(Price, 1973). However, as far as densities were concerned in the vertical distributions, there was a clear decrease in abundance from the top soil to deeper layer, irrespective of the forest or jhum soil under consideration.

The sites chosen for the present investigation, situated at an altitude of about 1900 m, though tropical/sub-tropical in climatic regime, one is tempted to make comparisons of estimates/densities with that of the temperate soil fauna mainly on the basis of vegetational similarities. In the same region, though situated at a lower altitude but similar vegetational type, Reddy (1980) reported a maximum of $1600 \times 10^2/m^2$ for a profile of only upto 10 cm depth. In contrast, Drift (1951) working on a beech forest soil, Harding (1967) in an oak woodland soil, Price (1973) in a pine forest soil reported densities of soil arthropods respectively $3365 \times 10^2/m^2$, $2150 \times 10^2/m^2$, and $2207 \times 10^2/m^2$. If these were the mean densities of one annual cycle, on a similar analysis for the present investigation, the forest system revealed about $2000 \times 10^2/m^2$, while the jhum system showed only about $416 \times 10^2/m^2$. Moreover, since the present investigation was done upto 40 cm layer of the soil and much of the comparative work cited above had been confined to the litter and top soil layer, it is reasonable, therefore, to compare the litter and top soil layer alone, with that of both tropical and temperate soil faunal workers. When so done, in the present investigation, in the forest there is an annual monthly mean density of about $1900 \times 10^2/m^2$, which nearly agrees with those of workers from temperate regions. These comparisons seem to be

.more reasonable than comparing estimates of tropical situations, especially those of Drift (1963) and Greenslade and Greenslade (1968) who reported soil arthropod densities of $514x10^2/m^2$ and $940x10^2/m^2$ respectively, and all from much lower altitudes and typical tropical rainforests.

To get a truer picture, a similar analysis as done for total soil fauna, was calculated for the major groups like Collembola, Acarina and "other arthropods" and upto orders/generic/ specific levels for these groups, as far as possible.

When so done for Collembola, it was seen that they formed nearly $10,000x10^2/m^2$ in the forest for one annual cycle, while only $1100-1300x10^2/m^2$ in the jhum system, indicating about 10 times reduction. As was expected, the litter layer contributed nearly $7000-8000x10^2/m^2$ densities in the forest system. Moreover, even the 0-10 cm top soil layer of both the systems, revealed larger densities, though the forest always had twice the amount as in the jhum (about $2000x10^2/m^2$ in the forest ; $900-1000x10^2/m^2$ in the jhum). A similar phenomena was seen in the 10-20 cm of the soil depth and very negligible difference at 20-30 cm. A unique feature of the present investigation is that no Collembola was found at 30-40 cm, either in the forest or jhum system.

Once again, on comparison, Reddy's (1980) data revealed collembolan abundance of $24-1312x10^2/m^2$ in similar pine plantation but younger stand at lower altitude. Other workers like Tragardh(1928), Kaczmarek (1973), Price (1973) and Tamura (1976)

reported 1200x10^2/m^2, about 200x10^2/m^2, 1461x10^2/m^2 and a little over 105x10^2/m^2 individuals of Collembola, respectively. An extreme comparison in Swedish pine forest revealed that most abundant data for Collembola lie between 400x10^2/m^2 and 900x10^2/m^2 (Axelson et al., 1973; Lohm et al., 1977; Baath et al., 1980). Further, workers in both Sweden and Finland revealed spruce forest soil collembolan densities below 500x10^2/m^2 (Huhta & Koskenniemi, 1975). However, a value nearer to 1000x10^2/m^2 of Collembola were recorded in spruce sapling in a Norwegian habitat by Leinaas (1976) and 315-2014x10^2/m^2 in coniferous forest soils by Hagvar (1982). From the Japanese forests, Tanaka (1970) and Kitazawa (1971) estimated the densities of Collembola to be between 130-1000x10^2/m^2. Niijima's (1971, 1975) estimates also lie within this range (about 350-950x10^2/m^2). These figures correspond very well with the present study in that the annual monthly mean densities of total Collembola recorded were nearly 850x10^2/m^2, 816x10^2/m^2 and 100x10^2/m^2 in the total forest, top layer (litter and 0-10 cm) and total jhum system, respectively.

Further break up of Collembola into families revealed that Poduridae and Hypogastruridae did not occur in any soil layer of both the forest and jhum systems, and recorded only in the litter layer of the forest. And of all the families, these were the lowest in abundance. This was followed by Neelidae, represented by only one species, Megalothorax minimus and Sminthuridae, though represented by Sphaeridia cornuta and Sminthurinus bimaculatus, was confined only in the litter layer of the forest and 0-10 cm of the forest and jhum soil. The next family Entomo-

bryidae, though occurred in all the three layers (litter, 0-10 cm and 10-20 cm) of the forest soil, was available only in top layer (0-10 cm) of the jhum soil. The last family Isotomidae was the most dominant family and available in all the layers except the last layer (30-40 cm) in both the forest and jhum soil.

Not only was the family Isotomidae the most abundant, but of the 17 species of Collembola, inclusive of the two species of this family, Isotoma (Desoria) trispinata was recorded as the highest density of all species and even among all groups. One is, therefore, tempted to point out that due to a typical dominant species of Collembola available in systems as in the present investigation, very good prospects for energy flow study exist. Further, it is known that where there are many species of one group in a given habitat, the evolutionary strategy for that group will be to diversify the food resources and utilize as much as possible, so that where the habitat contain many sources of food or energy input (litter layer in the forest system in the present investigation), the various elements of the soil fauna will specialize so as to reduce competition to a low level.

Interestingly enough, as seen in the present investigation, most if not all the species are confined to the litter layer or top soil layer with Isotoma (Desoria) trispinata dominating and all the other species at much lower level of density. Moreover, it is well documented that any given species of Collembola will have specific reproductive performance when fed on a particular fungus, the various collembolan species reacting

differently to any one fungal food (Torne, 1967; Kiffer & Cancela da Fonseca, 1971). This is very clearly demonstrated in the present study, where both the litter and top soil contribute to one type of fungal food based on pine needle breakdown which is the forest soil cover.

Interestingly enough, the same dominant species Isotoma (Desoria) trispinata is also dominant in the jhum system and more so in the top 0-10 cm layer. Once again, a confirmation to above reciprocal relationship between specific food and specific Collembola is seen here because the preparative measure for jhum fields before the onset of agriculture, is the accumulation of fallen down pine needles aggregated in furrows and burnt. Fungal activity, naturally is less as indicated also by a far less density of the dominant species in the jhum system. This reveals, further, the reason for total depletion of Collembola in the lower layer of the soil.

The next major group of soil fauna was Acarina, both in terms of abundance and quality. For one annual cycle in all the layers, they were not very far less in abundance in the forest than Collembola as indicated by the density of about 9000-9700x$10^2/m^2$. Moreover, in the jhum soil they formed nearly 2500x$10^2/m^2$ which was about 1.5 times more than Collembola. Further, an interesting observation was that this group formed nearly the same densities in both the litter (about 5000x$10^2/m^2$) and 0-10 cm (about 4000x$10^2/m^2$) unlike the Collembola, which dominated litter layer in the forest system only. However, nearly

2000-2200x$10^2/m^2$ was available only in the top 0-10 cm layer of the jhum system with a reduction of nearly 280-450x$10^2/m^2$ and thereafter total reduction/absence in the subsequent layers. Further, acari in the jhum soil were about 4-5 times less than the forest system. One phenomena similar to Collembola was that these animals (acari) were **again not** recorded in the 30-40 cm layer either in the forest or in the jhum system.

For comparisons with other workers, since total annual densities are not available, the present investigations' mean monthly annual density ranged from about 765-814x$10^2/m^2$ for the total system (forest), 411-443x$10^2/m^2$ in the litter, 312-321x$10^2/m^2$ in the 0-10 cm layer, 40-48x$10^2/m^2$ in the 10-20 cm layer and only 0.6-1x$10^2/m^2$ in the 20-30 cm layer of the forest. Once again, Reddy (1980) reported 84-416x$10^2/m^2$ as mean densities of acari in a pine forest of this region but at lower altitude. His maximum densities are nearly half of the present mean densities. However, Mitchell (1977) working in an aspen woodland soil recorded a total acari abundance of nearly 1600x $10^2/m^2$. Recently, Luxton (1982) working in a beech woodland soil reported annual monthly mean of nearly 680x$10^2/m^2$, which is more or less in concordance with the present finding. However, Choudhuri and Banerjee (1975) working in tropical forest of India, particularly during monsoon months, recorded nearly 1900x $10^2/m^2$. It is, therefore, indicative of sub-tropical and more of sub-temperate regime being operative in the present sites.

Among the major sub-orders of Acarina, the most dominant in the forest system was Cryptostigmata (Oribatida) and

was confined upto the depth of 20 cm and litter layer of the forest, while Prostigmata similarly, the second in terms of abundance in the forest, was the first (in terms of abundance) in the jhum and occupying similar layers. The Mesostigmata occupied third in terms of abundance and occupied all the layers except the last 30-40 cm, both in the forest and jhum systems. The least abundance of all these was Astigmata, which was available in the litter and 0-10 cm of the forest and only 0-10 cm of the jhum system.

Workers both from tropical and temperate regions, whether in forest soils or otherwise have always reported maximum density of Cryptostigmata among the acari and usually Astigmata the least in abundance, which agrees very well with the present study. However, to get a more meaningful picture the mean estimates of Cryptostigmata, Prostigmata, Mesostigmata and Astigmata were in the order of about $500x10^2/m^2$, $175x10^2/m^2$, $92x10^2/m^2$ and $16x10^2/m^2$ in the forest in the present investigation and when compared, were more or less in general agreement with that of Pande and Berthet (1975) working with a black pine plantation, Usher (1975) in a scot pine forest soil and Luxton (1982) working in a beech woodland soil. One is at a loss for comparing the present jhum system ($58x10^2/m^2$ for Cryptostigmata; $100x10^2/m^2$ for Prostigmata; $42x10^2/m^2$ for Mesostigmata; $5x10^2/m^2$ for Astigmata) to any other work for relative or absolute densities of these major sub-groups of acari. However, Fujikawa (1970a) suggested that plowing had detrimental effects on soil Cryptostigmata, and repeated cropping results in both qualita-

tive depletion of soil inhabiting Cryptostigmata (Edwards & Lofty, 1969, 1975; Bhattacharya et al., 1980).

It is known that Cryptostigmata show diversity of feeding habit which Schuster (1956) divided into three major types as (1) macrophytophages (2) microphytophages and (3) non-specialists. This feeding behaviour is probably responsible for their increased abundance in soil with overlying litter layer, as oribatids may have a catalysing effect in decomposition by stimulating microbial activity along with other members of the soil fauna. This stimulation may be due to one or all, like physical disruption of the litter, dissemination of spores, grazing of microflora and mixing of organic substrates (Wallwork, 1958; Macfadyen, 1964; Drift, 1965; Mitchell & Parkinson, 1976). This probably may, therefore, reflect as in the present investigation, occupation of ecological niches available as seen by the abundance of Prostigmata in contrast to Cryptostigmata in the jhum system.

The last major group of soil fauna were all put under a major sub-heading as "Other Arthropods". They comprised of approximately $3000 \times 10^2/m^2$ in the forest system and $1000 \times 10^2/m^2$ in the jhum system. The major sub-group of this category was Insecta, followed by Myriapods. The former contributed to nearly $1500 \times 10^2/m^2$ in the forest and $800 \times 10^2/m^2$ in the jhum, while the latter were only $500 \times 10^2/m^2$ in the forest system and about $80 \times 10^2/m^2$ in the jhum system. Arachnida followed these with an abundance of nearly $500 \times 10^2/m^2$ in the forest but only about

60-80x10^2/m^2 in the jhum. The least group, occurring only in the forest was Crustacea, represented by Isopoda, being nearly 100-150x10^2/m^2 in the forest and totally absent in the jhum system.

No real comparisons can be made for these "other arthropods" as a whole and it is, therefore, left to present their mean monthly annual densities as such in the present investigation. They are about 240x10^2/m^2 for the "other arthropods" in general and 139-149x10^2/m^2, 38-44x10^2/m^2, 40-42x10^2/m^2 and 12-14x10^2/m^2 for Insecta, Myriapoda, Arachnida and Crustacea, respectively. It is seen that among these "other arthropods" as a whole or when broken down into major sub-groups, the jhum system had 50% reduction or more.

Of the Insecta, Hymenoptera (Formicidae) formed the major order, followed by insect larvae. The former had nearly 700x10^2/m^2 (mean monthly about 58x10^2/m^2) in the forest and 500x10^2/m^2 (mean monthly about 42x10^2/m^2) in the jhum system, whereas the latter was about 300x10^2/m^2 (mean monthly 25x10^2/m^2) in the forest system and 140x10^2/m^2 (mean monthly 12x10^2/m^2) in the jhum. Among the myriapods, Symphyla formed the largest group comprising nearly 350x10^2/m^2 (mean monthly = 30x10^2/m^2) in the forest and just above 50x10^2/m^2 (mean monthly = 4x10^2/m^2) in the jhum system.

Further, most of the subsidiary groups of "other arthropods" showed aseasonal fluctuations in populations of a particular annual pattern, in both the forest and jhum systems.

However, the densities of many of these groups are comparable with the works of others elsewhere. For example, the present estimates of the mean monthly annual density of Protura (13-15x $10^2/m^2$) is comparable with the estimates of Huhta and Koskenniemi (1975), who found a range of 15-39x$10^2/m^2$ individuals from a coniferous forest soil of Finland, although much less than Gunnarsson's (1980) estimate for a Swedish coniferous forest soil (65-84x$10^2/m^2$). Further, Drift (1951) observed a density of 2x$10^2/m^2$ of Diplura from a beech forest floor within its humus layer. The present estimate is 7-9x$10^2/m^2$ individuals for the total forest system and about 4-5x$10^2/m^2$ for the humus (litter) layer alone. Saito's (1967) estimations of a diplopod density (2x$10^2/m^2$) from a warm temperate forest of Japan is comparable with the present density of about 3x$10^2/m^2$. However, the present estimates of pauropod density (4-5x$10^2/m^2$) is far too less as compare to those of Moore (1982) and Price (1975) from a California pine forest, being 35-41x$10^2/m^2$ and 167x$10^2/m^2$, respectively. In agreement with Salt *et al*. (1948) and Edwards (1958), Symphyla were the most numerous myriapods with densities of about 26-30x$10^2/m^2$ in the forest system. These estimates are, of course, higher than Anglade's (1967) estimates of about 18x$10^2/m^2$ from France, although Raw (1967) opined that their number may even exceed 200x$10^2/m^2$ individuals. Therefore, it may be concluded with Raw (1967) that such differential estimates undoubtedly reflect the efficiency of the sampling methods as well as the actual abundance of the different fauna in the systems under consideration.

The foregoing discussion relates to the densities of the soil fauna and their major groups in the present investigation. However, a better interpretation of the results lie in the knowledge of the percentages of these densities either vertically within the system or between the systems under consideration. This latter would probably give a better understanding of the local problems and the intricate inter-relationships that occur either among themselves or within the soil.

It is seen, therefore, that nearly 65% of the total soil fauna is confined to the litter layer and 29% in the top soil in the forest system. Moreover, if the litter and top soil layer of the forest is taken into consideration, they occupy nearly 94% of the total soil fauna. This phenomena was almost nearly similar in both the annual cycles. In the jhum system, the top soil layer (0-10 cm) concentrated nearly 73-79% of the total soil fauna. The next layer had nearly 16-22% of soil fauna during both the annual cycles.

When total soil fauna was broken down into major groups like Collembola, Acarina and "Other Arthropods", it was seen that their percentages of occurrences in all the layers and both the systems remained more or less constant for both the annual cycles. The interesting phenomena, however, was that Collembola and Acarina formed nearly the same percentages, 46% of the former and 41% of the latter, in the forest system. But in the jhum system, Acarina formed nearly 54% while Collembola only 26% of the total soil fauna. The remaining nearly 13% and 20% were occupied by "other arthropods" in the forest and jhum

systems, respectively. One common feature, irrespective of the groups/sub-groups/genera or species was that most of them were confined only to the litter or top soil layers, decreasing depth-wise and in most cases total absence in the last 30-40 cm in both the forest and jhum systems. This is understandable as soil fauna participate significantly in soil formation, function and maintenance processes. Therefore, they may serve as sensitive indicators of the state of soil and the impact of environmental changes (Hole, 1981).

Majority of workers reported Collembola as a whole being predominantly surface dwelling (Sheals, 1957; Dhillon & Gibson, 1962; Hale, 1966; Wood, 1967). Further, it is reported that the oribatids are mainly hemi-edaphic (Frenzel, 1936; Sheals, 1957). As in the present investigation where even at subgroup level of Cryptostigmata, it is known that such oribatid mites are characterised by their concentration in the top soil layers of 70-80%. Most species of oribatid mites will so occupy surface layers because they are thought to be feeders on litter fungi or other organic materials and, therefore, distributed with corresponding depth of the organic layer (Wallwork, 1967).

Changes in the percentages of the main group of Collembola, Acarina and "other arthropods", some species and genera will be discussed for the total study period subsequently. It is, therefore, confined in this section that the changes in percentage occurrence in the different soil strata of the major group of soil fauna in both the systems have been cited to merely reflect fluctuations in populations within strata for each annual cycle.

While observing the population dynamics relationships during the present investigation, it was seen that the total soil fauna revealed a definite monsoonic summer increase during the months of June-July-August and a fall during the winter months of December-January. This was also seen to be similar while Collembola was taken into consideration. Furthermore, the group Collembola when broken down into its major families, genera or species, as the case may be, this single peak of increase during wet summer and drastic fall in winter was observed for both the annual cycles. Except for the magnitude of fluctuations this unimodal phenomena of seasonal abundance during monsoonic summer for either total soil fauna, Collembola or its subsidiary groups, was seen to be more or less true in both the forest and jhum systems. Exceptions to these generalizations were minor negligible fluctuations in the jhum system at the lower soil depths.

It is known that seasonality is a conspicuous feature in the life history of many organisms in temperate zone. Further, with very slight temperature changes in the tropics, it is probably only rainfall which exerts the most dramatic effect on the environment (Denlinger, 1980). This, therefore, brings in a similar seasonal effect even under sub-tropical conditions as in the present investigation, though rainfall patterns vary from year to year. This increase during the monsoonic season coincided with the peaks of abundance of the total soil fauna in general and Collembola and its subsidiary groups in particular. The interesting phenomena observed was that similar to

severe obstacle as winter in the temperate zone, here too, once again the total soil fauna and Collembola and its subsidiary groups were least during the winter period of December-January.

Reports do exist for some tropical species development (of at least certain higher categories of animals) which appear to be aseasonal (Owen & Chanter, 1970; Ehrlich & Gilbert, 1973; Leuthold & Leuthold, 1975). However, MacArthur (1972) also points out that many tropical species could reveal highly seasonal phenomena, perhaps as a response to close packing of competitors and, therefore, the only strategy available is the selection of seasons that are best suited for active development. This may also be true for the present investigation as there exist a consistency in the pattern of fluctuations in both the annual cycles. Moreover, this unimodal phenomena of increase during the summer rainy months and the fall during winter months was seen in all the layers for the total soil fauna, Collembola and its subsidiary groups even upto species level, particularly in the forest and to a large extent in the jhum system. Therefore, there was no evidence of seasonal changes having effects on vertical distributions as noted by Glasgow (1939), Strickland(1945, 1947), Stockli (1957) and which were attributed by these authors to vertical migrations responding to climatic changes.

On comparisons with typical tropical soil workers, it is seen that mostly a post monsoonic peak was observed by Mukharji and Singh (1970), Choudhuri and Roy (1971a,b,c, 1972) and Prabhoo (1976), who worked in different parts of India.

However, Loots and Ryke (1966) working in tropical Africa found a peak during late summer. In the present investigation, in this respect we could say, it does not tally with tropical studies as our peaks, at least for total soil fauna and Collembola, were during mid-heavy-monsoonic rain. However, minimum population of soil fauna tallies with Loots and Ryke (1966) and Choudhuri and Roy (1971a).

The findings of previous workers suggest that total population of predominant Collembola attain their maximum at a period when soil moisture is optimum, coinciding with rainfall (Weis-Fogh, 1948; Macfadyen, 1952; Sheals, 1957; Haarlov, 1960; Milne, 1962; Davis, 1963; Rapoport & Najt, 1966; Niijima, 1971, 1975). They also attributed low rainfall combined with high rate of evaporation resulting in desiccation which could reduce the numbers due to high mortality of susceptible forms. With regard to Collembola in particular and its various sub-groups, the absence of winter maxima in the present study is in concordance with Drift (1951), Bellinger (1954), Poole (1961), Dhillon and Gibson (1962), Choudhuri and Roy (1967) and Niijima (1971,1975).

While taking Acarina into consideration in contrast to total soil fauna or Collembola, the former revealed a bimodal phenomena of increase in pre-monsoon (spring) and post-monsoon (autumn), particularly in the forest system. This was nearly true for all the layers under consideration, with a large autumn peak and smaller spring peak. One aspect, however, similar to that of total soil fauna or Collembola was a decrease in

winter. This was true for both the annual cycles and more so in the forest system and to a large extent in the jhum system, except where Acarina was treated at generic or species level. This bimodal peak of increase for Acarina has been reported mostly by temperate workers like Ford (1937, 1938), Riha (1951), Macfadyen (1952), Sheals (1957), Evans et al. (1961), Block (1965,1966 a, b), and Chiba et al. (1975). A similar finding was reported for Indian studies by Choudhuri and Pande (1979, 1982) though at much higher altitudes. A winter decrease in acarine populations in general and oribatids in particular is also reported by Evans et al. (1961), Madge (1965), Wallwork (1967) and others.

In case of the "other arthropods", a poor spring/summer increase and a winter fall in general agrees with works of temperate system, such as Drift (1951), though the fluctuations were not very clear cut in both the forest and jhum systems. The only phenomena observed in the second layer (10-20 cm) of the jhum was increase during late winter or early spring, which was attributed to hymenopteran increase, which also finds support of Brian (1965). Thus, the conspicuously high abundance of Formicidae, though irregularly, may be indicative of the tropical/sub-tropical characteristics of the study site (Raw, 1967) and, thereby, the importance of this group, particularly in the agroecosystem as jhum fallow under consideration (Risch & Carroll, 1982). Further, as stated earlier, the jhum system always recorded less abundance of "other arthropods" and its subsidiary groups, indicating its disturbed nature. However, the tendency of many of the groups to occur in the deeper layer of less disturbance finds support of Price and Benham (1977).

Photoperiod, an environmental token widely used in temperate regions, is known not to be obvious seasonal signal in the tropics. Interestingly enough, the duration of sunshine in the present investigation was significantly negatively correlated to all the soil animal groups undertaken (Tables LXIII to LXXIII). In contrast, it was seen that moisture content and rainfall revealed significantly positive relationship with most groups. Weis-Fogh (1948) showed instances of fairly defined soil communities related to moisture content such as "dry soil" and "moist soil" communities. This tallies with our present investigation in that relative humidity also seems to have positive effects on the population abundance of major soil groups.

The importance of moisture content in the soil in relation to soil microarthropods population, particularly in the Indian sub-continent was first recognised by Trehan (1945). Mukharji and Singh (1970) revealed the increase in microarthropods population for Varanasi soils where moisture content was high, while Choudhuri and Roy (1972) working in West Bengal also showed significant positive correlation between collembolan population and moisture content, however, only for certain districts in West Bengal. Rainfall, together with relative humidity during rainy season, leading to increase of moisture content of the soil is usually followed by proliferated growth of ground vegetation and soil microflora. Further, if the temperature is higher than at other times it facilitates litter decomposition which is favourable for many soil microarthropods.

Bellinger (1954) had pointed, however, that it is

coefficient

Table LXIII. Showing the correlation/between the different abiotic factors and Collembola (and its various families/genera/species) in the litter layer of the forest for the total study period.

Re. H. : Relative humidity
Rn. F. : Rainfall
Sn. D. : Sunshine duration
Mx. T. : Maximum temperature
Mn. T. : Minimum temperature
Ar. T. : Air temperature
Li. T. : Litter temperature
M. C. : Moisture content
Fr. W. : Fresh weights of litter
Dr. W. : Dry weights of litter
Cond. : Conductivity
C. : Organic carbon
N. : Nitrogen

TABLE LXIII

COLLEMBOLAN FAUNA	Re.H.	Rn.F.	Sn.D.	Mx.T.	Mn.T.	Ar.T.	Li.T.	M.C.	Fr.W.	Dr.W.	pH	Cond.	C	N
Collembola	0.435*	0.778**	-0.784**	0.819**	0.817**	0.793**	0.776**	0.649**	0.499*	0.023	0.517**	-0.336	0.365	0.141
Poduridae	0.488*	0.761**	-0.721**	0.837**	0.920**	0.800**	0.809**	0.781**	0.687**	0.010	0.598**	-0.369	0.180	0.005
Hypogastruridae	-0.318	-0.078	0.025	0.002	-0.170	-0.211	-0.053	0.052	0.124	0.209	0.004	-0.181	0.092	0.190
Isotomidae	0.310	0.707**	-0.719**	0.753**	0.694**	0.730**	0.670**	0.565**	0.489*	0.012	0.444*	-0.236	0.406*	0.125
Isotoma(Desoria) trispinata	0.323	0.734**	-0.715**	0.720**	0.674**	0.700**	0.655**	0.560**	0.466*	0.035	0.458*	-0.246	0.409*	0.103
Cryptopygus thermophilus	0.645**	0.798**	-0.792**	0.823**	0.940**	0.799**	0.829**	0.765**	0.672**	0.023	0.546**	-0.472*	0.293	0.175
Entomobryidae	0.587**	0.776**	-0.797**	0.854**	0.947**	0.834**	0.882**	0.711**	0.715**	0.119	0.592**	-0.442*	0.287	0.173
Dicranocentrus fraternus	0.677**	0.804**	-0.782**	0.754**	0.931**	0.843**	0.867**	0.747**	0.763**	0.105	0.560**	-0.534**	0.248	0.254
Dicranocentrus singularis	0.370	0.733**	-0.754**	0.833**	0.920**	0.786**	0.887**	0.694**	0.677**	0.097	0.404*	-0.425*	0.272	0.244
Entomobrya sp.	0.560**	0.593**	-0.613**	0.778**	0.861**	0.552**	0.750**	0.621**	0.694**	0.201	0.514**	-0.439*	0.123	0.052
Salina sp.	0.562**	0.781**	-0.685**	0.843**	0.924**	0.702**	0.885**	0.710**	0.671**	0.057	0.659**	-0.418*	0.098	0.056
Metacoelura sp.	0.704**	0.853**	-0.770**	0.738**	0.925**	0.750**	0.874**	0.763**	0.712**	0.056	0.693**	-0.560**	0.040	0.119
Seira sp.	0.696**	0.751**	-0.773**	0.765**	0.932**	0.842**	0.876**	0.697**	0.707**	0.120	0.531**	-0.509*	0.258	0.221
Lepidocyrtus sp.	0.543**	0.673**	-0.628**	0.748**	0.824**	0.836**	0.754**	0.602**	0.617**	0.100	0.429*	-0.229	0.235	0.115
Isotobryoides sp.	0.642**	0.853**	-0.798**	0.694**	0.814**	0.790**	0.813**	0.569**	0.558**	0.005	0.434*	-0.480*	0.284	0.236
Sminthuridae	0.695**	0.748**	-0.746**	0.790**	0.936**	0.744**	0.869**	0.740**	0.781**	0.174	0.501*	-0.506*	0.172	0.201
Sphaeridia cornuta	0.714**	0.680**	-0.732**	0.747**	0.891**	0.691**	0.820**	0.701**	0.761**	0.205	0.438*	-0.532**	0.135	0.185
Sminthurinus bimaculatus	0.530**	0.773**	-0.647**	0.749**	0.868**	0.721**	0.845**	0.699**	0.688**	0.078	0.406*	-0.381	0.226	0.202
Neelidae														
Megalothorax minimus	0.483*	0.778**	-0.739**	0.660**	0.731**	0.705**	0.674**	0.528**	0.378	0.112	0.303	-0.396	0.181	0.086

* = $P < 0.05$
** = $P < 0.01$

Table LXIV. Showing the correlation coefficient between the different abiotic factors and Collembola (and its various families/genera/species) in the 0-10 cm and 10-20 cm layers of the forest soil for the total study period.

Re. H. : Relative humidity
Rn. F. : Rainfall
Sn. D. : Sunshine duration
Mx. T. : Maximum temperature
Mn. T. : Minimum temperature
Ar. T. : Air temperature
So. T. : Soil temperature
M. C. : Moisture content
Pa. S. : Particle size
Poro. : Porosity
Cond. : Conductivity
C. : Organic carbon
N. : Nitrogen

TABLE LXIV

LAYERS	COLLEMBOLAN FAUNA	Re.H.	Rn.F.	Sn.D.	Mx.T.	Mn.T.	Ar.T.	Bó.T.	M.C.	Pa.S.	Poro.	pH	Cond.	C	N
0-10 cm	Collembola	0.726**	0.753**	-0.749**	0.698**	0.865**	0.760**	0.794**	0.522**	0.200	0.192	0.612**	-0.058	0.130	0.097
	Isotomidae	0.678**	0.759**	-0.712**	0.628**	0.816**	0.573**	0.705**	0.483*	0.137	0.203	0.253	-0.112	0.095	0.119
	Isotoma(Desoria) trispinata	0.656**	0.701**	-0.702**	0.667**	0.807**	0.756**	0.755**	0.463*	0.157	0.232	0.619**	-0.100	0.072	0.106
	Cryptopygus thermophilus	0.804**	0.805**	-0.719**	0.589**	0.832**	0.520**	0.761**	0.575**	0.176	0.185	0.036	-0.245	0.181	0.221
	Entomobryidae	0.553**	0.712**	-0.587**	0.529**	0.516**	0.589**	0.608**	0.526**	0.281	0.101	0.457*	-0.108	0.196	0.216
	Dicranocentrus fraternus	0.696**	0.776**	-0.792**	0.691**	0.824**	0.590**	0.770**	0.523**	0.506*	0.140	0.605**	-0.196	0.277	0.192
	Dicranocentrus singularis	0.380	0.491*	-0.398	0.580**	0.601**	0.502*	0.425*	0.429*	0.144	0.067	0.189	-0.030	0.221	0.390
	Entomobrya sp.	0.765**	0.682**	-0.669**	0.591**	0.854**	0.631**	0.781**	0.508*	0.213	0.115	0.616**	0.054	0.181	0.368
	Salina sp.	0.693**	0.802**	-0.738**	0.776**	0.869**	0.685**	0.741**	0.582**	0.282	0.021	0.522**	0.172	0.247	0.017
	Metacoelura sp.	0.831**	0.723**	-0.694**	0.240	0.160	0.575**	0.792**	0.567**	0.368	0.042	0.603**	-0.110	0.184	0.350
	Sminthuridae	0.742**	0.762**	-0.663**	0.652**	0.820**	0.678**	0.695**	0.553**	0.240	0.098	0.506*	-0.060	0.324	0.030
	Sphaeridia cornuta	0.754**	0.777**	-0.709**	0.643**	0.810**	0.639**	0.677**	0.545**	0.290	0.114	0.479*	-0.056	0.367	0.032
	Sminthurinus bimaculatus	0.731**	0.771**	-0.605**	0.699**	0.833**	0.715**	0.733**	0.568**	0.231	0.092	0.522**	-0.065	0.311	0.034
	Neelidae														
	Megalothorax minimus	0.766**	0.827**	-0.776**	0.745**	0.935**	0.798**	0.832**	0.615**	0.239	0.012	0.527**	-0.008	0.322	0.051
10-20 cm	Isotomidae	0.520**	0.638**	-0.583**	0.399	0.642**	0.496*	0.405*	0.509*	0.283	0.126	0.286	-0.112	0.015	0.110
	Isotoma(Desoria) trispinata	0.500*	0.625**	-0.491*	0.250	0.702**	0.453*	0.320	0.545**	0.381	0.185	0.160	0.192	0.018	0.211
	Cryptopygus thermophilus	0.573**	0.740**	-0.739**	0.511*	0.606**	0.592**	0.565**	0.485*	0.276	0.182	0.441*	0.123	0.027	0.051

* = $P < 0.05$
** = $P < 0.01$

Table LXV. Showing the correlation coefficient between the different abiotic factors and Collembola (and its various families/genera/species) in the 0-10 cm and 10-20 cm layers of the jhum soil for the total study period.

Re. H. : Relative humidity
Rn. F. : Rainfall
Sn. D. : Shunshine duration
Mx. T. : Maximum temperature
Mn. T. : Minimum temperature
Ar. T. : Air temperature
So. T. : Soil temperature
M. C. : Moisture content
Pa. S. : Particle size
Poro. : Porosity
Cond. : Conductivity
C. : Organic carbon
N. : Nitrogen

TABLE LXV

LAYERS	COLLEMBOLAN FAUNA	Re.H.	Rn.F.	Sn.D.	Mx.T.	Mn.T.	Ar.T.	So.T.	M.C.	Pa.S.	Poro.	pH	Cond.	C	N
0-10 cm	Collembola	0.397	0.401	-0.289	0.405*	0.476*	0.494*	0.293	0.309	0.152	0.105	0.238	0.157	0.100	0.148
	Isotomidae	0.518**	0.372	-0.493*	0.419*	0.541**	0.476*	0.329	0.397	0.195	0.172	0.506*	0.186	0.103	0.098
	Isotoma(Desoria) trispinata	0.464*	0.270	-0.542**	0.423*	0.562**	0.559**	0.448*	0.575**	0.086	0.160	0.480*	0.053	0.245	0.001
	Cryptopygus thermophilus	0.568**	0.521**	-0.456*	0.415*	0.528**	0.378	0.295	0.285	0.332	0.227	0.539**	0.394	0.005	0.202
	Entomobryidae	0.285	0.398	-0.153	0.301	0.405*	0.483*	0.219	0.275	0.135	0.116	0.123	0.176	0.143	0.195
	Dicranocentrus fraternus	0.238	0.345	-0.180	0.347	0.355	0.499*	0.208	0.330	0.385	0.156	0.054	-0.247	0.148	0.146
	Entomobrya sp.	0.259	0.342	-0.225	0.237	0.419*	0.485*	0.340	0.200	0.260	0.143	0.083	0.298	0.294	0.442*
	Salina sp.	0.327	0.433*	-0.262	0.648**	0.582**	0.656**	0.346	0.349	-0.069	-0.194	0.139	-0.009	0.045	-0.180
	Metacoelura sp.	0.299	0.321	-0.095	0.011	0.251	0.277	0.168	0.284	-0.009	-0.064	0.210	0.282	0.106	-0.063
	Sminthuridae	0.386	0.201	-0.352	0.455*	0.516**	0.445*	0.368	0.229	0.132	0.190	0.110	-0.143	0.004	-0.039
	Sphaeridia cornuta	0.263	0.032	-0.280	0.530**	0.603**	0.676**	0.480*	0.261	0.015	-0.194	0.101	-0.028	0.002	-0.021
	Sminthurinus bimaculatus	0.503*	0.465*	-0.592**	0.428*	0.436*	0.344	0.246	0.173	0.259	0.198	0.113	-0.229	0.011	-0.083
	Neelidae														
	Megalothorax minimus	0.384	0.523**	-0.327	0.373	0.563**	0.539**	0.319	0.310	0.211	0.024	0.063	0.113	0.163	0.204
10-20 cm	Isotomidae	0.502*	0.761**	-0.497*	0.301	0.561**	0.498*	0.521**	0.559**	0.055	0.105	0.305	0.390	0.043	0.118
	Isotoma(Desoria) trispinata	0.482*	0.783**	-0.455*	0.150	0.666**	0.456*	0.507*	0.545**	0.051	0.107	0.318	0.436*	0.095	0.236
	Cryptopygus thermophilus	0.520**	0.746**	-0.536**	0.557**	0.535**	0.571**	0.578**	0.575**	0.061	0.111	0.314	0.352	0.023	0.037

* = $P < 0.05$
** = $P < 0.01$

Table LXVI. Showing the correlation coefficient between the different abiotic factors and Acarina (and its various sub-orders/genera/species) in the litter layer of the forest for the total study period.

Re. H. : Relative humidity
Rn. F. : Rainfall
Sn. D. : Sunshine duration
Mx. T. : Maximum temperature
Mn. T. : Minimum temperature
Ar. T. : Air temperature
Li. T. : Litter temperature
M. C. : Moisture content
Fr. W. : Fresh weights of litter
Dr. W. : Dry weights of litter
Cond. : Conductivity
C. : Organic carbon
N. : Nitrogen

TABLE LXVI

ACARI-FAUNA	Re.H.	Rn.F.	Sn.D.	Mx.T.	Mn.T.	Ar.T.	Li.T.	M.C.	Fr.W.	Dr.W.	pH	Cond.	C	N
Acarina	0.218	0.287	-0.264	0.677**	0.627**	0.360	0.499*	0.461*	0.547**	0.149	0.451*	-0.197	0.011	0.069
Astigmata	0.169	0.455*	-0.382	0.599**	0.641**	0.428*	0.519**	0.359	0.229	0.156	0.591**	-0.212	0.046	0.100
Prostigmata	0.262	0.360	-0.392	0.749**	0.694**	0.415*	0.586**	0.410*	0.474*	0.116	0.463*	-0.262	0.122	0.080
Mesostigmata	0.317	0.251	-0.208	0.512*	0.549**	0.176	0.407*	0.503*	0.525**	0.077	0.392	-0.069	0.044	0.082
Parasitus diviortus	0.227	0.234	-0.106	0.572**	0.504*	0.208	0.353	0.493*	0.482*	0.013	0.394	-0.131	0.189	0.170
Cryptostigmata	0.181	0.255	-0.222	0.647**	0.529**	0.353	0.456*	0.448*	0.552**	0.168	0.431*	-0.130	0.044	0.102
Rhysotritia ardua	0.103	0.125	-0.135	0.475*	0.447*	0.141	0.295	0.327	0.382	0.159	0.394	-0.188	0.030	0.136
Euphthiracarus sp.	-0.100	-0.090	0.001	0.254	0.184	0.075	0.037	0.087	0.380	0.142	0.143	-0.046	0.149	0.019
Mesotritia sp.	0.054	0.042	0.007	0.386	0.384	0.099	0.202	0.239	0.351	0.151	0.265	-0.133	0.060	0.081
Galumna sp.	0.206	0.334	-0.267	0.630**	0.612**	0.431*	0.520**	0.398	0.523**	0.109	0.394	0.078	0.029	0.056
Neoribates sp.	0.065	0.228	-0.165	0.375	0.518**	0.400	0.412*	0.405*	0.539**	0.128	0.359	-0.005	0.086	-0.052
Dolicheremaeus sp.	0.402	0.378	-0.319	0.609**	0.589**	0.392	0.506*	0.617**	0.572**	0.147	0.325	0.234	0.038	0.031
Eremobelba sp.	0.401	0.341	-0.324	0.717**	0.714**	0.400	0.531**	0.503*	0.560**	0.136	0.462*	0.214	0.137	0.145
Suctobelba sp.	0.373	0.324	-0.366	0.594**	0.619**	0.291	0.488*	0.482*	0.606**	0.234	0.235	-0.288	0.153	0.072
Brachychthonius sp.	-0.343	-0.205	0.164	0.277	0.145	0.129	0.010	0.101	0.257	0.187	0.183	0.091	0.048	0.046
Uropodidae	-0.366	0.048	-0.063	0.159	0.057	0.097	0.024	0.020	0.123	0.007	0.238	0.013	0.054	0.064

* = $P < 0.05$
** = $P < 0.01$

Table LXVII. Showing the correlation coefficient between the different abiotic factors and Acarina (and its various sub-orders/genera/species) in the 0-10 cm and 10-20 cm layers of the forest soil for the total study period.

Re. H. : Relative humidity
Rn. F. : Rainfall
Sn. D. : Sunshine duration
Mx. T. : Maximum temperature
Mn. T. : Minimum temperature
Ar. T. : Air temperature
So. T. : Soil temperature
M. C. : Moisture content
Pa. S. : Particle size
Poro. : Porosity
Cond. : Conductivity
C. : Organic carbon
N. : Nitrogen

TABLE LXVII

LAYERS	ACARI-FAUNA	Re.H.	Rn.F.	Sn.D.	Mx.T.	Mn.T.	Ar.T.	So.T.	M.C.	Pa.S.	Poro.	pH	Cond.	C	N
0-10 cm	Acarina	-0.032	0.105	-0.215	0.167	0.118	0.264	0.152	0.119	0.139	0.205	0.205	-0.106	0.125	0.130
	Astigmata	0.288	0.163	-0.320	0.110	0.242	0.430*	0.223	0.128	0.022	0.179	0.174	-0.018	0.027	0.150
	Prostigmata	-0.044	0.289	-0.343	0.268	0.256	0.458*	0.306	0.218	0.047	0.077	0.374	-0.079	0.094	-0.172
	Mesostigmata	-0.337	0.075	-0.095	0.094	0.059	0.114	0.109	0.002	0.364	0.312	0.129	0.029	0.297	0.073
	Parasitus diviortus	-0.275	0.113	-0.152	0.185	0.193	0.162	0.120	0.105	0.310	0.294	0.169	0.113	0.189	0.097
	Cryptostigmata	0.009	0.146	-0.402	0.280	0.233	0.359	0.223	0.002	0.385	0.324	0.375	-0.227	0.107	0.144
	Rhysotritia ardua	0.543**	0.186	-0.445	0.354	0.420*	0.286	0.447*	0.232	0.287	0.060	0.472*	-0.240	0.120	0.433*
	Euphthiracarus sp.	-0.474*	-0.303	0.066	0.226	-0.100	0.121	0.079	-0.195	0.205	0.441*	0.072	0.042	0.013	0.168
	Mesotritia sp.	-0.422*	-0.190	-0.115	0.028	-0.163	0.071	0.141	0.451*	0.375	0.421*	0.039	0.090	0.026	0.069
	Galumna sp.	0.011	0.184	-0.357	0.186	0.188	0.274	0.153	-0.047	0.272	0.173	0.245	-0.369	0.134	0.027
	Neoribates sp.	-0.069	0.093	-0.443*	0.111	0.103	0.233	0.124	-0.123	0.269	0.257	0.391	-0.266	0.132	0.196
	Dolicheremaeus sp.	-0.007	0.231	-0.298	0.313	0.170	0.218	0.225	0.043	0.310	0.302	0.003	0.047	0.162	-0.005
	Eremobelba sp.	-0.183	0.084	-0.058	0.080	-0.016	0.355	0.113	0.100	0.254	0.172	0.114	-0.093	0.006	0.256
	Suctobelba sp.	-0.098	-0.117	-0.088	0.233	0.141	0.095	0.025	0.016	0.284	0.220	0.126	-0.107	0.029	0.138
	Brachychthonius sp.	-0.066	-0.041	-0.298	0.140	0.012	0.075	0.004	-0.037	0.487*	0.311	0.283	-0.315	0.060	0.040
	Uropodidae	0.385	0.507*	-0.585**	0.650**	0.669**	0.054	0.520**	0.444*	0.561**	0.429*	0.500*	-0.117	0.419*	0.045
10-20 cm	Acarina	0.546**	0.698**	-0.550**	0.497*	0.591**	0.580**	0.597**	0.576**	0.146	0.218	0.494*	0.329	0.109	0.128
	Prostigmata	0.525**	0.700**	-0.474*	0.476*	0.575**	0.521**	0.625**	0.540**	0.233	0.151	0.451*	0.275	0.268	0.095
	Mesostigmata	0.389	0.477*	-0.510*	0.359	0.393	0.464*	0.322	0.459*	0.028	0.250	0.330	0.295	0.153	0.117
	Parasitus diviortus	0.218	0.302	-0.340	0.316	0.256	0.272	0.261	0.362	0.002	0.026	0.063	0.335	0.271	0.092

* = $P < 0.05$

** = $P < 0.01$

Table LXVIII. Showing the correlation coefficient between the different abiotic factors and Acarina (and its various sub-orders/genera/species) in the 0-10 cm and 10-20 cm layers of the jhum soil for the total study period.

Re. H. : Relative humidity
Rn. F. : Rainfall
Sn. D. : Sunshine duration
Mx. T. : Maximum temperature
Mn. T. : Minimum temperature
So. T. : Soil temperature
M. C. : Moisture content
Pa. S. : Particle size
Poro. : Porosity
Cond. : Conductivity
C. : Organic carbon
N. : Nitrogen

TABLE LXVIII

LAYERS	ACARI-FAUNA	Re.H.	Rn.F.	Sn.D.	Mx.T.	Mn.T.	So.T.	M.C.	Pa.S.	Poro.	pH	Cond.	C	N
0-10 cm	Acarina (Total)	0.354	0.411*	-0.366	0.455*	0.491*	0.223	0.128	0.022	0.179	0.174	-0.018	0.027	0.150
	Astigmata	0.382	0.401	-0.399	0.362	0.373	0.306	0.218	0.047	0.077	0.374	-0.079	0.094	-0.172
	Prostigmata	0.395	0.509*	-0.514*	0.540**	0.647**	0.109	0.002	0.364	0.334	0.112	0.029	0.297	0.073
	Mesostigmata	0.352	0.389	-0.407*	0.485*	0.423*	0.120	0.105	0.310	0.294	0.169	0.113	0.189	0.097
	Parasitus diviortus	0.264	0.325	-0.412*	0.405*	0.411*	0.222	0.002	0.385	0.324	0.375	-0.227	0.107	0.144
	Cryptostigmata	0.627**	0.755**	-0.753**	0.691**	0.795**	0.447*	0.232	0.287	0.060	0.472*	-0.240	0.120	0.433*
	Rhysotritia ardua	0.630**	0.672**	-0.755**	0.685**	0.782**	0.079	-0.195	0.205	0.441*	0.072	0.042	0.013	0.168
	Euphthiracarus sp.	0.290	0.609**	-0.477*	0.439*	0.496*	0.141	0.451*	0.375	0.421*	0.039	0.090	0.026	0.069
	Mesotritia sp.	0.364	0.547*	-0.381	0.309	0.323	0.153	-0.047	0.272	0.173	0.245	-0.369	0.134	0.027
	Galumna sp.	0.471*	0.362	-0.427*	0.450*	0.505*	0.124	-0.123	0.269	0.257	0.391	-0.266	0.132	0.196
	Neoribates sp.	0.631**	0.405*	-0.461*	0.520**	0.482*	0.225	0.043	0.310	0.302	0.003	0.047	0.162	-0.005
	Dolicheremaeus sp.	0.251	0.253	-0.413*	0.310	0.401	0.113	0.100	0.254	0.172	0.114	-0.093	0.006	0.256
	Eremobelba sp.	0.404*	0.400	-0.330	0.410*	0.323	0.025	0.016	0.284	0.220	0.126	-0.107	0.029	0.138
	Suctobelba sp.	0.449*	0.296	-0.451*	0.282	0.403	0.004	-0.037	0.487*	0.311	0.283	-0.315	0.060	0.040
	Brachychthonius sp.	-0.175	0.201	-0.395	0.269	0.213	0.520**	0.444	0.561**	0.429*	0.500*	-0.117	0.419*	0.045
10-20 cm	Acarina (Total)	0.383	0.406*	0.332	0.402	0.400	0.597**	0.576**	0.146	0.218	0.494*	0.329	0.109	0.128
	Prostigmata	0.301	0.407*	0.283	0.395	0.376	0.625**	0.540**	0.233	0.151	0.475*	0.268	0.068	0.095
	Mesostigmata	0.253	0.398	0.299	0.401	0.358	0.322	0.459*	0.028	0.251	0.330	0.295	0.153	0.117
	Parasitus diviortus	0.274	0.346	0.403	0.409*	0.375	0.261	0.362	0.002	0.026	0.063	0.335	0.271	0.092

* = $P < 0.05$

** = $P < 0.01$

Table LXIX. Showing the correlation coefficient between the different abiotic factors and Insecta, Myriapoda, Arachnida, Crustacea and their various orders in the litter layer of the forest for the total study period.

Re. H. : Relative humidity
Rn. F. : Rainfall
Sn. D. : Sunshine duration
Mx. T. : Maximum temperature
Mn. T. : Minimum temperature
Ar. T. : Air temperature
Li. T. : Litter temperature
M. C. : Moisture content
Fr. W. : Fresh weights of litter
Dr. W. : Dry weights of litter
Cond. : Conductivity
C. : Organic carbon
N. : Nitrogen

TABLE LXIX

OTHER ARTHROPODS	Re.H.	Rn.F.	Sn.D.	Mx.T.	Mn.T.	Ar.T.	Li.T.	M.C.	Fr.W.	Dr.W.	pH	Cond.	C	N
Other arthropods (Total)	0.303	0.415*	-0.287	0.362	0.428*	0.319	0.481*	0.427*	0.118	0.180	0.501*	-0.400	0.309	0.109
Insecta	0.119	0.217	-0.107	-0.101	0.207	0.188	0.296	0.031	0.023	0.004	0.422*	-0.359	0.401	0.307
Protura	0.353	0.264	-0.357	0.234	0.314	0.269	0.261	0.252	0.380	0.238	0.141	-0.099	0.104	0.058
Diplura	-0.125	-0.109	0.244	-0.362	-0.214	-0.208	-0.141	0.061	0.026	0.087	0.142	-0.073	0.288	0.229
Diptera	-0.030	0.051	0.041	-0.107	-0.041	0.011	-0.020	0.011	0.138	0.155	0.170	0.018	0.144	0.177
Coleoptera	-0.318	0.505*	-0.531**	0.256	0.213	0.196	0.176	0.211	0.357	0.136	0.040	-0.162	0.235	0.001
Hymenoptera	-0.280	-0.214	0.199	-0.394	-0.125	0.004	-0.175	0.322	0.227	0.128	0.260	-0.212	0.385	0.260
Isoptera	0.153	0.597**	-0.012	0.373	0.416*	0.207	0.289	0.460*	0.064	0.417*	0.092	0.357	0.131	0.208
Orthoptera	0.099	0.696**	0.205	0.256	0.374	0.277	0.292	0.425*	0.285	0.020	0.118	0.306	0.174	0.271
Dermaptera	0.098	0.580**	0.220	0.651**	0.365	0.241	0.278	0.424*	0.328	0.099	0.233	0.302	0.147	0.167
Hemiptera	0.114	0.582**	0.056	0.261	0.446*	0.313	0.341	0.431*	0.651**	0.205	0.260	0.296	0.118	0.077
Psocoptera	0.406*	0.434*	-0.359	0.580**	0.628**	0.600**	0.701**	0.288	0.494*	0.311	0.130	-0.303	0.111	0.404*
Insect larvae	-0.264	-0.288	0.353	-0.529**	0.274	-0.184	-0.110	0.260	0.232	0.067	0.016	0.108	0.190	0.364
Myriapoda	0.266	0.398	-0.441*	0.393	0.571**	0.531**	0.481*	0.497*	0.583**	0.022	0.580**	-0.359	0.518**	0.159
Chilopoda	0.016	0.026	0.061	-0.212	-0.061	-0.265	0.488*	0.227	0.203	0.029	0.273	-0.233	0.281	0.159
Diplopoda	0.405*	0.681**	-0.705**	0.642**	0.763**	0.602**	-0.024	0.047	0.071	0.094	0.022	-0.064	0.219	0.071
Symphyla	0.143	0.304	-0.336	0.316	0.486*	0.481*	0.615**	0.530**	0.476*	0.049	0.519**	-0.335	0.160	0.064
Pauropoda	0.331	0.204	-0.370	0.316	0.387	0.344	0.382	0.437*	0.286	0.084	0.527**	0.346	0.134	0.159
Arachnida	0.288	0.478*	-0.356	0.303	0.412*	0.203	0.339	0.463*	0.052	0.463*	0.543*	-0.303	0.259	0.097
Araneida	0.305	0.493*	-0.373	0.321	-0.430*	0.233	0.411*	0.481*	0.018	0.456*	0.511*	-0.401	0.254	0.094
Pseudoscorpionida	-0.282	-0.353	0.422*	-0.362	-0.461*	-0.505*	0.326	-0.456*	0.513*	0.159	0.206	0.288	0.136	0.077
Crustacea														
Isopoda	0.640**	0.759**	-0.222	0.519**	0.744**	0.580**	0.741**	0.588**	0.352	0.072	0.359	-0.520**	0.519**	0.159

* = $P < 0.05$
** = $P < 0.01$

Table LXX. Showing the correlation coefficient between the different abiotic factors and Insecta, Myriapoda, Arachnida, Crustacea and their various orders in the 0-10 cm layer of the forest soil for the total study period.

Re. H. : Relative humidity
Rn. F. : Rainfall
Sn. D. : Sunshine duration
Mx. T. : Maximum temperature
Mn. T. : Minimum temperature
Ar. T. : Air temperature
So. T. : Soil temperature
M. C. : Moisture content
Pa. S. : Particle size
Poro. : Porosity
Cond. : Conductivity
C. : Organic carbon
N. : Nitrogen

TABLE LXX

OTHER ARTHROPODS	Re.H.	Ra.F.	Sn.D.	Mx.T.	Mn.T.	Ar.T.	So.T.	M.C.	Pa.S.	Poro.	pH	Cond.	C	N
Other arthropods (Total)	0.450*	0.501*	-0.421*	0.409*	0.530**	0.550**	0.587**	0.413*	0.119	0.109	0.380	0.097	0.113	0.190
Insecta	-0.250	-0.392	0.314	-0.236	-0.272	-0.408*	-0.430*	0.340	-0.094	0.363	-0.323	0.153	-0.019	0.172
Protura	-0.609**	-0.345	0.180	-0.056	-0.239	-0.259	-0.411*	-0.290	-0.129	0.071	0.198	-0.325	-0.055	-0.143
Diplura	0.284	0.300	-0.349	-0.083	-0.116	0.213	0.264	-0.044	0.118	0.093	0.032	-0.147	0.142	0.231
Diptera	-0.518**	-0.451*	0.591**	-0.311	-0.411*	-0.427*	-0.357	-0.568**	-0.159	0.194	-0.304	0.277	-0.045	0.186
Coleoptera	0.281	0.500*	-0.426*	0.229	0.326	0.294	0.443*	0.392	-0.006	-0.244	0.175	-0.128	-0.061	0.071
Hymenoptera	-0.289	-0.378	-0.303	-0.160	-0.220	-0.345	-0.381	-0.324	-0.057	0.421*	-0.360	0.244	0.024	-0.018
Isoptera	-0.158	0.298	-0.222	0.158	0.332	0.181	0.345	0.442*	-0.003	-0.376	0.115	0.105	-0.036	-0.004
Orthoptera	0.087	0.112	-0.244	0.283	0.211	0.362	0.144	0.221	-0.093	-0.095	0.347	-0.120	-0.041	-0.093
Dermaptera	0.064	0.159	0.096	0.053	0.124	0.072	0.098	0.127	0.504*	0.116	0.222	0.117	0.094	-0.100
Hemiptera	-0.082	-0.054	-0.237	0.141	0.007	0.075	-0.070	0.134	0.440*	0.103	0.164	-0.242	0.198	-0.079
Psocoptera	0.466*	0.388	-0.475*	0.401	0.515**	0.477*	0.494*	0.322	-0.135	0.155	0.347	0.152	0.379	0.466*
Insect larvae	-0.057	-0.206	0.245	-0.537**	-0.483*	-0.339	-0.350	-0.261	-0.215	-0.031	-0.148	-0.249	-0.234	0.027
Myriapoda	0.408*	0.413*	-0.432*	0.405*	0.401	0.389	0.405*	0.392	0.201	0.183	0.195	0.075	0.174	0.160
Chilopoda	0.058	0.009	-0.060	-0.082	-0.095	-0.006	-0.143	-0.061	0.113	-0.064	-0.004	0.083	-0.327	-0.197
Diplopoda	0.328	0.577**	-0.499*	0.308	0.383	0.321	0.502*	0.469*	0.127	-0.140	0.267	-0.074	0.068	0.286
Symphyla	0.535**	0.710**	-0.536**	0.538**	0.681**	0.459*	0.628**	0.631**	0.421*	0.161	0.383	0.081	-0.204	0.103
Pauropoda	0.664**	0.665**	-0.704**	0.673**	0.803**	0.701**	0.739**	0.513*	0.319	-0.245	0.318	0.072	0.299	0.117
Arachnida	0.599**	0.445*	-0.429*	0.373	0.602**	0.571**	0.640**	0.445*	0.076	-0.032	0.499*	0.074	0.218	0.241
Araneida	0.634**	0.437*	-0.414*	0.357	0.573**	0.560**	0.609**	0.418*	0.098	0.050	0.471*	0.085	0.223	0.139
Pseudoscorpionida	0.025	0.085	-0.076	0.126	0.146	0.043	0.182	0.167	-0.160	-0.581**	0.146	-0.082	-0.049	0.206
Crustacea														
Isopoda	0.644**	0.758**	-0.626**	0.734**	0.796**	0.753**	0.816**	0.628**	0.132	-0.109	0.440*	-0.064	0.078	0.195

* = $P < 0.05$
** = $P < 0.01$

Table LXXI. Showing the correlation coefficient between the different abiotic factors and Insecta, Myriapoda, Arachnida and their various orders in the 10-20 cm layer of the forest soil for the total study period.

Re. H. : Relative humidity
Rn. F. : Rainfall
Sn. D. : Sunshine duration
Mx. T. : Maximum temperature
Mn. T. : Minimum temperature
Ar. T. : Air temperature
So. T. : Soil temperature
M. C. : Moisture content
Pa. S. : Particle size
Poro. : Porosity
Cond. : Conductivity
C. : Organic carbon
N. : Nitrogen

TABLE LXXI

OTHER ARTHROPODS	Re.H.	Rn.F.	Sn.D.	Mx.T.	Mn.T.	Ar.T.	So.T.	M.C.	Pa.S.	Poro.	pH	Cond.	C	N
Other arthropods (Total)	0.313	0.386	-0.301	0.400	0.320	0.221	0.201	0.390	0.190	0.105	0.300	0.219	0.121	0.113
Insecta	0.210	0.305	0.286	0.256	0.214	0.305	0.425*	0.393	0.290	0.100	0.298	0.212	0.113	0.108
Diplura	0.140	0.285	0.193	0.190	0.112	-0.205	-0.402	0.150	0.158	0.092	0.120	0.193	0.105	0.063
Coleoptera	0.437*	0.396	-0.423*	0.175	0.236	0.420*	0.501*	0.105	0.209	0.117	0.252	0.132	0.090	0.120
Hymenoptera	-0.391	-0.400	0.295	-0.162	-0.197	0.201	0.403	0.218	-0.223	0.102	0.108	0.112	0.106	0.079
Isoptera	0.390	0.203	0.151	0.292	0.186	0.115	0.289	0.059	0.110	0.085	-0.193	-0.092	0.005	0.015
Insect larvae	0.113	0.309	0.400	0.382	0.296	0.286	0.360	0.305	0.103	0.119	0.273	0.120	0.127	0.151
Myriapoda	0.223	0.280	-0.279	0.301	0.315	0.200	0.175	0.315	0.120	0.110	0.287	0.205	0.124	0.127
Chilopoda	0.038	0.180	0.256	0.213	0.295	0.203	0.293	0.309	0.102	0.098	0.201	0.092	0.074	0.101
Diplopoda	0.300	0.187	-0.315	0.206	0.219	0.191	0.121	0.158	0.003	0.073	0.192	0.035	0.093	0.091
Symphyla	0.407*	0.520**	-0.380	0.417*	0.409*	-0.295	0.261	0.275	0.100	0.130	0.165	0.128	0.172	0.114
Arachnida														
Araneida	0.439*	0.328	-0.288	0.413*	0.458*	0.177	0.105	0.280	0.103	0.121	0.263	0.155	0.112	0.095

* = $P < 0.05$
** = $P < 0.01$

Table LXXII. Showing the correlation coefficient between the different abiotic factors and Insecta, Myriapoda, Arachnida and their various orders in the 0-10 cm layer of the jhum soil for the total study period.

Re. H. : Relative humidity
Rn. F. : Rainfall
Sn. D. : Sunshine duration
Mx. T. : Maximum temperature
Mn. T. : Minimum temperature
Ar. T. : Air temperature
So. T. : Soil temperature
M. C. : Moisture content
Pa. S. : Particle size
Poro. : Porosity
Cond. : Conductivity
C. : Organic carbon
N. : Nitrogen

TABLE LXXII

OTHER ARTHROPODS	Re.H.	Rn.F.	Sn.D.	Mx.T.	Mn.T.	Ar.T.	So.T.	M.C.	Pa.S.	Poro.	pH	Cond.	C	N
Other arthropods (Total)	0.195	0.390	0.270	0.301	0.291	0.310	0.279	0.388	0.123	0.107	0.206	0.147	0.102	0.157
Insecta	0.150	0.188	-0.280	0.269	0.220	0.162	0.380	0.315	0.198	0.108	0.305	0.190	0.119	0.180
Protura	-0.003	0.137	-0.159	0.181	0.297	0.180	0.152	0.291	0.093	0.008	0.128	-0.125	0.009	-0.043
Diplura	0.160	0.238	-0.166	0.136	0.092	0.123	0.286	0.158	0.005	0.110	0.093	0.174	0.100	0.182
Diptera	0.194	0.065	-0.048	-0.096	-0.088	0.097	0.105	0.129	0.113	0.081	0.104	-0.201	0.024	0.053
Coleoptera	0.440*	0.389	0.474*	0.313	0.515**	0.249	0.283	0.305	0.191	0.102	0.128	0.182	0.081	0.171
Hymenoptera	-0.453*	0.105	0.204	0.123	0.243	0.136	0.202	-0.114	0.102	0.186	0.292	-0.105	0.046	0.103
Orthoptera	0.083	0.234	0.361	0.138	0.120	0.075	0.109	0.126	0.081	0.095	0.113	0.120	0.035	-0.079
Dermaptera	0.054	0.077	0.151	0.162	0.103	0.101	0.114	0.196	0.100	0.096	0.158	0.170	0.120	0.066
Insect larvae	0.028	0.260	0.177	0.182	0.123	0.197	0.219	0.187	0.201	0.126	0.179	0.155	0.158	0.120
Myriapoda	0.320	0.310	-0.203	0.296	0.308	0.366	0.308	0.386	0.170	0.098	0.105	0.098	0.119	0.190
Chilopoda	0.015	0.151	-0.120	0.175	0.293	0.305	0.278	0.213	0.105	0.075	0.175	0.038	0.068	0.179
Diplopoda	0.093	0.275	0.101	0.305	0.185	0.291	0.187	0.201	0.161	0.100	0.098	0.059	0.075	0.186
Symphyla	0.231	0.559**	-0.223	0.410*	0.386	0.379	0.253	0.429*	-0.218	0.113	0.118	0.197	0.201	0.225
Arachnida														
Araneida	0.218	0.358	0.198	0.252	0.328	0.376	0.398	0.206	0.089	0.059	0.401	0.120	0.113	0.103

Table LXXIII. Showing the correlation coefficient between the different abiotic factors and Insecta, Myriapoda , Arachnida and their various orders in the 10-20 cm layer of the jhum soil for the total study period.

Re. H. : Relative humidity
Rn. F. : Rainfall
Sn. D. : Sunshine duration
Mx. T. : Maximum temperature
Mn. T. : Minimum temperature
Ar. T. : Air temperature
So. T. : Soil temperature
M. C. : Moisture content
Pa. S. : Particle size
Poro. : Porosity
Cond. : Conductivity
C. : Organic carbon
N. : Nitrogen

TABLE LXXIII

OTHER ARTHROPODS	Re.H.	Rn.F.	Sn.D.	Mx.T.	Mn.T.	Ar.T.	So.T.	M.C.	Pa.S.	Poro.	pH	Cond.	C	N
Other arthropods (Total)	0.286	0.397	0.356	0.403	0.379	0.298	0.291	0.360	0.102	0.143	0.302	0.110	0.183	0.157
Insecta	0.123	0.191	0.153	0.365	0.274	0.151	0.263	0.410*	0.154	0.103	0.291	0.087	0.270	0.124
Protura	0.038	0.130	-0.073	0.183	0.227	0.113	0.180	0.198	0.038	0.079	0.132	-0.014	0.036	-0.067
Diplura	0.110	0.201	0.105	0.206	0.183	0.197	0.289	0.231	0.017	0.109	0.207	0.156	0.109	0.005
Coleoptera	0.096	0.102	0.128	0.389	0.293	0.249	0.323	0.202	0.132	0.158	0.186	0.084	0.150	0.096
Hymenoptera	0.185	0.098	0.052	0.215	0.152	0.164	0.105	0.153	0.096	0.142	0.113	0.190	-0.087	0.016
Orthoptera	0.054	0.015	-0.068	0.103	0.096	0.071	0.121	0.107	0.008	0.032	0.246	0.068	0.003	0.091
Dermaptera	0.013	0.073	0.025	0.127	0.152	0.021	0.081	0.098	0.014	0.074	0.017	0.006	0.100	-0.033
Insect larvae	0.151	0.068	0.190	0.281	0.260	0.207	0.301	0.269	0.121	0.164	0.054	0.011	0.201	0.118
Myriapoda	0.093	0.308	0.298	0.377	0.361	0.375	0.312	0.423*	0.169	0.298	0.124	0.085	0.107	0.176
Chilopoda	0.023	0.068	0.156	0.180	0.272	0.201	0.163	0.290	0.108	0.186	0.090	0.023	0.009	0.047
Symphyla	0.122	0.297	0.350	0.400	0.390	0.360	0.407*	0.413*	0.246	0.375	0.290	0.164	0.186	0.135
Arachnida														
Araneida	0.087	0.147	0.102	0.168	0.123	0.214	0.290	0.261	0.093	0.007	0.076	0.006	0.085	0.006

* = P 0.05
** = P 0.01

always essential to distinguish between substrate humidity and ambient moisture content in relation to Collembola. Most forms for different stages of development are also known to require over 89% of relative humidity for functional properties (Christiansen, 1964). This is supported by the fact that number of oviposition and growth rate can be decreased by reduced temperature (Sharma & Kevan, 1963a,b,c; Hale, 1965a,b). Add to this, less rainfall and moisture content in winter would certainly decrease the number of Collembola as clearly recorded in the present investigation. Such positive correlation of moisture content to Collembola have also been observed by Agrell (1941), Knight (1961) and Poole (1961). However, many investigations have shown no relationship between moisture content and various groups of soil fauna (Macfadyen, 1952, 1954; Marcuzzi, 1962, 1973), while others reported definite negative correlation (Hammer, 1953; Stebayev, 1962).

One could, therefore, attribute that in the present investigation which is neither totally typical tropical nor temperate, the clear cut seasonality of abundance for the groups of soil arthropods under consideration had a direct relationship as they coincided with periods of uninterrupted rainfall. This, therefore, had a combined effect due to complimentary nature of increase in relative humidity and moisture content, primarily along with increase in air temperature, litter/soil temperature, maximum and minimum temperature, respectively. Therefore, with temperature and water content being increased both could have played a role together than any of these individual abiotic factors.

In the present study, temperature showed positive relationships with many of the soil faunal groups as the populations start building up with the onset of warm summer and decrease with the approach of winter. These results are in close resemblance with Kevan (1965), Butcher et al. (1971), Gupta and Mukharji (1978) who reported the existence of marked effect of temperature on soil arthropods in general and Collembola in particular. From the warm temperate forest of Japan, Niijima (1971) had attributed low temperature as one of the important causes of low density of Collembola in winter, as is the case in the present study. Thus, temperature is one of the factors responsible for optimum oviposition and growth rate, at least in Collembola (Kevan, 1955, 1965; Hale, 1966, 1967), giving rise to a peak abundance in summer.

Add to these, reports exist emphasizing temperature as influencing factor on the metabolic rate but considering it ecologically insignificant as most of the soil fauna are capable of vertical migration. It is now well documented that many soil invertebrates move down regularly with the rise and fall of temperature below a critical level (Dowdy, 1944; Mitchell, 1978).

Further, examples exist on the roles and importance of habitat's microenvironmental factors in relation to faunal compositions, densities and fluctuations in seasons. In the present study, the region's meteorological factors were taken into consideration to merely reflect the general trend of correlation as these factors (macroenvironments) in turn may affect the microenvironments of the habitats.

The next major factor, pH, also played a similar role as the above mentioned factors more so in the litter layer and less in subsequent layers of both the systems. Further, this factor had highly significant positive relationship with most Collembola (Tables LXIII, LXIV & LXV) and very few acarine sub-groups (Tables LXVI, LXVII & LXVIII), except oribatids (Karppinen, 1955; Bhattacharya & Raychaudhuri, 1977). Information on the effects of soil pH on soil arthropods is limited and partly contradicted. Christiansen (1964) concluded from field studies that soil pH have very little effect on Collembola. Gisin (1943) on the other hand considered several species to be either basophile or acidophile. The pH of the soil in the present investigation was always acidic, therefore, the species encountered may probably be acidophile, as was also reported by Hale (1966), Nosek (1967) and others with particular reference to Collembola. As mentioned earlier, on the other hand, there exist reports of pH having very little or no effect on collembolan populations (Agrell, 1941; Bellinger, 1954; Paclt, 1956; Cassagnau, 1961; Christiansen, 1964).

The next factor, conductivity, which was negatively related for most of the soil faunal groups was, however, significant only for some collembolan species at the litter layer in the forest system like Cryptopygus thermophilus, entomobryids (except Lepidocyrtus) and sminthurid collembolans. This may probably be due to the fact that the soil cover enables the retention of total soluble solids while in the jhum system, the solids get diluted away. Further, since pH has influence on con-

ductivity, therefore, except for Collembola and some of its genera/species, Acarina and "other arthropods" did not reveal significant relationship.

In regard to other physico-chemical factors, in terms of C, N, soil porosity and particle size, none of these seemed to play major role with any of the soil faunal groups under present investigation. Once again, these factors may have operated in harmony with pH which is low and acidic for these conifer sites. Further, the phenolic properties of the litter retard decomposition resulting in accumulation of acid raw humus over a podzolized soil profile. These lead to productivity being low at these sites, regeneration operating below optimum level and finally site degradation (Weetman, 1962). Moreover, the present region and site situated at higher altitude has an optimum temperature for litter production much lower than that needed for decomposition as pointed out by Macfadyen (1969).

It is probably more than physical and chemical properties of the soil and that it is either direct, indirect or catalytic role of soil animals which maintain the fertility and structure of soil (Macfadyen, 1961b, 1963b; Hill et al., 1975). Therefore, by affecting the properties of soil and populations of other organisms, soil fauna manipulate their biota, numerically and spatially, rather than the edaphic effects on them.

The soil is a physically and chemically diverse environment that is used by a wide variety of invertebrate animals and microorganisms. The species differ in the distribution of their activities in space, time and biological function. It is neither surprising nor particularly insightful that morphologically different species are also ecologically different. The interesting and important question is the degree to which ecological differentiation is a necessary condition for the coexistence of the soil organisms, and hence an important factor in the organization of soil communities.

Therefore, having dealt at length with single species their population dynamics and the effects of abiotic and edaphic factors on fluctuating tendencies, it was felt best to analyse the community relationships, to get a clear insight into the two systems undertaken in the present investigation. Hence, a community study, along with comparative ecosystem analysis was carried out. However, not all the major groups recorded in the present investigation were used for this study. The two dominant groups of soil fauna, Collembola and Cryptostigmata, where most of the identifications were possible upto generic/specific level, were taken up for the community studies. Moreover, even among these the unit was not always at the specific level, for some were treated at generic and even family levels or so. This was so done taking into consideration that the higher levels of taxocene were tentatively identified to contain one species only.

When Collembola was seen as a community between the two systems, there were 17 species available in the forest in contrast to only 10 in the jhum. However, in the 0-10 cm layer of both the systems, there were 11 species in the forest and 10 in the jhum, the latter due to the absence of Dicranocentrus singularis. One could, therefore, very clearly observe that there were 6 species/groups confined only in the litter layer and no where else. Interestingly enough, the 10-20 cm and 20-30 cm soil layers had only 4 and 3 species in the forest and jhum respectively in the former depth, while only one each in the latter layer. Further, even those which were present in the jhum system were absent during the winter months. Of all these, only Isotoma (Desoria) trispinata occurred throughout all the layers, while Cryptopygus thermophilus and other isotomids occurred only upto 10-20 cm layer of both the systems.

The richness and variety, however, of natural ecological communities, which today has come to be known as ecological diversities, have never been more highly valued than they are now. This is all the more necessary to understand the complexity of the community because not only do each species differ from one another but also the individuals within any one species are unique. Further, it can truly be said that no two individual units making up a community are alike. Diversity, therefore, enables one to understand the stability of the environment under consideration.

The various indices used for measuring diversity were Margalef's, Shannon-Wiener's and H_{max}, in the present investi-

gation. Moreover, the evenness and redundance values were also worked out to get the picture of distributions. The values obtained for all these were always much higher in the forest than in the jhum, and this was reflected not only in the total system but in the different soil layers also. Interestingly enough except for the Margalef's index of the first annual cycle, all these values, irrespective of the systems and the soil layers, revealed a summer maxima and a winter minima. This coincided very well with population dynamic data where not only some species were absent during winter but also they were least abundance during these months. The evenness values ranged usually from a minimum of 0.500 to a maximum of nearly 0.900 or more. This clearly indicates that the number of species or groups undertaken have been very well represented.

In contrast to Collembola, the oribatid mites (Cryptostigmata) had only 11 species in the forest and 9 in the jhum. The groups Uropodidae and other oribatids were totally absent in the jhum system during the present period of investigation. Further, unlike Collembola, there was no reduction of the number of these species in the 0-10 cm layer, either in the forest or in the jhum system. However, similar to Collembola, the 10-20 cm layer of the soil recorded only 3 and 2 species in the forest and jhum, respectively. The only species which occurred throughout, though absent in certain months, irrespective of the depths in both the systems, was Dolicheremaeus, followed by Rhysotritia ardua and Eremobelba, though absent for the second annual cycle in the forest and both the annual cycles in the jhum in the 10-20 cm soil depth.

While calculating the diversity indices, it was again seen that maximum values were in the forest in comparison to the jhum. The values were much less not only in the total system but also in the subsequent soil layers. Though there was no definite winter fall and summer increase as for Collembola, the values of these indices did generally reflect the same phenomena for Cryptostigmata also. The values for evenness approximated nearly 1.00 in most cases which, therefore, confirms that most, if not, all species have been taken into consideration.

Though most values of diversity indices for both Collembola and oribatids approximated nearly the same, the former did show higher species richness, which is obvious from the number of species that it possesses.

After the comparisons between these two faunal communities by themselves, it was necessary to find out their actual similarities between both the ecosystems. The Sørensen's and Average Faunal Resemblance values revealed nearly 50-100% range of similarities between the two systems. However, it was in the 0-10 cm layer of the soil that 100% similarity was recorded while both the total system and 10-20 cm layer recorded much less (a maximum of only 85%). Once again, it was in the winter months that there was very high similarity and the least in summer.

On a similar comparison for the system, using oribatid communities, both Sørensen's and Average Faunal Resemblance values ranged from nearly 50-90%, but this was both for the total system and 0-10 cm soil layer.

In addition, Morisita's index of similarity was also worked out for these systems using these two faunal groups. For Collembola, it approximated unity irrespective of the total system or different layers, while for the oribatids, it ranged from 0.500 to 0.900 in general. This indicated that there was evenly distributed collembolan and oribatid communities with very little of aggregation or clumpiness.

Diversity has been used as an indicator of relative stability (van Emden & Williams, 1974), and ecological dogma, though, not resolved on cause and effect, couples the properties of diversity and stability (Blumberg & Crossley, 1983). Increased species diversity in tropical areas and most climaxed communities have been attributed to climatic stability, long evolutionary history, high productivity and spatial heterogeneity. Since factors affecting the structures of communities are varied and often interacting, a better understanding of species diversity could always be gained by studies of groups with extremely similar ecological requirements. Therefore, in the present investigations only Collembola and Cryptostigmata were undertaken for such comparative studies.

The temporal patterns of species diversities observed in the present investigation are consistent with other studies of temperate arthropod communities (Evans & Murdoch, 1968; Lewis, 1969; Pimentel & Wheeler, 1973; Root, 1973; Uetz, 1975), where the greatest number of species were found in midsummer. Of all the abiotic factors, temperature and rainfall, once again seem to strongly regulate not only the density, but also species

richness. In both the communities the decrease is probably related to the beginning of soil frost (in winter), which is a predominant factor to be reckoned with at the altitude at which the present investigation was carried out.

With regard to their spatial patterns of diversity, it supports the hypothesis of Pianka (1974) and Uetz (1975), where the litter layer and the forest in general has the greater number of species and diversity than the jhum system. It is suggested that more productive habitat can support more species. Probably, with an increase in standing crop of fungal food, each species may utilize less of the total range of available food and so more species can co-exist. The litter habitat further, may help in reducing the microclimatic fluctuations, maintaining moisture, providing structural retreats and introducing a heterogenous substrate. This physical complexity of environments has been correlated with diversities in birds (MacArthur & MacArthur, 1961; Cody, 1968), lizards (Pianka, 1967), molluscs (Kohn, 1967), crustaceans (Abele, 1973) and insects (Murdoch et al., 1972; Turner & Broadhead, 1974). Also it is possible that species could partition the habitat vertically (Huhta, 1971). Thus, microhabitat diversities and vertical stratifications would tend to increase in species richness. Further, spatial heterogeneity in the litter environment might influence the relative abundance of populations within and between species.

In the present investigation, since the litter was taken as a whole unit by itself, these microhabitat variations were not identified. However, it did reflect the above mentioned

phenomena where the largest number of species and greatest diversity occurred in the litter habitat rather than in any of the underlying soil compartments. Future studies on minor interval depths would probably reflect a greater understanding of such a system.

Among the very few Indian works on similar approach, mentionce can be made of Bhattacharya et al. (1981) who have also pointed out that cryptostigmatid mites prefer to orient themselves near the soil surface for easy accessibility of available food.

From the present investigation, further, it revealed that Collembola showed a stronger dominance by several generalist species and with very little difference with community composition between the forest and jhum through the soil gradients, even at reduced level of species. The oribatid community, however, consisted of species that differ in their distributions along the habitat gradients with relatively low dominance and greater degree of community differentiation between the two systems except for the top surface layers. Challet and Bohnsack (1968) and Bohnsack (1973) reached similar conclusions using indices of community similarity based upon species presence or absence.

Competitive advantage in one habitat may be offset by movement of individuals from adjacent habitats where competitive balance differ. Such a system could easily function where the habitats are in close proximity as in the present investiga-

tion. This would probably lead to the hypothesis that either the community differentiation increases with the physical separation of the habitats or that reproduction differs more between species in a habitat than does the abundance or both acting together. This means that competitively superior species act as source of colonizers of adjacent habitats while competitively inferior species are dependent upon input of immigrants to sustain their density. This is very clearly exemplified in the present investigation where among the collembolan species, Isotoma (Desoria) trispinata colonized both the forest and jhum systems dominantly throughout the soil gradients as well as throughout the period of investigation.

Unlike this, cryptostigmatid mites did not have any competitively superior species. It is known that habitat differentiation should be the greatest in animals with lowest rates of reproduction and dispersal (Solhoy, 1975; Douce & Crossley, 1977; Addison, 1977). Oribatids have restricted reproductive potentials compared with Collembola. Moreover, Collembola has much higher rate of reproduction and dispersal and, therefore, this represents weighted average of selection in all available habitats as can be seen very clearly in the present investigation.

Based on these two communities alone, the similarities and dissimilarities between the two ecosystems undertaken (forest and jhum), were analysed. A quantification of similarity or dissimilarity of two communities have been in existence since the beginning of this century (Jaccard, 1902; Yule, 1912). Use

of such similarity measurements is usually for estimations of the rate and direction of sucoession and man-induced changes in living communities. To be useful in practice, the measure at least should fulfil one of the following criteria, that, (i) it should not change when two stable or climax communities are compared with each other at different times and/or (ii) it should show a steady and consistent change when a changing community is compared with a stable one at regular intervals (Huhta, 1979).

The latter parameter was the characteristic of present investigation. The total systems and the top surface layers showing a great degree of similarity as indicated by Sørensen's and Average Faunal Resemblance indices, could probably be attributed to one species at least in Collembola, Isotoma (Desoria) trispinata, which hardly reacted to clear cutting or shifting agriculture. This species, thus, exerts a strong influence on the index values resulting in seemingly high similarities between jhum area (fallow) and forest system. This phenomena, however, gets clarified for subsequent soil depths where the similarity reduces to nearly 50%, probably attributing to the actual differences between these two systems.

The present investigation, therefore, revealed a phenomena of architectural choices using these two major groups of soil communities for their similarities or dissimilarities between the forest and jhum systems, as was also observed by Robinson (1981). It, therefore, could be attributed to the degree of evolutionary rather than ecological specialization responsi-

ble when such comparisons are made (Scriber, 1973). This fact proves that every taxon has a geographical range, which fluctuates through time and becomes discontinuous, and though individuals are distributed within the range at various points at any given time, they may not be available at the same point at a second time.

GENERAL DISCUSSION

One of the hallmarks of the recent decade of ecological research was the consideration of ecosystems as objects *per se*. If one conceptualises the terrestrial biosphere as a mosaic of ecosystem types, forest ecosystems are unique. For such sustaining yields it is the soil component of such ecosystems that probably make up the singular most important component of any terrestrial ecosystem.

The concept of soil as a biological system, however, is by no means a new one. And this is not the first thesis to be written on soil animals. Further, the most complex of soil fauna occur in forests, both temperate and tropical, that our understanding of the structure and functioning is far from complete. Even by narrowing the terms of reference, as in the present investigation, the task is not much simplified. All these become magnified when one were to start comparing such a complex system to that of a man-made or man-induced ecosystem, making a change in geomorphology of the land.

The clearing and cultivation of tropical forests is usually accompanied by a decline in soil fertility (Nye & Greenland, 1960; Sanchez, 1973; Ayanaba *et al.*, 1976), thereby, the faunal groups that depend on such ecological niches. The result of present investigation clearly show a drastic reduction in faunal abundance between the untouched forest stand soil and the clear-cut-burnt jhum system soil. The litter layer, which is again revealed by the present investigation, is the homeland

of more species with greater abundance, but litter burnt with even minimal primitive tillage practices, is likely to retain less rain water and hence run off and seepage could be higher. The cumulative effects of these changes are drastic fall in the qualitative and quantitative composition of soil fauna, as already pointed out.

The region under consideration with heavy rainfall, in comparison with the rest of India, probably enhances the above phenomena. However, microenvironments, just like macroenvironments, are not static entities — they change with time. It follows, therefore, that the associated fauna will also change with time. These faunal changes may be short term (cyclical) or long term (successional). Short term changes are shown by species that alter their vertical distribution patterns and long term with microclimate and food availability.

The present investigation did not identify any of the former, while the latter, at least in the forest ecosystem, was stable. But stability of microclimate increases progressively with depths. The present investigation, however, revealed the greatest of erratic fluctuations with depths of soil layers, both at population and community level, true for both the forest and jhum soils. Are we, therefore, comparing a true stable system with that of a non-stable one or two systems existing at different degrees of stability? From the results of present study we would concur with the latter.

As pointed out in the introduction, jhum is a way of life with the tribal population of the hill tracts of North-East India. This age-old practice, previously in harmony with nature, is governed by the whole social, historical and environmental setting of these tribal people, with one sole aim of getting maximum return for minimum effort. However, because of population pressure and limited areas, the practice cannot be sustained. Moreover, if allowed unchecked, the few successional species arriving at climax level would also disappear. Geologically, North-East India, has known to be a gateway rather than amphitheatre of faunal radiation, its transitional nature being unquestionable (Mani, 1974).

The capacity of any environment to support species is an ecological property, which is determined ultimately by the physical environment and in the present study — the soil. Each individual species, therefore, play unique role in the ecosystem as a whole, while influencing every other species through its interspecific interactions. Therefore, when even forest ecosystems in this part of the globe are in a stage of succession, the removal of this or rather replacement by shifting agricultural practices, would be drastic for obvious reasons. Ecological communities, in particular soils, are perhaps the most fragile and yet complex of biological structures.

CONCLUDING REMARKS

With the foregoing background, an overview of the study prompted us to arrive at the following clusters of conclusions. The present investigation revealed that the total soil fauna reduced to nearly 5 times in the jhum (1-2 years fallow) as compared with the untouched forest stand. However, there was about 50% reduction when only the soil layers were taken into consideration. There was also clear reduction in soil faunal level with increasing depths, recording even total absence of the dominant groups at lower layer beyond 20-30 cm profile.

The two dominant soil faunal groups, Collembola and Acarina, recorded nearly the same abundance values in the forest soils. However, there was about ten fold decrease of Collembola and five fold decrease of Acarina in the jhum soils, though the acari accounted more than 1.5 times of the collembolans. The family Isotomidae and sub-order Cryptostigmata were the dominant group among the Collembola and Acarina, respectively. Among the "Other Arthropods", there was nearly threefold reduction in the jhum as compared to the forest and the insects as a whole were the largest group. In general, the forest occupied nearly 94% of the soil fauna in the surface layer, inclusive of the litter regime, while only about 79% in the jhum.

With regards to the population dynamics, it was seen that there was a mid-monsoonic increase and decline in winter, irrespective of the faunal groups, the soil profiles or the two

systems under consideration, except Acarina. This latter had two population peaks, a smaller spring peak and a larger autumn peak with, however, a winter fall. Temperature and moisture (including humidity and rainfall) were the factors seen to play major roles as revealed by their significant relationship, directly with the soil fauna. The duration of sunshine was one significant factor which showed negative relationship. Moreover, most abiotic factors were much better related to the forest soil fauna rather than the jhum. In both systems, however, the edahic factors played very little role.

Community analysis and ecosystem similarity studies revealed the largest variety of species in the litter or the top surface (0-10 cm) soil layer. Of the 17 species of Collembola at the litter layer, 6 species seemed to be confined only in this layer as revealed by the presence of only 11 and 10 species in the forest and jhum, respectively, in the 0-10 cm soil layer. A drastic reduction in the subsequent layers to 3 species and even to only one species was observed. Diversity indices values were always much higher in the forest than in the jhum system, understandably.

On the other hand, the oribatid community recorded 11 species in the forest and 9 species in the jhum upto 10 cm soil layer. Unlike Collembola, no species occupied the litter layer alone (except Uropodidae). The subsequent soil layers, however, recorded drastic reduction to about 3 species in the forest and 2 species in the jhum system.

The similarity values showed only 50-70% between the two systems though, however, at the surface layer of the soil (0-10 cm), the similarity increases to about 85% and sometimes even 100%. A clear cut uniform distribution was seen with very little aggregations or clumpiness.

The present investigation seeked to extend the analytical insights from population levels to community and the ecosystems. On the one hand, community dynamics have been interpreted as species-population phenomena, while on the other, population dynamics was studied only within the community concept.

REFERENCES

6. REFERENCES

Abele, L.G. 1973 Species diversity of decapod crustaceans in marine habitats. Ecology 55, 156-161.

Addison, J.A. 1977 Population dynamics and biology of Collembola on the Truelove Lowland. In: Truelove Lowland, Devon Island, Canada : A High Arctic Ecosystem (L.C. Bliss, ed.). University of Alberta Press, Edmonton.

Agrell, I. 1941 Zur Okologie der Collembolen. Untersuchungen im schwedischen Lappland. Opusc. ent. suppl. 3, 1-236.

Ahlgren, I.F. & C.E. Ahlgren 1960 Ecological effects of forest fires. Bot. Rev. 26, 483-533.

——————— 1965 Effects of prescribed burning on soil micro-organisms in a Minnesota jack pine forest. Ecology 46,304-310.

Aitchison, C.W. 1979a Winter-active subnivean invertebrates in Southern Canada. II. Coleoptera. Pedobiologia 19, 121-128.

——————— 1979b Winter-active subnivean invertebrates in Southern Canada. III. Acari. Pedobiologia 19, 153-160.

——————— 1979c Winter-active subnivean invertebrates in Southern Canada. IV. Diptera and Hymenoptera. Pedobiologia 19,176-182.

Alexander, F.E.S. & R.M. Jackson 1955 Preparation of sections for study of soil micro-organisms. In: Soil Zoology (D.K. McE. Kevan, ed.), Butterworths, London. pp. 433-440.

Allen, S.E. (ed.) 1974 Chemical analysis of ecological materials. Blackwell Scientific publ., Oxford. 565 pp.

Anderson, J.M. 1971 Observations on the vertical distribution of Oribatei (Acarina) in two woodland soil. In: Proc. 4th Coll. Pedobiologiae. Ann. Zool.-Ecol. Anim. Paris. pp. 257-272.

Anderson, J.M. 1978 Inter-intra-habitat relationships between woodland Cryptostigmata species diversity and the diversity of soil and litter microhabitats. Oecologia 32, 341-348.

_____ & T.G. Wood 1984 Mound composition and soil modification by two soil feeding termites (Termitinae : Termitidae) in a riparian Nigerian forest. Pedobiologia 26, 77-82.

Anglade, P. 1967 Etude de populations de Symphyles en sol cultive et d'influence de traitments du sol. In: Progress in Soil Biology (O. Graff & J.E. Satchell, eds.). pp. 372-381.

Aoki, J. 1965 Oribatid mites (Acarina : Oribatei) from Himalaya with descriptions of several new species. Coll. Arts and Science, Chiba, 4, 289-302.

Arnason, T., J. Lambert, F. Uck & R. Hebda 1980 Maya medicinal plants of San Jose Succotz. Ethnopharmacology 2, 345-346.

_____, J.D.H. Lambert, J. Cal & H. Vernon 1982 Decline of soil fertility due to intensification of land use by shifting agriculturists in Belize, Central America. Agro Ecosystems 8, 27-37.

Arshad, M.A., N.K. Mureria & S.O. Keya 1982 Effect of termite activities on the soil microflora. Pedobiologia 24, 161-167.

Athias-Binche, F. 1981 Ecological studies on soil uropodid mite communities (Arachnida : Parasitiformes) from deciduous forest ecosystems. I. Introduction, studied material, biology. Vie Milieu 31,137-147.

Attems, C. 1937 Diplopoda of India. Mem. Ind. Mus. 11, 133-323.

Axelson, B., U.Lohm, H. Lundkvist, T.Persson, J. Skoglund & A. Wiren 1973 Effects of nitrogen fertilization on the abundance of soil fauna populations in a scots pine stand. Royal College of Forestry, Stockholm, Research Notes No. 14, 1-18.

Ayanaba, A., S.B. Tuckwell & D.S. Jenkinson 1976 The effects of clearing and cropping on the organic reserves and biomass of tropical forest soils. Soil Biol. Biochem. 8, 519-525.

Ayyar, T.V.R. 1922 The weevil fauna of South India with special reference to species of economic importance. Bull. Agr. Res. Inst., Pusa. 125, 21.

_____ & Ramakrishna 1930 Contribution to our knowledge of South Indian Coccidae. Bull. Agr. Res. Inst., Pusa. 197, 31.

Baath, E., B. Berg, U.Lohm, B.Lundgren, H.Lundkvist, T.Rosswall, B.Soderstrom & A.Wiren 1980 Effects of experimental acidification and liming on soil organisms and decomposition in a scots pine forest. Pedobiologia 20, 85-100.

Babbatt, B.I.P. 1983 Distribution survey of soil insects at Millers Flat, Central Otago. N.Z.J. Exp. Agric. 11, 83-87.

Baker, E.W. 1945 Scheloribates chauhani a new species of oribatid mite from India. J. Wash. Acad. Sci. 35, 386-388.

Balogh, J. 1958 Lebensgemeinschaften der Landtiere ihre Erforschung unter besonderer Berucksichtigung der zoologischen Arbeitsmethoden. Verlag der Ungarischen Akademie der Wissenschaften, Budapest. 560 pp.

_____ 1972 Oribatid Genera of the World (Translated by L. Gozmany). Budapest, Akademia. 188 pp.

Banerjee, S. 1972 Microarthropods and humus formation. J. Ind. Soc. Soil Sc. 20, 403-405.

Bano, K. & R.V. Krishnamoorthy 1978 The role of the millipede Jonespeltis splendidus Verhoeff in soil humification. In: Soil Biology and Ecology in India (C.A. Edwards & G.K. Veeresh, eds.), UAS Tech. Series No. 22, pp. 106-110.

_____ 1981 Relative rates of litter decomposition and humification of various soils by the millipede Jonespeltis splendidus. In: Progress in Soil Biology and Ecology in India (G.K. Veeresh, ed.), UAS Tech. Series No. 37, pp. 87-91.

Bartlett, H.H. 1956 Fire, primitive agriculture and grazing in the tropics. In: Man's Role in Changing the Face of the Earth (W.L. Thomas, ed.), Univ. Chicago Press, Chicago. pp. 678-702.

Baweja, K.D.	1939	Studies of the soil fauna with special reference to the recolonization of sterile soil. J. Anim. Ecol. 8, 120-161.
Behan, V.M., S.B. Hill & D.K. McE. Kevan	1978	Effects of nitrogen fertilizers, as urea, on acarina and other arthropods in Quebec black spruce humus. Pedobiologia 18, 249-263.
Bellinger, P.F.	1954	Studies of soil fauna with special reference to the Collembola. Bull. Conn. Agric. Expt. Stan. 583, 1-67.
Berthet, P. & G. Gerard	1965	A statistical study of the microdistribution of Oribatei (Acari). Oikos 16, 214-227.
Bhaduri, A.K. & D.N. Raychaudhuri	1967	A note on soil oribatid mites from Calcutta. Sci. Cult. 33, 450.
————	1968	Studies on the oribatid mites of Calcutta and suburbs. Orient. Insects. 2, 195-200.
————	1978	Distribution of oribatid mites (Acari) in India. In: Soil Biology and Ecology in India (C.A. Edwards & G.K. Veeresh, eds.), UAS Tech. Series No. 22, pp. 113-117.
Bhaduri, A.K., D.K.Chakrabarti & D.N.Raychaudhuri	1974	A new species of the genus Basilobelba (Acari : Oribatei) from Calcutta, India. Acta Arachnol. 25, 86-89.
————, T. Bhattacharya & D.K. Chakrabarti	1975	Two new species of oribatid mites (Acari) of the genus Chauroproctus Pearce from Calcutta, India. Mitt. Zool. Mus., Berlin.
Bhattacharya, T., A.K. Bhaduri & D.N. Raychaudhuri	1974	Soil oribatid mites of Shantiniketan, Birbhum, West Bengal (Acari : Lohmanniidae). Oriental Ins. 8, 281-289.
———— & D.N. Raychaudhuri	1977	Monthly variation in the density of soil microarthropods in a wasteland of Santiniketan in relation to some climatic and edaphic factors. In: Proc. 2nd Oriental Entomol. Symp., Madras. 57.
————	1979	Monthly variation in the density of soil microarthropods in relation to some climatic and edaphic factors. Entomon 4, 313-318.

Bhattacharya, T., V.C. Joy & S. Joy 1980 Soil inhabiting cryptostigmata (Acari) of the rice field ecosystem in relation to agro-technical measures. Tropical Ecology and Development (Proc. 5th Int. Symp. Trop. Ecol., Kuala Lumpur), 981-987.

_____, S. Joy & V.C. Joy 1981 Community structure of soil Cryptostigmata under different vegetational conditions at Santiniketan. J. Soil Biol. Ecol. 1, 27-42.

_____ & S. Chatterjee 1984 Diurnal variation in the abundance of soil microarthropods with special reference to Cryptostigmata (Acari). Viswa-Bharati Journal of Research (Science), 5, 47-55.

Bingham, C.T. 1903 Fauna of British India including Ceylon and Burma : Hymenoptera. 11,414 p.

Blackith, R.E. 1974 The ecology of Collembola in Irish blanket bogs. Proc. Royal Irish Acad. 74, 203-226.

Block, W. 1965 Distribution of soil mites (Acarina) on the Moor House National Nature Reserve, Westmorland, with notes on their numerical abundance. Pedobiologia 5, 244-251.

_____ 1966a Seasonal fluctuations and distribution of mite populations in moorland soil with a note on biomass. J. Anim. Ecol. 35, 487-503.

_____ 1966b The distribution of soil Acarina on eroding blanket bog. Pedobiologia 6, 27-34.

Blumberg, A.Y. & D.A. Crossley, Jr. 1983 Comparison of soil surface arthropod populations in conventional tillage, no-tillage and old field systems. Agro-Ecosystem 8, 247-253.

Bocock, K.L. & J. Heath 1967 Feeding activity of the millipede Glomeris marginata Villers in relation to its vertical distribution in the soil. In: Progress in Soil Biology (O. Graff & J.E. Satchell, eds.), Braunschweig, Amsterdam, pp. 233-240.

Bohnsack, K.K. 1973 Distribution of oribatids near Barrow, Alaska. In: Proc. 3rd Int. Congr. Acarology (M. Daniel & B. Rosicky, eds.), Akademia, Prague. pp. 71-74.

Bornebusch, C.H. 1930 The fauna of forest soil (Skovbundens Dipreverden). Forsth. Forsøgsv. Danm. 11, 1-224.

Borthakur, D.N., A. Singh, R.R. Awasthi & R.N. Rai 1978 Shifting cultivation in the North-Eastern Region. In: Resources, Development and Environment in the Himalayan Region, DST, Govt. of India. pp. 330-342.

Brian, M.V. 1965 Social insect populations. Academic Press. pp. 135.

Brower, J.E. & J.H. Zar 1977 Field and laboratory methods for general ecology. WM. C. Brown Co. Publishers, Dubuque, Iowa, 194 pp.

Buffington, J.D. 1967 Soil arthropod populations of the New Jersey Pine Barrens as affected by fire. Ann. Ent. Soc. Amer. 60, 530-535.

Burges, A. & F. Raw (eds.) 1967 Soil Biology. Academic Press, London. 532 pp.

Butcher, J.W., R. Snider & R.J. Snider 1971 Bioecology of edaphic Collembola and Acarina. Ann. Rev. Entomol. 16, 249-288.

Butovitsch, V. von & W. Lehner 1933 Freilanduntersuchungen der Bodenfauna und deren Bedeutung fur die forstliche Praxis. Z. Forst u Jagdwiss. 65, 225-248.

Cameron, A.E. 1913 General survey of the insect fauna of the soil within a limited area near Manchester : a consideration of the relationships between soil insects and the physical conditions of their habitat. J. Econ. Biol. 8, 159-204.

Carneiro, R.L. 1960 Slash and burn agriculture : a closer look at its implications for settlement patterns. In: Man and Culture (A.F.C. Walace, ed.), Philadelphia.

_____ 1961 Slash and burn cultivation among the Kuikuru and its implications for cultural development in the Amazon Basin. In: The Evolution of Horticultural Systems in Native South America, Causes and Consequences : A Symposium. (J. Wilbert, ed.), Sociedad de Ciencias La Salle, Caracas. pp. 47-65.

Carpenter, G.H. 1917 Collembola, Zoological results of the Abor Expedition, 1911-1912. Rec. Ind. Mus., Calcutta. 8, 561-568.

Cassagnau, P. 1961 Ecologie du sol dans les Pyrenees centrales les biocenoses des Collemboles. Herman, Paris. 235 pp.

Chakrabarti, D.K. & A.K. Bhaduri 1972 New records of soil oribatid mites (Acari : Oribatei) from the districts of Nadia and 24-Parganas (West Bengal). Sci. Cult. 38, 499-500.

_____, A.K. Bhaduri & D.N. Raychaudhuri 1972 One new species and a new subspecies of oribatid mites (Acari:Oribatei) from West Bengal, India. Acta Arachnol. 24, 86-90.

_____ 1973 A new subspecies and a few new records of soil oribatid mites (Acari: Oribatei) from West Bengal. Sci. Cult. 39, 365-366.

Challet, G.L. & K.K. Bohnsack 1968 The distribution and abundance of Collembola at Pt. Barrow, Alaska. Pedobiologia 8, 214-222.

Channa Basavanna,G.P. & B.K. Rajagopal 1978 Soil dwelling hemiptera. In: Soil Biology and Ecology in India (C.A. Edwards & G.K. Veeresh, eds.), UAS, Tech. Series No. 22, pp. 181-186.

Chhotani, O.B. 1981 Soil termites of India. In: Progress in Soil Biology and Ecology in India (G.K. Veeresh, ed.), UAS Tech. Series No. 37, pp. 229-235.

Chiba, S., T. Abe, J. Aoki, G. Imadate, K. Ishikawa, M. Kondoh, M. Shiba & H. Watanabe 1975 Studies on the productivity of soil animals in Pasoh forest reserve, West Malayasia. I. Seasonal change in the density of soil mesofauna : Acari, Collembola and others. Sci. Rep. Hirosaki Univ. 22, 87-124.

Choudhuri, D.K. 1960 Influence of temperature on the development of Onychiurus furciferus and its mathematical representation. Proc. Zool. Soc., Calcutta. 13, 123-128.

_____ 1961 Effects of some soil structure on Collembola. Sci. Cult. 27, 494-495.

_____ 1962 Collembolan aggregation in a single forest habitat and their variance. Sci. Cult. 28, 490-491.

Choudhuri, D.K. 1963a Temperature and its effects on the three species of the genus Onychiurus (Collembola). *Proc. Zool. Soc., Calcutta.* 16, 97-117.

_____ 1963b Effects of some physical factors on the genus Onychiurus (Collembola). Proc. Natl. Sci., India. Section B, 33, 538-546.

_____ & S. Roy 1965 The role of edaphic factors on the distribution of subterranean collembolan fauna of West Bengal. Proc. 1st Latin Am. Colloq. Soil Biol. 391-403.

_____ 1967 Qualitative composition of the collembolan fauna of some uncultivated fields in Nadia Distric (West Bengal) with a correlation between monthly population and individual soil factors. Rev. Ecol. Biol. Sol. 4,504-515.

_____ 1970 Interactions between soil Collembola and other subterranean arthropods. Sci. Cult. 36, 280-282.

_____ 1971a Seasonal fluctuation and vertical distribution of the genus Lepidocyrtus (Collembola : Insecta) in some uncultivated fields of Gangetic West Bengal, India. Rev. Ecol. Biol. Sol. 8, 253-259.

_____ 1971b The Collembola (Insecta) of the uncultivated fields in Burdwan district (West Bengal), with remarks on correlation between monthly population and certain soil factors. Proc. Zool. Soc., Calcutta. 24, 33-39.

_____ 1971c Distribution of Collembola in relation to soil conditions in the district of Jalpaiguri, West Bengal (India). Annales de Zoologie (INRA Publ.), Paris. 10, 289-296.

_____ 1972 An ecological study on Collembola of West Bengal (India). Rec. Zool. Surv. India. 66, 81-101.

_____ & S. Banerjee 1975 Qualitative and quantitative composition of Acari and Collembola in relation to soil organic matter-microbes complex. Orient. Ins. 9, 313-316.

Choudhuri, D.K. & S. Banerjee 1977 Soil factors and oribatid mites under conditions of West Bengal. The Univ. Burdwan Publ. 1-88.

_____, A.K. Hazra & S. Roy 1978 Soil factors governing the distribution of Collembola (Insecta) in the graveyard of Berhampur, Murshidabad District, West Bengal. In: Soil Biology and Ecology in India (C.A. Edwards & G.K. Veeresh, eds.), UAS Tech. Series No. 22, pp. 161-172.

_____, S. Banerjee & S. Roy 1978 Distribution of oribatids in relation to soil condition in the district of Hooghly, West Bengal, India. Abstract Vth Intl. Congr. Acarol., Michigan State University, USA. p. 80.

_____ & T. Pande 1979 High altitude soil animals and their relation with soil factors, with special reference to mites. Rev. Ecol. Biol. Sol. 16, 219-226.

_____ 1982 An ecological study of acarines from soil of Himalayan ecosystem. Geobios 1, 24-26.

Christensen, P.E. & P.C. Kimber 1975 Effect of prescribed burning on the flora and fauna of S.W. Australian forests. Proc. Ecol. Soc. Australia. 9, 85-106.

Christiansen, K. 1964 Bionomics of Collembola. Ann. Rev. Entomol. 9, 147-178.

Clarke, W.C. 1976 Maintenance of agriculture and human habitats within the tropical forest ecosystem. Human Ecology 4, 247-259.

Cloudsley-Thompson, J.L. 1958 Spiders, scorpions, centipedes and mites. Pergamon, London. 228 pp.

Cody, M.L. 1968 On the methods of resource division in grassland bird communities. Am. Nat. 100, 371-376.

Conklin, H.C. 1957 Hanunoo Agriculture : A report on an integrated system of shifting cultivation in the Phillipine. FAO Forestry Development Paper No. 12, FAO, Rome. 109 pp.

Cragg, J.B. 1961 Some aspects of the ecology of moorland animals. J. Anim. Ecol. 30, 205-234.

Darlong, V.T. 1979 A quantitative study of soil arthropods in forest and jhum ecosystems of Meghalaya, India. Unpublished M.Sc. dissertation, NEHU, Shillong. 31 pp.

_____ & J.R.B. Alfred 1982 Differences in arthropod population structure in soils of forest and jhum sites of North-East India. Pedobiologia 23, 112-119.

_____ 1984 A comparative seasonal population dynamics of a dominant collembolan species in pine forest and jhum soils of Meghalaya. Abstract, 3rd Orient. Entomol. Symp., Trivandrum. p. 105.

Darwin, C.R. 1840 On the formation of mould. Trans. Geol. Soc. London. 5, 505-509.

_____ 1881 The formation of vegetable mould through the action of worms, with observations on their habits. J. Murray, London. 326 pp.

David, H. 1965 Philoscia sacchari A new soil isopod damaging sugarcane buds in Tanjore District (Crustacea : Isopoda). J. Zool. Soc. India. 17, 120-122.

_____ 1978 Soil arthropod pests of sugarcane in Tamil Nadu and their control. In: Soil Biology and Ecology in India (C.A. Edwards & G.K. Veeresh, eds.), UAS Tech. Series No. 22, pp. 244-249.

Davis, B.N.K. 1963 A study of microarthropod communities in mineral soils near Corby, Northants. J. Anim. Ecol. 32, 49-71.

Davis, R.C., M. Hassall & S.L. Sutton 1977 The vertical distribution of isopods and diplopods in a dune grassland. Pedobiologia 17, 320-329.

_____ & S.L. Sutton 1977 Spatial distribution and niche separation of woodlice and millipedes in a dune grassland ecosystem. Proc. 6th Int. Congr. Soil Zool., Uppsala.

Davis, W.M. 1928 The effects of variation in relative humidity on certain species of Collembola. J. Exptl. Biol. 7, 79-88.

Deka, H.K. 1981 Studies on soil microbial population of jhum fallows of different ages. Unpublished Ph.D. Thesis, NEHU, Shillong, 226 pp.

Delamare-Debouteville, C.	1951	Microfauna du sol des pays temperes et tropicaux. Vie et Milieu, Suppl. 1, 360 pp.
Denevan, W.M.	1966	A cultural-ecological view of former aboriginal settlement in the Amazon Basin. Prof. Geogr. 18, 346-351.
————	1971	Campa subsistence in the Gran Pajonal, eastern Peru. Geogrl. Rev. 61,496-518.
Denlinger, D.L.	1980	Seasonal and annual variation of insect abundance in the Nairobi National Park, Kenya. Biotropica 12, 100-106.
Dennison, D.F. & I.D. Hodkinson	1984a	Structure of the predatory beetle community in a woodland soil ecosystem. III. Seasonal activity pattern as revealed by pitfall trapping. Pedobiologia 26, 45-56.
————	1984b	Structure of the predatory beetle community in a woodland soil ecosystem. IV. Population densities and community composition. Pedobiologia 26,. 157-170.
Dhillon, B.S.	1964a	Estimation of soil arthropod population. I. Development of sampling tool. Proc. All India Ent. Res. Workers' Conference and Plant Protection Seminar, ICAR, New Delhi.
————	1964b	Estimation of soil arthropod population. II. Extraction apparatus. Ibid.
———— & N.H.E. Gibson	1962	A study of the Acarina and Collembola of agricultural soils. I. Numbers and distribution in undisturbed grassland. Pedobiologia 1, 189-209.
Di Castri, L.F.	1963	Etat de nos connaissances sur les biocoenoses edaphiques du Chili. In: Soil Organisms (J. Doeksen & J. van der Drift, eds.). North-Holland Publishing Co., Amsterdam. pp. 375-385.
Diem, K.	1903	Untersuchungen uber die Bodenfauna in den Alpen. Jahrb. Naturwiss. Ges. St. Galen, 1901-2, 1-234.
Doeksen, J. & J. van der Drift	1963	Soil Organisms. Proceedings of the Colloquium on soil fauna, soil microflora and their relationships, Oosterbeek, Netherlands. North-Holland Publishing Co., Amsterdam. 453 pp.

Douce, G.K. & 1977 Acarina abundance and community structure of an arctic costal tundra. Pedobiologia 16, 32-42.

Dowdy, W.W. 1944 The influence of temperature on vertical migration of invertebrates inhabiting different soil types. Ecology 25, 449-460.

Drift, J. van der 1951 Analysis of the animal community in a beech forest floor. Tijdschr. Ent. 94, 1-168.

_____ 1963 A comparative study of the soil fauna in forests and cultivated land on sandy soils in Suriname. Studies on the fauna of Suriname and other Guyanas, Vol. VI. Vitg. Natuurw. Studkring. 32, 1-42.

_____ 1965 The effects of animal activity in the litter layer. In: Experimental Pedology (E.G. Hallsworth & D.V. Crawford, eds.), Butterworths, London. pp. 227-235.

Drummond, H. 1886 On termite as tropical analogue of the earthworm. Proc. R. Soc. Edinburg 13, 137-146.

Dutta, A.D. & T. Sen Gupta 1981 Seasonal activity and population density of ground dwelling beetles of Dooras area, West Bengal. In: Progress in Soil Biology and Ecology in India (G.K. Veeresh, ed.), UAS Tech. Series No. 37, pp. 178-180.

Eaton, T.H. & R.F. Chandler 1942 The fauna of forest humus layers in New York. Cornell Univ. Agr. Exptl. Stat. Mem. 247, 1-26.

Edwards, C.A.T. 1955 Soil sampling for symphylids and a note on populations. In: Soil Zoology (D.K. McE. Kevan, ed.), pp. 152-156.

_____ 1958 The ecology of Symphyla. I. Populations. Ent. Exp. Appl. 1, 308-319.

_____ 1959 The ecology of Symphyla. II. Seasonal soil migrations. Ent. Exp. Appl. 2, 257-267.

_____ 1961 The ecology of Symphyla. III. Factors controlling soil distributions. Ent. Exp. Appl. 4, 239-256.

Edwards, C.A. & J.R. Lofty 1969 The influence of agricultural practice on soil micro-arthropod populations. In: The Soil Ecosystem (J.G. Sheals, ed.), Systematics Association Publ., London. pp. 237-247.

_____ 1975 The influence of cultivations on soil animal populations. In: Progress in Soil Zoology (J. Vanek, ed.), Akademia, Prague. pp. 399-407.

_____ & G.K. Veeresh 1978 Soil Biology and Ecology in India. Proc. 1st All India Symp. Soil Biol. Ecol., UAS Tech. Series No. 22, Bangalore. 344 pp.

Ehrlich, P.R. & L.E. Gilbert 1973 Population structure and dynamics of the tropical butterfly Heliconius ethilla. Biotropica 5, 69-82.

Eitminaviciute, I. 1959 Migration of oribatids in the soil layers. Acta Parasitologia (Lithunica). 2, 111-117.

Elmes, G.W. 1978 Populations of Myrmica (Formicidae) living on different types of Calluna moorland — a semi natural habitat of southern England. Memorabilia Zool. 29, 41-60.

_____ & J.C. Wardlaw 1982 A population study of the ants Myrmica sabuleti and Myrmica scabrinodis, living at two sites in the south of England. I. A comparison of colony populations. J. Anim. Ecol. 51,651-664.

Engelman, M.D. 1961 The role of soil arthropods in the energetics of an old field community. Ecol. Monogr. 31, 221-238.

Enghoff, H. 1983 A survey of the distribution of centipedes in Denmark (Chilopoda). Entomol. Medd. 50, 1-6.

Evans, M.E.G. 1969 The surface activity of beetles in a northern English wood. Trans. Soc. Brit. Ent. 18, 247-262.

Evans, G.O., J.G. Sheals & D. MacFarlane 1961 The Terrestrial Acari of British Isles. Adland & Son, Dorking. 219 pp.

Evans, F.C. & W.W. Murdoch 1968 Taxonomic composition, trophic structure and seasonal occurrence in a grassland insect community. J. Anim. Ecol. 37, 259-273.

Ewing, H.E.	1910	New Acarina from India. Trans. Acad. Sci., St. Louis. 19, 113-121.
Farb, P.	1959	Living earth. Harper and Brothers, New York. 178 pp.
Fjellberg, A.	1975	Organization and dynamics of Collembola populations on Hardangervidda. Ecol. Stud. 17, 73-79.
Fletcher, T.B.	1917	Lists of crops and pests. Rept. Proc. 2nd Ent. Mtg., Pusa. p. 340.
————	1920	Annotated list of Indian crop pest. Rept. Proc. 3rd Ent. Mtg., Pusa. p. 1136.
FAO (Food and Agriculture Organization)	1957	Shifting cultivation. Trop. Agr. (Trinidad). 34, 159-164.
Ford, J.	1937	Fluctuations in natural populations of Collembola and Acarina. I. J. Anim. Ecol. 6, 98-111.
————	1938	Fluctuations in natural populations of Collembola and Acarina. II. J. Anim. Ecol. 7, 350-369.
Forsslund, K.H.	1943	Studien über die Tierwelt des Nordschwedischen Waldbodens. Medd. Stat. Skogförsöksanst. 34, 1-264.
————	1945	Sammanfattende översikt över vid markfauna — undersökningar i Västerbotten paträffode djurformer. Meddn. St. SkogsförsAnst. 34, 341-364.
Fourman, K.L.	1936	Kleintierwelt, Kleinklima, Mikroklima. Mitt. Forstwirtsch. u. Forstwiss. 7, 596-615.
————	1938	Untersuchungen über die Bedeutung der Bodenfauna bei der biologischen Umwandlung des Bestandesabfalles forstlicher Standorte. Ibid. 9, 144-169.
————	1939	Labensbedingungen und Verhaltensweisen der Bodenfauna forstlicher Standorte. Ibid. 10, 160-167.
Franz, H.	1950	Bodenzoologie als Grundlage der Bodenpflege. Akademie-Verlag, Berlin. 316 pp.

Franz, H. 1975 Die geschichte der bodenzoologie und ihre einbeziehung in die bodenkundliche forschung. In: Progress in Soil Zoology (J. Vanek, ed.), Proc. 5th Int. Coll. Soil Zool., Academia, Prague. pp. 13-23.

Freeman, J.D. 1955 Iban Agriculture : A report on the shifting cultivation of hill rice by the Iban of Sarawak. HMSO, London. 148 pp.

Frenzel, G. 1936 Untersuchungen über die Tierwelt des Wiesenbodens. G. Fischer, Jena. 130 pp.

Fujikawa, T. 1970a Relation between oribatid fauna and some environments of Nopporo National Forest in Hokkaido (Acarina : Cryptostigmata). II. Oribatid fauna in soils under four different vegetations. Appl. Ent. Zool. 5, 69-83.

———— 1970b Distribution of soil animals in three forests of northern Hokkaido. II. Horizontal and vertical distribution of oribatid mites (Acarina : Cryptostigmata). Appl. Ent. Zool.5,208-212.

———— 1974 Comparison among oribatid fauna from different microhabitats in forest floors. Appl. Ent. Zool. 9, 105-114.

Gabbutt, P.D. 1967 Quantitative sampling of the pseudoscorpion Chthonius ischnocheles from beech litter. J. Zool., London. 151, 469-478.

Gasdorf, E.C. & C.J. Goodnight 1963 Studies on the ecology of soil arachnids. Ecology 44, 261-268.

Geoffroy, J.-J. 1981 Etude d'un ecosysteme forestier mixte. V. Traito generaux du peuplement de Diplopodes edaphiques. Rev. Ecol. Biol. Sol. 18, 357-372.

Gilyarov, M.S. 1949 Osobenosti pochvy kak sredy obitaniya i ee znachenie v évolutzü nasekomykh. Akademiya Nauk SSSR, Moskva, Leningrad. 279 pp.

Ghilarov, M.S. 1968 Soil stratum of terrestrial biocenoses. Pedobiologia 8, 82-96.

———— 1979 Soil fauna of Brown soil in the Caucasus beech and fir mixed forests and some other communities. Pebobiologia 19, 408-424.

Ghilarov, M.S. & T.S. Perel 1971 Soil fauna in mixed coniferous deciduous broad-leaved forests of Southern Primorie (Soviet Far East). Pedobiologia 11, 240-261.

Ghaisas, P.S. & D.P. Ranade 1981 Record of Japyx solifugus (Diplura) from Poona. In: Progress in Soil Biology and Ecology in India (G.K. Veeresh, ed.), UAS Tech. Series No. 37, pp. 147-152.

Ghosh, A.K. 1981 Ecology of subterranean aphids (Homoptera : Insecta) in India. Ibid. pp. 223-228.

Gisin, H. 1948 Öekologie und Lebensgemeinschaften der Collembolen in Schweizerischen Excursionsgebiet Basels. Rev. suisse Zool. 50, 131-224.

Glasgow, J.P. 1939 A population study of subterranean soil Collembola. J. Anim. Ecol. 8, 323-353.

Goesswald, K. 1981 Bodenverbesserung durch Waldameisen und ihre Auswirkung (Soil improvement by forest ants and its effects). Waldhygiene 14, 85-106.

Graff, O. & J.E. Satchell (eds.) 1967 Progress in Soil Biology. Proc. 3rd Coll. Soil Zool., Braunschweig-Volkenrode, 1966. North-Holland Publishing Co., Amsterdam. 656 pp.

Greenslade, P.J.M. 1972 Distribution patterns of Priochirus species (Coleoptera : Staphylinidae) in the Solomon Islands. Evolution 26, 130-142.

_____ & P. Greenslade 1968 Soil and litter fauna densities in the Solomon Islands. Pedobiologia 7, 362-370.

Grimmett, R.E.R. 1926 Forest floor covering and its life. Trans. Proc. New Zealand Inst. 56, 423-440.

Gunnarsson, B. 1980 Distribution, abundance and population structure of Protura in two woodland soils in Southwestern Sweden. Pedobiologia 20, 254-262.

Gupta, C.S. 1963 Ecological studies on Camponotus compressus Fabr. (Formicidae : Hymenoptera). Agra Univ. J. Res. (Sci.). 12, 45-52.

Gupta, C.S. 1964 Studies on the ecology and population pattern of Oecophylla smaragdina Fabr. (Formicidae : Hymenoptera) during spring at Hardwar. Agra Univ. J. Res. (Sci.), 13, 59-66.

——— 1966 Effect of temperature on Oecophylla smaragdina Fabr. (Formicidae : Hymenoptera). Trop. Ecol. 7, 125-135.

——— 1968a Studies on the population structure of the nests of the Indian 'Red Ant' — Oecophylla smaragdina Fabr. (Formicidae : Hymenoptera). In: Proc. Symp. Recent Adv. Trop. Ecol., Intl. Soc. Trop. Ecol., Varanasi, India. pp. 187-198.

——— 1968b Studies on the effects of light, wind and moisture on Oecophylla smaragdina Fabr. Trop. Ecol. 9,131-139.

——— 1970 Ecological studies on the ant, Myrmemocystus setipes Forel. G.K.V.J. Sci. Res. 2, 134-148.

Gupta, S.K. 1981 Some soil prostigmatid mites (Acarina) from Bihar. In: Progress in Soil Biology and Ecology in India (G.K. Veeresh, ed.), UAS Tech. Series No. 37, pp. 93-99.

Gupta, G.P. & S.P. Mukharji 1976a Microarthropods in some cultivated soil at Varanasi. Indian J. Entomol. 38, 272-280.

——— 1976b Qualitative composition of the fauna of cultivated and uncultivated soil. Indian J. Entomol. 38, 313-324.

——— 1978 Population fluctuations of soil arthropods in uncultivated field. Indian J. Entomol. 40, 63-73.

Haarløv, N. 1955 Vertical distribution of mites and collembola in relation to soil structure. In: Soil Zoology (D.K. McE. Kevan, ed.), pp. 167-179.

——— 1960 Microarthropods from Danish soils. Ecology, Phenology. Oikos, suppl. 3, 1-176.

Hafeez-Kardar, M.A. 1972 A new species of Lohmannidae (Acarina : Oribatei) from India. Orient. Ins. 6, 61-64.

Hafeez-Kardar, M.A. 1974 Two new species of Tectocepheidae (Acari : Oribatei) from India. Orient. Ins. 8, 51-54.

Hagvar, S. 1982 Collembola in Norwegian coniferous forest soils. I. Relations to plant communities and soil fertility. Pedobiologia 24, 255-296.

Hale, W.G. 1963 The Collembola of eroding blanket bog. In: Soil Organisms (J. Doeksen & J. van der Drift, ed.). pp. 406-413.

_____ 1965a Observations on the breeding biology of Collembola. Pedobiologia 5, 146-152, 161-177.

_____ 1965b Post-embryonic development in some species of Collembola. Pedobiologia 5, 228-243.

_____ 1966 A population study of moorland Collembola. Pedobiologia 6, 65-99.

_____ 1967 Collembola. In: Soil Biology (A. Burges & F. Raw, eds.), Academic Press, London. pp. 363-395.

Hammer, M. 1953 Investigations of the microfauna of Northern Canada. II. Collembola. Acta Artica 6, 1-108.

_____ 1972 Microhabitats of oribatid mites on a Danish woodland floor. Pedobiologia 12, 412-423.

Haq, M.A. 1978 Some aspects of the taxonomy of oribatid mites from the soils of Kerala. In: Soil Biology and Ecology in India (C.A. Edwards & G.K. Veeresh, eds.), UAS Tech. Series No. 22, 117-134.pp.

_____, N.R. Prabhoo & Clement Adolph 1981 Distribution and abundance of soil fauna in two vegetationally different sites in Kerala. In: Progress in Soil Biology and Ecology in India (G.K. Veeresh, ed.), UAS Tech. Series No. 37, pp. 35.

Harding, D.J.L. 1967 Seasonal changes in the abundance of Cryptostigmata in the forest floor of an Oak woodland. In: Proceedings of 2nd International Congress of Acarology (G.O. Evans, ed.), Akademiai Kiado, Budapest. pp. 23-30.

Harris, D.R. 1971 The ecology of swidden cultivation in the Upper Orinoco rainforest, Venezuela. Geogrl. Rev. 61, 475-495.

Hartmann, F. 1951 Der Waldboden, Humus-, Boden- und Wurzeltypen als Standortsanzeiger. Österreiches Produktivatäts Zentrum, Wien. 151 pp.

Hattar, S.J.S. & J.R.B. Alfred 1984 A population dynamic study and community analysis of Collembola in pine forest soils of Meghalaya, N.E. India. Abstract, 3rd Orient. Entomol. Symp., Trivandrum. p. 104.

Hayes, A.J. 1965 Studies on the distribution of some Phthiracarid mites (Acari : Oribatidae) in a coniferous forest soil. Pedobiologia 5, 252-261.

Hazra, A.K. 1978 Ecology of Collembola in a deciduous forest floor of Birbhum District, West Bengal in relation to soil moisture. Orient. Insects. 12, 265-274.

_____ 1982 Soil and litter arthropod fauna of Silent Valley, Kerala : A preliminary report. J. Soil Biol. Ecol. 2, 73-77.

_____ & D.K. Choudhuri 1981 Studies on the distribution of collembolan in two different soil conditions (Gangetic alluvium and laterite soil) in relation to some major edaphic factors. In: Progress in Soil Biology and Ecology in India (G.K. Veeresh, ed.), UAS Tech. Series No. 37, pp. 131-142.

Hesse, P.R. 1955 A chemical and physical study of the soils of termite mounds in East Africa. J. Ecol. 43, 449-461.

Heyward, F. & A.N. Tissot 1936 Some changes in the soil fauna associated with forest fires in the longleaf pine region. Ecology 17,659-666.

Hill, S.B., L.J. Metz & M.H. Farrier 1975 Soil mesofauna and silvicultural practices. In: Forest Soils and Forest Land Management. Proc 4th N. American Forest Soils Conference (B. Bernier & C.H. Winget, eds.), Les Presses de L'Universite Laval, Quebec. pp.119-135.

Hole, F.D. 1981 Effects of animals on soil. Geoderma 25, 75-112.

Hope, J.G. 1943 An investigation of the litter fauna of two types of pine forest. Bull. Wagner Inst. Sci. Philad. 18, 1-7.

Horn, H.S. 1966 Measurement of overlap in comparative ecological studies. Amer. Naturalist 100, 419-424.

Hovemeyer, K. 1984 The dipterous community of a beech wood on limestone — Production of imagines, abundance and spatial distribution particularly of larvae. Pedobiologia 26, 1-16.

Huhta, V. 1971 Succession in the spider communities of the forest floor after clear-cutting and prescribed burning. Ann. Zool. Fenn. 8, 483-542.

_____ 1979 Evaluation of different smilarity indices as measures of succession in arthropod communities of forest floor after clear-cutting. Oecologia 41, 11-23.

_____, E. Karppinen, M. Nurminen & A. Valpas 1967 Effect of silvicultural practices upon arthropod, annelid and nematode populations in coniferous forest soil. Ann. Zool. Fenn. 4, 87-143.

_____, M. Nurminen & A. Valpas 1969 Further notes on the effect of silvicultural practices upon the fauna of coniferous forest soil. Ann. Zool. Fenn. 6, 327-334.

_____ & A. Koskenniemi 1975 Numbers, biomass and community respiration of soil invertebrates in spruce forests at two latitudes in Findland. Ann. Zool. Fenn. 12,164-182.

_____ & M. Mikkonen 1982 Population structure of Entomobryidae (Collembola) in a mature spruce stand and in clear cut reforested areas in Findland. Pedobiologia 24, 231-240.

Imms, A.D. 1912 On some Collembola from India, Burma and Ceylon. Proc. Zool. Soc. London. pp. 80-124.

Jaccard, P. 1902 Gesetze der Pflanzenverteilung in der alpinen region. Flora 90, 349-377.

Jacot, A.P. 1940 The fauna of soil. Q. Rev. Biol. 15, 28-58.

Jacot, A.P. 1933 Two-winged moss-mites of Nilgiri Hills. Rec. Ind. Mus., Calcutta. 35, 371-374.

Jahn, E. 1944 Bodentieruntersuchungen in den Flugsandböden des Marchfeldes. Habilitationsschr. Hochschule f. Bodenkult Wien.

Jaiyebo, E.O. & A.W. Moore 1964 Soil fertility and nutrient storage in different soil vegetation systems in a tropical rainforest environment. Trop. Agr. (Trinidad), 41, 129-159.

Joffe, J.S. 1936 Pedology. Rutgers University Press, New Brunswick, New Jersey. 575 pp.

Joosse, E.N.G. 1969 Population structure of some surface dwelling Collembola in a coniferous forest soil. Neth. J. Zool.19,621-634.

——————— 1970 The formation and biological significance of aggregation in the distribution of Collembola. Neth. J. Zool. 20, 299-314.

——————— 1971 Ecological aspects of aggregations in Collembola. Rev. Ecol. Biol. Sol. 8, 91-97.

——————— 1973 The effects of constant and fluctuating temperature on the production of spermatophores and eggs in populations of Orchesella cincta (Linne) (Collembola, Entomobryidae). Neth. J. Zool. 23, 488-502.

——————— 1975 Feeding activity and availability of food in Collembola. In: Progress in Soil Biology (J. Vanek, ed.), Proc. 5th Int. Coll., Prague, 1973, Academia, Prague. pp. 315-324.

——————— 1981 Ecological strategies and population regulation of Collembola in heterogeneous environments. Pedobiologia 21, 346-356.

——————— & G.J. Testerink 1977 The role of food in the population dynamics of Orchesella cincta (Linne) (Collembola). Oecologia 29, 189-204.

Joy, S. & T. Bhattacharya 1981 Cryptostigmatid population of the soil of a banana plantation in relation to some edaphic factors. In: Progress in Soil Biology and Ecology in India (G.K. Veeresh, ed.), UAS Tech. Series No. 37, pp. 100-106.

Kaczmarek, M.	1973	Collembola in the biotopes of the Kampinos National Park distinguished according to the natural succession. Pedobiologia 13, 257-273.
————	1975	An analysis of Collembola communities in different pine forest environments Ekol. Pol. 23, 265-293.
Karg, W.	1982	Investigation of habitat requirements geographical distribution and origin of predatory mite genera of the cohort Gamasina for use as bioindicators. Pedobiologia 24, 241-248.
Karppinen, E.	1955	Ecological and transect survey of Finnish camisiids (Acari : Oribatei). Annals Zoologici Societatis Zoologicae Botanicae Fennicae 17, 1-80.
Kemp, B.P.	1955	The termites of north eastern Tanganyika, their distribution and biology. Bull. Ent. Res., London. 46, 113-135.
Kevan, D.K. McE.(ed)	1955	Soil Zoology. Proceedings of the University of Nottingham Second Easter School in Agricultural Science. Butterworths Scientific Publications, London. 512 pp.
————	1962	Soil Animals. Philosophical Library, New York. 237 pp.
✓————	1965	The soil fauna — its nature and biology. In: Ecology of Soil-Borne Plant Pathogens — Prelude to Biological Control (K.F. Baker & W.C. Snyder, ed), pp. 33-51.
Kiffer, E. & J.P. Cancela da Fonseca	1971	Sur les rapports entre microarthropodes et micromycetes d'un sol forestier. Zent. Hyg. 126, 510-520.
Kilgore, B.M.	1972	Impact of prescribed burning on a Sequoia-mixed conifer forest. Proc. Ann. Tall Timbers Fire Ecol. Conf., Canada. pp. 345-375.
————	1973	The ecological role of fire in Sierran conifer forests : its application to National Park management. Quaternary Research. 3, 496-513.

Kilgore, B.M. 1976 From fire control to fire management: An ecological basis for policies. Trans. 41st N. Amer. Wildl. Nat. Resources Conf. pp. 477-493.

Kime, R.D. & G. Wauthy 1984 Aspects of relationships between millipedes, soil texture and temperature in deciduous forests. Pedobiologia 26, 387-402.

Kitazawa, Y. 1962 The ecological functions of soil animals in Japanese land areas (in Japanese). Pedologist 6, 37-41.

——————— 1971 Biological regionality of the soil fauna and its function in forest ecosystem types. In: Productivity of Forest Ecosystem. Proc. Brussels Symp. 1969 (Ecology and Conservation, 4), UNESCO. 485-498 pp.

Knight, C. 1961 The Tomocerinae in old field stands of North Carolina. Ecology 42,140-14[illegible].

Kohn, A. J. 1967 Environmental complexity and species diversity in the gastropod genus Conus in Indo West Pacific reef platforms. Am. Nat. 101, 251-259.

Kokhiya, M.S. 1983 An estimate of the role of diplopods of the transcaucasian terrace forests in biological turnover. Zool. Zh. 62, 1425-1428.

Koponen, S. 1975 Spider populations in a sub-alpine birch forest. In: Fennoscandian tundra ecosystems (F.E. Wielgolaski, ed.) 2, 66-72.

——————— 1977 Spider fauna (Araneae) of Kevo area, northernmost Findland. Rep. Kevo Subarctic Res. Stat. 13, 48-62.

Kubiëna, W.L. 1948 Entwicklungslehre des Bodens. Springer Verlag, Wien. 215 pp.

——————— 1955 Animal activity in soils as a decisive factor in establishment of humus forms. In: Soil Zoology (D.K. McE. Kevan, ed.), pp. 73-82.

Kuebelboeck, G. 1982 Comparacion de los arthropodos epigeos del bosque humedo tropical y de un cultivo migratorio en San Carlos de Rio Negro (Terr. Amazonas, Venezuela). Trop. Ecol. 23, 98-104.

Kühnelt, W.	1950	Bodenbiologie mit besonderer Berücksichtigung der Tierwelt. Herold, Vienna. 368 pp.
————	1961	Soil biology with special reference to the animal kingdom (English edition, translated by N. Walker), Faber, London. 397 pp.
————	1963	Soil-inhabiting arthropoda. Ann. Rev. Entomol. 8, 115-136.
Kurup, N.C. & N.R. Prabhoo	1984	Population dynamics of soil Collembola (Insecta) of an abandoned field in Kerala. Abstract, 3rd Orient. Entomol. Symp., Trivandrum, p. 64-65.
Lal, K.B.	1939	Ants of Delhi. Ind. J. Ent. 1, 107.
———— & R.N. Singh	1947	Seasonal history and field ecology of wolly aphids in Kumaon hills. Ind. J. Agric. Sci. 17, 211-218.
Lawrence, R.F.	1953	The biology of the cryptic fauna of forests with special reference to the indigenous forests of South Africa. A.A. Balkema, Cape Town and Amsterdam. 408 pp.
————	1964	The fauna of the forest soil. In: Ecological studies in South Africa (D.H. S. Davis, ed.), pp. 126-136.
Lebrun, Ph., H.M. Andre, A. De Medts, C. Gregoire-Wibo & G. Wauthy (eds.)	1983	New Trends in Soil Biology. Proc. 8th Int. Colloqu. Soil Zoology, 1982. Oltignies-Louvain-la-Neuve. 709 pp.
Lee, K.E. & T.G. Wood	1971	Termites and soil. Academic Press, London/New York. 251 pp.
Leinaas, H.P.	1974	Symphyla and Pauropoda from two coniferous forests in South Norway. Norsk ent. Tidsskr. 21, 161-166.
————	1976	Ecological investigations of Collembola in a spruce forest at Nordmoen, Romerike. Univ. Oslo, Unpubl. thesis. 149 pp. (In Norwegian).
————	1978	Seasonal variation in sampling efficiency of Collembola and Protura. Oikos 31, 307-312.

Leinaas, H.P. 1981 Activity of arthropoda in snow within a coniferous forest, with special reference to Collembola. Holarct. Ecol. 4, 127-138.

_____ 1983 Winter strategy of surface dwelling Collembola. Pedobiologia 25, 235-240.

Leuthold, W. & B.M. Leuthold 1975 Temporal patterns of reproduction in ungulates of Tsavo East National Park, Kenya. E. Afr. Wildl. J. 13, 159-169.

Lewis, T. 1969 The diversity of the insect fauna in a hedgerow and neighboring fields. J. Appl. Ecol. 6, 453-458.

Lewis, W.M., Jr. 1974 Effects of fire on nutrient movement in a South Carolina pine forest. Ecology 55, 1120-1127.

Lohm, U., H. Lundkvist, T. Persson & A. Wiren 1977 Effects of nitrogen fertilization on the abundance of enchytraeids and microarthropods in Scots pine forests. Studia Forestalia Suecia 140, 1-23.

Loots, G.S. & P.A.J. Ryke 1966 A comparative quantitative study of the microarthropods in different types of pasture soil. Zool. Afr. 2, 157-197.

Lussenhop, J. 1976 Soil arthropod response to prairie burning. Ecology 57, 88-98.

Luxton, M. 1972 Studies on the oribatid mites of a Danish beech wood soil. I. Nutritional biology. Pedobiologia 12,434-463.

_____ 1975 Studies on the oribatid mites of a Danish beech wood soil. II. Biomass, calorimetry and respirometry. Pedobiologia 15, 161-200.

_____ 1981a Studies on the oribatid mites of a Danish beech wood soil. III. Introduction to field populations. Pedobiologia 21, 301-311.

_____ 1981b Studies on the oribatid mites of a Danish beech wood soil. V. Vertical distributions. Pedobiologia 21, 365-386.

_____ 1981c Studies on the oribatid mites of a Danish beech wood soil. VI. Seasonal population changes. Pedobiologia 21, 387-409.

Luxton, M. 1981d Studies on the astigmatid mites of a Danish beech wood soil. Pedobiologia 22, 29-38.

_____ 1981e Studies on the prostigmatid mites of a Danish beech wood soil. Pedobiologia 22, 277-303.

_____ 1982 The biology of mites from beech woodland soil. Pedobiologia 23, 1-8.

MacArthur, R.H. 1972 Geographical ecology. Harper and Row, New York. 269 pp.

_____ & J.W. MacArthur 1961 On bird species diversity. Ecology 42, 594-598.

Macfadyen, A. 1952 The small arthropods of a Molinia fen at Cothill. J. Anim. Ecol. 21, 87-117.

_____ 1953 Notes on methods for the extraction of small soil arthropods. J. Anim. Ecol. 22, 65-77.

_____ 1954 The invertebrate fauna of Jan Mayen Island (East Greenland). J. Anim. Ecol. 23, 261-297.

_____ 1955 A comparison of methods for extracting soil arthropods. In: Soil Zoology (D.K. McE. Kevan, ed.), Butterworth, London. pp. 315-332.

_____ 1957 Animal Ecology : Aims and Methods. Pitman, London. 264 pp.

_____ 1961a Improved funnel type extractors for soil arthropods. J. Anim. Ecol. 30, 171-184.

_____ 1961b Metabolism of soil invertebrates in relation to soil fertility. Ann. Apl. Biol. 49, 215-218.

_____ 1963a Animal Ecology : Aims and Methods. 2nd edn., Pitman, London. 344 pp.

_____ 1963b The contribution of microfauna to total soil metabolism. In: Soil Organisms (J. Doeksen & J. van der Drift, eds.), North-Holland Publishing Co., Amsterdam. pp. 3-17.

Macfadyen, A. 1964 Relations between mites and microorganisms and their significance in soil biology. Acarologia 6, 142-149.

_____ 1969 The systematic study of soil ecosystem. In: The Soil Ecosystem : A Symposium (J.G. Sheals, ed.), Systematics Assoc. Publ. 8, 191-197.

MacLagan, D.S. 1932 An ecological study of the "Lucerne Flea" (Smynthurus viridis Linn.). Bull. Ent. Res. 23, 101-145, 151-190

Madge, D.S. 1964 The humidity reactions of oribatid mites. Acarologia 6, 566-591.

_____ 1965 The effects of lethal temperatures on oribatid mites. Acarologia 7, 121-130.

Mahajan, S.P. & J. Singh 1981 Seasonal variations of collembolan populations in arable soil. In: Progress in Soil Biology and Ecology in India (G.K. Veeresh, ed.), UAS Tech. Series No. 37, p. 125.

Majer, J.D. 1984 Short-term responses of soil and litter invertebrates to a cool autumn burn in Jarrah (Eucalyptus marginata) forest in Western Australia. Pedobiologia 26, 229-247.

Maldague, M.E. 1959 Analysis de sols et materiaux de termitiers du Congo Belgie. Insects Soc. 6, 343-359.

_____ & F. Hilger 1963 Observations faunistiques et microbiologiques dans quelques biotopes forestiers equatoriaux. In: Soil Organisms (J. Doeksen & J. van der Drift, eds.), North-Holland Publishing Co., Amsterdam. pp. 368-374.

Mani, M.S. 1974 Biogeography of the Himalaya. In: Ecology and Biogeography in India (M.S. Mani, ed.), Junk, The Hague, pp. 648-663.

Manshard, W. 1974 Tropical Agriculture : A Geographical Introduction and Appraisal. Longman, London.

Marcuzzi, G. 1962 Contributions to the knowledge of soil fauna of South-Eastern Alps. Int. Congr. Entomol., Wien, Verhandl. 3, 154-158.

Marcuzzi, G. 1966 Preliminary quantitative observations on the soil fauna near Padova (Italy). Pedobiologia 6, 219-255.

_____ 1973 Ecological considerations on the Collembola fauna of South-Eastern Alps and prealps. Rev. Ecol. Biol. Sol. 10, 327-340.

Margalef, R. 1968 Perspective in ecological theory. Univ. Chicago Press, Chicago.

Mari Mutt, J.A. & R.K. Bhattacharjee 1980 Four new species of Dicranocentrus from North-East India and Nepal (Collembola : Entomobryidae : Orchesellinae). Pacific Insects 22, 162-170.

Marshall, V.G. 1968 Microarthropods from two Quebec woodland humus forms. III. The Sarcoptiformes (Acarina). Ann. Ent. Soc. Quebec. 13, 65-88.

Mathur, R.M. & B. Singh 1959 A list of insect pests of forest plants in India and adjacent countries. Ind. For. Bull. (Ent.). No.171.

McColl, H.P. 1974 The arthropods of the floors of six forest types on the West Coast, South Island : A Preliminary Report. Proc. N.Z. Ecol. Soc. 21, 11-16.

Mertens, J. & J.P. Blancquaert 1980 Population dynamics of Orchesella cincta (Collembola) in experimental conditions. Pedobiologia 20, 301-308.

_____, R. Coessens & J.P. Blancquaert 1982 Population structure of Orchesella cincta (Collembola) in the field based on instar determination. Pedobiologia 23, 9-20.

Merrett, P. 1976 Changes in the ground-living spider fauna after heathland fires in Dorset. Bull. Br. Arachnid. Soc. 3, 214-221.

Metz, L.J. 1971 Vertical movement of Acarina under moisture gradients. Pedobiologia 11, 262-268.

_____ & M.H. Farrier 1971a Prescribed burning and populations of soil mesofauna. Environ. Entomol. 2, 433-440.

_____ 1971b Prescribed burning and soil mesofauna on the Santee Esperimental Forest. U. S. Forest Serv., Southeast. Forest Exp. Sta., Prescribed Burning Symp. pp. 100-105.

Michelbacher, A.E.	1949	The ecology of Symphyla. Pan- Pacif. Ent. 25, 1-11.
Milne, S.	1962	Phenology of a natural population of soil Collembola. Pedobiologia 2, 41-52.
Mishra, B.K. & P.S. Ramakrishnan	1981	The economic yield and energy efficiency of hill agro-ecosystems at higher elevations of Meghalaya in Northeastern India. Oecol. Applic. 2, 369-389.
————	1983a	Slash and burn agriculture at higher elevations in north-eastern India. I. Sediment, water and nutrient losses. Agric. Ecosys. Environ. 9,69-82.
————	1983b	Slash and burn agriculture at higher elevations in north-eastern India. II. Soil fertility changes. Ibid. 9, 83-118.
Misra, R.	1972	Ecology work book. Oxford and IBH Publishing Co.
Mitchell, M.J.	1977	Population dynamics of oribatid mites (Acari : Cryptostigmata) in an aspen woodland soil. Pedobiologia 17, 305-319.
————	1978	Vertical and horizontal distributions of oribatid mites (Acari : Cryptostigmata) in an aspen woodland soil. Ecology 59, 516-525.
————	1979	Effects of physical parameters and food resources on oribatid mites in forest soil. In: Recent Advances in Acarology (J.G. Rodriguez, ed.), Academic Press, London. pp. 585-592.
———— & D. Parkinson	1976	Fungal feeding of oribatid mites (Acari : Cryptostigmata) in an aspen woodland soil. Ecology 57, 302-312.
Mitra, S.K.	1973	A revision of Salina MacGillivray 1894 (Collembola : Entomobryidae) from India. Orient. Ins. 7, 159-202.
————	1976a	A new genus and species of termitophilous Collembola (Entomobryidae : Cyphoderinae) from India. Rev. Ecol. Biol. Sol. 13, 645-652.

Mitra, S.K. 1976b Some Collembola from Arunachal Pradesh (Entomobryidae). Orient. Ins. 10, 143-149.

_____ 1982 On the humped-back genus of Collembola from India (Collembola : Entomobryidae). Abstract, 5th Int. Colloq. Apterygota, Cath. Univ. Louvain, p.4[illegible].

_____ & D.K. Choudhuri 1973 A new Paronelline genus of Indian springtail (Collembola : Entomobryidae) with the descriptions of 3 new species. Rev. Ecol. Biol. Sol. 10, 359-377.

_____, A.K. Hazra & A.K. Sanyal 1978 Distribution of Collembola in accordance with different vegetation at Eden Gardens, Calcutta. In: Soil Biology and Ecology in India.(C.A. Edwards & G.K. Veeresh, eds.), UAS Tech. Series No. 22, pp. 152-156.

_____, A.K. Hazra, A.K. Sanyal & S.B. Mandal 1981 Changes in the population structure of Collembola and Acarina in a grassland ecosystem in Calcutta. In: Progress in Soil Biology and Ecology in India (G.K. Veeresh, ed.), UAS Tech. Series No. 37, pp. 143-146.

Mohanasundaram, M. 1982 Indian eriophyid studies III. Acarologia 3, 249-263.

Mollon, A. 1982 Etude d'un ecosysteme forestier mixte. VII. Composition et phenologie du pleuplement des Dipteres a larves edaphiques. (Investigations in a mixed forest ecosystem. VII. Composition and phenology of the edaphic Diptera community). Rev. Ecol. Biol. Sol. 19, 289-306.

Montagnini, F. & C.F. Jordan 1983 The role of insects in the productivity decline of cassava (Manihot esculenta) on a slash and burn site in the Amazon Territory of Venezuela. Agric. Ecosys. Environ. 9, 293-302.

Moore, F.R. 1982 Ecology of the Pauropoda from a coal shale heap in Lancashire, England. Pedobiologia 24, 309-317.

Morisita, M. 1959 Measuring of interspecific assoqiation and similarity between communities. Mem. Fac. Sci. Kyushu Univ. Ser E. 3, 65-80.

Mukharji, S.P. & J. Singh 1967 Some aspects of the study of soil arthropods in the wheat field and floral garden. J. Scientific Research, B.H.U. 2, 177-185.

_____ 1970 Seasonal variations in the densities of a soil arthropod population in a rose garden at Varanasi (India). Pedobiologia 10, 442-446.

Mukherjee, P. & S. Roy 1981 Collembolan community in two contrasting environments of West Bengal. In: Progress in Soil Biology and Ecology in India (G.K. Veeresh, ed.), UAS Tech. Series No. 37, pp. 126-130.

Mukhopadhyaya, M.C. & S.K. Saha 1981 Observations on the natural population and sexual behaviour of Orthomorpha coarctata (Polydesmida, Paradoxosomatidae), a millipede of decaying wood and litter. Pedobiologia 21, 351-358.

Muller, P.E. 1879 Studier over Skovjord, som bidrag til skovdyrkingens theori. I. Om bogemuld og bogemor paa sand og ler. Tidsskr. Skovbr. 3, 1-124.

_____ 1884 Iden. II. Om muld og mor i egeskove og paa heder. Tidsskr. Skovbr. 7, 1-232.

Murdoch, W.W., F.C. Evans & C.H. Peterson 1972 Diversity and pattern in plants and insects. Ecology 53, 819-829.

Murphy, P.W. 1953 The biology of forest soils with special reference to the mesofauna or meiofauna. J. Soil Sci. 4, 155-193.

_____ 1955 Long-term changes in collembolan populations with special reference to moorland soils. In: Soil Zoology (D.K. McE. Kevan, ed.), pp. 157-166.

_____ (ed.) 1962 Progress in Soil Zoology. Butterworths Scientific Publications, London. 398 pp.

Nabialczyk-Karg, J. 1980 Density and bionass of soil inhabiting insect larvae in a rape field and in a meadow. Pol. Ecol. Stud. 6, 305-316.

Nadvornyj, V.G. 1983 Vertical migrations and life activity of the soil mesofauna in the central part of the Ukrainian forest steppe. Pedobiologia 25, 49-64.

Naglitsch, F. 1966 Uber Veranderungen der Zusammensetzung der Mesofauna wahrend der Rotte organischer Substanzen im Boden. Pedobiologia 6, 178-194.

Nef, L. 1962 The distribution of Acarina in the soil. In: Progress in Soil Zoology (P.W. Murphy, ed.), pp. 56-58.

Niijima, K. 1966a Collembola of the subalpine coniferous forest of Kita-Yatsugatake volcano (in Japanese with English résume). Kontyu 34, 244-247.

———— 1966b Diversity and frequency of Collembola found in three different vegetations of the alpine region of Mt. Tateyama, Central Japan (in Japanese with English résume). Kontyu 34, 339-346.

———— 1971 Seasonal changes in collembolan populations in a warm temperate forest of Japan. Pedobiologia 11, 11-26.

———— 1975 Seasonal changes in collembolan populations in a warm temperate forest of Japan. II. Population dynamics of the dominant species. Pedobiologia 15, 40-52.

Nosek, J. 1957 Poznamky k ekologii pudny fauny s hlediska biologie fudy. Slovenskej Akademie Vied v Bratislava. 154 pp.

———— 1975 Niche of Protura in biogeocoenoses. Pedobiologia 15, 290-298.

———— 1977 Proturan synusies and niche separation in the soil. Soil Organisms as Component of Ecosystems. Ecol. Bull. 25, 138-142.

———— 1982 The importance of Protura as indicators. Pedobiologia 24, 249-253.

Nye, P.H. 1955 Some soil forming process in the humid tropics. IV. The action of the soil fauna. J. Soil. Sci. 6, 73-83.

Nye, P.H. & D.J. Greenland	1960	The soil under shifting cultivation. Tech. Commun. 51. Commonwealth Bureau of Soils, Harpenden. 156 pp.
Odum, E.P.	1971	Shifting cultivation in Latin America. FAO, Rome.
Ogino, K., P. Saichuae & G. Imadate	1965	Seasonal changes of soil microarthropod populations in Central Thailand. Nature and Life in South East Asia. 4, 303-315.
Owen, D.F. & D.O. Chanter	1970	Species diversity and seasonal abundance in Charaxes butterflies (Nymphalidae). J. Ent. 46, 135-143.
Paclt, J.	1956	Bionomie und okologie, biologie der primar. Hugellosen Insekten.pp.91-117.
Pakem, B., J.B. Bhattacharjee, B.B. Dutta & B. Datta Ray (eds.)	1976	Shifting cultivation in North East India. North East India Council of Social Sciences and Research, Shillong. 116 pp.
Pai, C.G.A. & N.R. Prabhoo	1981	Preliminary observations on the microarthropod fauna of paddy fields and adjoining uncultivated soils in South Kerala. In: Progress in Soil Biology and Ecology in India (G.K. Veeresh, ed.), UAS Tech. Series No. 37, pp. 27-32.
Panda, S. & B.C. Guru	1984	Seasonal variation in numbers of Collembola (Apterygota : Insecta) in cultivated and uncultivated fields of Bhuvaneswar, Orissa, India. Abstract, 3rd Orient. Entomol. Symp., Trivandrum, p. 30.
Pande, Y.D. & P. Berthet	1975	Observations on the vertical distribution of soil oribatei in a woodland soil. Trans. R. ent. Soc., London. 127, 259-275.
Paul, D. & J.R.B. Alfred	1984	A comparative study of soil microarthropods in three disturbed ecosystems of Meghalaya, North-East India. Abstract, 3rd Orient. Entomol. Symp., Trivandrum, p. 50.
Pearce, N.D.F.	1906	On some oribatidae from Sikkim Himalaya. J. Roy. Micr. Soc., 1906, 269-273.

Pearse, A.S. 1943 Effects of burning and raking off litter on certain soil animals in the Duke forest. Am. Midl. Nat.29,406-424

_____ 1946 Observations on the microfauna of the Duke forest. Ecol. Monogr.16,127-150.

Peck, S.B. & A. Forsyth 1982 Composition, structure and competitive behaviour in a guild of Ecuadorian rain forest dung beetle (Coleoptera : Scarabaeidae). Can. J. Zool. 60, 1624-1634.

Pelzer, K.J. 1957 Agriculture in humid tropics. Proc. 9th Pacific Sci. Congr., Bangkok. 20, 124-143.

Petal, J. 1980 Ant populations, their regulation and effect on soil in meadows. Ekol. Pol 28, 297-326.

Pfetten, J. v. 1925 Beiträge zur Kenntnis der Fauna der Waldstreu (Fichtenuntersuchungen). Z. angew. Ent. 11, 35-54.

Phillipson, J. (ed.)1970 Methods of study in soil ecology. UNESCO, Paris. 303 pp.

_____ (ed.)1971 Methods of study in quantitative soil ecology : population, production and energy flow. IBP Handbook No. 18, Blackwell Scientific Publications, Oxford. 297 pp.

_____ & E. Meyer 1984 Diplopod numbers and distribution in a British beechwood. Pedobiologia 26, 83-94.

Pianka, E.R. 1967 On lizard species diversity : North American flatland deserts. Ecology 48, 333-351.

_____ 1974 Evolutionary Ecology. Harper and Row, New York. 356 pp.

Pielou, E.C. 1966 The measurement of diversity in different types of biological collections. J. Theoret. Biol. 13, 131-144.

Pillai, S.K. 1922 Beiträge zur Kenntnis der Fauna der Waldstreu (Kiefernstreu). Z. angew. Ent. 8, 1-30.

Pimental, D. & A.G. Wheeler, Jr. 1973 Species and diversity of arthropods in the alfalfa community. Environ. Entomol. 2, 659-668.

Plowman, K.P. 1979 Litter and soil fauna of two Australian sub-tropical forests. Australian J. Ecol., 4, 87-104.

_____ 1981a Comparison of invertebrate ground fauna of three habitats at Cooloola, Queensland. Proc. R. Soc., Queensland. 92, 43-47.

_____ 1981b Inter-relation etween environmental factors and Cryptostigmata and mesostigmata (Acari) in the litter and soil of two Australian sub-tropical forests. J. Anim. Ecol. 50, 533-542.

_____ 1981c Distribution of Cryptostigmata and Mesostigmata (Acari) within the litter and soil layers of two sub-tropical forests. Aust. J. Ecol. 6, 365-374.

Pocock, R.I. 1892 Report upon two collections of Myriapoda sent from Ceylon by Mr. Green and from various parts of Southern India by Mr. Edgar Thurston, of the Government Central Museum, Madras. J. Bombay Nat. Hist. Soc. 7, 131-174.

Poinsot, N. 1966 Etude ecologique des Collemboles des dunes de Bayne. Rev. Ecol. Biol. Sol. 3, 483-493.

Pomeroy, D.E. 1977 Biological studies on a peaty podzol. III. Numbers of soil-living Collembola. Pedobiologia 17, 115-134.

Poole, T.B. 1961 An ecological study of the Collembola in a coniferous forest soil. Pedobiologia 1, 113-137.

_____ 1963 The effect of some environmental factors on the pattern of distribution of soil Collembola in a coniferous woodland. Pedobiologia 2, 169-182.

Popp, E. 1970 Communities of moss mites (Oribatei) in a gradient area. Oikos 21, 236-240.

Poursin, J. M. & J.F. Ponge 1984 Study of microarthropod populations in three acid forests humus localities in Foret-D-Orleans (Loiret, France). Pedobiologia 26, 403-414.

Prabhoo, N.R. 1971a Soil and litter Collembola of South India. I. Arthropleona. Orient. Ins. 5, 1-46.

_____ 1971b Soil and litter Collembola of South India. II. Symphypleona. Orient. Ins. 5, 243-262.

_____ 1972 South Indian Protura. I. Two new species and three new records of Acerentomoidae. Rev. Ecol. Biol. Sol. 9, 711-718.

_____ 1976 Soil microarthropods of a virgin forest and adjoining teafields in the Western Ghat : A brief ecological study. Orient. Ins. 10, 435-442.

_____ & V. Muraleedharan 1980 A new species of Tomocerus (Tomoceridae : Collembola) from India. Entomon 5, 207-210.

Pramanik, M.M. & D.N. Raychaudhuri 1978 A new polyaspid mite (Acarina : Mesostigmata) from West Bengal, India. In: Soil Biology and Ecology in India (C.A. Edwards & G.K. Veeresh, ed.), UAS Tech. Series No. 22, pp. 143-145.

Prasad, V. 1965 Soil mites of Sabour (Bhagalpur). Sci. Cult. 31, 495-496.

_____ 1974 A catalogue of mites of India. Indira Acarology Publishing House, Ludhiana, India. 320 pp.

Price, D.W. 1973 Abundance and vertical distribution of microarthropods in the surface layers of a California pine forest soil. Hilgardia 42, 121-148.

_____ 1975 Vertical distribution of small arthropods in a California pine forest soil. Ann. Ent. Soc. America. 68, 174-180.

_____ & G.S. Benham, Jr. 1976 Vertical distribution of pomerantziid mites (Acarina : Pomerantziidae). Proc. Entomol. Soc., Washington. 78, 309-313.

_____ 1977 Vertical distribution of soil inhabiting microarthropods in an agricultural habitat in California. Env. Ent. 6, 575-580.

Pullan, R.A. 1975 Burning impact on African savannas. Geogrl. Mag. 47, 432-438.

Raina, M.K., P. Kachroo, S. Dhar & J. Singh 1981 An ecological study of soil mesofauna from soil and litter of evergreen forest and grasslands in Yusmarg of Kashmir, Himalayas. In: Progress in Soil Biology and Ecology in India (G.K. Veeresh, ed.), UAS Tech. Series No. 37, p. 33 (Abstract).

Rangaswamy, H.R. & G.P. Channa Basavanna 1969 A contribution to the knowledge of millipedes (Diplopoda: Arthropoda) of Mysore State. Mysore J. Agric. Sci. 3, 7-12.

_____, R. Govindan & B.N. Viswanath 1978a A contribution to the knowledge of millipedes (Diplopoda : Arthropoda) of Karnataka State II. In: Soil Biology and Ecology in India (C.A. Edwards & G.K. Veeresh, eds.), UAS Tech. Series No. 22, pp. 94-97.

_____ 1978b Progress of Research on Diplopoda in Karnataka. In: Soil Biology and Ecology in India (C.A. Edwards & G.K. Veeresh, eds.), UAS Tech. Series No. 22, pp. 98-105.

Ramakrishnan, P.S. & O.P. Toky 1978 Preliminary observations on the impact of jhum (shifting agriculture) on the forested ecosystem. Resources, Development and Environment in the Himalayan Region, DST, Govt. of India. pp. 343-354.

_____ 1981 Soil nutrient status of hill agro-ecosystems and recovery pattern after slash and burn agriculture (jhum) in North-Eastern India. Plant and Soil 60, 41-64.

_____, O.P. Toky, B.K. Mishra, & K.G. Saxena 1978 Slash and burn agriculture in North-Eastern India. In: Fire Regimes and Ecosystem Properties (H. Mooney, J.M. Bonnicksen, N.L. Christensen, J.E. Lotan & W.A. Reiners, eds.), USDA Forest Service General Technical Report, Washington D.C. pp. 570-586.

Ramann, E. 1911 Regenwurmer und Kleintiere im deutschen Waldboden. Int. Mitt. f. Bodenk. 1, 138-164.

Rapoport, E.H. & J. Najt — 1966 — Ecologia de los microarthropods en suelos Gley and Solonchak de Bahia Blanca, Argentina. Monografias, Progress en Biologia del Suelo, Actas Del Primer Coloquio Latin Americano de Biologia del Suelo. pp. 521-614.

Rappaport, R.A. — 1971 — The flow of energy in an agricultural society. Sci. Am. 224, 116-132.

Raw, F. — 1956 — The abundance and distribution of Protura in grassland. J.Anim. Ecol. 25, 15-21.

——— — 1967 — Arthropoda (Except Acari and Collembola). In: Soil Biology (A. Burges & F. Raw, eds.), Academic Press, London. pp. 323-362.

Reddy, M.V. & J.R.B. Alfred — 1977 — Seasonal fluctuations of soil arthropod population in a pine forest ecosystem of North-East India. Proc. All India Symp. Environ. Biol. p. 13.

——— — 1978a — Microarthropods associated in the decomposition process of pine litter of Meghalaya pine (Pinus kesiya Royle) forests. In: Soil Biology and Ecology in India (C.A. Edwards & G.K. Veeresh, eds.), UAS Tech. Series No. 22, pp. 31-35.

——— — 1978b — Some observations on the earthworm population and the biomass in a sub-tropical pine forest. Ibid. pp. 78-82.

Reddy, M.V. — 1980 — Ecosystem structure of a pine forest in North-East India with particular reference to consumer and decomposer arthropods. Unpubl. Ph.D. thesis, NEHU, Shillong. 247 pp.

——— — 1981 — Microarthropods and the rate of litter disappearance in a pine plantation ecosystem of North-East India. Pedobiologia 22, 339-344.

——— & B.A. Ao — 1984 — Seasonal relative abundance of Formicidae on the floor of mixed deciduous forest ecosystem. 3rd Oriental Entomology Symposium, Trivandrum, Abstract. p. 124.

Reddy, D.N.R., B.N. Viswanath & V.V. Belvadi	1981	A preliminary study on the ant fauna of Bisthenhatti. In: Progress in Soil Biology and Ecology in India (G.K. Veeresh, ed.), UAS Tech. Series. No. 37, pp. 200-205.
Reeves, R.M.	1969	Seasonal distribution of some forest soil oribatei. In: Proc. 2nd Int. Cong. Acarology (G.O. Evans, ed.), Akademiai Kiado, Budapest. pp. 23-30.
Ressl, F. & M. Beier	1958	Zur okologie, biologie und phenologie der heimischen Pseudoskorpione. Zool. Jb. (Syst.). 86, 1-26.
Robinson, J.B.D.	1958	Some chemical characteristics of "Termite soils" in Kenya coffee fields. J. Soil Sci. 9, 58-65.
Robinson, J.V.	1981	The effect of architectural variation in habitat on a spider community : an experimental field study. Ecology 62, 73-80.
Roesgaard, H. & K. Lindhardt	1979	The effect of straw burning on predaceous arthropods of the soil surface. Danish J. Plant Soil Sci. 83,305-323.
Roonwal, M.L.	1958	Recent work on termite research in India (1947-57). Trans. Bose Res. Inst. Calcutta. 22, 77-100.
———	1981	Termites of agricultural importance in India and their control. In: Progress in Soil Biology and Ecology in India (G.K. Veeresh, ed.), UAS Tech. Series. No. 37, pp. 253-264.
Root, R.B.	1973	Organisation of a plant-arthropod association in simple and diverse habitats : the fauna of collards (Brassica oleracea). Ecol. Monogr. 43, 95-124.
Rothney, G.A.J.	1890	Notes on Indian ants. Trans. Ent. Soc. London. pp. 347-374.
Rowe, J.S.	1970	Spruce and fire in northwest Canada and Alaska. Proc. Ann. Tall Timbers Fire Ecol. Conf., Canada. pp. 245-254.
Roy, S. & J.P. Banerjee	1984	Comparative study of the collembolan community in undisturbed grassland and forest soils of Burdwan. Abstract, 3rd Orient. Ent. Symp., Trivandrum. p. 46-47.

Rice, L.A. 1932 The effect of fire on prairie animal communities. Ecology 13, 392-401.

Riha, G. 1951 Zur ökologie der oribatiden in Kalksteinböden. Zool. Jb. 80, 407-450.

Risch, S.J. & C.R. Carroll 1982 The ecological role of ants in two Mexican agroecosystems. Oecologia 55, 114-119.

Rishi, N.D. 1981 Distribution and abundance of arthropod soil fauna in various ecosystems of the Kashmir Valley. In: Progress in Soil Biology and Ecology in India (G.K. Veeresh, ed.), UAS Tech. Series No. 37, p. 34 (Abstract).

Saito, S. 1967 Productivity of high and low density populations of Japonaria laminata armigera (Diplopoda) in a warm temperate forest ecosystem. Res. Popul. Ecol. 9, 153-166.

Salt, G. 1952 The arthropod population of the soil in some East African pastures. Bull. Ent. Res. 43, 203-220.

——— 1955 The arthropod population of soil under elephant grass in Uganda. Bull Ent. Res. 46, 539-545.

——— , F.S.J. Hollick, F. Raw & M.V. Brian 1948 The arthropod population of pasture soil. J. Anim. Ecol. 17, 139-150.

Salmon, J.T. 1949 New methods in microscopy for the study of small insects and arthropods. Roy. Soc. N.Z. Sci. Congr. pp. 250-253.

Sanchez, P.A. 1973 Soil management under shifting cultivation. Review of Soils Research in Tropical Latin America, North Carolina Exp. Sta. Tech. Bull. 219, 46-67.

——— 1976 Soil management in shifting cultivation areas. In: Properties and Management of Soils in the Tropics, John Wiley and Sons. pp. 346-413.

Sanyal, A.K. 1981 Ecology of soil aribatid mites in an uncultivated field at Gangetic delta of West Bengal. In: Progress in Soil Biology and Ecology in India (G.K. Veeresh, ed.), UAS Tech. Series No, 37, pp. 107-112.

Sanyal, A.K. & A.K. Bhaduri 1982 Seasonal changes in the density of soil oribatid mites in relation to temperature and water content of soil at Sagar Island, 24-Parganas, West Bengal. Proc. Symp. Ecol. Anim. Popul. Zoological Survey of India. Part 3, 119-126.

_____ & B.J. Sarkar 1984 Ecology of soil oribatid mites in three contrasting sites at Botanical Garden, Howrah, West Bengal. Abstract, 3rd Orient. Entomol. Symp., Trivandrum. p. 45-46.

Sarkar, S. 1984a Soil arthropod community from a natural site in Tripura. Abstract, 3rd. Orient. Entomol. Symp., Trivandrum. p. 31.

_____ 1984b Systematic account of oribatid mites of Tripura. Abstract, Ibid. p. 17.

Sauer, C.O. 1967 Land and Life. Univ. California Press., Berkeley and Los Angeles.

Schaller, F. 1949 Zur okologie der Collembolen in Kalsteinboden (nebst einigen Bemerkungen uber Proturen). Zool. Jb. (Syst.). 78, 263-293.

Schlippe, P.D. 1956 Shifting cultivation in Africa : the Zande System of Agriculture. Routledge and Kegan Paul, London.

Scott, G.A.J. 1974 Effects of shifting cultivation in the Gran Pajonal, eastern Peru. Proc. Assoc. Amer. Geog. 6, 58-61.

_____ 1977 The role of fire in the creation and maintenance of savana in the Montana of Peru. J. Biogeography. 4, 143-167.

Scriber, J.M. 1973 Latitudinal gradients in larval feeding specialization of the world papilionidae (Lepidoptera). Psyche 80, 355-373.

Schuster, R. 1956 Der Anteil der Oribatiden an den Zersetzungsvorgangen im Boden. Z. Morph. Oekol. Tiere 45, 1-33.

Seastedt, T.R. & D.A. Crossley, Jr. 1984 The influence of arthropods on ecosystems. Bioscience 34, 157-161.

Sen-Sarma, P.K.	1981	Recent advances in termite research in India and future strategy. In: Progress in Soil Biology and Ecology in India (G.K. Veeresh, ed.), UAS Tech. Series No. 37, pp. 236-253.
Shannon, C.E. & W. Weaver	1949	The Mathematical Theory of Communication. Univ. Illinois Press, Urbana.
Sharma, G.D. & D.K. McE. Kevan	1963a	Observations on Isotoma notabilis (Collembola : Isotomidae) in eastern Canada. Pedobiologia 3, 34-47.
———	1963b	Observations on Folsomia similis (Collembola : Isotomidae) in eastern Canada. Pedobiologia 3, 48-61.
———	1963c	Observations on Pseudosinella petterseni and Pseudosinella alba (Collembola : Entomobryidae) in eastern Canada. Pedobiologia 3, 62-74.
Sharma, T.C.	1976	The prehistoric background of shifting cultivation. In: Shifting Cultivation in North-East India (B. Pakem et al., eds.), NEICSSR, Shillong. pp. 1-4.
Sheals, J.G.	1957	The Collembola and Acarina of uncultivated soil. J. Anim. Ecol. 26, 125-134.
Shrikande, J.C. & A.N. Pathak	1948	Earthworms and insects in relation to soil fertility. Curr. Sci. 17, 327-328.
Siddappaji, C. & G.P. Channa Basavanna	1978	Myllocerus as soil dwellers. In: Soil Biology and Ecology in India (C.A. Edwards & G.K. Veeresh, eds.), UAS Tech. Series No. 22, pp. 249-254.
Silvestri, F.	1916	Four new species of Aulacobolus Poc. (Diplopoda : Spirobolidae) from India. Rec. Indian Mus. 12, 41-48.
Simpson, E.H.	1949	Measurement of diversity. Nature 163, p. 688.
Singh, J.	1978	Soil fauna studies in India. In: Soil Biology and Ecology in India (C.A. Edwards & G.K. Veeresh, eds.), UAS Tech. Series No. 22, pp. 226-235.
——— & S.P. Mukharji	1971	Qualitative composition of soil microarthropods in some fields at Varanasi (India). Orient. Ins. 5, 487-494.
———	1973	Population size of soil arthropods in some fields at Varanasi (India). Sci. Cult. 39, 498-500.

Singh, J. & K.S. Pillai 1973 The world beneath us. Sci. Reporter pp. 318-321.

_____ 1975 A study of soil micro-arthropod communities in some fields. Rev. Ecol. Biol. Sol. 12, 579-590.

_____ 1976 Biocoenology of soil acari in some fields in Varanasi. Acarology Newsletter, Bangalore, 2, 5-6.

_____ 1981 Community structure and biocoenology of soil microarthropods in some tropical fields at Varanasi (India). J. Soil Biol. Ecol. 1, 5-20.

_____ & U.R. Singh 1975 An ecological study of soil microarthropod from soil and litter of tropical deciduous forest of Varanasi (India). Trop. Ecol. 16, 81-85.

_____ & S.V. Mahajan 1981 Quantitative composition of soil mesofauna in tropical arable and deciduous forest soils. In: Progress in Soil Biology and Ecology in India (G.K. Veeresh, ed.), UAS Tech. Series No. 37 pp. 35 (Abstract).

Singh, U.R. & D. Singh 1978 A quantitative study of collembolan communities in different ecosystems. Indian J. Entomol. 40, 39-41.

Snider, R.M. 1984 The ecology of Polydesmus inconstans (Diplopoda : Polydesmidae) in Michigan woodlots. Pedobiologia 26, 185-196.

Solheim, W. G. 1967 Southeast Asia and the West. Science 157, 896-902.

Solhoy, T. 1975 Dynamics of oribatei populations on Hardangervidda. In: Fennoscandian Tundra Ecosystems, Part 2. Animals and Systems Analysis (F. Wielgolaski, ed.), Springer-Verlag, Berlin. pp. 55-59.

Sørensen, T.A. 1948 A method of establishing groups of equal amplitude in plant sociology based on similarity of species content, and its application to analyses of the vegetation on Danish commons. K. danske Vidensk. Selsk. Biol. Skr. 5, 1-34.

Soudek, S. 1928 Fauna of the forest soil. Bull. Ecol. sup. Agron. Brno. R.C.S. Fac. Silvicult. 8, 1-24.

Starling, J.H. 1944 Ecological studies on the Pauropoda of the Duke forest. Ecol. Monogr. 14, 291-310.

Stebayev, I.B. 1962 Zoological characteristics of Tundra soils. Zool. J. Soviet Acad. Sci. 41, 816-825.

Stebbing, E.P. 1914 Indian forest insects of economic importance. Coleoptera. Govt. India Publication. 648 pp.

Stewart, O.C. 1970 Fire as the first great force employed by man. In: Man's Role in Changing the Face of the Earth (W.L. Thomas, ed.), Univ. Chicago Press, Chicago. pp. 123-129.

Stockli, A. 1957 Die metazoenfauna van weisen und Ackerboden aus der umgebung surich. Londw. jb. Schweiz. 6, 571-595.

Streit, B. 1982 Microarthropod population gradients and aggregations in the soil of a mixed temperate deciduous forest. Rev. Suisse Zool. 89, 993-1004.

Strenzke, K. 1949 Ökologische studien uber die Collembolen gesellschaften feuchter Böden Ost-Holsteins. Arch. Hydrobiol. 42,201-303.

Strickland, A.H. 1945 A survey of the soil and litter fauna of some forest reserves and cacao estates in Trinidad, British West Indies. J. Anim. Ecol. 14, 1-11.

_____ 1947 The soil fauna of two contrasted plots of land in Trinidad, British West Indies. J. Anim. Ecol. 16, 1-10.

Sutton, S.L. 1972 Woodlice. Ginn & Co. Ltd., London.

Takeda, H. 1973 A preliminary study on Collembolan populations in a pine forest. Res. Popul. Ecol. 15, 76-39.

_____ 1976 Ecological studies of collembolan populations in a pine forest soil. I. The life cycle and population dynamics of Tetracanthella sylvatica Yosii. Rev. Ecol. Biol. Sol. 13, 117-132.

_____ 1978 Ecological studies of collembolan populations in a pine forest soil. II. Vertical distribution of Collembola. Pedobiologia 18, 22-30.

Takeda, H. 1979a Ecological studies of collembolan populations in a pine forest soil. III. The life cycles and population dynamics of some surface dwelling species. Pedobiologia 19, 34-47.

——— 1979b. Ecological studies of collembolan populations in a pine forest soil. IV. Comparison of distribution patterns. Res. Popul. Ecol. 21, 120-134.

——— 1983 A long term study of life cycles and population dynamics of Tullbergia yosii and Onychiurus decemsetosus (Collembola) in a pine forest soil. Pedobiologia 25, 175-185.

——— 1984 A long term study of the life cycle and population dynamics of Folsomia octoculata Handschin (Insecta : Collembola) in a pine forest soil. Res. Popul. Ecol. 26, 188-194.

Tamura, H. 1967 Some ecological observations on Collembola in Sapporo, Northern Japan. J. Fac. Sci. Hokkaido Univ. 16, 238-252.

——— 1976 Population studies on Folsomia octoculata (Collembola : Isotomidae) in a subalpine coniferous forest. Rev. Ecol. Biol. Sol. 13, 69-91.

Tanaka, M. 1967 Number, standing crop and species composition of Collembola and number of mites in soil (in Japanese). Report of ecological study of Ebino Heights. 2. Kyushu Dist. Soc. Ecol. Soc. Jap. pp. 21-26.

——— 1970 Ecological studies on communities of soil Collembola in Mt. Sobo, southwest Japan. Jap. J. Ecol. 20, 102-110.

Tarras-Wahlberg, N. 1961 The oribatei of a central Swedish bog and their environment. Oikos, suppl. 4, 1-56.

Tayade, D.S. & A.K. Raodeo 1978 Bionomics of Myllocerus undecimpustulatus Fst. infesting cotton in Marathwada. In: Soil Biology and Ecology in India (C.A. Edwards & G.K. Veeresh, eds.) UAS Tech. Series No. 22, pp. 256-258.

Testerink, G.J. 1982 Strategies in energy consumption and partitioning in Collembola. Ecological Entomology 7, 341-351.

Thomas, J.O.M.	1979	An energy budget for a woodland population of oribatid mites. Pedobiologia 19, 346-378.
Tischler, W.	1955	Synökologie der Landtiere. Fischer, Stuttgart. 414 pp.
Toky, O.P. & P.S. Ramakrishnan.	1981a	Run-off infiltration losses related to shifting agriculture (Jhum) in North-eastern India. Environmental Conservation 8, 313-320.
————	1981b	Cropping and yields in agricultural systems of the North-Eastern Hill Region of India. Agro Ecosystem 7, 11-25.
————	1982	A comparative study of the energy budget of hill agro-ecosystems with emphasis on the slash and burn system (jhum) at lower elevations of North-Eastern India. Agricultural System 9, 143-154.
Tomlin, A.D. & J.J. Miller	1982	Protura (Arthropoda: Hexapoda) collected from southern Ontario. Proc. Entomol. Soc., Ontario. 112, 73-75.
Torne, E. von	1965	Experimentelle Untersuchungen uber den EinfluB der Lebenstatigkeit von Mikroorganismen und Bodentieren auf den Abbau von Zellulose I. Pedobiologia 5, 211-227.
————	1967	Beispiele fur mikrobiogene Einflusse auf den Massenwechsel von Bodentieren. Pedobiologia 7, 296-305.
Tragardh, I.	1928	Studies on the fauna of the soil in Swedish forests. 4th Int. Congr. Ent., Ithaca. 2, 781-792.
Trehan, K.N.	1929	Life history, bionomics and control of Myllocerus maculosus Desp. (Coleoptera: Curculionidae). Bull. Agr. Res. Inst., Pusa. 181, 28.
————	1945	Some observations of the soil fauna of cotton fields at Lyallpur. Proc. Indian Acad. Sci. 21(B), 191-201.
Tullgren, A.	1917	Ein sehr einfacher Ausleseapparat für terricole Tierformen. Z. Angew. Ent. 4, 149-150.

Turner, B.D. & E. Broadhead	1974	The diversity and distribution of psocid populations on Mangifera indica L. in Jamaica and their relationships to altitude and micro-epiphyte diversity. J. Anim. Ecol. 43, 173-190.
Tuxen, S.L.	1949	Über den Lebenszyklus und die postembryonale Entwicklung zweier dänischer Proturengattungen. Biol. Skr. 6, 1-50.
————	1965	The Protura. Herman, Paris. 360 pp.
Tyagi, N. & H.N. Baijal	1979	Two new species of Collembola collected from sugarcane fields, District Bijnor, Uttar Pradesh (India). J. Entomol. Res. 3, 177-181.
Uetz, G.W.	1975	Temporal and spatial variation in species diversity of wandering spiders (Araneae) in deciduous forest litter. Environ. Entomol. 4, 719-724.
Ulrich, A.T.	1933	Die macrofauna der Waldstreu. Mitt. Forstwirstsch. Forstwiss. 4, 283-323.
Usher, M.B.	1969	Some properties of the aggregation of soil arthropods : Collembola. J. Anim. Ecol. 38, 607-622.
————	1970	Seasonal and vertical distribution of a population of soil arthropods : Collembola. Pedobiologia 10, 224-236.
————	1971	Seasonal and vertical distribution of a population of soil arthropods : Mesostigmata. Pedobiologia 11, 27-39.
————	1975	Seasonal and vertical distribution of a population of soil arthropods : Cryptostigmata. Pedobiologia 15, 364-374.
Vanek, J. (ed.)	1975	Progress in Soil Zoology. Proc. 5th Int. Colloq., Prague (1973). 630 pp.
van Emden, H.F. & G.C. Williams	1974	Insect stability and diversity in agro-ecosystems. Ann. Rev. Entomol. 19, 455-475.
Vannier, G.	1970	Reactions des micro-arthropodes aux variations de l'etat hydrique du sol. Recherche cooperative sur programme du C.N.R.S. No. 40. Ed. C.N.R.S. Paris.

Vatsauliya, P.K.	1981	Ecological studies on jhum fallows of Byrnihat (Meghalaya) with particular reference to soil fauna. Unpubl. Ph.D. thesis, NEHU, Shillong. 241 pp.
——————— & J.R.B. Alfred	1980	Quantitative study of the soil arthropods in jhum ecosystems of North-East India. Indian Zoologist 4, 153-160.
———————	1981	Quantitative study of soil arthropods in jhum ecosystems. In: Progress in Soil Biology and Ecology in India (G.K. Veeresh, ed.), UAS Tech. Series No. 37, p. 33 (Abstract).
Veeresh, G.K. (ed.)	1981	Progress in Soil Biology and Ecology in India. Proc. 2nd All India Symp. Soil Biol. Ecol., UAS Tech. Series No. 37, Bangalore. 351 pp.
——————— , H.P. Prabhuswamy & N.V.M. Reddy	1981	Preliminary observation on soil fauna of grassland and cultivated soil of Hebbal, Bangalore. In: Progress in Soil Biology and Ecology in India (G.K. Veeresh, ed.), UAS Tech. Series No. 37, p. 36 (Abstract).
——————— & D. Rajagopal	1983	Applied Soil Biology and Ecology. Sharada Publications, Bangalore.
Verghese, A. & G.K. Veeresh	1978	Ants of India — A Brief Review. In: Soil Biology and Ecology in India (C.A. Edwards & G.K. Veeresh, eds.), UAS Tech Series No. 22, 172-181.
Verhoeff, K.W.	1934a	Diplopoda, Symphyla, Pauropoda, Chilopoda. In: Tierwelt Mitteleur (P. Brohmer, P. Ehrmann & G. Ulmer, eds.), 2, 1-120.
———————	1934b	Symphyla und Pauropoda. In: Klassen und Ordnungen des Tierreiches (H.G. Bronn, ed.), V/II/III/1-2, Leiferung.
Viereck, L.A.	1937	Wildfire in the Taiga of Alaska. Quat. Res. 3, 465-495.
Viswanath, B.N., R. Govindan & H.R., Rangaswamy	1978	Moisture an essential factor for the survival of Polytus mellerborgii (Boheman) (Coleoptera : Curculionidae). In: Soil Biology and Ecology in India (C.A. Edwards & G.K. Veeresh, eds.), UAS Tech. Series No. 22, pp. 254-255.

Vlug, H. & J.H. Borden	1973	Soil acari and collembolan populations affected by logging and slash burning in a coastal British Columbia coniferous forest. Environ. Entomol. 2, 1016-1023.
Volz, P.	1934	Untersuchungen über Mikroschichtung der Fauna von Waldböden. Zool. Jb. (Abt. Syst.). 66, 153-210.
Waldorf, E.S.	1976	Spider size, microhabitat selection and use of food. Amer. Midland Naturalist 96, 76-87.
Wallwork, J.A.	1958	Notes on the feeding behaviour of some forest soil Acarina. Oikos 9, 260-271.
————	1959	The distribution and dynamics of some forest soil mites. Ecology 40,557-563.
————	1967	Acari. In: Soil Biology (A. Burges & F. Raw, eds.), Academic Press, London. pp. 363-395.
————	1970	Ecology of soil animals. McGraw-Hill, London. 283 pp.
————	1976	The distribution and diversity of soil fauna. Academic Press, London. 355 pp.
————	1983	Oribatids in forest ecosystems. Ann. Rev. Entomol. 28, 109-130.
Watters, R.F.	1971	Shifting cultivation in Latin America. FAO Forestry Development Paper No. 17, FAO, Rome. 305 pp.
Webster, C.C. & P.N. Wilson	1966	Agriculture in the Tropics. Longman, London.
Weetman, G.F.	1962	Nitrogen relations in a Black spruce (Picea mariana Mill.) stand subject to various fertilizer and soil treatments. Rep. Pulp. Res. Ins. Canada, Woodl. Res. Ind. 134, 122 pp.
Weis-Fogh, T.	1948	Ecological investigations on mites and collemboles in the soil. Natura jutl. 1, 135-270.
White, G.	1789	The Natural History and Antiquities of Selborne. McMillan, London. 591 pp.

Wiggins, E.A., E.A. Curl & J.D. Harper	1979	Effects of soil fertility and cotton rhizosphere on populations of Collembola. Pedobiologia 19, 75-82.
Wilken, G.D.	1977	Integrating forest and small scale farm systems in Middle-America. Agroecosystems 3, 291-302.
Willard, J.R.	1973	Soil invertebrates III. Collembola and minor insects : populations and biomass. Technical Report, IBP, No.19.
Williams, E.C.	1941	An ecological study of the floor fauna of the Panama rain forest. Bull. Chicago Acad. Sci. 6, 63-124.
Witkamp, M. & D.A. Crossley	1966	The role of arthropods and microflora in breakdown of white oak litter. Pedobiologia 6, 293-303.
Wood, T.G.	1967	Acari and Collembola of moorland soils from Yorkshire, England. II. Vertical distribution in four grassland soils. Oikos 18, 137-140.
Woolley, T.A.	1960	Some interesting aspects of oribatid ecology (Acarina). Ecology 53, 251-253.
Wolters, V.	1983	Ecological studies of Collembola in a beech wood on limestone (in German). Pedobiologia 25, 73-85.
Wroughton, R.C.	1892	Our ants. J. Bomb. Nat. Hist. Soc. 7, 13-16.
Yadava, C.P.S., R.K. Mishra & R.C. Saxena	1978	Ecological studies on white grub Holotrichia consanguinea Blanch. In: Soil Biology and Ecology in India (C.A. Edwards & G.K. Veeresh, eds.), UAS Tech. Series No. 22, pp. 209-216.
Yosii, R.	1966	On some Collembola of Afghanistan, India and Ceylon, collected by the Kuphe Expedition, 1960. Reprinted from results of the Kyoto University Scientific expedition to the Karakoram and Hindukush, 1955, Vol. VIII.
Yule, G.U.	1912	On the methods of measuring association between two attributes. J. Roy. Statist. Soc. 75, 579-642.

Zimba, D.T.	1978	Geography of Meghalaya. Standard Printing Press, Gauhati, India.
Zinke, P.J., S. Sabhashri & P. Kunstadter	1978	Soil fertility aspects of the "Lua" forest fallow system of shifting cultivation. In: Farmers in the Forest (P. Kunstadter, E.C. Chapman & S. Sabhashri, eds.), East West Centre, Honolulu, Hawaii.
Zoological Survey of India, Govt. of India.	1980	State of Art Report : Zoology

****

MNRE Library
Acc. No 101778
Acc. by
Class by 24/6/87
Sub. Heading by
Data. by
Transcribed by