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**Records of the
Zoological Survey of India**

**The Diversity of Collembola (Hexapoda)
from East and North-East India
with some notes on their ecology**

**G. P. MANDAL
A. K. HAZRA**

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INTRODUCTION

The collembolans commonly called “spring-tails” are small, entognathous, wingless insects possessing a spring-like forked jumping organ, the furca underneath the fourth abdominal segment. They are minute in size (less than 6 mm in length); antennae primarily with 4 segments. The presence of antennae and absence of cerci distinguish them from the other entognathous hexapods. The collembolans have very diverse distribution occurring in all Zoo-geographical regions of the world inhabiting a wide range of ecological niche and climate. It includes a variety of habitats where they feed as scavengers on decaying vegetation and soil fungi even occurring in the vicinity of both south and north poles upto 83° south latitude in Antarctica. The collembolans are major components of terrestrial ecosystems (and particularly significant members of the soil communities), constituting a significant proportion of the animal biomass reaching densities of 200 to 1800 individuals per dm³, densities surpassed by the Acarine soil population (Handschin, 1955).

They are prevalent in almost all kind of situations (Butcher *et al.*, 1971), in mosses, under stones, caves, in ant and termite nests, surface of lakes and ponds even in the intertidal zone. Some species viz, the snowflea, *Hypogastrura nivicola* live permanently on glacier or snow fields. The greatest diversity and density are seen in soil rich organic matter. They are polyphagous in general, but some species are saprophagous (decomposed plants), coprophagous (excrements), necrophagous (cadavers), mycetophagous (fungi), or bacteriophagous (Thibaud, 1970). There are about 7500 species described worldwide (Frans Janessens, 2005). Springtails are the oldest group of hexapods recored in the fossil and are found in the Rhynie chert approximately 395 million years ago (Greenslade, 1988), most fossils have been described from Baltic, Mexican and Dominican Republic abber, and with very few exceptions represent extant genera.

So far no detailed account in respect to the diversity and distribution Collembola is available from the east and north-eastern states of India. Therefore, the present project is taken to enrich the knowledge of Indian spring tails with intensive coverage of the states of the study areas viz. Orissa, West Bengal, Sikkim, Assam, Tripura, Meghalaya, Manipur, Mizoram, Nagaland and Arunachal Pradesh in order to achieve the following objectives :

1. To ascertain the diversity of Collembola qualitatively from the above states of India.
2. To study the seasonal abundance and species diversity after two different ecological habitates of West Bengal.

3. To evaluate the role of edaphic factors like temperature, moisture, pH, organic carbon, nitrate and phosphate of soil on the distribution of Collembola.

REVIEW OF LITERATURE

Extensive taxonomic and ecological studies of collembola have been published through out the world. The latest checklist of worldwide fauna of collembola has recently been published by Janessens (2005).

The first Indian species of collembola from Malabar hill regions was described by Ritter (1910, 11). Imms (1912, 1948) made extensive study on the collembolan insects of India, Burma and Ceylon and brought out a catalogue of the oriental species of the spring tails in his book. Carpenter (1917) described a new genus and 6 new species of families Poduridae and Entomobryidae from the material of the Abor expedition in the North-Eastern regions of Kemp (1911-1912) followed by description of four new species of family Entomobryidae from Siju-cave, Garo Hills, Assam, Carpenter (1924). Parker (1921) found some insects in the snow at an altitude of 14,000 ft. altitude of the Siachen glacier.

Handschin (1928 '29) made an account of 5 new species of from South India. Significant contribution in the directory of Indian collembolan was made by Bonet (1930) followed by *Protanura carpenter* (Mukherjee, 1932a), *Proisotoma* sp. (Brown, 1932b) and a few more (Denis, 1936, '47 and '48; Stach, 1947). Baijal (1955, '58 and '71) described 32 species from Northern India including the "Nival zone of North-West Himalaya"

Salmon (1956a, b, '57a, b, '64, '69, '70) enriched our knowledge of Indian Collembola through decription of one new genus and quite a good number of species and redescription of *Xenylla obscura* Imms(1956) and records of two species from India. Choudhuri (1958a, b) and Choudhuri and Roy (1965) added a few species in *Onychiurus* from India.

Yosii (1966a) dealt with collembolan species of high altitudes comprising a new genus after the 'Himalayan Expedition of the Chiba University, 1963' under the leadership of Prof. M. Numata comprising of 38 new species and a new monotypic genus, *Nepalanura* (*N. paranurodes*) representing 11 families. Afterward, Yosii (1966 b) described 20 new species in 9 genera from 'KUPHE Expedition (1960) followed by Yosii (1966c) a new genus and species of collembola of the Siachen Glacier in Karakoram.

Prabhoo (1970, '71a, b, c) recorded the first marine Collembola from India followed by 74 species and a new genus, *Indoscopus* (*I. spinosus*) through extensive surveys of the bark, mosses, soil and litter in the Western Ghat and Kerala. Later, Prabhoo and Murlidharan (1980) described a new species *Tomocerus mitrai* from Himachal Pradesh.

Mitra (1966-2001) carried out taxonomic study on Indian Collembola and established two new genera, *Yosiia* and *Delamarerus*. Mitra (1967) made a detailed account of accessory ocular structure of Paronellinae (Collembola). Furthermore, Mitra (1973) established a new Paronellinae genus of Indian spring-tail including description of three new species and made revision of the genus *Salina* with addition of 10 species and 1 sub species from India. Mitra (1973) also studied the post-embryonic morphological differentiation including chaetotaxy in *Callyntrura (Handschinphysa) lineata* followed by publication of several collembolan species of *Callyntrura* (Mitra, 1974) and 2 new species of *Dicranocentroides* (Mitra, 1975), *Delamarerus* and the species *immsi* of termitophilous collembola from Orissa and some springtail species including a new species, *Seira arunachala* from Arunachal Pradesh (Mitra, 1976).

Mitra (1977) redefined two genera, *Akabosia* and *Yosiia* with special reference to chaetotaxy. The 'humped-back' Paronellinae genus *Idiomerus* of the Western Ghats was made known due to Mitra (1990) stating of its chaetotaxy, phylogeny and biogeography by Mitra (1994).

Hazra (1995, '98) recorded 9 species of collembola from Meghalaya and faunal diversity (Apterygota) of India. Later Hazra *et al.*, (2000) made addition of 11 species under 8 genera of collembolan to the directory of collembolan from Tripura which happened as the first record of Collembolan fauna from this state of India. Mandal and Hazra (2002) described 8 species in 4 genera of Collembola from SVN, Andhra Pradesh. Mitra, Mandal and Hazra (2004) described 12 species representing 9 genera under 2 families of Collembola from Uttaranchal state which included several topotypes. Hazra *et al* (2001) and Hazra and Mandal (2003 & 2004) showed the diversity of collembola in the Sikkim Himalaya reporting 39 species under 26 genera of 5 families, and describing 33 species of 20 genera of 5 families of springtails from Western Ghats and 17 species of 11 genera in 3 families from Jammu and Kashmir and 8 species of 6 genera in 2 families in Jharkhand and 11 species of 10 genera in the 3 families from Himachal states respectively. The above authors published an account 11 species in 10 genera of the insects from the Rajasthan state (Mandal and Hazra, 2005).

ECOLOGY

Diem (1903) first studied soil fauna in the Alpine soils followed by McAtee (1907) in the forest floor and grassland meadow. The temperature preference of different species of collembolan was observed by Agrell (1941) who inferring that the insects could withstand the considerable range of temperature from 2 to 38°C with the effects of humidity and soil moisture on the collembolan fauna. Weis-Fogh (1948) reported highest collembolan population in autumn and lowest in summer whereas Macfadyen (1952, 53 and 54) found maximum of population in winter. According to Murphy (1953) the population of these insects concentrated

in the upper layer of woodland soil while Bellinger (1954) indicated preference of habitat was dependent to the factors like moisture content, nature of organic matter and microfloral component. Haarlov (1955 and 1960) studied the vertical distribution of mite and Collembola in relation to the size and shape of soil cavities, relative humidity and availability of food and emphasised the effect of moisture and organic matter on the life of collembola.

Sheals (1956, '57) noted the quantitative composition of Collembolan and Acarine community in respect to vertical, horizontal and seasonal distribution of these micro-arthropods after the vegetation, temperature, soil structure and other edaphic factors (organic carbon content, acidity of soil and insecticides). Christiansen *et al.* (1961) observed positive correlation of population density of springtails with organic matter, nitrate, particle size and moisture content of soil of Hunter caves. Choudhuri (1961, '62a, b and '63) made a substantial contribution on the ecology of Collembolan fauna highlighting influences of different ecological factors in the reproduction and development of collembolan species and showed edaphological factors playing significant part in conditioning the make up of collembolan population both quantitatively and qualitatively and its ability to withstand the condition of desiccation during dry spell. Dhillon and Gibson (1962) observed that 85-90% collembola concentrated in the first 0-10 cm which might be due to higher concentration of organic matter and sufficient moisture available in the strata.

Choudhuri and Roy (1966, '67, '70a, b and '71a, b, '72) studied extensively the effect of soil conditions on the distribution of collembolan fauna and their population fluctuation in West Bengal. According to them, high concentration of organic matter and the sufficient moisture of the strata having substantial effect on the maximum collembolans, acari and fungal population while vegetation exerts playing an indirect effect of porosity, humus and moisture of soil on the Collembolan population. Hale (1966, '67), noticed peak populations related to their life cycles and prevalence of large number of juveniles with the influence of various physical and chemical factors, in the distribution of collembola. Mukherjee and Singh (1967 and '70) found that collembolan population attained its peak in the wheat field and rose garden during March and August and declined during May-July and December. Prabhoo (1967, '71a, b and '76) studied the micro-geographic variation and taxonomy of collembola of southern part of India with record a number of new species and found negative correlation of soil fauna with moisture in inundated paddies (Prabhoo, 1981).

Rappoport (1967) observed a positive correlation between the numerical strength of dark forms and the altitude and Ashrof (1971) worked out the effects of temperature grades and relative humidity on survival of Collembola and stated favourable temperature of different species ranging between 10-30°C and optimal humidity between 75-100%. Singh and

Mukherjee (1971 and '73) published the role of soil-arthropods in the the Indo-Gangetic plane while Nijima (1971) studied seasonal changes in the collembolan population in a warm forest.

Edward and Lofty (1973, '74) worked out the correlation between ploughing and population size and indicated little effects of nitrogen, organic manure and other factors on fauna of grassland. Choudhuri and Banerjee (1975) asserted high organic matter raising the population. According to Singh and Pillai (1975 and '81) community structure and biocoenology of soil micro-arthropods constituting 85.2-92.6% springtail population being less abundant in uncultivated field than the cultivated one. Hazra *et al.* (1976, '77) observed the effect of pH on the insect fauna of uncultivated field suggesting that pH of soil between 6.3-7.5 were probably ideal for most of the species. They same (1982, '84) found interdependency between Collembolan and fungal population and the organic matter content of soil in a grassland ecosystem of Kerala and West Bengal.

Bhattacharyya and Raychoudhuri (1979) noticed variation of density of soil micro-arthropods including collembola in relation to some climate and edaphic factors. The distribution of collembola was reported to be governed by major edaphic soil factors and heavy metals and fungi having a positive correlation between fungi and collembola and negative with heavy metals Hazra and Choudhuri (1981, '83 and '90). Hagvar (1982, '87) mentioned that the number of species was directly proportional with increasing soil fertility and pH. Mitra, *et al.* (1983a, b), Mitra and Gangopadhyay (1986) studied changes of population structure in grassland and observed effects of crop rotation and fertilizers on the population of Collembola and Acarina in agri-ecosystem.

Reddy (1984 and '86) contributed significantly on the ecology of collembolan insects by considering the soil-arthropod as indicator of environmental quality. Bisht and Chatteraj (1985 and '86) carried out an extensive work on the seasonal incidence and effects of soil factors (pH) and altitude. Reddy and Venkataiah (1986, '89 and '90) showed the impact of different meteorological and edaphic variables of the grassland and tree planted areas of Andhra state of India. Guru *et al.* (1988) did not find significant differences in the population of two contrasting sites and showed *Cryptopygus thermophilus* as the predominant species in both site. Veeresh (1990) made observations of the role of soil fauna in organic matter turn over and nutrient cycling.

Guru and Das (1991) recorded two population peaks in the rice paddies of Orissa in September and February and density differences might be due to different types of agricultural practices. Guru and Panda (1991) demonstrated the role of collembolans in regulating C/N ratio and found decrease in carbon and increase in nitrogen content in comparison to the

control experiments. Sengupta and Sanyal (1991) found that soil micro-arthropods suffered reduction in numbers of species under the stress on agricultural practice and opined that inundation had most adverse effect on the population in addition to the effect of the fertilizer application and ploughing.

Sinha *et al.* (1991) found Acari to outnumber the Collembolans in a vegetable garden and deciduous forest in the postmonsoon maxim followed by a winter hike, except *Isotomurus sp* which became visible in winter. Chakraborty and Bhattacharyya (1992) studied the soil micro-arthropod fauna of a rubber plantation and an adjacent wasteland in Tripura. Pal *et al.* (1992) made observation of the distribution of Collembola and fungal flora and seasonal abundance in relation to different soil factors of the forest of Burdwan reaching its peak in August and September during when the concentration of organic carbon, moisture and nitrate were fairly high and declined in the summer. Stork and Eggleton (1992) proposed most useful measures like, abundance, biomass, density, species richness, trophic structure, food wave structure, key stone species, ecosystem engineering for assessing soil quality and their ecology in combination with microbial and non-biological (Hydrological, physical and chemical) criteria.

The effect of continuous cultivation through crop rotation on micro-arthropods with special emphasis on Collembola in India first came from Mitra (1993) who observed that crop rotation and other agronomic practices over years significantly reduced Collembolan population and diversity of species with consequent reduction of C/N ratio of soil, microbial activities and crop yield. Hazra and Sanyal (1996) ascertained the role of collembolan insects in building up of primary soil fauna in particular habitat and alluvial soil in particular.

Bhattacharyya and Hazra (1997) concluded that vegetable cultivation with crop-rotation supported maximum abundance and diversity of both Collembola and micro-organisms. Hazra *et al.* (1999) made studies of population dynamics of spring tails and interaction between Collembola and fungi populations of garbage dumping areas in Kolkata and Mitra *et al.* (1999) could measured effects of monoculture in the diversity of Collembola fauna, both qualitatively and quantitatively in the sugarcane field and found *Isotomurus balteatus* as the most predominant taxon of the 11 species of wheat, jute and paddy fields during cultivation in the West Bengal. Hazra and Bhattacharyya (2003) invetigated the fauna of agricultural ecosystems and waste disposal sites of West Bengal with special reference to their microbial association and effect of agricultural practices leading poor soil environment which resulted pollution and reduced the micro fauna quantitatively or qualitatively. Ghosh and Roy (2005) made an assessment of the impact on the density, distribution and diversity of collembolan fauna in the soil of Himalayan tea garden.

MATERIAL AND METHODS

Collections of Collembolans were made during faunistic survey to North East India conducted by Zoological Survey of India from 1990-2002 from the North-Eastern states (Assam, Tripura, Sikkim, Manipur, Nagaland, Mizoram, Meghalaya and Arunachal Pradesh and Eastern states from Orissa and West Bengal (Maps. 1-11). Earlier collections present in the Apterygota section of Zoological Survey of India were also reexamined in this study.

A white enamel tray and aspirator were most useful tools for the purpose of taxonomic studies. An amount of alcohol was used in the tray or the large petridish during beating the bushes, mosses or forest litters for collections collembolans in order to induce the insects to jump on these objects. Thereafter, they were picked up with fine brush before putting them in the fixative.

Collembola were extracted in good number and variety from the known quantity of soil samples by employing stainless steel corers (5 cm in height and 8.33 sq.cm inner diameters). The cores were then placed on modified high gradient extraction apparatus (Macfadyen, 1953) and were fixed in Iron augur with a rotating Iron rod (Figs. 1 & 2).

Preserved specimens were cleared in Marc Andre 1 medium (Distilled water 30 cm³, Chloral hydrate 40 gm, Glacial acetic acid 30 cm³). Fresh specimens were 'explode' for displaying chaetotaxy. Specimens were kept in this medium until cleared. Specimens can be safely kept in Mark Andre 1 medium as long 36 hours. Dark specimens were kept in Potassium hydroxide (KOH) or Hydrogen peroxide (H₂O₂) for softening the chitin.

The collembolans were preserved in Von-Torne's medium comprising of 1000cc. Isopropyl alcohol, 30cc glacial acetic acid and 3cc 40% formaldehyde. Hoyer's mounting medium (50cc. distilled water, 200g. Chloral hydrate, 40cc. glycerine, 20gm. Gum Arabic filtering them through glass wool) were used for slide-mounting of the specimens.

Identification of specimens has been done using a phase contrast compound microscope following Christiansen and Bellinger (1980). The diagrams presented in this study have been drawn directly from the wild specimens and some with reproduction of Salmon (1958), Yosii (1966) and Mitra (1966) due to obvious reasons.

MORPHOLOGY AND TERMINOLOGY

(Figs. 3 and 4)

The body of the Collembola is clothed with different types of hairs arranged in patterns, which facilitate easy identification of the insects. Cuticle is swelled, sensory domes from

which arise tricothria (long, plain, wavy sensory hairs), lasiotrichia (long, ciliated, wavy sensory hairs), and wavy sensory hairs.

Head : more or less oval shaped, prognathous or hypognathous varies considerably in different species while in Sminthuridae, the long axis of the head is typically vertical and the antennae arise dorsally. Antennae are normally of four basic segments but in many Sminthuridae, the ultimate or penultimate two segments are divided into a few or many sub-segments.

Post antennal Organ (PAO) : of immense taxonomic value is found in some families between the antennal base and the eye region. The eye patch usually located on a heavily pigmented area behind each antenna consists of from 1 to 8 in more or rectangular arrangement.

Thorax : each segments of the thorax bears a pair of six segmented legs sometimes with one or more subapical hairs on the tibio-tarsus (tenent hairs). Terminating in one or two claws, the larger is known as unguis, the smaller is known as unguiculus.

Abdomen : Unlike other insects, the abdomen of collembola is 6 segmented but in Symphypleona, the first four segments of the abdomen are fused with thorax to form a globular mass. In majority species of Symphypleona, the females bear chitinous structures on each side of the annus. A circular or cylindrical bilobed appendage, ventral tubule (collophore) is present in the abdomen. The furcula is appended to the ventral surface of the fourth segment of the abdomen of the majority of species. The structure is composed of a pair of appendages fused in their basal portion to form the manubrium. From this basal segment a pair of separate elongate structures known as dentes is attached to the basal segment and a small hook like structure, mucrones at the distal end.

A. TAXONOMIC STUDIES

Key to Families of Collembola

1. Body linear; at least first 4 abdominal segments dorsally separated by membranes lacking setae, or furcula rudimentary or absent (Suborder Arthropleona) 2
- Body globular; first 4 abdominal segments fused dorsally; furcula always well developed (Suborder Symphypleona) 10
2. First thoracic segments distinct with dorsal setae (Section- Poduromorpha) 3
- First thoracic segment frequently indistinct without dorsal setae (Section Entomobryomorpha) 5
3. Dentes more than 3 times as long as manubrium, with distal ring of granules
..... **PODURIDAE**

- Dentes absent or relatively shorter and not ringed 4
- 4. Pseudo-ocelli present, at least on antennal base or dorsum of fifth abdominal segment ONYCHIURIDAE
- Pseudo-ocelli absent HYPOGASTRURIDAE
- 5. Mucro hairy; fourth antennal segment shorter than third; body scaled (first instar juveniles lack all these characters except of at least some species of *Tomocerus*..... ENTOMOBRYIDAE (Subfamily Tomocerinae)
- Mucro with at most 1-2 setae; fourth antennal segment at least as long as third; scales present or absent..... 6
- 6. Dentes with dentate spines; mucro subequal in length to dens or longer ENTOMOBRYIDAE (Subfamily Oncopodurinae)
- Dental spine simple (rarely) or absent; mucro usually much shorter than dens 7
- 7. Postantennal organ present, or absent, and setae at most unilaterally ciliate ISOTOMIDAE
- Postantennal organ absent; some setae multilaterally ciliate..... 8
- 8. Dens dorsally crenulate and curving upward, basally in line with manubrium ENTOMOBRYIDAE (Subfamily Entomobryinae)
- Dens not crenulate, straight and usually forming a basal angle with manubrium 9
- 9. Eyes and pigment absent; dens with large dorsal scales and without apical lobe ENTOMOBRYIDAE (Subfamily Cyphoderinae)
- Eyes and pigment present; dens without dorsal scales and with apical lobe ENTOMOBRYIDAE (Subfamily Paronellinae)
- 10. Antennae shorter than head; eyes absent NEELIDAE
- Antennae longer than head, or at least 1 + 1 eyes (sometimes unpigmented) SMINTHURIDAE

Key to Subfamilies of Hypogastruridae

- Mandible with a basal molar plate Hypogastrurinae
- Mandible without a molar plate or absent Neanurinae

Key to genera of *Hypogastrurinae*

1. Postantennal organ absent *Xenylla*
- Postantennal organ present 2
2. Eyes present *Ceratophysella*
- Eyes absent *Willemia*

Genus *Ceratophysella* Börner in Brohmer, 1932

1932. *Ceratophysella* Börner, *Fauna von Deutschland* (4) : 134-144.

Type species : *Podura armata* Nicolet, 1842.

1. *Ceratophysella indovaria* Salmon

(Fig. 5)

1970. *Hypogastrura indovaria* Salmon, *Trans. Biol. Sci.*, 12(13) : 149.

Diagnostic Characters : Dark brown in colour, ocelli on black fields. Body with sparse to heavy short and long curved simple setae. Antennae shorter than head, ratio 19 : 20, segment IV without sensory knob, but with 7-9 short, stout, bent sense rods and numerous long stout simple setae. Post Antennal Organ very irregular, consisting of 4-12 indistinct disconnected lobes with or without central boss. Body length 0.8 mm. Legs with claw and finely granulate unguiculus; long tenent hair never clavate. Dens with a double row setae down anterior face, each row with four setae; mucro finely granulate and spoon shaped with two distinct lamellae.

Material examined : Arunachal : 2 exs, between Bame and Basar (West Siang Dist.), 28.III.1999, Coll. A.K. Hazra; 6 exs; Itanagar (Hill stream side and Itanagar Zoo), 07.IV.1999, Coll. A. K. Hazra; Sikkim : 60 exs, Geyzing Bazar, 21.III.1999, Coll. A.K. Hazra; 5 exs; Legship, hill slope of Rangeet River, 09.V.1998, Coll. A.K. Hazra, 30 exs; Pemayangtse, Geyzing, 10.V.1998, Coll. A.K. Hazra; Mizoram : 54 exs, Aizwal, 12.IV.1994, Coll. A.K. Hazra; 78 exs; Kwankwan. 04.IV.1994, Coll. A.K. Hazra; Manipur : 2 exs, Keibul National Park (Churachandpur Dist.), 02.IV.1992, Coll. A.K. Hazra.

Distribution : India : Sikkim, Arunachal, Assam, Manipur, Mizoram and West Bengal.

Remarks : The species first described by Salmon (1970) from Sikkim conform with the present species abundant at Mizoram in comparison to other states.

***2. *Ceratophysella indica* Salmon**

(Fig. 6)

1956. *Ceratophysella indica* Salmon, *Victoria Univ. College, Wellington, N.Z.*, 171-174.

Diagnostic characters : Medium to dark brown in colour with a dorso-lateral row of irregular shaped yellow marks on each side. Body with moderate, short and long simple straight or slightly curved setae. Antennae little longer than head, ratio of antennal four segments I-IV 14:15:18/20:24, segment IV with three apical sensory knobs and 5-6 stout, curved subapical sense rods, 2-3 slender, straight, apical sense rods clothed with relatively long simple setae. Ocelli 8 on each side; P.A.O. with to five irregular foliaceous lobes arranged around a central ill-defined zone. Claws of legs with a single central inner tooth and a long, slender basal seta to each side. Furcula with manubrium 38, dens 27, mucro 18, mucro boat shaped and lamellate. Length to 0.8 mm.

Distribution : India : Sikkim.

Remarks : Salmon (1956) first described this species from Gangtok (India), during this study, the material of the National Zoological Collection, Calcutta fully confirm with Salmon (1956).

Key to the species of *Ceratophysella*

- Unguiculus vestigial and tenent hair faintly clavate *indica*
- Unguiculus finely granulate and tenent hair never clavate *indovaria*

Genus *Xenylla* Tullberg1869. *Xenylla* Tullberg, *W. Schultz Boktryckeri, Uppsala*, 21 pp.1970. *Xenylla* Salmon, *R. Soc. N.Z., Biology Sci.*, 12(13) : 145-152.

Type species : *Xenylla maritima* Tullberg, 1869.

3. *Xenylla obscura* Imms

(Fig. 7)

1912. *Xenylla obscura* Imms, *Proc. Zool. Soc. London* : 80125.1970. *Xenylla obscura* Salmon, *R. Soc. N.Z. Biology Sci.*, 12(13) : 145-152.

Diagnostic Characters : Body length 1.4 mm; elongate in shape; colour indigoblue, segmental margins and ventral side pale. Antennal segment ratio as 10 : 12 : 12 : 14. P.A.O. absent; unguis carinate without lateral teeth but with 1, 1, 1 inner tooth near the apex; unguiculus absent. Ventral tube with 4 + 4 setae. Tenent hair, 2, 2, 2 very long and capitate

at the end. Dentes and mucro separated, mucro short, thick about half as long as dens; dens with two long simple posterior setae.

Material examined : Arunachal : 1 ex, Muri (Subansiri Dist.), 25.III.1999, Coll. A.K. Hazra; 1 ex, Daporizo (Subansiri distt), 26.III.1999, Coll. A.K. Hazra; Manipur : 10 exs, Moreh (Chandel Dist.), 13.IV.1992. Coll. A.K. Hazra; Mizoram : 10 ex, Tukul (Aizwal), 31.III.1994, Coll. A.K. Hazra; Nagaland : 55 exs, Itangki Reserve forest (Dimapur) 18.III.1997, Coll. A.K. Hazra.

Distribution : India : Arunachal, Manipur, Mizoram and Nagaland.

Remarks : The species was first described by Imms (1912) followed by confirmation of Salmon (1970). The insects of fetched from the places of north eastern India during the investigation appear same as of the previous authors except some minor morphometric differences and colour variation.

Subfamily NEANURINAE

This subfamily is recognized by the absence of the mandibular molar plate and at times the mandible itself.

Key to Genera of Neanurinae

1. Furcula well developed, mucro long with recurved apex and two slender plate like recurved teeth each joined to the mucronal base by delicate lamellae *Uchidanurida*
- Furcula reduced or absent 2
2. Last abdominal segment rounded 3
- Last abdominal segment bilobed 4
3. Mandible without molar area with large projecting plate like group of teeth..... *Spinanurida*
- Mandibles long, slightly curved and needle like, with two external small apical teeth *Pronura*
4. P.A.O represented by a rounded circle of the integument without granulation *Lobella*
- P.A.O.absent *Neanura*

Genus *Neanura* MacGillivray

1893. *Neanura* MacGillivray, *Entomol.*, 25 : 313-318.

Type species : *Achorutes muscorum* Templeton, 1835.

*4. *Neanura sikkimensis* Yosii

(Fig. 8)

1966. *Neanura sikkimensis* Yosii, *J. Coll. Arts. And Sci., Chiba Univ.*, 4(4) : 461-531.

Diagnostic characters : White in colour. Eyes 2 + 2, very large and unpigmented. Antennal ratio of the segments 20 : 25 : 40, segment IV with 3 apical bulbs and 8 curved setae, last two segments dorsally ankylosed. P-seta distinct. Mandible tridentate, maxilla elongate, labium acutely pointed; unguis carinate, untoothed. Ventral tube with 3 + 3 setae. Furcal rest apparently a transverse swelling of the integument. Body length 1.8 mm.

Distribution : India : Sikkim.

Remarks : Yosii (1966) described this species from Sikkim which are fully similar to those retained in the NZC, and the descriptions of Yosii (1966).

Genus *Lobella* Börner

1906. *Lobella* Börner, *Mitt. Naturhist. Mus. Hamburg*, 23 : 147-188.

Type species : *Achorutes (Lobella) sauteri*, Börner, 1906.

3. *Lobella kraepelini* (Börner)

(Fig. 9)

1906. *Protanura kraepelini* Börner, *Mitt. Naturhist. Mus Hamburg*, 23 : 147-188.

1910. *Neanura dubiosa* Ritter, *Ann. Wiener Nat. Hofmus*, 24 : 379-396.

1912. *Neanura pudibunda* Imms, *Proc. Zool. Soc. London*, 80-125.

1917. *Protanura spinifera* Carpenter, *Rec. Ind. Mus. Calcutta*, 26 : 286.

1959. *Lobella kraepelini* (Börner): Yosii, *Contr. Biol. Lab. Kyoto. Univ.*, 10 : 1-65.

Diagnostic characters : Body length upto 2.3 mm. Red in colour. Antennae : Head as 5 : 6. Antennal segments III and IV almost fused dorsally. Eyes 3 + 3. Mandibles well developed, triangular in shape bearing 6 teeth. Maxillae elongated, distal part with 2 teeth accompanied by a fringed, hyaline lamella, apex of which surpassing by far the head of the maxillar shaft. Abdominal segment VI with a pair of tubercles thus giving rise to the species a prominent feature to distinguish it from other related species. P.A.O. present. Body length 2.3 mm.

Material examined : Arunachal : 2 exs, Nechipu (West Kameng Dist.), 01.IV.1999, Coll. A.K. Hazra and party; 2 exs, Leni village (West Kameng Dist.), 01.IV.1999, Coll. A.K. Hazra and party; Mizoram : 6 exs, Siahalta Hill slope, 07.IV.1994, Coll. A.K. Hazra and party; 3 exs, Chawnhu forest, Lawngtlai, 02.IV.1994, Coll. A.K. Hazra.

Distribution : Singapur, India : Arunachal and Mizoram.

Remarks : The species was first described by Börner (1906) followed by confirmation of Yosii (1959). Carpenter (1917) described this species as a *Prostanura spinifera* collected by S.W. Kemp (Abor Expedition) from N. E. Assam. During this investigation, the present authors described this species from Arunachal and Mizoram appear same as of the previous authors except some minor morphometric differences and colour variation.

***6. *Lobella (Lobella) assamensis* Yosii**
(Fig. 10)

1966. *Lobella (Lobella) assamensis* Yosii, J. Coll. Arts & Sci., Chiba Univ., 4(4) : 461-531.

Diagnostic characters : Body length 1.5 mm. White in colour. Antennae subequal to head in length, antennal segments III and IV dorsally confluent, segments IV with 3 obscure apical bulbs and 8 sensory setae. Eyes 3 + 3 poorly pigmented. Labrum coarsely granulated and with 2 + 2 large setae. Mandible elongate with 1 basal and 5 distal teeth and a short, barbed apical ramus. Maxilla tridentates apically. Labium truncate. Ventral tube with 4 + 4 setae. Furcal rest median, heap rounded with 1 + 1 setae. P.A.O. present. Body length 1.5 mm.

Material examined : Mizoram : 2 exs, Chawnhu Forest, Lawngtlai, 02.IV.1994, Coll. A.K. Hazra.

Distribution : India : Assam and Mizoram.

Remarks : Yosii (1966) first described this species from Difu, Assam. The insects of several places of eastern India collected during the investigation appear same as of the previous authors except some minor morphometric differences.

Key to species of *Lobella*

- Mandibles triangular with 6 teeth; maxilla elongated with 2 distal teeth.....
.....*kraepelini*
- Mandibles rather elongate with 5 distal and 1 basal teeth; maxilla with 3 distal teeth
.....*assamensis*

Genus *Pronura* Delamare Deboutteville

1951. *Pronura* Delamare Deboutteville, *Hermann, Paris*. 360 pp.

***7. *Pronura indiana* Salmon**

(Fig. 11)

1969. *Pronura indiana* Salmon, *Zoology Publication, Victoria Univ.*, 51 : 40-49.

Diagnostic characters : Body and legs white in colour. Body wide and flat sparsely clothed with short, simple setae, lateral and posterior ones sometimes longer. Ocelli three widely separated. Antennae shorter than head ratio 7 : 10 with numerous long simple setae, segment III bearing sensory organ of two very small sensory clubs. P.A.O. and furcula absent. Legs with simple sickle shaped claws with no tooth but with a short basal seta. Adb. VI is shallowly bilobed. Body length 0.75 mm and breadth 0.3 mm.

Distribution : India : Sikkim and Assam.

Remarks : The species was brought to light due to Salmon (1969) at an altitude of 8610 ft of Lachung (Sikkim) and from Sibsagar (Assam) amongst the collection of Dr. T. Clay of British Museum Natural History are found the same as the specimens retained in the NZC, Calcutta and description of described Salmon (1969).

Genus *Spinanurida* Salmon

1964. *Spinanurida* Salmon, *Bull. Roy. Soc. N.Z.*, 7(1) : 144.

Type species : *Spinanurida mandibulata* Salmon, 1964.

***8. *Spinanurida mandibulata* Salmon**

(Fig. 12)

1969. *Spinanurida mandibulata* Salmon, *Zool. Publ. Victoria Univ.*, 51 : 40-49.

Diagnostic characters : Creamy white in colour sparsely overlaid with scattered dark blue pigment granules. Body sparsely clothed with with short simple curved setae, lateral and posterior setae often longer lateral one sometimes with apical swelling. Ocelli 8 on each side Antennae four segmented, segments III and IV almost completely fused, ratio of segments I-III as 25 : 20 : 42, the basal segments very broad, 25 long and 49 wide, segment IV with subapical retractile knobs in sensory pit. Abdominal segment VI with 6 anal spines in two transverse rows. Legs with relatively very small, finely granulated claws without any teeth; unguiculus absent; two long clavate tenent hairs long clavate and two in numbers on the outer edge of each tibiotarsus and three shorter clavate tenent hairs on the inner edge. Furcula and tenaculum absent. Body length 0.66 mm.

Distribution : India : Sikkim.

Remarks : On examination of the specimens of Dr. Clay lying with the NZC, Calcutta, it appears that it conforms fully with the description of Salmon (1969) in morphology including its morphometrics.

Genus *Uchidanurida* Salmon

1964. *Uchidanurida* Salmon, *Bull. Roy. Soc. N.Z.*, 7(1) : 144.

Type species : *Uchidanurida altitudina* Salmon, 1964.

*9. *Uchidanurida altitudina* Salmon

(Fig. 13)

1969. *Uchidanurida altitudina* Salmon, *Trans. Bio. Sci.*, 12(13) : 145-152.

Diagnostic Characters : White with blue pigmented ocellar fields. Ocelli five to each side. Body clothed with two sparse distinct transverse rows of short simple curved setae across the dorsal surface of each trunk segment. Antennae very short, rarely as long as half of the head, segment IV almost as long as entire bearing several long plain setae even longer than those of segment IV. PAO with small central boss and three indistinct lobes sometimes appear little twisted. Abdominal segment IV slightly longer than that of III as 37 : 27, segment VI with two small anal spines. Legs with claw bearing one basal and two Unguiculus and tenent hairs absent; claw with basal internal tooth and two lateral external teeth. Furcula with manubrium : dens : mucro ratio 17 : 15 : 12, dens with three stout simple spines and one curved simple seta; mucro long with recurved apex and two slender plate like recurved teeth each joined to the mucronal base by delicate lamellae. Body length 0.56 mm.

Distribution : India : Sikkim.

Remarks : Salmon (1970) described this species from the moss of Lachen (Sikkim); collected by Dr. T. Clay of B.M.N.H. The present author could not collect the same specimen during the present study.

Family ONYCHIURIDAE

This family is characterized by the presence of pseudocelli on the head and trunk, distinctive and usually complex sense organ on the third antennal segment. Eyes are always absent and lacks pigment and of furcula. Body form and mouth part structure are in general as in Hypogastrurinae except in *Willemia* which differs in having the post antennal organ tubercles in a circle instead of in two parallel lines.

Key to genera of Onychiuridae

1. Apical sense organ of third antennal segment with sense clubs concealed behind 4-5 granulate integumental papillae *Onychiurus*
- Apical sense organ of third antennal segment without sense clubs concealed papillae 2
2. Sense organ of third antennal segment composed of 2 small rods, with 1 large, papillated sensory curved club on each side *Mesaphorura*
- Sense organ of third antennal segment composed of finely granulated papillae, 5 guard setae, 2 very large, reticulated, bulbous sense clubs and 2 straight sense rods *Spelaphorura*

Genus *Onychiurus* Gervais

1841. *Onychiurus* Gervais, *Echo Monde Savant*, 8 : 372.

1958. *Onychiurus* Choudhuri, *Proc. Ent. Soc. London*, pp. 155-159.

Type species : *Podura ambulans* Linnaeus, 1758.

***10. *Onychiurus indicus* Choudhuri and Roy
(Fig. 14)**

1965. *Onychiurus indicus* Choudhuri and Roy, *Rev. Ecol. Biol. Sol* : 123-127.

Diagnostic characters : Colour creamy white. Cuticle uniformly finely granulated and marginal portion of each segment not clearly defined, and antennal base not differentiated from rest of head. Pseudocelli dorsally three at base of each antenna forming a triangle, two obliquely on hind margin of head, ventrally two ventral pseudocelli on either side of head. Antenna cylindrical and shorter than width of head segment IV apically with a crecentic fold housing a small globular papilla; ratio of antennal segments I : IV as 3 : 4 : 5 : 10. P.A.O. with 8-12 small free or overlapping compound vesicles. Unguis untoothed; unguiculus without basal lamella. No furcula remnant visible.

Material examined : West Bengal : 12 exs, Botanical garden, Shibpur (Howrah), 16.I.2001. Coll. G.P. Mandal.

Distribution : India : West Bengal.

Remarks : The material collected during the present investigation indicates that the species are conspecific in every aspect with those of Choudhuri and Roy (1965).

Genus *Mesaphorura* Börner

1901. *Mesaphorura* Börner, *Abh. Naturwiss. Ver. Bremen*, 17 : 1-141.

1966. *Mesaphorura* Yosii, *J. Coll. Arts. and Sci., Chiba Univ.*, 4(4) : 461-531.

Type species : *Mesaphorura krausbaueri* Börner, 1901.

*11. *Mesaphorura choudhuria* Yosii

(Fig. 15)

1966. *Mesaphorura choudhuria* Yosii, *J. Coll. Arts. and Sci., Chiba Univ.*, 4(4) : 461-531.

Diagnostic characters : Body white in colour. Antennae pedunculate, segments III and IV with border, segment IV with 7 curved distal sensory setae. P.A.O narrowly elongated. Anal spine acute, slightly curving upwards; unguis small, untoothed; unguiculus absent and tenent hair absent. Furcula absent. Body length 1.0 mm.

Material examined : Sikkim : 25 ex, Tashi, Gangtok, 25.IV.1998, Coll. A.K. Hazra 8 ex, 26.IV.1998, Water falls towards Tssangu, 26.IV.1998, Coll. A.K. Hazra, 6 ex, Ranipool Paddy field area, Gangtok, 30.X.1992, Coll. A.K. Hazra.

Distribution : India : Sikkim.

Remarks : On comparison the present specimens with those of Yosii (1966) appear same with some morphometric differences.

Genus *Spelaphorura* Bagnall

1948. *Spelaphorura* Bagnall, *Ann Maag. Nat. Hist.*, (12) 2 : 81-96.

1958. *Spelaphorura* Salmon, *Trans. Zoology*, 145-146.

Type species : *Spelaphorura glenniei* Bagnall, 1948.

*12. *Spelaphorura clayae* Salmon

(Fig. 16)

1958. *Spelaphorura clayae* Salmon, *Trans. Zoology*, 145-146.

Diagnostic character : White in colour with sparse, mostly short, simple setae with a few posterior ones longer. Antennae a little shorter than the head in length, ratio of antennal segments I-IV as 5 : 11 : 32 : 13 : 19; the third and fourth segments indistinctly divided. P. A.O. situated in a deep oval depression and comprising 18 simple foliaceous vesicles having the thicker inner ends. Ratio of claw and posterior setae as 30 : 32 : 44. Furcal ridge absent. Unguiculus about half as long as claw with distinct bubbous granulated lamella and needle-like extension. Body length 0.5 mm.

Material examined : Sikkim : 3 exs, Gangtok, 12.IV.1998, Coll. A. K Hazra; 8 exs, Gangtok (6000ft), 10.XI.1952, Coll. Dr. T. Clay.

Distribution : India : Sikkim.

Remarks : Salmon (1958) described the species of amongst collection of Dr. T. Clay (BMNH) in the dry and rotten leaves of 6000 ft high above Sikkim. The present materials taken from the study area conform to Salmon (1958) in types and description.

Family ISOTOMIDAE

This family includes Arthopleona with distinct antennal segments, mouth parts with well developed mandibular molar plate, pronotum reduced without setae and with a postantennal organ of a single tubercle. Unguis with a single inner margin. Abdominal segments III and IV similar in length lacking scales or 'flexed' setae.

Key to genera of ISOTOMIDAE

1. P.A.O present 2
- P.A.O absent *Isotomiella*
2. Ventral manubrial setae 14 or more 3
- Ventral manubrial setae 6 or fewer 7
3. Ocelli 8 + 8 4
- Ocelli 3 + 3 5
4. P.A.O elongate 6
- P.A.O small and ovoid, setae arising from papillae *Papillomurus*
5. Ocelli 3 + 3, dentes with two prominent corrugations and mucro with small apical and large subapical tooth *Parafolsomia*
- Ocelli 5 + 5, mucro distinctly separated from dens, abdominal segment V and VI fused *Cryptopygus*
6. Abdominal setae multilaterally ciliated in some cases *Isotomurus*
- Abdominal setae unilaterally ciliated 8
7. Dental crenulation absent *Ballistrura*
- Dental crenulation present *Rhodanella*

8. Tenent hair present, dentes with 20 rather strong setae in three longitudinal rows *Isotomina*

 — Tenent hair absent, dentes with less than 20 strong setae *Isotoma*

Genus *Isotomurus* Börner

1903. *Isotomurus* Börner, *Ges. Naturwiss Freunde Berlin*, 1903 : 129-182.

1963. *Isotomurus* Yosii, *Contr. Biol. Lab., Kyoto. Univ.*, 15 : 4.

Type species : *Podura palustris* Muller, 1776.

13. *Isotomurus balteatus* (Reuter)

(Fig. 17)

1876. *Isotoma balteatus* Reuter, *Med. Soc. Fauna et. Flora. Fenn.*, 1 : 82.

1963. *Isotomurus balteatus* (Reuter) Yosii, 1963. *Contr. Biol. Lab, Kyoto. Univ.*, 15 : 4.

Diagnostic characters : Colour with a deep violet pigment appearing black which form distinct transverse band on the anterior margin of tergites. Ocelli 8 + 8. Antennal segment ratio is 10 : 15 : 16 : 26. Ant. IV with short subapical sense rods. P.A.O as large as anterior ocellus. Furcula large. Dens distinctly annulated with dorsal side; mucro with a small apical, 2 large subapical and large external lateral teeth.

Material examined : Arunachal : 12 exs, Bomdila (West-Kameng Dist.), 02.IV.1999, Coll. A.K. Hazra; 2 exs, ALPA (Upper Subansiri Dist.), 26.III.1999, Coll. A.K. Hazra; 2 exs, Kodak Village (Upper Subansiri Dist.), 26.III.1999, Coll. A.K. Hazra. Tripura : 60 exs, Nirmahal (West Tripura Dist.), 07.V.1995, Coll. A.K. Hazra. Manipur : 15 exs, Longtinmanlei, (Churachandpur Dist.), 16.VI.1993, Coll. R.S. Burman; 12 exs, Kharasam (Churachandpur Dist.), 14.VI.1993, Coll. R.S. Burman.

Distribution : India : Arunachal, Manipur, Orissa, Tripura and West Bengal.

Remarks : The species was first described as *Isotoma balteatus* by Reuter (1876). Yosii (1963) revised the generic status of the species to *Isotomurus*. On critical examination of the types and the specimens taken from the different localities of Arunachal, Manipur and Tripura, both are conspecific in every aspect.

Genus *Isotoma* Bourlet

1839. *Isotoma* Bourlet, *Mem. Soc. Sci. Agric. Arts Lille* : 377-417.

Subgenus *Desoria* Nicolet, 1841

1841. *Desoria* Nicolet, *Bibl. Univers.*, (2) 32 : 384-387.

1896. *Desoria* Macgillivray, *Can. Entomol.*, 28 : 47-58.

Type species : *Desoria saltans* Nicolet, 1841.

14. *Isotoma (Desoria) trispinata* (Macgillivray)
(Fig. 18)

1896. *Desoria trispinata* Macgillivray, *Can. Entomol.*, 28 : 47-58.

1966. *Desoria trispinata* Macgillivray: Yosii, *J. Coll. Art. And Sci. Chiba Univ.*, 4(4) : 461-531.

Diagnostic characters : Dark brown with light yellowish pigments. Post antennal organ rounded. Antennal segment IV with one subapical cone. Mucro tridentate and unguis without tooth. Manubrium ventrally with many setae arranged in a triangle. Dentes dorsally with some setae.

Material examined : Sikkim : 1 ex, Tackchan river bank; Gangtok, 30.X.1992, Coll. A.K. Hazra; 14 exs, Kabi, 07.XI.1992, Coll. A.K. Hazra.; 10 exs, Tashi-hills, 01.XI.1992, Coll. A.K. Hazra; 10 exs, Singhik, 05.XI.1992, Coll. A.K. Hazra; 3 exs, Tikjuk, 05.V.1998, Coll. A.K. Hazra.

Distribution : USA, Europe, Indonesia, Japan Nepal, India : Sikkim, Assam and Nagaland.

Remarks : Macgillivray (1896) first described the species followed by Yosii (1966) from Indonesia and Japan. The species collected during the present investigation fully conform with Macgillivray (1896) and Yosii (1966) with some morphometrical differences which in no way favour in consideration of the species as new member of the genus.

*15. *Isotoma (Desoria) mazda* Yosii

1971. *Desoria mazda* Yosii, *Khumbu Himal*, 4 : 80-130.

Diagnostic characters : The species is totally dark brown in colour without pigments called "Glacial fleas" of Himalayan and was described by Yosii (1971) from the Nare Glacier.

Material examined : Sikkim : 15 exs, Tssangu Lake Glacier side (East Dist.), 26.IV.1998, Coll. A.K. Hazra.

Distribution : Nepal, India : Sikkim.

Remarks : Yosii (1971) described this species from the Nare Glacier (Amai-Dublong Gletscher, 5,550 mts altitude). On critical analyses of morphology, it appears that there lies little differences but pending further study with more specimens, the species has been kept as such as Yosii (1971).

Key to species of *Isotoma* (Desoria)

- Dark brown without pigments *mazda*
- Dark brown with light yellowish pigments *trispinata*

Genus *Isotomina* Börner

1903. *Isotomina* Börner, *Naturwiss Freunde Berlin*, 1903 : 129-182.

1947. *Isotomina* Stach, *Pol. Aka. Umi., Krakow.*, 488 pp.

Type species : *Isotomina agreni* Börner, 1903

16. *Isotomina thermophila* (Axelson)

(Fig. 19)

1900. *Isotomina thermophila* Axelson, *Medd. Soc. Faun. et., Flora. Fenn.*, **26** : 113.

1947. *Isotomina thermophila* Stach, *Pol. Aka. Umi., Krakow.*, 488 pp.

Diagnostic characters : Body length 0.7 mm. Colour uniformly gray. Eyes 8 + 8. Antennae slightly dark with pale extremities; ratio of antennal segments I-IV 24 : 32 : 34 : 50; segment III with a pair of small sensory organ in a groove, segment IV with a low terminal bulbs and long, curving sensory setae subequal. PAO subequal, broadly elliptical; unguis carinate without tooth; unguiculus, triangular with a basal inner margin broad and swollen at the middle. Tenent hair absent. Furcula well developed not reaching the ventral tube. Dentes ventrally with about 20 rather strong setae in 3 longitudinal rows. Mucro short, equally bidentate.

Material examined : Arunachal : 4 exs, Leni village (West Kamang Dist.) 01.IV.1999, Coll. A.K. Hazra. Sikkim : 12 exs, Ranipool paddy field area (East Dist.), 30.X.1992, Coll. A.K. Hazra.

Distribution : Cosmopolitan, India : Sikkim, Arunachal Pradesh.

Remarks : Axelson (1900) first described this species followed by Stach (1947). The species of the present investigation are similar to those Axelson (1900) and Stach (1947) with some morphometrical differences which do not favour for establishing it as new member of the genus.

Genus *Isotomiella* Bagnall

1939. *Isotomiella* Bagnall, *Entomol. Mon. Mag.*, **75** : 91-102.

1966. *Isotomiella* Yosii, **8** : 333-405.

Type species : *Isotoma minor* Schaeffer, 1896.

17. *Isotomiella minor* (Schaffer)

(Fig. 20)

1898. *Isotomiella minor* Schaffer, *Naturgesch.*, 64 : 393-425.1966. *Isotomiella minor* Yosii, *Kyoto Univ., Sci., Expd. to the Karakoram & Hindukush*, 8 : 333-405.

Diagnostic characters : White in colour. Posterior face with 2 + 2 setae. Antennal segment I with a ventral sensory seta; ratio of antennal segments I-IV 5 : 5 : 8 : 10. Eyes and PAO absent. Legs without clubbed setae; unguis carinate, untoothed; unguiculus small, broad, about one half of unguis in length and untoothed. Ventral tube anteriorly with 4+4 setae in two rows. Manubrium ventrally with 5 + 5 and dorsally with some 10 weak setae. Dentes indistinctly annulated with more than 40 ventral setae in three longitudinal rows and dorsal setae 6 weak setae (basal 2, parabasal 2 and median 2). Body length 0.8mm.

Material examined : Sikkim : 12 exs, Ranipool paddy field area (East distt.), 30.X.1992, Coll. A.K. Hazra.

Distribution : Cosmopolitan, India : Sikkim.

Remarks : Schaffer (1898) first described this species followed by Yosii (1966). The species of the present investigation fully conform with Schaffer (1898) and Yosii (1966) showing some morphometrical differences.

Genus *Parafolsomia* Salmon1949. *Parafolsomia* Salmon, *Brit. Sci. News.*, 2(19) : 196-198.

Type species : *Parafolsomia trioculata* Salmon, 1956.

*18. *Parafolsomia trioculata* Salmon

(Fig. 21)

1956. *Parafolsomia trioculata* Salmon, *Proc. Roy. Ento. Soc. London* : 127-128.

Diagnostic characters : Colour pale yellow with deep dorsal and lateral bluish black granular pigments. Body clothed with short simple setae and occasional longer setae. Ocelli 3 on each side. Antennae subequal to head in length, ratio of antennal segments I-IV 5 : 9 : 15 : 25, segment IV with apical sensory dome, five to six stout, large, curved sense rods and numerous short setae. PAO elongate elliptical, very narrow, and seven times longer than broad, with a constriction or band across the middle. Legs with deep blue coxae; claw without any teeth; unguis short, lanceolate with broad curved inner lamella. Furcula : Manubrium with hooks, mucro ratio as 30 : 29 : 9. Body length 1.4 mm.

Material examined : Sikkim : 8 exs, Tssangu (East Dist.), 26.IV.1998, Coll. A.K. Hazra.

Distribution : India : Sikkim.

Remarks : Salmon (1956) described this species from the collections of Dr. T. Clay of B.M.N.H (1952). The materials examined here appear to be same as those of Dr. Clay described by Salmon (1956) in morphology and morphometrics.

Genus *Papillomurus* Salmon

1941. *Papillomurus* Salmon, *Trans. R. Soc. N. Z.*, **70** : 282-431.

Type species : *Papillomurus transequatoria* Salmon, 1941.

*19. *Papillomurus transequatoria* Salmon (Fig. 22)

1969. *Papillomurus transequatoria* Salmon, *Zool. Publ. Vict. Univ.*, **51** : 40-48.

Diagnostic characters : Ocelli 8 on each side. Antenna subequal to head; ratio of antennal segments 53 : 33 : 30 : 17. Ant. II with many similar slender sense rods; segment IV with apical dome; abdominal segments 6 : 7. PAO elliptical. Claw with finely granulated base, unguiculus lanceolate with three broad lamellae and about half as long as claw; mucro dens 3.2 times longer than manubrium; dens annulated and corrugated, the uncorrugated part 2-3 times as long as mucro; mucro tridentate, with large apical, slightly longer preapical and large lateral teeth. Body length 1.47 mm.

Material examined : Sikkim : 7 exs, Lachung, 23.IV.1998, Coll. Dr. A.K. Hazra.

Distribution : India : Sikkim.

Remarks : The species was described by Salmon (1969) from the moss on rotten tree trunk in pine wood at 8610 ft. altitude of Lachung. The species of the present investigation fully conform with Salmon (1969) showing some morphometrical differences.

Genus *Rhodanella* Salmon

1949. *Rhodanella* Salmon, *Brit. Sci. News.*, **2**(19) : 196-198.

Type species : *Rhodanella plumosa* Salmon, 1949.

*20. *Rhodanella plumosa* Salmon (Fig. 23)

1969. *Rhodanella plumosa* Salmon, *Zool. Publ. Victoria Univ.*, No. **51** : 40-48.

Diagnostic characters : Ocelli 8 on each side in the form of black pigment patches. Antennae little longer than head as 16 : 13; ratio of antennal segments I-IV 14 : 20 : 26 : 44, segment IV with slender curved and straight sense rods and setae. PAO small more or less ovoid. Abdominal segments III and IV subequal in length, segments V and VI fused; tenaculum not seen. Unguiculus granulated, lanceolate. Claw with a single long slender non clavate tenent hair almost as long as claw. Furcula reaching beyond abdominal segment II. Manubrium with mucrodens 30 : 95, mucro indistinctly separated from dens, ratio being 91 : 4; dens small, annulated and corrugated, the uncorrugated portion about 2.5 times as long as mucro. Body length 0.6 mm.

Distribution : India : Manipur and Sikkim.

Remarks : Salmon (1969) described this species from Lachung, Sikkim, 8610 ft. altitude in moss on pine trunks in pine woods; and Imphal, Manipur state in rotting *Eichoring*.

Genus *Cryptopygus* Willem

1902. *Cryptopygus* Willem, *Ann. Soc. Entomol. Belg.*, 46 : 275-283.

Type species : *Cryptopygus antarcticus* Willem, 1902.

21. *Cryptopygus thermophilus* Axelson

(Fig. 24)

1900. *Cryptopygus thermophilus* Axelson, *Medd. Soc. Fauna et. Flora. Fenn.*, 26 : 113; Stach.

1947. *Cryptopygus thermophilus* Polska Akademia Umiejetnosci, *Krakaow*, 488 pp; Stach.

1963. Yosii, *Contr. Biol. Lab. Kyoto. Univ.*, 15 : 4.

Diagnostic characters : Body length 1.2 mm. Colour generally dark brown with numerous pale spots. Eyes 8 + 8. Antennal segment IV without distinguishable seta. P.A.O about 3 times as long as the nearest eye. Unguis without lateral teeth but with a clear inner teeth; unguiculus tooth-less. Ventral tube with 2 basal posterior setae and 4 + 4 distal anterior setae. Manubrium 1/2-3/5 as long as dens, with 1 + 1 ventral setae dens with numerous dorsal crenulations, 6 + 6 dorsal setae, and about 20 ventral setae.

Material examined : Manipur : 2 exs, Khowpuibung village (Churachandpur Dist.), and 01.IV.1992. Coll. A.K. Hazra.

Distribution : North America, Japan, India : Manipur, Assam, Orissa and West Bengal.

Remarks : Axelson (1900) described the species followed by Stach (1947) and there after Yosii (1963). The insects sorted out from the collections of the Zoological Survey of India conform fully with those of the previous authors especially of Yosii (1963) in all aspects.

Genus *Ballistrura* Börner

1906. *Ballistrura* Börner, Mitt. Naturhist. Mus. Hamburg, 23 : 147-188.

Type species : *Isotoma schoetti* Dallan Torre, 1895.

*22. *Ballistrura bengalensis* Yosii

(Fig. 25)

1966. *Ballistrura bengalensis* Yosii, Kyoto Univ. Sci., Expd, to the Karakoram and Hindukush, 1955. 8 : 333-405.

2003. *Ballistrura bengalensis* Hazra and Bhattacharyya, 2003. Zool Surv. Ind., Occ. Paper No. 214 : 1-199.

Diagnostic characters : Body length 0.8 mm. Colour uniformly reddish purple upon antennae and dorsal side of the body. Eyes 8 + 8, black. Antennae slightly longer than head, ratio of antennal segments 7 : 12 : 16 : 25. PAO is broadly oblong. Unguis straight, not toothed; unguiculus triangular, tenent hairs 2, 2, 2. Ventral tube with 3 + 3 anterior and 1 + 1 posterior setae. Furcula well developed. Manubrium dorsally with numerous short scattered dorsal setae, ventral side smooth and without setae. Dentes not much tapered; mucro elongate, carinate ventrally and apically bidentate and equal with many ventral dental setae with no dental dorsal crenulations.

Material examined : West Bengal : 16 exs, Botanical garden, Kolkata. 17.X.2003.Coll. G.P. Mandal; 6 exs, Bethuadahri Reserve Forests, 16.III.2000, Coll. G.P. Mandal.

Distribution : India : West Bengal.

Remarks : Yosii (1966) described the species from the material collected from his expedition to Expedition to the Karakoram and Hindukush sponsored by Kyoto University, Japan following confirmation by Hazra and Bhattacharyya (2003) from India. The present specimens look like those of Yosii (1966) and Hazra and Bhattacharyya (2003) in both morphology and chaetotaxy.

Family ENTOMOBRYIDAE

This family includes members of the Arthropleona characterised by reduced prothorax, without setae and postantennal segment and with scales or multilateral ciliate setae on all trunk segments, trochanteral organ, a series of short differentiated setae on the inner surface of the trochanter, fourth abdominal segment of some species much longer than the third. Without postantennal organ. Unguis and unguiculus always well developed and the former has a characteristic lamellar structure in most subfamilies. Furcula always well developed; dens and mucro are characteristics of the different subfamilies. Sexual dimorphism little or absent.

Characteristics of Subfamilies of Entomobryidae :

Subfamily	Scales	Maximum Eye No.	Adult Post Antennal Organ	Dental Spines	Mucro
ENTOMOBRYINAE	+ or –	8	–	+ or –	Short, 2 teeth
CYPHODERINAE	+	0	–	–	Elongate
PARONELLINAE	–	8	–	–	Short, 2-4 teeth
ONCOPODURINAE	+	4	+	+	Elongate
TOMOCERINAE	+	6	–	+	Elongate

Subfamily ENTOMOBRYINAE

It is distinguished by dorsal crenulate dentes and the short hook-like or bidentate mucro. Body with hairs or scales or both, the chaetotaxy of head and trunk, and number of eyes.

Key to genera of Entomobryinae

1. Body with scales 2
- Body without scales 8
2. Mucro falcate *Seira*
- Mucro bidentate 3
3. Dentes with scales on ventral surface 4
- Dentes without scales *Willowsia*
4. Fourth abdominal segment more than twice as long as the third 5
- Fourth abdominal segment at midline less twice as third *Heteromurus*
5. Eyes 8 + 8. Antennae not annulate *Lepidocyrtus*
- Eyes 8 + 8. Antennae annulate 6
6. Antennae annulated on III-IV 7
- Antennae 5 segmented, segment I subdivided. Dens dorsally crenulated *Dicranocentrus*

7. Dens corrugated *Setogaster*
 — Dens not corrugated and mucro bidentate *Lepidosira*
 8. Eyes 4 + 4 or fewer *Sinella*
 Eyes 8 + 8, fourth abdominal segment at midline more than 3 times as long as the third
 *Entomobrya*

Genus *Lepidocyrtus* Bourlet

1839. *Lepidocyrtus* Bourlet, *Mem. Soc. Agric. Arts. Sci. Douai* : 89-166.

Type species : *Lepidocyrtus curvicollis* Bourlet, 1839.

23. *Lepidocyrtus magnificus* Carpenter
 (Fig. 26)

1924. *Lepidocyrtus magnificus* Carpenter, *Rec. Ind. Mus., Cal.*, 26 : 285-289.

1995. *Lepidocyrtus magnificus* Hazra, *State Fauna Series, Zool. Surv. Ind.*, 4(3) : 13-32.

Diagnostic Characters : Body length 2.75 mm. Pale yellow in colour. Antenna twice as long as head, Antennal segments III and IV relatively short; ratio of antennal segments I-III 6 : 14 : 10 : 17. Mucro with the strong teeth. Mesonotum very prominent, four times as long as metanotum. Claw elongate, little curved with narrow internal lamella proximal and distal teeth. Manubrium somewhat longer than dentes; mucro relatively stout with strong teeth, the dorsal spine short. Fourth abdominal segment seven times as long as third. Spring half as long as body. The last abdominal segment dark violet.

Material examined : Arunachal : 32 exs, Sessa Culvert No. R-55/4A (West Kameng), 31.III.1999, Coll. A.K. Hazra, Manipur : 58 exs, Santipur and Checklaphai Reserve Forest (Churachanpur) 03.IV.1992, Coll. A.K. Hazra. Mizoram : 15 exs, New Saiha, 07.IV.1994, Coll. A.K. Hazra. Nagaland : 38 exs, Phek Culvert No. 36/3 (Phek), 24.III.1997, Coll. A.K. Hazra. Tripura : 10 exs, Hatiposa Village (South Tripura), 04.V.1995. Coll. A.K. Hazra. Sikkim : 1 ex, Ranikhola (Gangtok), 30.X.1992, Coll. A.K. Hazra; 2 exs, Sarmsa Orchid garden (Gangtok) 31.X.92, Coll. A.K. Hazra; 27 exs, Singhik, 05.XI.1992, Coll. A.K. Hazra; 2 exs, Kabi, 07.XI.1992, Coll. A.K. Hazra; 133 exs; Benjong (South), 09.XI.1992, Coll. A.K. Hazra; 2 exs, Ravangla, 03.V.1998, Coll. A.K. Hazra; 60 exs; Monastary campus, Pemayangtshi, 10.V.1998. Coll. A.K. Hazra.

Distribution : Singapur, Malayasia, India : Arunachal, Manipur, Mizoram, Nagaland, Sikkim and Tripura.

Remarks : Carpenter (1924) described the species from Indian subcontinent and after long years Hazra (1995) put it in the list of fauna of the state of West Bengal. The author during the present study could identify a quite good number of specimens from the northeastern states of India. The specimen on examination has been observed to be similar to those of the types in all aspects and hence it is confirmed.

24. *Lepidocyrtus (Ascocyrtus) medius* Schaeffer
(Fig. 27)

1898. *Lepidocyrtus medius* Schaeffer, *Naturgesch.*, **64** : 393-425.
 1912. *Lepidocyrtus medius* Börner, *Tijdschr. V. Entom.*, **56** : 44-61.
 1926. *Lepidocyrtus medius* Handschin, *Treubia*, **8** : 446-461.
 1949. *Lepidocyrtus medius* Uchida, *Insecta. Mat. Sap.*, **17** : 38-47.
 1959. *Lepidocyrtus medius* Yosii, *Contr. Biol. Lab. Kyoto., Univ.*, **10** : 26.

Diagnostic characters : Colour brownish white. Eyes black with a median spot between eyes. Eyes 8 + 8. Antennae pigmented purple distally, segments without scales, segment I with denuded setae; ratio of antennal segments I-IV 12 : 28 : 30 : 42. Ant/Head as 28 : 15. **Ths. II** is protruded considerably over the head. Thoracic segments. II : III 15 : 7. Legs without scales at least on distal segments; unguis and tenent hair usual; unguiculus strongly truncate on its inner side. Furcula with manubrium: dens as 1 : 1. Manubrium is ventrally scaled and with 3 + 3 terminal setae. Dentes are normally with 4 rows of setae. Mucro with apical tooth elongated, anteapical tooth little smaller. Abdominal segments III : IV 1 : 3. Body length 1.5 mm.

Material examined : Sikkim : 10 exs, Ranikhola River bank, Gangtok, 30.X.1992, Coll. A.K. Hazra. 10 exs; West of Tashi Hills, 01.XI.1992, Coll. A.K. Hazra; 13 exs, side of hillstream, Singhik, 04.XI.1992, Coll. A.K. Hazra; 16 exs, Benjong, 09.XI.1992. Coll. A.K. Hazra. 8 exs, Jorethang, 09.XI.1992, Coll. A.K. Hazra; 40 exs, Rongpo, 12.XI.1992, Coll. A.K. Hazra; 10 exs., Dophang, Geyzing, 3.V.1998., Coll. A.K. Hazra; 90 exs, Legship, 09.V.1998, Coll. A.K. Hazra. Tripura : Rudrasagar (West), 06.V.1995, Coll. A.K. Hazra. Nagaland : 65 exs, Phek and Khezkinoma (Phek), 24.III.1997, Coll. A.K. Hazra, 20 exs; Khezikinoma; 35 exs, Pulebadge (Kohima) wild life sanctuary, 25.III.1997, Coll. A.K. Hazra. Mizoram : 10 exs, Kolash, 31.IX.1996. Coll. S.K. Mitra; 12 exs, Saiha Circuit House, Saiha, 06.IV.1994. Coll. A.K. Hazra; 2 exs, Zemabawk, 13.IV.1994, Coll. A.K. Hazra. Manipur : 10 exs, Keibul National Park (Churachandpur). 02. IV.1992, Coll. A.K. Hazra; 3 exs, Jiribam, 23.VI.1993. Coll. R.S. Burman; 12 exs, Imphal, 21.VI.1993, Coll. R.S. Burman.

Distribution : Singapur, Malayasia, India : Manipur, Mizoram, Nagaland, Sikkim and Tripura.

Remarks : The species was established by Schaeffer (1898) followed by revisions and redescriptions of several authors in subsequent years. The specimens taken from the several states of north east parts of India appear to be the same as those identified previously except some morphometric differences.

25. *Lepidocyrtus (Acrocyrtus) malayanus* Yosii
(Fig. 28)

1959. *Lepidocyrtus (Acrocyrtus) malayanus* Yosii, *Contr. Biol. Lab. Kyoto. Univ.*, 10 : 28.

Diagnostic characters : Body length 2.5 mm. Ground colour brownish white. Eyes black ventral side. Fore margin of the head with a row of about 12 + 12 robust setae. Eyes 6 + 6. Antenna : Head as 12 : 7. Antennae intensely coloured with bluish pigments distad of segment II, segments I and II with scarce dorsal setae; ratio of antennal segments I-IV 9 : 18 : 11 : 23. Mesonotum strongly hanging over the head. Unguis long.; unguiculus slender, lanceolate and pointed. Furcula pale with Manubrium : dens. Manubrium with dense scales and with 3 + 3 terminal setae. Abdominal segments III : IV as 1 : 5. Dorsal appendix of dental lobe acute. Mucro bidentate with a basal spine; apical and anteapical tooth subequal.

Material examined : Arunachal : 100 exs, Sangrila (Tawang), 07.IV.1998, Coll. A.K. Hazra; 20 exs, Saiha village (Tawang), 06.IV.1994, Coll. A.K. Hazra. Sikkim : 9 exs, Ranipool Paddy field area (East Dist.) 30.X.1992, Coll. A.K. Hazra; 5 exs, Benjong (South). 09.XI.1992, Coll. A.K. Hazra; 230 exs, Namuna Basti Namchi (South Dist.), 30.IV.1998, Coll. A.K. Hazra; 30 exs, Kewizing, near P.W.D Bunglow, 03.V.1998. Coll. A.K. Hazra. Mizoram : 20 exs. Hill slopes, Circuit house, Saiha, 06.IV.1994, Coll. A.K. Hazra. Nagaland : 25 exs, Rangpahar Reserve Forests (Dimapur). 19. III.1997, Coll. A.K. Hazra; 25 exs, Itangki Reserve Forest (Dimapur), 18.III.1997, Coll. A.K. Hazra, 35 exs. Tripura : 7 exs, Sepahijola, W.L.S. (West Dist.), 26.IV.1995, Coll. A.K. Hazra, 7 exs. Manipur : 20 exs, Santipur (Charuchandrapur Dist.), 03.IV.1992, Coll. A.K. Hazra.

Distribution : Singapore, Malayasia, India : Mizoram, Nagaland, Arunachal Pradesh, Manipur, Mizoram, Nagaland Sikkim and Tripura.

Remarks : Yosii (1959) described the species in the subgenus *Acrocyrtus* of *Lepidocyrtus*. The species remained unattended afterwards. The present author during the survey made by the Zoological Survey of India could identify the species from different places of north-eastern states of the subcontinent which are similar to those described by Yosii (1959).

26. *Lepidocyrtus (Acrocyrtus) heterolepis* Yosii
(Fig. 29)

1959. *Lepidocyrtus (Acrocyrtus) heterolepis* Yosii, *Contr. Biol. Lab. Kyoto. Univ.*, 10 : 33.

Diagnostic characters : Body length 1.6mm. Body uniformly with bluish tinge. Ant./Head as 12 : 7. Eyes black 8 + 8. Head with a transverse stripe along the fore margin; frontal area and ventral side of the head dark. Antennae uniformly bluish pigmented. antennal segment; segments I and II with scales dorsally without setae; ratio of antennal segments I-III 15 : 30 : 28 : 48. Thoracic segments I and II little protruded, segments. II, III as 75 : 25. Legs with unguis with usual teeth and unguiculus lanceolate. Furcula not well developed. Manubrium: Dens as 24 : 18. Manubrium with ventral scaled and with 3 + 3 terminal setae. Dentes shorter than manubrium, mucro bidentate, two teeth subequal and with a basal spine. Abdominal segments III : IV as 3 : 12.

Material examined : Manipur : 11 exs, Longtinmanlei (Churachandpur distt.), 16.VI.1993. Coll. R.S. Burman; 2 exs, S. Vaoying (Churachandpur), 04.IV.1992, Coll. A.K. Hazra. Arunachal : 5 exs, Dirang (West Kamang), 04.IV.1999, Coll. A.K. Hazra; 50 exs, Rupa Valley (West Kameng), 01.IV.1999, Coll. A.K. Hazra; 6 exs, Tawng (Tawang) 07.IV.1999, Coll. A.K. Hazra.

Distribution : Singapur, Malayasia, India : Arunachal and Manipur.

Remarks : The species was described in the subgenus by Yosii (1959) and was kept as such for longer period. The survey of the collembolan fauna of the northeastern states resulted quite a good number of specimens of the genus which on identification appear to be the same species of the subgenus and genus.

27. *Lepidocyrtus exploratorius* Carpenter (Fig. 30)

1924. *Lepidocyrtus exploratorius* Carpenter, *Rec. Ind. Mus., Calcutta*, 26 : 286.

1995. *Lepidocyrtus exploratorius* Hazra, *State Fauna Series, Zool. Surv. Ind.*, 4(3) : 13-32.

Diagnostic characters : Body length 1.7 mm, body colour uniformly pale yellow, antennae deep violet and faint violet string on coxae. Relative length index of antennae as 5 : 7 : 7 : 11. Furcula nearly half as long as body; manubrium slightly larger than dentes; mucro relatively slender with prominent teeth, the dorsal spine elongate and acute.

Material examined : West Bengal : 12 exs, Bethuadahari Reserve Forest, 12.III.2000, Coll. G.P. Mandal.

Distribution : India : Meghalaya (South Garohills) and West Bengal.

Remarks : Carpenter (1924) recorded this species from Meghalaya (Siju Cave) and described in detail. After a long period, Hazra (1995) could identify the species in the collembolan fauna of the state of Meghalaya. During the survey of the collembolan fauna in the state of

West Bengal, the author could collect the species which seem like those described by the previous authors.

28. *Lepidocyrtus caudatus* Carpenter

(Fig. 31)

1917. *Lepidocyrtus caudatus* Carpenter, *Rec. Ind. Mus, Calcutta*, 8(IX) : 561-568.

Diagnostic characters : Pale yellow in colour with violet patches on the antennal segment Mesonotum slightly prominent, half as long as metanotum. Furcula more than half as long as body; dentes 1.3 times length of manubrium; mucro with strong procurved terminal and dorsal teeth and slender dorsal spine. The elongate cerciform tergum of the Abdominal segments with elongate cerci. Body length 2.5 mm.

Material examined : Arunachal : 8 exs, Dirang (West Kamang Dist.), 04.IV.1999, Coll. A.K. Hazra; Manipur : 21 exs, Longtinmanlei (Churachandpur Dist.), 16.VI.1999. Coll. R.S. Burman.

Distribution : Myanmar, India : Arunachal Pradesh, Manipur and Sikkim.

Remarks : The species came to light due to Carpenter (1917) from India and has been remaining as such. The number of specimens from the collections of the Zoological Survey of India under the leadership of Dr. A.K.Hazra was identified as *Lepidocyrtus caudatus* Carpenter (1917) which are found to conform to those of the types lying in the NZC, Calcutta.

29. *Lepidocyrtus (Lanocyrtus) cyaneus* (Tullberg)

(Fig. 32)

1869. *Lepidocyrtus cyaneus* Tullberg, *W. Sch. Bokt. Uppsala*, 21 pp.

1959. *Lepidocyrtus cyaneus* Yosii, *Contr. Biol. Lab. Kyoto. Univ.*, 10 : 25.

Diagnostic characters : Antennal segments /Head 8.5. Ratio of antennal segments I-III 10 : 19 : 19 : 32. Mesothorax slightly protruded over the head. Thoracic segments II/III as 5 : 3. Legs coloured on the proximal half of coxae. Furcula coloured untill to the basal part of dentes. Furcula with manubrium : Dens as 10 : 9. Manubrium ventrally scaled with 2 + 2 serrated terminal setae. Dental lobe without appendix. Abdominal segments. III/IV as 4 : 13. Body length 1.0 mm.

Material examined : Arunachal : 22 exs, Yazali (Upper Subansiri Dist.), 24.III.1999, Coll. A.K. Hazra. Manipur : 15 exs, St. Thomas School Camp, Upper Hundeng (Ukhrul Dist.), 08.IV.1992, Coll. A.K. Hazra; 7 exs, S. Vaoying (Churachandpur Dist.), 04.IV.1992, Coll. A.K. Hazra.

Distribution : Malaysia, Singapur, Vietnam and India : Arunachal and Manipur.

Remarks : Tullberg (1869) recorded the species from Sweden with a brief description. Later Yosii (1959) made revisionary study of the species from the material fetched during the expedition of Kyoto University (Japan). During this study the specimens of the survey of the Zoological Survey of India are observed same as those of Yosii (1959) in toto.

30. *Lepidocyrtus curvicollis* Bourlet

(Fig. 33)

1839. *Lepidocyrtus curvicollis* Bourlet, *Mem. Soc. Sci. Agric. Arts Lille*, 1839 : 377-417.

1959. *Lepidocyrtus curvicollis* (S. Str) *curvicollis* Yosii, *Contr. Biol., Lab. Kyoto. Univ.*, 10 : 23.

Diagnostic characters: Ground colour white with slight brownish tinge. Eyes black. Ant/Head 2 : 1 Antenna scaled and the segment II bluish distad; ratio of antennal segments I-III 1 : 2 : 3. Mesothorax moderately hanging over the head; thoracic segments II : III 2 : 1. Legs with basal two segments slightly pigmented to blue. Manubrium : Dens 25 : 26. Dentes without dental appendix. Mucro bi-dentate and with a basal spine; manubrium ventrally scaled and 2 + 2 terminal setae. Abdominal segments III : IV 1 : 4. Body length 2.0.mm.

Material examined : Arunachal : 100 exs, Sela top (Tawang Dist.), 06.IV.1999, Coll. A.K. Hazra.

Distribution : Europe, India : Arunachal Pradesh.

Remarks : Bourlet (1839) discovered the species from Belgium which was lying unattended for than a century when Yosii (1959) revised the same after comparision with the material collected during the expedition of Kyoto University (Japan). In the present investigation, the specimens resulted from the survey of collembolan fauna of the north east reveal that the specimens appear similar to those described by Yosii (1959) in every respect.

Key to species of *Lepidocyrtus*

1. VIth abdominal segment with elongate cerciform tergum *caudatus*
- VIth abdominal segment without elongate cerciform tergum 2
2. Unguiculus truncate *medius*
- Unguiculus not truncate 3
3. Mesonotum relatively longer and shorter *exploratorius*
- Mesonotum relatively larger 4

- 4. Dentes with prominent setae *malayanus*
- Dentes without prominent setae 5
- 5. Modified scales in front of the head *heterolepis*
- Modified scales absent in front of the head 6
- 6. Thoracic segment II very prominent and protruded *magnificus*
- Thoracic segment II little protruded 7
- 7. Mesothorax little protruded; ratio of thoracic segments II: III as 5:3 and abdominal segments III/IV as 4:13 *cyaneus*
- Mesothorax moderately protruded; ratio of thoracic segments II : III as 2 : 1 and abdominal segments III : IV as 1 : 4 *curvicollis*

Genus *Lepidosira* Schott

1925. *Lepidosira* Schott, *Sarawak Mus. Journ.*, **3** : 107-127.

*31. *Lepidosira unguiserrata* Salmon (Fig. 34)

1970. *Lepidosira unguiserrata* Salmon, *Trans. Biol. Sci.*, **12**(13) : 145-52.

Diagnostic characters : Brownish with deep blue ocellar fields. Antennae about three times as long as head, the four segments related as 45 : 90 : 75 : 125. Ant. IV with apical sensory knob. Abd. IV four times as long as Abd III. A single strong clavate tenent hair subequal to claw in length. Mucro bidentate with slightly curved basal spine. Body length 2.2 mm.

Material examined : Arunachal : 120 exs, Pine forest Ziro (Lower Subansiri Dist.), 23.III.1999. Coll. A.K. Hazra; 100 exs. New Urgeling (Tawang), 07.IV.1999, Coll. A.K. Hazra.

Distribution : India : Sikkim and Arunachal Pradesh.

Remarks : Salmon (1970) discovered the species from India. Several specimens on examination were found to conform to the species described by Salmon (1970) and also the types retained in the NZC, Calcutta in morphology and chaetotaxy.

Genus *Sinella* Brook

1882. *Sinella* Brook, *J. Linn. Soc. London Zool.*, **16** : 541-545.

Type species : *S. curviseta* Brook, 1882.

32. *Sinella curviseta* Brook
(Fig. 35)

1882. *Sinella curviseta* Brook, *J. Linn. Soc. London. Zool.*, 16 : 541-545.

1966. *Sinella curviseta* Yosii, *J. Coll. Arts & Sci., Chiba Univ.*, 4(4) : 461-531.

Diagnostic characters : Body with scattering of reddish pigment granules. Eyes with pigmented patches. Antennal segment III with many extremely minute blunt setae at its apical half clavate. Tenent hair clavate. Unguis with minute apical tooth, unguiculus acuminate. Mucro very long with basal spine.

Material examined : Arunachal : 123 exs, Sapper (West Kameng), 04.IV.1999, Coll. A.K. Hazra. Sikkim : 440 exs, Jorethang and Namuna Basti, Namchi, 09.XI.1992 and 30.IV.1998, Coll. A.K. Hazra; 80 exs, 4 km North-West of Singhik, 05.XI.92, Coll. A.K. Hazra; 12 exs, Yuksum (West Dist.), 07.V.1998, Coll. A.K. Hazra; 55 exs, Geyzing Bazar, 08.5.1998, Coll. A.K. Hazra; 34 exs, Jorethang, 13.V.1998, Coll. A.K. Hazra.

Distribution : Worldwide, India : Arunachal, Assam, Punjab, Sikkim and West Bengal.

Remarks : Brook (1882) first described this species followed by Yosii (1966). Several specimens on examination were found to conform to the species described by Yosii (1966) and also the types retained in the NZC, Calcutta in morphology and chaetotaxy.

Genus *Dicranocentrus* Schott

1925. *Dicranocentrus* Schott, *Sarawak Mus. Journ.*, 3 : 107-127.

Type species : *D. sundanensis* Schott, 1925.

33. *Dicranocentrus indicus* Bonet
(Fig. 36)

1930. *Dicranocentrus indicus* Bonet, *Eos.*, 6 : 249-273.

1960. *Dicranocentrus indicus* Yosii, *Kyoto, Univ., Sci., Expt. Karakoramand Hindukush*, 8 : 330-405.

Diagnostic characters : Eyes black. Meso thorax fringed with pigmented margins anteriorly and laterally. Antennareddish violet, annulated, five segmented, segment I subdivided, IV elongated, ratio of segments I : II 3 : 4. Manubrium dorsally beset with many plumose setae. Dentes dorsally crenulated and one blunt ciliated seta near the basis. Dental spines absent. Mucro bidentate equally and with or without a basal spine.

Material examined : Arunachal : 500 exs, Sangti vill. (West Kameng Dist.), 3.IV.1999, Coll. A.K. Hazra. Manipur : 60 exs, Khowpuibung Villlage, 01.IV.1992; 10 exs, Santipur 3.IV.1992; 4 exs, Checkalpai Reserve forest, 3.IV.1992, Coll. A.K. Hazra; 4 exs, Litan (Charuchandrapur Dist.), 12.VI.1993, Coll. R.S. Burman Behind Forest Rest House, Vairengate, 16.IV.1994, Coll. A.K. Hazra, 2 exs., Hill slope, circuit House, Saiha, 6.IV.1994, Coll. A.K. Hazra; 10 exs, Zoo Garden Aizal, 30.III.1994, Coll. A.K. Hazra. Mizoram : 32 exs, Keolie village (Phek Dist.), 24.III.1997, Coll. A.K. Hazra. Nagaland : 12 exs, Khezikinome, 24.III.1997, Coll. A.K. Hazra. 25 exs, Botanical garden, Kohima, 23.III.1997.

Distribution : Indonesia, South Pacific Islands, India : Nagaland, Manipur, Mizoram, Arunachal Pradesh, Maharashtra, West Bengal.

Remarks : Bonet (1930) first described the species followed by revision of Yosii (1960) on the basis of the material of the expedition to Karakoram and Hindukush of Kyoto University (Japan). The present collections of the Zoological Survey of India reaffirm the species after comparison of the specimens with description of Bonet (1930) and Yosii (1960) with the types made available to the author.

34. *Dicranocentrus simplex* Yosii

(Fig. 37)

1959. *Dicranocentrus simplex* Yosii, *Contr. Biol. Lab. Kyoto. Univ.*, **10** : 41.

Diagnostic characters : Ground colour whitish. Antennae, legs and ventral side of the body diffusely pigmented to blue. Distal segments of antennae and legs are darker. Antennal six segmented, the first two segments subdivided, segment V with sign of distal annulation; ratio of segments I-VI 5 : 23 : 9 : 31 : 70 : 12. Legs not scaled. Tenent hair of legs spiny. Unguiculus lanceolate and prominently and acute. Furcula well developed. Manubrium : Dens 11 : 17. Distal end of the Dentes with smooth long distal part, about 6 times the mucro in length. Mucro bidentate, the apical tooth prolonged and anteapical one short. Body length 1.7 mm.

Material examined : Arunachal : 26 exs, Bomdila (West Kamang Dist.), 01.IV.1999, Coll. A.K. Hazra.

Distribution : Singapur, India : Arunachal Pradesh.

Remarks : Yosii (1959) described the species in detail from Singapur. The Indian specimens taken from the montane region near Bomdila are observed the same as that of Yosii (1959) in most diagnostic features with minor differences in chaetotaxy.

Key to species of *Dicranocentrus*

- Antennae 5 segmented, segment I subdivided, IV elongated and distinctly annulated. Dental spines absent *indicus*
- Antennae 6 segmented, the first two segments indistinctly subsegmented. Dental spines present *simplex*

Genus *Setogaster* Salmon

1951. *Setogaster* Salmon, *Proc. R. Entomol. Soc. London*, B 20 : 131-141.

Type species : *Setogaster bispinosis* Handschin, 1932.

***35. *Setogaster manipuri* Salmon
(Fig. 38)**

1951. *Setogaster manipuri* Salmon, *Roy. Soc. N. Z. Biol. Sci.*, 51 : 41-48.

Dignostic characters : Pale yellow with violet pigmented ocellar fields. Antennae annulated on segments III-IV in female and IV only in male. Legs with claws having a pair of strong outer lateral teeth, five inner teeth in male and six inner teeth in female. Dens annulated and corrugated the mucro with very prominent, slightly curved, double basal spine. Lamella serrated. Abdominal segment IV four times longer than segment III. Body length of female 1 mm and male 1.3 mm.

Material examined : 17 exs, Santipur, Manipur, 3.IV.1992, Coll. A.K. Hazra.

Distribution : India : Manipur.

Remarks : Salmon (1951) recorded this speciess from Manipur based on the collection of Dr. T. Clay from Manipur. During the faunistic survey of the Zoological Survey of India, a few specimens came across which are identified as the species described by Salmon (1951) in descriptions and illustrations.

Genus *Entomobrya* Rondani

1861. *Entomobrya*, Rondani, *Dipterologiae Italicae Prodrum*, 40 : 40.

Subgenus *Homidia* Börner

1906. *Entomobrya* Börner, *Mitt. Naturhist. Mus. Hamburg*, 23 : 147-188.

Type species : *Entomobrya (Homidia) cingula* Börner, 1906.

***36. *Entomobrya (Homidia) cingula* Börner**

1906. *Homidia cingula* Börner, Mitt. Naturhist. Mus. Hamburg, 23 : 147-188.

Diagnostic characters : Back ground yellowish. Body not compressed. Dentes with 33 spines. Abdominal segments III and IV with black blue pigmented transverse bands. Apical mucronal tooth smaller than anteapical.

Material examined : Arunachal : 52 exs, Bame (Upper Subansiri), 28.III.1999, Coll. A.K. Hazra; 25 exs, Menga cave surrounding (Upper Subansiri), 26.III.1999, Coll. A.K. Hazra. Manipur : 22 exs, Imphal, 29.III.1992, coll. A.K. Hazra.

Distribution : India : Arunachal Pradesh, Manipur, Sikkim, Mizoram, Nagaland, Orissa, and West Bengal.

Remarks : The European species, *Entomobrya (Homidia) cingula* was first come into light due to Börner (1906). After nearly a century, the species was rediscovered from Arunachal and Manipur which after comparison with the types and description of Börner (1906) appear conspecific.

Genus *Seira* Lubbock

1869. *Seira* Lubbock, Trans. Linn. Soc. London, 27 : 277-297.

Type species : *Degeeria domestica* Nicolet, 1842.

***37. *Seira arunachala* Mitra**

(Fig. 39)

1976. *Siera arunachala* Mitra, Oriental Insects, 10(2) : 143-149.

Diagnostic characters : Body pale yellow with two darker blue black vacuolated patches on each side near tergal margins of thoracic segment III. Relative length index of Thoracic segments II : III = 25 : 20. Body clothed with setae and scales; 8 + 8 ocelli in 2 dark ocellar fields; relative length index of antennal segments I : II : III : IV = 11 : 17 : 20 : 30. Abdomen fusiform; relative length index of Abdominal segments I : II : III : IV : V : VI = 16 : 20 : 60 : 14 : 4. Furcula well developed. Manubrium : Dentes = 39 : 60; dentes annulated, marginal crenulations thrown into folds ending abruptly distally; mucrone typically falciform without basal spine. Body length 1.7 mm.

Material examined : Arunachal : 1 ex, Menga cave, 26.III.1999, Coll. A.K. Hazra; 52 exs, Bame (Upper Subansiri Dist.), 28.III.1999, Coll. A.K. Hazra.

Distribution : India : Arunachal Pradesh.

Remarks : Mitra (1976) described the species from India. The material resulted from our collection from two remote places of Arunachal are identified same as that of Mitra (1976) in all respects.

38. *Seira indica* (Ritter)

(Fig. 40)

1911. *Callistocyrtus indicus* Ritter, *Naturhist. Hofmus. Wien.*, **24** : 379-398.

1930. *Pseudosira indica* Bonet, *Eos*, **6** : 249-273.

1936. *Lepidocyrtus unifasciatus* Denis, *Mem. Conn. Acad. Arts and Sci.*, **10** : 261-282.

1966. *Seira indica* Yosii, *Kyoto Univ. Sci. Exp.* 1955, **8** : 333-405.

Diagnostic characters : Body length 1.8 mm. Eyes 8 + 8. Body colour brownish with bluish pigments with yellowish brown pigments covering abdominal segments II, III, some spots of head and thoracic segment .II. Antennae scaled dorsally, segments III and IV faintly annulated; ratio of antennal segments I-IV 7 : 9 : 9 : 45. Furcula well developed. Manubrium dorsally with many ciliated setae. Dentes dorsally crenulated. Mucro falciform.

Material examined : Arunachal : 1 ex, Menga cave (Upper subansiri Dist.), 26.III.1999, Coll. A.K. Hazra.

Distribution : India : Arunachal, Assam, Nagaland and Maharashtra.

Remarks : The species was described in *Callistocyrtus* by Ritter (1911) followed by Bonet (1930) in *Pseudosira*, Denis (1936) in *Lepidocyrtus*. It was Yosii (1966) who from the specimens of expedition sponsored by Kyoto University (Japan) transferred the generic status to *Seira* which has now been use. During our survey, only one specimen was identified which look like the species of Yosii (1966). Systematic status of the species has been kept as such until discovery of more specimens from the subcontinent.

Key to species of *Siera*

- Anterior face of ventral tube with 4+4 ciliated macrochaetae and 4+4 non-ciliated setae *arunachala*
- Anterior face of ventral tube with 2+2 terminal setae and 2+2 larger ciliated setae *indica*

Subfamily CYPHODERINAE

Members may be distinguished from other entomobryids by the ocelli, dental crenulations, and dental spines.

Key to genera of Cyphoderinae

1. Mandibles reduced 2
- Mandibles not reduced 3
2. Unguiculus lanceolate, with a broad outer teeth *Cyphoderus*
- Unguiculus lanceolate without broad outer teeth *Cyphoderopsis*
3. Unguis with theca, inner ungual teeth plate-like and fringed, molar area with 4-5 teeth; mucro small with 2-3 teeth *Pseudocyphoderus*
- Unguis with tunica, inner ungual teeth tendril-like and fringed; molar area well developed; mucro long with 2 teeth *Delamarerus*

Genus *Cyphoderus* Nicolet

1842. *Cyphoderus* Nicolet, *Neue Denkschr. Allg. Schweiz. Ges. Naturwiss.*, 6(3) : 1-88.

Type species : *Cyphoderus albinos* Nicolet, 1842.

39: *Cyphoderus javanus* Börner

(Fig. 41)

1906. *Cyphoderus javanus* Börner, *Mitt. Nat. Hist. Mus. Hamburg.*, 23 : 180.

1966. *Cyphoderus javanus* Yosii, *Kyoto. Univ. Expt. Karakoram and Hindukush*, 8 : 381.

1969. *Cyphoderus javanus* Prabhoo, *Orient. Ins.* 5(1) : 38.

Diagnostic characters : Body white without trace of pigment. Ant. /Head as 12 : 7. Ratio of antennal segments I-IV 2 : 7 : 4 : 10. Furca in ratio as 8:5:2. Manubrium ventrally scaled and without setae, dorsal side with many ciliated setae. Mucro subequal to the distal outer scale in length bidentate apically and with a slight lateral edge. Body length 1.7 mm.

Material examined : Arunachal : 22 ex, Sela top (Tawang distt.), 6.IV.1999. Coll. A.K. Hazra. Manipur : 2 ex, Longtinmanlei, 16.VI.1993, Coll. R.S. Burman; 1 ex; Mao (Charuchandrapur distt.), 20.VI.1993, Coll. R.S. Burman. Sikkim : 10 exs, Ranipool paddy field (East distt.), 30.X.1992, Coll. A.K. Hazra; 2 exs, Rangpo, PWD Rest House campus (East distt.), 12.XI.1992, Coll. A.K. Hazra.

Distribution : Indonesia, Thailand, Japan, India : Arunachal pradesh, Manipur, Mizoram, Sikkim, Orissa, West Bengal, Kerala.

Remarks : Börner (1906) recorded the species from Europe. Sixty years later Yosii (1966) made a detailed description of the species from Karakoram and Hindukush mountains followed

by Prabhoo (1969) from Kerala. After examination of the types and later identified specimens, it appears similar and reaffirms Börner (1906).

Genus *Cyphoderopsis* Carpenter

1917. *Cyphoderopsis* Carpenter, *Rec. Ind. Mus. Calcutta*, 8(ix) : 561-568.

Type species : *Cyphoderopsis kempi* Carpenter, 1917.

*40. *Cyphoderopsis gracilis* Carpenter

(Fig. 42)

1924. *Cyphoderopsis gracilis* Carpenter, *Rec. Ind. Mus., Calcutta*. 26 : 288.

1995. *Cyphoderopsis gracilis* Hazra, *State Fauna Series, Zool. Surv. Ind.*, 4(3) : 13-32.

Diagnostic characters : Body uniformly pale yellow colour; mesonotum 2.25 times as long as metanotum; ratio of antennal segments I-IV I : II : III : IV = 3 : 6 : 6 : 10; fourth abdominal segment six times as long as the third; furcula about 3 quarters as long as body, dens three quarter as manubrium; mucro relatively short with blunt terminal and two acute dorsal teeth.

Distribution : India : Meghalaya.

Remarks : Carpenter (1924) recorded the species from Sijucave at an altitude of 500 ft. of Meghalaya state. Thereafter, Hazra (1995) described the species from the state of Meghalaya.

41. *Cyphoderopsis ceylonica* Yosii

(Fig. 43)

1966. *Cyphoderopsis ceylonica* Yosii, *Kyoto Univ. Sci. Expd to the Karakoram & Hindukush*, 1955, 8 : 333-405.

Diagnostic characters : White coloured body; absence of eye and pigment; Ant / Head as 5 : 3; Antennal segments III and IV with slender and short sensory setae; ratio of antennal segments I-IV as 13 : 26 : 20 : 45; Unguis with well developed inner basal pair of teeth, the anterior one wing-like; Unguiculus lanceolate without tooth; Furcula elongate; manubrium : dens 75 : 50. Mucro elongate with almost straight apical tooth.

Distribution : Srilanka, India : Meghalaya and West Bengal.

Remarks : Yosii (1966) first recorded this species from Siju cave, Meghalaya. After examination of the types and later identified specimens, it appears similar and reaffirms Yosii (1966).

***42. *Cyphoderopsis kemp* Carpenter**
(Fig. 44)

1917. *Cyphoderopsis kemp* Carpenter, *Rec. Ind. Mus. Calcutta*, 8(ix) : 561-568.

Diagnostic characters : Body length 1.5 mm, white colour, antenna 1.25 as long as head; ratio of antennal segments I-IV as 5 : 8 : 6 : 14; Claws with a strong basal teeth and two distal teeth; Furcula two-thirds as long as body; manubrium longer than dens and mucro together; dens 3.5 times as long as mucro; mucro with blunt terminal and a strong proximal tooth little basal serrations and a feeble distal dorsal tooth.

Distribution : India : Assam.

Remarks : Carpenter (1917) described the species from the collection of S.W. Kemp (26.11.1911) from Assam. The present author could not collect the same specimen during the present study.

Key to the species of *Cyphoderopsis*

1. Fourth abdominal segment four times as long as the third. Mucro elongate 2
- Fourth abdominal segment six times as long as the third. Mucro short with 2 acute teeth *gracilis*
2. Mucro elongate, apical tooth large and straight *ceylonica*
- Mucro blunt, apical tooth strong and terminal *kemp*

Genus *Pseudocyphoderus* Imms

1912. *Pseudocyphoderus* Imms, *Proc. Zool. Soc. London* : 80-125.

Type species : *Pseudocyphoderus annendalei* Imms, 1912.

43. *Pseudocyphoderus annendalei* Imms
(Fig. 45)

1912. *Pseudocyphoderus annendalei* Imms, *Proc. Zool. Soc. London* : 80-125.

1966. *Pseudocyphoderus annendalei* Yosii, *Kyoto Univ. Sci. Expd to Karakorum & Hindukush*, 1955, 8 : 333-405.

Diagnostic characters : Body length 1.3 mm. Colour white. Ant: Head as 11 : 3. Antennal segment IV without terminal bulb; ratio of antennal segments I-IV 4 : 7 : 7 : 8. Tenent hair of legs feeble, either simply setaceous or dubiously clubbed. Unguiculus large with broad outer tooth at about the middle. Furca in ratio 65 : 30 : 12. Manubrium indistinctly subdivided

into two parts subequal in length. Mucro short, apically blunt and with two large intermittent teeth.

Material examined : Orissa : 13 exs, Termite mounds, Baphlimali (Raigada), 31.I.95, Coll. A.K. Hazra 22 exs, Ratnagiri Reserve Forest (Raigada). 30.I.1995, Coll. A.K. Hazra.

Distribution : India : Orissa, Andhra Pradesh and Maharastra.

Remarks : The species was first described by Imms (1912) from England. Later Yosii (1966) redescribed the species from the insects taken from the expedition to Karakoram and Hindukush montane areas. During the present investigation, the study of material of the survey conducted by the Zoological Survey of India and its comparison with the type indicates that the species are similar to those described earlier.

Genus *Delamarerus* Mitra

1976. *Delamarerus immsi* Mitra, *Rev. Ecol. Biol. Socl.*, 13(4) : 645-652.

Type species : *Delamarerus immsi* Mitra, 1976.

44. *Delamarerus immsi* Mitra

(Fig. 46)

1976. *Delamarerus immsi* Mitra, *Rev. Ecol. Biol. Sol.*, 13(4) : 645-652.

Diagnostic characters : White without any trace of pigment. Antenna: body 20 : 64. Antennae uniformly clothed with short setae; legs clothed with spiniform, long, ciliated setae; furcula clothed with long plumose scales and setae.; Ratio of antennal segments I-IV 2 : 8 : 4 : 7 Relative length index of Ths. II : III = 35 : 18; Unguis extremely modified in the presence of a large tunica at apex, fringed plate-like structures, originating from the base of each unguis and continuing anteriorly through its outer surface, pairs inner unguis and distal teeth present; unguiculi lanceolate without outer winglike- tooth, tenent hairs setaceous; Relative length index of Abds I : II : III : IV : V : VI = 8 : 10 : 9 : 73 : 3 : 1. Manubrium : Dentes : mucro as 15 : 7 : 5. Mucro very long, slender with 2 apical teeth. Body length 1.6 mm.

Material examined : Orissa : 8 exs, Termite mounds, Baphlimali (Raigada), 31.I.95, Coll. A.K. Hazra; 6 exs, Dandabar Reserve Forests, 30.I.1995, Coll. A.K. Hazra.

Distribution : India : Orissa and Andhra Pradesh.

Remarks : Mitra (1976) established the genus on the basis of its type, *Delamarerus immsi* from India. The present author reaffirmed the systematic position of the genus and species after the material of the faunistic survey of collembola throughout India.

Subfamily TOMOCERINAE

The essential features of the subfamily are: antenna with last two segments ringed and the fourth much shorter than the third.

Genus *Tomocerus* Nicolet

1842. *Tomocerus* Nicolet, *Neue Denkschr. Allg. Schweiz. Ges. Naturwiss.*, 6(3) : 1.

Type speciess : *Macrotoma minor* Lubbock, 1862.

45. *Tomocerus mitrai* Prabhoo

(Fig. 47)

1980. *Tomocerus* (S. Str.) *mitrai* Prabhoo and Murlidharan, *Entomon.*, 5(3) : 207.

Diagnostic characters : Ground colour yellowish-white with blue-pigment towards lateral margin of thorax and antennal segments.II-III. Ocellar field deep blue, ocelli 6 + 6. Body clothed with brownish blunt scales with prominent striation and finely ciliated setae. Dentes with ventral scales towards the distal half and two rows of 8-10 plumose in each row. Unguis of usual type with 5 to 6 teeth. Dental spine brown in colour, finely striated longitudinally in a single row as 3, 1.5, 1. Mucro elongated with intermittent teeth on outer lamella and two basal teeth and the outer basal tooth bearing toothlet.

Material examined : Arunachal : 100 exs, Sangrila (Tawang), 6.IV.1999, Coll. A.K. Hazra; 1 ex, Sela pass down slope (Tawang), 6.IV.1999, Coll. A.K. Hazra. Sikkim : 20 exs, Tashi hills (Gangtok), 01.XI.1992, Coll. A.K. Hazra; 50 exs, Animal Husbandry Farm, Kewizing (Ravangla), 3.V.1998, Coll. A.K. Hazra; 60 exs, Kewizing near P.W.D. Bunglow, 3.V.1998, Coll. A.K. Hazra.

Distribution : India : Arunachal, Himachal and Sikkim.

Remarks : Prabhoo (1980) recorded the species from the Himachal state and it conforms fully with the specimens studied during this discourse in all respects.

*46. *Tomocerus petalospinus* Salmon

(Fig. 48)

1969. *Tomocerus petalospinus* Salmon, *Zool. Pub. Victoria Univ.*, 51 : 39.

Diagnostic characters : Deep brown to greyish brown in colour with long setae and many strongly fluted scales. Antennal segments. III and IV strongly annulated and more or less fused. Claws with one pair of strong basal teeth and fine inner teeth; Tenent hair slightly

shorter than claw. Manubrium: Dens 25 : 41. Mucro clothed with simple setae and a large preapical, small apical, seven large median and ten fairly large lateral teeth. Dens with both large and small basally 'petaloid spines' are forming a ring around the base of each spine. Body length 4.5 mm.

Material examined : Sikkim : 70 exs, Dethong Basti, Ravangla, 2.V.1998, Coll. A.K. Hazra; 30 exs, Animal Husbandry Farm, Kewizing, Ravangla, 3.V.1998, Coll. A.K. Hazra.

Distribution : India : Sikkim.

Remarks : Salmon (1969) described the species from Sikkim which collected from different places of Sikkim appear like that of Salmon (1969) in morphology and chaetotaxy.

***47. *Tomocerus serratospinus* Salmon**
(Fig. 49)

1969. *Tomocerus serratospinus* Salmon, *Zool. Publ. Victoria Univ.*, 51 : 39-49.

Diagnostic characters : Deep brown to grey brown, in colour with paler legs and furcula. Ocelli subequal, six on each side. Antennal segments III and IV completely fused and approximately five times longer than segment II. Claw with a pair of large inner teeth, a row of five smaller teeth and a pair of large external basal teeth. Mucro clothed with simple setae and small apical tooth, a large subapical, three large medium conical teeth and five or six small lateral teeth. Spines of dens both large and small strongly serrated, many strongly serrated comb-like setae and numerous long, simple setae on each dens.

Material examined : Sikkim : 40 exs, Dethong Basti, Ravangla, 2.V.1998, Coll. A.K. Hazra; 5 exs, Ravangla, 3.V.1998, Coll. A.K. Hazra.

Distribution : India : Sikkim.

Remarks : Salmon (1969) recorded this species from the collection of T. Clay (BMNH) in 1952 of Sikkim. The present insects of the present survey of collembolan fauna throughout Sikkim look similar to Salmon (1969).

Key to species of *Tomocerus*

1. Dental spine simple and ciliated with 10 spines *mitrai*
- Dental spine large with more than 10 spines 2
2. Dental spine strongly serrated with a cup like process *serratospinus*
- Dental spine with small and large basal petaloid forming a ring *petalospinus*

Subfamily PARONELLINAE

Members of this subfamily may be distinguished from other entomobryids by the straight unringed dentes, without spines but with a terminal bladder like projection. The mucro is short and blunt and quite different from that of other entomobryids.

Key to genera of Paronellinae

1. Body covered with scales 2
- Body covered without scales 3
2. Eyes 8 + 8 6
- Eyes less in number *Alloscopus*
3. Mucro well developed, stout, bidentate or tridentate, dental scale appendages equal or subequal to mucronal length 4
- Mucro vestigial like a hook, dental scale appendage highly enlarged *Yosiia*
4. Mucro with 2 apical teeth, ventral tube with 5 + 5 macrochaetae, frontal spines reduced 5
- Mucro with 3 apical teeth; ventral tube with 4 + 4 macrochaetae, frontal spines well developed *Salina*
5. Flexed ciliated setae along the dorsal surface of the thorax and the anterior part of the abdomen *Pseudoparonellides*
- Flexed ciliated setae absent, single median cercus on the fifth abdominal segment *Heteromuricus*
6. Dental scale appendages and 4 + 4 frontal spines present, antennal segments without thick brush setae *Callyntrura*
- Dental scale appendage and 4 + 4 frontal spines absent, antennal segments with thick brush setae *Dicranocentroides*

Genus *Salina* MacGillivray

1894. *Salina* MacGillivray, *Can. Entomol.*, **26** : 105-110.

Type species : *Salina banksi* MacGillivray, 1894.

48. *Salina indica* (Imms)

(Fig. 50)

1912. *Cremastocephalus indicus* Imms, *Proc. Zool. Soc. London* : 80-125.

1957. *Salina indica* (Imms): Salmon, *Acta. Zool. Cracov.*, 11(14) : 313-362 (in Part).

1973. *Salina indica* (Imms) : Mitra, *Oriental Insects*, 7(2) : 159-202.

Diagnostic characters : Body length 1.4 mm. Colouration : General ground colour of body pale yellow, usually devoid of any dark pigment, occasionally the tergal margins and lateral extension of abdominal segment III with faint blue pigment. Antennal segments pale yellow, segments I, II, III with a faint of diffused blue pigments or absent in some cases. Legs and furcula pale yellow without any trace of rings or bands. Clothing : General surface of body densely clothed with acuminate, stiff microchaete; flexed macrochaetae subobliquely truncated and broadly acuminate, present on head. Thoracic segments II-III and abdominal segments I-VI with ciliated, acuminate macrochaetae; Isiotrichia present as on abdominal segments II (2 + 2), III (3 + 3), IV (2 + 2). Head : Frontal spines 1 + 1, conspicuous ; 2 dark pigmented ocellar fields one on each side of the head, each field containing 8 ocellii, arranged in two longitudinal parallel rows; ratio of antennal segments I-IV : 36 : 53 : 40 : 60. Thorax : Relative length index of Thoracic segments : II : III = 25 : 17. Unguis elongate, slightly curved with paired basal, a median and a distal unpaired teeth on inner margin, paired external basolateral teeth normal. Unguculus of truncate type, nondentate; tenent hair well developed finely ciliated, clavate, tibiotarsal lobes well developed. Abdomen : Relative length index of Abdominal segments I : II : III : IV : V : VI = 13 : 19 : 6 : 64 : 10 : 4; rami of retinaculum each with four teeth, corpus with a single median seta; ventral tube well developed. Manubrium: mucrodens = 45 : 54, mucro long, narrow, superficially lobed into three teeth; dental scale appendages relatively small faintly striated.

Material examined : Arunachal : 40 exs, Mofutu (Phumpare), 20.XI.1999, Coll. A.K. Hazra. Manipur : 40 exs, Kolasib (Charuchandrapur Dist.) 01.XI.1996. Coll. S.K. Mitra; 2 exs, Santipur (Churachandpur), 3.IV.1992, Coll. A.K. Hazra; 37 exs, Singut (Churachandpur), 18.VI.1993, Coll. R.S. Burman. Sikkim : 19 exs, Mangan-chungthang road, Singhik, 3.XI.92, Coll. A.K. Hazra; 100 exs, Namchi, 27.IV.1998, Coll. A.K. Hazra; 5 exs, Singhik, 34.XI.1992. Coll. A.K. Hazra. Tripura : 6 exs, Nirmahal (West), 7.V.1995. Coll. A.K. Hazra; 10 exs, Paratia (South), 4.V.1995, Coll. A.K. Hazra.

Distribution : India : Sikkim, Arunachal, Manipur, Mizoram, Tripura, Uttarpradesh and West Bengal.

Remarks : Imms (1912) described the species as *Cremastocephalus indicus* from India. During revision of the species of *Salina*, Salmon (1957) changed the generic status of the species to *Salina* after its characters. Thereafter, Mitra (1973) redescribed the species with confirmation of its generic status. During this investigation, the material of the north eastern states are also identified the same after comparison with the types available in NZC, Calcutta.

***49. *Salina bengalensis* Mitra**
(Fig. 51)

1966. *Salina bengalensis* Mitra, *J. Ent. New Delhi*, 28(1) : 67-73.

1973. *Salina bengalensis* Mitra, *Oriental Insects*, 7(2) : 159-202.

Diagnostic characters : Body length 1.5 mm. Colouration : General ground colour of body pale yellow. Thoracic tergites II, III dark with orange suffusion at its margin, pigment continued to on abdominal tergites. I-VI in addition to orange to dark brown patches. Clothing : Body clothed with micro and macrochaetae, most of which ciliated, microchaetae slender and acuminate. Head : Pear-shaped with two dark ocellar fields bearing with 8 ocelli in each field; ocelli G and H smaller; 1 + 1, frontal spines 1 + 1 present. Ratio of antennal segments I-IV 27 : 41 : 31 : 46. Thorax : Prothorax reduced, relatively length of segments. II : III 17 : 13; unguis with paired basal and two unpaired inner teeth; tenent hair clavate. Abdomen : Relative ratio of length of abdominal segments I-VI 11 : 5 : 14 : 2 : 49 : 9 : 6. Ventral tube short. Manubrium: microdens 41 : 48; mucro long, superficially lobed into three teeth; dental scale appendage relatively short striated apically.

Material examined : West Bengal : 8 exs, Botanical Garden (Howrah), 16.I.2003, Coll. G.P. Mandal.

Distribution : India : West Bengal.

Remarks : The species, *Salina bengalensis* was first described by Mitra (1966) from West Bengal. He(1973) revised it as such which are quite like exactly with insects collected from the Botanical Garden resembling the types of Mitra (1966 and 1973) in all respects.

50. *Salina biformis* Mitra
(Fig. 52)

1966. *Salina biformis* Mitra, *J. Ent. New Delhi*, 28(1) : 67-73.

1973. *Salina biformis* Mitra, *Oriental Insects*, 7(2) : 159-202.

Diagnostic characters : Body length 1.2–1.4 mm. Coloration : Two types of colour—dark and lighter. Head : Frontal spines 1 + 1 Ocelli 8 + 8, each group in two parallel rows, ocelli G and H smaller. Clothing : Macrochaetae more or less obliquely truncated and broadly acuminate on head, thoracic segments II, III and abdominal segments I-IV; macrochaetae of Thoracic II, III/Abdominal segments I, II = 23, 26/17, 4. Thorax : Unguis short, curved with outer two paired basolateral, a paired inner basal and two distal unpaired teeth. Trochanteral organ poor. Abdomen : Ventral tube anteriorly with 4 + 4 macrochaetae and 7 + 7 microchaetae with 9 + 9 micro chaetae posteriorly and a short unpaired median proximal spiny seta.

Material examined : Mizoram : 10 exs, Kolasib, 01.IX.1996, Coll. S.K. Mitra.

Distribution : India : West Bengal, Mizoram, Haryana and Uttar Pradesh.

Remarks : Mitra (1966, 1973) described the species *Salina biformis* from West Bengal. The specimens collected from Mizoram during this survey conform to those of Mitra (1966, 1973). According to Mitra (1966), the species possesses two types of colour pattern. On further investigation it indicates sexual dimorphism in the species where male is darker, much bulky and stout body with a well defined genital ring surrounded with papillae and females being lighter form, slender and without genital ring.

51. *Salina celebensis* (Schaeffer) (Fig. 53)

1898. *Cremastocephalus celebensis* Schaeffer, *Naturgesch.*, 64 : 393-425.

1957. *Salina celebensis* Salmon, *Acta. Zool. Cracov.*, 11(14) : 313-362 (in Part).

1973. *Salina celebensis* Mitra, *Oriental Insects*, 7(2) : 159-202.

Diagnostic characters : Body length 2 mm. Colouration : Pale yellow to ochreous, rarely with dark patches and dark tergal margins. Head : 1 + 1 Frontal spines 1 + 1. Head : Antenna I = 15:29. Thorax : Unguis little curved paired, inner basal teeth large, two unpaired inner teeth and usual external basolateral teeth. Unguiculus large, truncate abruptly from half of its length. Abdomen : Ventral tube with 4 + 4 macrochaetae anteriorly on its anterior face; microchaetae on the anterior face and posterior face not noted; mucro short, broad deeply lobed into three teeth. Dental scale appendages large subequal to mucro with distal striations. Clothing : Body clothed with flexed macrochaetae and blunt or broadly acuminate apices; number of macrochaetae on thoracic II, III/abdominal segments I, II = 7, 5/2, 3.

Distribution : England, Singapur, India : Assam.

Remarks : This species first recorded from England by Schaeffer (1898) followed by Salmon (1957) from Singapur and Assam (India) through beating of the foliage of undergrowth of an evergreen forest of 350ft, Oating (Assam).

52. *Salina javana* (Handschin) (Fig. 54)

1928. *Cremastocephalus javanus* Handschin, *Treubia*, 10 : 245.

1973. *Salina javana* (Handschin) Mitra, *Orient Ins.*, 7(2) : 179.

Diagnostic characters : Colouration : General ground colour varying from light green to pale yellow. Clothing : Body clothed with broadly acuminate macrochaetae, microchaetae

sparsely cloth the general surface of body; lasiotrichia present as abdominal segments II (2 + 2), III (3 + 3), IV (2 + 2); chaetotaxy of head as characteristic of the *celebensis* group. Head : Ocelli 8 + 8; ratio of length of antennal segments I-IV 51 : 64 : 57 : 75; frontal spines 1 + 1. Thorax : Relative length index of Thoracic segments II : III = 38 : 18. Legs similar; unguis short, broad little curved; tenent hair well developed. Abdomen : Relative length index of abdominal segments I-VI = 11 : 20 : 3 : 80 : 9 : 5; segment IV elongate. Manubrium: mucrodens 65 : 67, mucrotridentate, distinctly lobed; dental scale appendage large, subequal to mucro with striations. Body length 1.5-2 mm.

Material examined : West Bengal : 12 exs, Botanical garden (Howrah), 16.I.2003, Coll. G.P. Mandal.

Distribution : Indonesia, India : West Bengal.

Remarks : Handschin (1928) described the species as *Cremastocephalus javanus* from Java (Indonesia). Mitra (1973) revised the generic status of the species to *Salina* which is confirmed in this study on the basis of present collections and its comparison with the types retained in NZC, Calcutta.

53. *Salina montana* (Imms)

(Fig. 55)

1912. *Cremastocephalus montanus* Imms, *Proc. Zool. Soc. London* : 80-125.

1957. *Salina montana* Salmon, *Acta. Zool. Cracov.*, 11(14) : 313-362.

1973. *Salina montana* Mitra, *Orient. Ins.*, 7(2) : 159-202.

Diagnostic characters : Coloration : Ground colour of head and body usually white, sometimes pale yellow; tergal margins of thoracic II, III and abdominal segments I, II edged with violet to blue black pigments. Clothing : Acuminate microchaetae as general clothing of body, macrochaetae anteromedially on either side of Abdominal segment. IV in a straight line. Head : Pear shaped with 1 + 1 dark ocellar field, each field with 8 + 8 ocelli; ratio of length of antennal segments I-IV 47 : 67 : 57 : 93. Thorax : Relative length index of Ths II : III = 29 : 17; unguis with paired basal and two distal unpaired teeth on inner margin. Abdomen : Relative laength of abdominal segments I : II : III : IV : V : VI 13 : 23 : 4 : 79 : 14 : 8.5; ventral tube short with 4 + 4 ciliated macrochaetae and 7 + 7 microchaetae on its anterior face. Manubrium: mucrodens = 58 : 63; mucro short, broad prominently lobed into three teeth; Dental scale appendages large, striated apically, subequal to the length of mucro. Body length 2 mm.

Material examined : Mizoram : 12 exs, Hill stream, KwanKwan, 4.IV.1994, Coll. A.K. Hazra. Manipur : 15 exs, Checkalphai Reserve Forest (Churachandpur), 3.IV.1992, Coll. A.K. Hazra.

Distribution : India : Mizoram, Manipur, West Bengal, and Uttar Pradesh.

Remarks : Imms (1912) described the species in *Cremastocephalus* from England followed by generic change of Salmon (1957) and okayed by Mitra (1973) after his study of Indian specimens. The material of the present study reaffirms the systematic position of the species with the above characters.

54. *Salina yosii* Salmon (Fig. 56)

1964. *Salina yosii* Salmon, *Bull. roy. Soc. N.Z.*, 7(2) : 145.

Diagnostic characters : **Coloration** : General ground colour of body varying from white to pale yellow; symmetrical purple to violet markings present dorsally on thoracic II, III and abdominal segment III. Legs and furca pale yellow and without pigment. **Clothing** : Body clothed with slender acuminate, ciliated macrochaetae interspersed with longer macrochaetae. **Thorax** : Prothorax reduced, relative length index of thoracic segments II : III : 29 : 15. Hind tibio-tarsi much longer than the fore and mid ones; unguiculus truncate with a prominent midrib; tenent hair long, clavate, finely ciliated. **Abdomen** : Relatively length index of abdominal segments I : II : III : IV : V : VI = 13 : 26 : 3 : 84 : 14.5 : 7.5. **Manubrium** : mucrodens 56 : 68, mucro short, broad and distinctly lobed into 3 teeth, dental scale appendages large, subequal to mucro. **Length** (excluding appendages) : 2 mm.

Material examined : Orissa : 14 exs, Dandabar Reserve Forest (Raigada), 30.I.1995, Coll. A.K. Hazra.

Distribution : China and Thailand, India : Orissa, West Bengal.

Remarks : Salmon (1964) recorded the species from Thailand. The present specimens from Orissa conform with those of Salmon (1964) in morphology and chaetotaxy.

55. *Salina striata* (Handschin) (Fig. 57)

1928. *Cremastocephalus striatus* Handschin, *Treubia*, 10 : 245-270.

1929. *Salina striata* Handschin, *Rev. Suisse. Zool.* 36 : 229-262.

1961. *Salina striatella* Yosii, *Nature and life in South East Asia*, 1 : 171-200.

1973. *Salina striata* Mitra, *Orient. Ins.*, 7(2) : 159-202.

Diagnostic characters : **Coloration** : Head and body white pale yellow to white in colour, head capsule with a medial dirty brown patch. Antennal segment I with a bluish longitudinal

basal streak and another distal blue black pigmented patch. Clothing : Body sparsely clothed with short, ciliated acuminate microchaetae interspersed with flexed macrochaetae. Head : Pear shaped dorsally, frontal spine present 1 + 1; ocelli 8+8. Thorax : Relative length index of thoracic segments II : III = 15 : 9. Legs similar, unguis slightly curved with paired basal and single unpaired distal teeth on inner margin. Abdomen : Abdominal segments I : II : III : IV : V : VI = 8 : 14 : 3 : 41 : 7 : 3; Ventral tube well developed. Manubrium : mucrodens 28 : 33, mucro short, broad, prominently lobed into three teeth, median sometimes truncated tooth; dental scale appendages subequal to mucro with faint longitudinal striations. Body length : 3 mm.

Material examined : Arunachal : 1 ex, Rupa valley, 1.IV.1999, Coll. A.K. Hazra; 20 exs, Tippi, Bhalukpong (West Kamang distt.). 30. III.1999, coll. A.K. Hazra. Meghalaya : 25 exs, Nongstoin, 21.III.1991, Coll. A.K. Hazra; 10 exs, Nongfa river bed (West Khasi Hill), 22.III.1991, Coll. A.K. Hazra; 42 exs, Botanical gardens, Shillong, 28.III.1991, Coll. A.K. Hazra, 500 exs, Cherapunjee (East Khasi Hill) under growth of forest; 27.III.1992, Coll. A.K. Hazra.

Distribution : India : Arunachal, Assam, Meghalaya, Nagaland and Nilgiri Hills (Tamil Nadu).

Remarks : Handschin (1928) described the species as *Cremastocephalus striatus* followed by its generic transfer to *Salina* (Handschim, 1929) and conformation of generic by Yosii (1961) and Mitra (1973). On examination of a good number of specimens of north eastern states, it appears that the species described by Handschim (1928), Yosii (1961) and Mitra (1973) are conspecific in all respects.

56. *Salina tricolor tricolor* (Handschin)

(Fig. 58)

1928. *Cremastocephalus tricolor* Handschin, *Treubia*, 10 : 245-270.

1929. *Salina tricolor* Handschin, *Rev. Suisse, Zool.*, 36 : 229-262.

1973. *Salina tricolor tricolor* Mitra, *Orient Ins.* 7(2) : 159-202.

Diagnostic characters : Coloration : Head and body pale yellow with variable distribution of pigments. Clothing : Body sparsely and uniformly clothed with ciliated microchaetae interspersed with broadly acuminate, ciliated macrochaetae. Head : Pear shaped; Ocelli 8 + 8; frontal spines 1 + 1 present; ratio of length of antennal segments I-IV 26 : 33 : 29 : 46. Thorax : Relative length index of thoracic segments II : III = 9 : 4. Legs similar, unguis with paired basal and 2 distal unpaired inner teeth. Abdomen : Relative length index of abdominal segments I : II : III : IV : V : VI = 4 : 9 : 1.5 : 29 : 4 : 2.5; Ventral tube well developed.

Manubrium : mucrodens 22 : 25; mucro deeply lobed in to three teeth, dental scale appendage nearly equal to mucro and with longitudinal striations. Body length 2 mm.

Material examined : Mizoram : 6 exs, Kolasib, 31.IX.1996, Coll. S.K. Mitra. Nagaland : 18 exs, Culvert No 36/3, phak (Phak Dist.), 24.III.1997. Coll. A.K. Hazra.

Distribution : India : Manipur, Mizoram, Nagaland and Kerala.

Remarks : The species was first described as *Cremastocephalus tricolor* by Handschin (1928). In the very following year, he (1929) changed the genus to *Salina*. During revision of *Salina*, Mitra (1973) revised it in detail and raised it as a subspecies of *Salina tricolor tricolor* which in this study has been confirmed after the type species and the collembolans collected during this investigation.

***57. *Salina tricolor sikkimensis* Mitra**
(Fig. 59)

1973. *Salina tricolor sikkimensis* Mitra, *Orient Ins.*, 7(2) : 159-202.

Diagnostic characters : Body length 1-1.5 mm. Colour pale yellow with dark blue black patches covering thoracic segment-III and abdominal segments-I and II; thoracic segment-II with or without pigment; half of abdominal segment-IV with posterior dark blue black pigment or irregular blotches or spots of the same pigment; lateral extension of abdominal segment-III with or without extensive patch. Antennae pale yellow without dark pigment. Legs with femora dark apex, tibio-tarsi with basal and apical dark blue black patches.

Material examined : Nagaland : 18 exs, Khezikinoma (Phak), 24.III.1997, Coll. A.K. Hazra. Sikkim : 6 exs, Ranipool paddy field (East), 30.X.1992, Coll. A.K. Hazra.

Distribution : India : Nagaland and Sikkim.

Remarks : Mitra (1973) established the subspecies, *sikkimensis* of species *Salina tricolor* in his revisionary studies of the genus. Further study on the material gathered during this survey reveals that the systematic position of the subspecies, *sikkimensis* of *Salina tricolor* as established by Mitra (1973) is justified.

***58. *Salina choudhurii* Mitra**
(Fig. 60)

1973. *Salina choudhurii* Mitra, *Orient Ins.*, 7(2) : 159-202.

Diagnostic characters : Coloration : Pale yellow in colour with two symmetrical dark blue-black longitudinal bands, one on either side encircling the entire body through margins

of head; thoracic and abdominal segments interconnected by the two transverse bands, margin of the band on abdominal segment-II sometimes extending to segments-I and III. Antennal segment-I bluish basally and laterally, segments-II, III, and IV darker distally with faint bluish pigment. Legs with femora faintly bluish towards apex; rest of the appendages and furcula without pigment. Clothing : Antennae clothed with short acuminate ciliated setae, segments-III, IV with smooth erect setae. Legs with femora clothed with setae, tibio-tarsi with longer acuminate, relative stiff ciliated setae. Manubrium clothed with short, acuminate, ciliated setae, dentes with relatively long setae. Head : Ant-I/ Head 23/15. Ocelli 8 + 8, ocelli G and H smaller than the rest. Antennae appreciably long, C. twice the total length of head and body (excluding furca); ratio of length of antennal segments-I-IV 23 : 29 : 25 : 32, antennal segment-IV faintly annulated. Thorax : Relative length index of Ths. II : III = 36 : 9; Unguis short, slightly curved with inner paired basal and single unpaired distal teeth, outer basolateral teeth small, unguiculi large, truncate; tibio-tarsal lobe overhanging the base of unguiculus, well developed; tenent hair well developed, clavate, minutely ciliated; trochanteral organ composed of C.30 small spines. Abdomen : Abdominal segment-IV more than 10 times the length of segment-III; relative length index of segments I : II : III : IV : V : VI = 7 : 11 : 10 : 107 : 9 : 7. Manubrium : mucrodens 27 : 22, mucro tridentate bearing truncated apical teeth. Body length 1.7 mm.

Material examined : Meghalaya : 4 exs, Botanical garden, Shillong 28.III.1991. Coll. A.K. Hazra; 7 exs, Forest near Mousumi cave, 27.III.1991. Coll. A.K. Hazra; 5 exs, Nongstoin, 22.III.1992. Coll. A.K. Hazra.

Distribution : India : Assam and Meghalaya (East Khasi and West Khasi Hills).

Remarks : After critical examination of the types of Mitra (1973) and the collections received from the survey of north eastern states, it appears that the identification of the species, *Salina choudhurii* is apt in the taxonomic point of view.

Key to the species and subspecies of *Salina*

1. Mucro long, narrow, superficially lobed into teeth, dental scale appendage relatively small, tergites with many macrochaetae The *Indica* Group 2
- Mucro short, broad, deeply lobed into teeth, dental scale appendage relatively large, tergites with less number of macrochaetae The *Celebensis* Group 4
2. Body always with patches of blue-black or orange pigments 3
- Body without any pigment, thoracic tergites II, III and abdominal tergites I, II margins darker and II sometimes with faint violet pigment *indica*

3. Thoracic tergite II with transverse orange bands or patches, abdominal tergites I-IV with median orange patches or pigments and V-VI with caudal patches.....
.....*biformis*
- Thoracic tergites II, III with dark blue-black pigment or orange suffusion extending abdominal tergites I., II; I-VI sometimes without patches *bengalensis*
4. Body devoid of dark pigment, tergal margins seldom with faint violet pigment; chaetotaxic formula of Ths. II, III/Abds. I, II=7, 5/2, 3*celebensis*
- Body mostly with dark or variable or without pigment..... 5
5. Pigment usually in the form of violet streaks or small patches 6
- Pigment in the form distinct of longitudinal or transverse bands with various combination of pigments 7
6. Lateral margins of thoracic segments-II, III and abdominal tergites-I, II, darker with darker pigment intrudeing into abdominal tergite-II; thoracic segments-II, III and abdominal-I-IV with inconsistent violet patches *montana*
- Lateral margins of thoracic segments-II, III and abdominal-I, II, III with purple pigment; abdominal segment-IV with two characteristic median and caudal patches on each having violet lateral streaks..... *yosii*
7. Pigment usually tending to form longitudinal bands..... 8
- Pigment usually tending to form transverse bandsat least on thorax 9
8. Two longitudinal usually interrupted bands on each side of thoracic segments-II, III and abdominal-I, II and IV with an additional median and caudal band or patch
.....*striata*
- Two longitudinal bands forming more or less characterstic quadrangle ones on each side of body, lateral bands darkest; abdominal segmentd II- IVwith an additional median streaks *tricolor*
- A. Pigment does not cover entire surface of any segment *tricolor tricolor*
- B. Dark blue-black pigment totally covers Th.III, Abds.I, II, Th.II entirely with pigment or non pigmented; half of Abd.IV posterodorsally with dark blue black pigment or with irregular blotches or spots; chaetotaxy mostly like *tricolor* *sikkimensis*
9. Thoracic segments III with transverse blue-black bands; abdominal segments-I, II, V and VI with a continuous lateral band from head to segment III and IVwith paired medial patch.....*javana*

- A dark blue-black band surrounds the entire body through lateral margins of the Head, thorax and abdomen with two dark blue-black narrow transverse bands which on abdominal segment-II and IV connecting the lateral bands *choudhuria*

Genus *Dicranocentroides* Imms

1912. *Dicranocentroides* Imms, *Proc. Zool. Soc. London* : 80-125.

Type species : *Dicranocentroides fasciculatus* Imms, 1912.

59. *Dicranocentroides indica* (Handschin)

(Fig. 61)

1929. *Aphysa indica* Handschin, *Rev. Suisse, Zool.*, **36** : 221-262.

1975. *Dicranocentroides indica* (Handschin) : Mitra, *Rec. Zool. Surv. India*, **71** : 57-95.

Diagnostic characters : Coloration : Head and body brown colour with faint purple blue pigment. Antennal segments-I, II and III with a distinct distal bluish ring, IV mostly with blue pigment. Legs with dark brown pigment; furca with diffused blue pigment. Clothing : Body clothed with scales, cervix and anterior margin of thoracic segment II with a 'Collar' of acuminate setae; macrachaetae obliquely truncated thoracic II, III and abdominal segments I, II and III; segments IV, V and VI with acuminate setae at the posteromedial part. Head : with two dark ocellar fields, each having 8 ocelli in two longitudinal parallel rows. Antennal segments I and II stouter; ratio of length of antennal segments. I-IV 17 : 19 : 13 : 25; segment IV superficially annulated, apical sense knobs not distinct. **Thorax**: Relative length index of thoracic segments II : III = 12 : 9. Legs similar; unguis with paired basal and medial unpaired teeth, unguiculus lanceolate; tenent hair long, narrow and clavate. Abdomen : Relative length index of abdominal segments I; II; II : IV : V : VI = 6 : 6 : 3 : 29 : 3 : 1; Ventral tube long with protrusible vesicle retracted. Manubrium: mucrodens 22 : 35, mucro short, quadrangular with six striated teeth.

Material examined : Arunachal : 25 exs, Sessa, West Kamang Dist. 31.III.1999, Coll. A.K. Hazra. Manipur : 10 ex, Santipur, 3.IV.1992, Coll. A.K. Hazra; 2 exs; Keibul Natinal park, Churachandpur, 2.IV.1992; 22 exs, Chakalpai reserve forest (Churachandpur), 3.IV.1992, Coll. A.K. Hazra. Mizoram : 25 exs, Sairep (Lunglei), 17.IV.1995, Coll. T.P. Bhattacharjee. Nagaland : 18 exs, Karbi Aulong Road (Dimapur), 19.IV.1997. Coll. A.K. Hazra.

Distribution : India : Assam, Nagaland, Manipur, Meghalaya, Mizoram, West Bengal and Kerala.

Remarks : Hanschin (1929) described the species in *Aphysa* from Europe. In course of revision of Indian fauna of collembola, Mitra (1975) transferred the generic status of the species to *Dicranocentroides* on the basis of characters of the genus. During the present investigation, it has been possible to confirm the systematic position after the collections of the collembolan insects and its comparison with the description and types of Mitra (1975).

60. *Dicranocentroides flavescens* Yosii

(Fig. 62)

1966. *Dicranocentroides fasciculatus* f. n. *flavescens* Yosii, Res. Kyoto Univ. Sci. Exped. Karakoram and Hindukush, 1955, 8 : 333-405.

Diagnostic characters : Coloration : Body pale yellow to brownish generally without dark patches; tergal margins margins of abdomen III and IV with faint bluish pigment having a dark characteristic patch on vertex in between two ocellar fields; antennae without pigment. Head : Pear shaped when viewed from above; 1 + 1 dark ocellar field, each with 8 ocelli in two longitudinal parallel rows. Antennae subequal to body; relative length index of antennal segments is I-IV : 15 : 17 : 12 : 19. Thorax : Relative length index of thoracic segments II : III 14 : 8.5. Legs similar; unguis little curved with paired external basolateral teeth; unguiculus lanceolate, acuminate usually with 2 outer teeth. Abdomen : Relative length index of abdominal segments I : II : III : IV : V : VI 5 : 6 : 4 : 39 : 5.5 : 2; ventral tube long with protrusible vesicles retracted. Manubrium : mucrodens 28 : 38; dentes armed with two closely apposed rows of spines on inner margin; mucro large, parallel sided with 6 teeth. Body length 2-3.5 mm.

Material examined : Arunachal : 52 exs, Sessa, 31.III.1999, 150 exs, Hill stream side, Tippi, 30.III.12999, Coll. A.K. Hazra. Mizoram : 20 exs, Sairep, 17.IV.1995, Coll. T.P. Bhattacharyay, 10 exs, Pythor village, 4.IV.1994, Coll. A.K. Hazra. Nagaland : 20 exs, Khezikenoma, 24.III.1997; 12 exs, Keolie village, 24.III.1997, Coll. A.K. Hazra. Sikkim : 6 exs, Singhik, 5.IX.92; 500 exs, Namchi, 30.IV.1998; 330 exs, Namuta Basti, Namchi, 30.IV.1998; 60 exs, Dethong Basti, Ravangla, 2.V.1998, Coll. A.K. Hazra. Tripura : 4 exs, Ranikhola (West), 2.V.1995, Coll. A.K. Hazra.

Distribution : Nepal, India : Manipur, Maharastra, Mizoram, Nagaland, Sikkim, Tripura, Arunachal Pradesh, Uttar Pradesh and West Bengal.

Remarks : Yosii (1966) described the species from the collections of expedition to Karakoram and Hindukush mountains. The material from the different places of north eastern states of India is found to be same as described by Yosii (1966).

61. *Dicranocentroides fasciculatus* Imms

(Fig. 63)

1912. *Dicranocentroides fasciculatus* Imms, *Proc. Zool. Soc. London* : 80-125.
 1917. *Paronella crassicornis* Carpenter, *Rec. Ind. Mus. Calcutta*, **8** : 561-568. New synonymy.
 1925. *Dicranocentroides fasciculatus* Schott, *Sarawak Mus. Jour.*, **3** : 107-127 (Lapus for *fasciculatus*).
 1957. *Dicranocentroides fasciculatus* Salmon, *Acta Zool. Cracov.*, **11**(14) : 313-362.
 1975. *Dicranocentroides fasciculatus* Mitra, *Rec. Zool. Surv. Ind.*, **71** : 57-95.

Diagnostic characters : Coloration : Males larger and darker, female lighter and smaller; thoracic segment II with reddish to brown pigment and abdominal segments III, IV and V, dark brown, IV, V sometime paler. Clothing : Clothed with pseudoscales of various shapes and sizes from lanceolate to secondarily truncated or round apices. Head : Pear shaped, when viewed from above; 1 + 1 dark ocellar field, each field containing 8 ocelli, arranged in 2 longitudinal parallel rows. Thorax : Relative length index of thoracic segments II : III = 46 : 32. Legs similar; unguis moderately curved with external basolateral teeth; trochanteral organ well developed, each tibio-tarsus with 6-7 very stout, stiff, spiniform setae on inner and lateral margins. Abdomen : Relative length index of abdominal segments I : II : III : IV : VI : VI 21 : 21 : 13 : 108 : 9 : 4; ventral tube long with 3 protrusible vesicles and 2 anterior small rudimentary vesicles. Manubrium: mucrodens = 85 : 122; mucrodens large with 5-6 teeth. Body length 2-3 mm.

Material examined : Arunachal : 150 exs, Hill stream side, Tippi, 30.III.12999, Coll. A.K. Hazra. Mizoram : 20 exs, Sairep, 17.IV.1995, Coll. T.P. Bhattacharyay, 8 exs, Pythor village, 4.IV.1994, Coll. A.K. Hazra. Nagaland : 30 exs, Khezikenoma, 24.III.1997; 12 exs, Keolie village, 24.III.1997, Coll. A.K. Hazra. Sikkim : 5 exs, Singhik, 5.IX.92; 500 exs, Namchi, 30.IV.1998; 330 exs, Namuta Basti, Namchi, 30.IV.1998; 60 exs, Ravangla, 2.V.1998, Coll. A.K. Hazra. Tripura : 4 exs, Raukhola (West), 2.V.1995, Coll. A.K. Hazra.

Distribution : Nepal, India : Sikkim, Arunachal Pradesh, Manipur, Mizoram, Nagaland and Tripura.

Remarks : The species was described first by Imms (1912) and thereafter by Carpenter (1917), Schott (1925), Salmon (1957) and Mitra (1975). The insects of different places of the study areas are fully similar to those described earlier. During this study, the species, *Paronella crassicornis* described by Carpenter (1917) has been proposed as a new synonymy of the present species after critical examination of characters.

***62. *Dicranocentroides salmoni* Mitra**

(Fig. 64)

1957. *Dicranocentroides fasciculatus* Salmon, Acta, Zool. Cracov., 11(14) : 313-362.1957. *Handschinphysa crassicornis* Sensus Salmon, ibid.1975. *Dicraanocentroides salmoni* Mitra, Rec. zool. Surv. India, 71 : 57.

Diagnostic characters : Coloration : Extremely variable colour pattern. Pigmented; thoracic II and abdominal segment III with median pigmentation extending laterad, abdominal segment IV with two transverse bands. Clothing : Body clothed with scales and ciliated obliquely truncated macrochaetae (brush setae) present on head, thoracic II III and abdominal segments I, II; segment IV with posterior-median and of V, VI acuminate, ciliated setae, III with 2 median macrochatae on each side and IV with 16 macrochaetae at the middle. Head : Pear shaped when viewed from above; ocellar field dark 1 + 1 each with 8 ocelli in two longitudinal rows. Antennae subequal to the length of head and body; ratio of length of antennal segments I-IV 20 : 19.5 : 14 : 25. Thorax : Relative length index of thoracic segments II : III = 14 : 10. Legs similar; tibio-tarsi anteriorly segmented with 6-7 lateral spine like setae; unguis elongate, unguiculus lanceolate; tenent hair long and clavate. Abdomen : Relative length index of segments I : II : III : IV : V : VI 7 : 7 : 4 : 37 : 4 : 2; ventral tube long, rami of reticulum each with 4 teeth. Manubrium: mucrodens 28 : 40; each dentes armed with a row of stout spines of more than three fourth of its length and transiting into stiff ciliated setae; mucro large with 6 teeth. Body length 2.3 mm.

Material examined : Arunachal : 10 exs, Neharlagoon 21.III.1999, Coll. A.K. Hazra Manipur : 32 exs, Checkalphai Reserve Forest 3.IV.1992, Coll. A.K. Hazra; 3 exs, Kharasam (Churachandpur), 14.VI.1993, Coll. R.S. Burman. Mizoram : 20 exs, Saiha, 7.IV.1994 Coll. A.K. Hazra, 20 exs; Chawnhu Forest, Lawngtlai, 2.IV.1994, Coll. A.K. Hazra; 36 exs, Sairep, Lunglei, 17.IV.1995, Coll. T.P. Bhattejee. Nagaland : 12exs, Pulebadge wild Sanctuary, 25.IV.1997, Coll. A.K. Hazra; 10 exs, Jufa Hills (Kohima); 23.III.1997, Coll. A.K. Hazra; 8 exs, Karbi-Awlong Road (Dimapur), 19.III.1997, Coll. A.K. Hazra; 2 exs, Ysemyong (Mokokchung), 21.III.1994, Coll. P. Mukhopadhyay. Sikkim : 9 exs, Singhik, 5.XI.92, Coll. A.K. Hazra; 23 exs, Mangan-chungthun Road, 3.XI.1992, Coll. A.K. Hazra, 23 exs, Benjong South district, 9.XI.1992, Coll. A.K. Hazra, 15 exs, Tong, 3.XI.1992, Coll. A.K. Hazra; 47 exs, South east of Tashi Hills, 01.XI.1992, Coll. A.K. Hazra; 5 exs, Kabi, 7.XI.1992, Coll. A.K. Hazra; 1 ex, Rongo, P.W.D Rest house Campus, 12.XI.1992, Coll. A.K. Hazra; 3 exs, Kopche, 28.IV.1998, Coll. A.K. Hazra.

Distribution : India : Arunachal, Assam, Manipur, Mizoram, Meghalaya, Nagaland and Sikkim.

Remarks : Mitra (1975) described the species *Dicranocentroides salmoni* Salmon (1957). On critical study, it appears that the species, *Dicranocentroides fasciculatus* Salmon (1957) *Handschinphysa crassicornis* sensu Salmon (1957) to be the synonyms of his species. The present authors are also of same opinion with Mitra (1975) after examination of a large number of specimens of various places of the study areas,

63. *Dicranocentroides gisini* Mitra (Fig. 65)

1975. *Dicranocentroides gisini* Mitra, *Rec. Zool. Surv. Ind.*, 71 : 57-95.

Diagnostic characters : Coloration : Body pale yellow; Ths II, III, Abds I, II, II, usually devoid of any dark pigmented patches. Clothing : Body clothed with scales and dark, macrochaetae on head flexed (brush setae); thoracic II, III, abdominal segments I, II and IV-VI with median and posterior acuminate setae. Head : Pear shaped. Ocellar field dark 1 + 1 each with 8 ocelli in two longitudinal. Antenna subequal to the length of head and body with variable segments; ratio of length of antennal segments I-IV 11 : 15 : 16 : 20. Thorax : Relative length index of thoracic segments II : III = 14 : 9.8. Legs all similar; unguis little curved with 2 external basolateral teeth; unguiculus lanceolate, acuminate with 5 lamellate and serrated 5 teeth. Abdomen : Relative length index of abdominal segments I : II : III : IV : V : VI 7 : 7 : 3.5 : 34 : 5 : 3.5; Ventral tube long with protrusible vesicle retracted. Manubrium : mucrodens = 27 : 40; dentes armed with two closely apposed rows of spines on inner margin; mucro large with 6 teeth, lateral tooth large, surpassing beyond the apical tooth. Body length 2.3 mm.

Material examined : Nagaland : 1 ex, Minkong protected forest (Mokokchung), 22.III.1994, Coll. P. Mukhopadhyay; 1 ex, Lungsong (Wokha), 14.X.1998, Coll. T.K. Pal.

Distribution : India : Orissa, Nagaland, and Uttaranchal.

Remarks : The collembolan species first described by Mitra (1975) conform fully with the material brought from two places of Nagaland in morphology and chaetotaxy and types of Mitra (1975) retained with NZC, Calcutta.

Key to the species of *Dicranocentroides*

1. Body without dark pigmented patches 2
- Body with distinct dark pigmented patches 3
2. Body dark brown to pale yellow, lateral edges of thorax and abdomen faintly pigmented at times antennae not pigmented *flavescens*

- Body brown with faint purple blue pigment: Antennal segments I, II, III each with a pigmented distal ring, segment.IV pigmented..... *indica*
- 3. Abdominal segments I, II and VI without pigment, III with a middle quadrangular dark patch, IV also with a posterior transverse band *gisini*
- Abds. III, IV dorsally and/or laterally always pigmented patches..... 4
- 4. Sexually dimorphic in colour pattern; thoracic segment II totally pigmented with reddish blue pigment, thoracic III and abdominal segments.I, II with lateral dark pigment and IV of both sexes with violet or metallic pigment in each laterally*fasciculatus*
- Sexually not dimorphic in colour pattern; males and females pigmented with equal intensity; thoracic III and abdominal segments I, II mostly with dark pigmented patches *salmoni*

Genus *Callyntrura* Börner

1906. *Callyntrura* Börner, *Mitt. Naturhist. Mus. Hamburg.*, 23 : 147-188.

64. *Callyntrura (Callyntrura) serrata* (Salmon) (Fig. 66)

1957. *Handschinphysa serrata* Salmon, *Acta. Zool. Cracov.*, 11(14) : 313-362.

1957. *Aphysa serrata* Salmon, *Bull. Roy. Soc., N.Z.*, 7(2) : 145-644.

1974. *Callyntrura (Callyntrura) serrata* Mitra, *Rev. Ecol. Biol Sol.*, 11(13) : 397-439.

Diagnostic characters : Coloration : Body with deep blue-black shading extending as a broad lateral band along the sides of the head, thorax and abdominal segments I-III. Antennae and legs shaded with deep blue. Furcula yellow. Clothing : Body clothed with scales and ciliated spine like setae and a pair of lasiotrichia on each of the abdominal segments III and IV; dens with a row of very stout and long, finely plumose setae along the posterior and anterior face. Head : Ocelli 8 + 8 on each side. Antennae longer than head. Thorax : Claw with a pair of small outer lateral teeth; unguiculus on the hind feet almost reaching the subequal inner tooth; clavate tenent hair strong, slender and slightly longer than the claw to each foot. Abdomen : Manubrium to mucrodens = 54 : 85 : 4; mucro with two prominent apical teeth, one prominent subepical tooth on the posterior face, a large lateral tooth and a row of tooth like serration along the posterior edge which is most salient feature of the sopecies. Body length 1.4 mm.

Material examined : Tripura : 5 exs, Sepahijola (West) 29. IV.1995, Coll. A.K. Hazra.

Distribution : India : Nagaland and Tripura.

Remarks : Salmon (1957) first described the species as *Handschinphysa serrata* and later in the same year in the genus *Aphysa*. In course of revision of the genus of his collections, Mitra (1974) determined its generic and subgeneric status as *Callyntrura* (*Callyntrura*) *serrata* Mitra (1974). The insects as received from Tripura in this study look like those of Salmon (1957) and Mitra (1974) so far the description and comparison of the types are concerned.

***65. *Callyntrura* (*Callyntrura*) *zaheri* Mitra**
(Fig. 67)

1974. *Callyntrura zaheri* Mitra, *Rev. Ecol. Biol. Sol.*, 11(3) : 397-439.

Diagnostic characters : Coloration : Pale yellow in colour with variable violet to blue black patches on head and body. Clothing : Body clothed with ciliated setae and scales bearing faint striations, scales mostly lanceolate. Head : Pear shaped. Frontal spines 4 + 4; ocelli 8 + 8. Head /Ant.I variable. Thorax : Relative length index of thoracic segments II : III 16 : 6.5. Legs similar, tibiotarsi divided anteriorly; unguis little curved with a paired basal, a medial unpaired and a subapical rudimentary teeth; unguiculus lanceolate; tenent hair well developed, finely ciliated, clavate. Manubrium: mucrodens = 37 : 44; mucro deeply lobed into 7 teeth, dental scale appendages absent. Body length 2.5-3 mm.

Material examined : Orissa : 24 exs, Baphlimali hill top (Raigada), 31.I.95, Coll. A.K. Hazra.

Distribution : India : Orissa and West Bengal.

Remarks : The present species described by Mitra (1974) conforms fully with the description and types of Mitra (1974) which leads to reaffirmation of its systematic position.

66. *Callyntrura* (*Callyntrura*) *semiviolacea* (Handschin)
(Fig. 68)

1929. *Microphysa semiviolacea* Handschin, *Rev. Suisse Zool.*, 36 : 229-262.

1964. *Aphysa semiviolacea* Salmon, *Bull. roy. Soc. N.Z.*, 7(2) : 145-644.

1974. *Callyntrura* (*Callyntrura*) *semiviolacea* Mitra, *Rev. Ecol. Biol. Sol.*, 11(3) : 397-439.

Diagnostic characters : Coloration : Pale yellow in colour with variable pigmented patches; thoracic II, III and abdominal segments I, II, III with violet to blue pigments at its margin extending laterally to abdominal segments III, IV; IV and V, mostly non-pigmented; thoracic. II and abdominal segments II, III and posterior of abdominal segments IV and VI with seldom dorsal pigmented patches. Antennal bases with violet pigment. Femora sometime with darker distal patches. Clothing : Head, body and appendages clothed with setae and lanceolate

scales; macrochaetae on head, abdominal segments IV, V, VI acuminate, thoracic II, III and abdominal segments I, II, III with obliquely truncated macrochaetae. Head : Pear shaped with 4 + 4 dark frontal spines; ocelli 8 + 8 in pigmented ocellar fields; Antennae very long, about twice and a half the length of head and body. Ant. I/Head diagonal = 31/19; ratio of length of antennal segments I-IV : 38 : 37 : 23 : 84. Abdomen : Relative length index of abdominal segments I : II : III : IV : V : VI 3.2 : 6 : 2 : 27 : 3 : 2; ventral tube long; anterior face anteriorly with macrochaetae transiting posteriorly; rami of retinaculum each with 4 teeth; dental scale appendages absent; mucro deeply lobed into 6 teeth; dentes dorsally near base of mucrones with two short with minute striations. Body length 2 mm.

Material examined : Orissa : 8 exs, Sijumali (Rayagada) 12.XI.1994, Coll. A.K. Hazra.

Distribution : India : Orissa, Tamilnadu, and Kerala.

Remarks : Handschin (1929) described the species as *Microphysa semiviolacea*. The same author (1964) revised its generic status to *Aphysa* on the basis of its characters. Mitra (1974) changed systematic position once again to the present one, *Callyntrura (Callyntrura) semiviolacea* since the characters are found not to tally with the material taken from the different places of the study areas and also with the types retained in the NZC, Calcutta.

67. *Callyntrura (Handschinphysa) vestita* (Handschin)

(Fig. 69)

1925. *Microphysa vestita* Handschin, *Treubia*, 6 : 225-270; 1928, *Treubia*, 10 : 225-270.

1957. *Handschinphysa vestita* Salmon, *Acta. Zool. Cracov.*, 11(14) : 313-362.

1974. *Callyntrura (Handschinphysa) vestita* Mitra, *Rev. Ecol. Biol. Sol.*, 11(3) : 397-439.

Diagnostic characters : Coloration : Unique in colour pattern and usually without any variation; body green in fresh, pale yellow in spirit dark purple to blue black patches covering head, thoracic II, III and abdominal segments I, II, III. Clothing : Body clothed with flexed macrochaetae, acuminate, nonflexed setae and scales. Head : Pear shaped with 4 + 4 dark frontal spines; ocelli 8 + 8. Antennae subequal or little longer than body, ratio of length of antennal segments I-IV 43 : 40 : 27 : 60. Thorax : Relative length index of thoracic segments II : III 63 : 31; unguis straight, little curved apically with inner, paired basal teeth reduced, single unpaired tooth small; external basolateral teeth large; unguiculi lanceolate. Abdomen : Relative length index of abdominal segments I : II : III : IV : V : VI 18 : 31 : 14 : 172 : 22 : 9; rami of retinaculum each with 4 teeth. Manubrium: mucrodens = 45 : 53; mucro usually with 6 teeth, dental scale appendages small. Body length 2-2.5 mm.

Material examined : Manipur : 24 exs, Checkalpai Reserve Forest (Churachandpur) 3.IV.1992, Coll. A.K. Hazra. Meghalaya : 6 exs, Nongstoin (West Khasi Hill), 20.III.1991;

4 exs, Botanical garden, Shillong, 28.III.1991, Coll. A.K. Hazra; 4 exs, Umedinpur (Shillong), 4.III.1965, Coll. B.K. Tikadar.

Distribution : Indonesia, India : Assam, Manipur, Meghalaya and Nagaland.

Remarks : Handschin (1925) first described the species as *Microphysa vestita* and the same author (1957) revised it as *Handschinphysa vestita*. The present status of the species *Callyntrura (Handschinphysa) vestita* is due to Mitra (1974) who during the revision of the genus compared the description and types of Salmon (1957) before change of the systematic status and is confirmed during this study.

68. *Callyntrura (Handschinphysa) lineata* (Parona)
(Fig. 70)

1892. *Entomobrya lineata* Parona, *Atti. Soc. Ital., Milano*, **34** : 132-135.

1912. *Paronella borneri* Imms, *Proc. Zool. Soc. London*, pp. 80-125, New synonymy.

1912. *Paronella phanolepis* Imms, *ibid*, pp. 80-125, new synonymy.

1957. *Handschinphysa lineata* Salmon, *Acta. Zool. Cracov.*, **11**(14) : 313-362.

1974. *Callyntrura (Handschinphysa) lineata* Mitra, *Rev. Ecol. Biol. Sol.*, **11**(3) : 397-439.

Diagnostic characters : Coloration : Body pale yellow with variable purple to blue black pigment; head with or without pigment thoracic I, II and abdimal segments I, II, III. Pigmented with purple to blue black pigment laterally or entirely. Clothing : Head, body and appendages clothed with setae and pseudoscales; macrochaetae flexed, obliquely truncated and ciliated (brush setae) setae on thoracic II, III and abdominal segments I, II, III. Antennae and legs clothed with darker, acuminate, cililated setae. Head : Pear shaped, frontal spines 4 + 4 present; ocelli, 8 + 8. Head/Ant I = 28/27; ratio of length of antennal segments I-IV 28 : 28 : 18 : 48; apex segment IV with a conspicuous sense knob encircled with setae. Thorax : Relative length index of thoracic segments II : III 52 : 22; unguis elongate, little curved, unguis with paired inner and 2 distal unpaired teeth; unguiculus lanceolate; tenent hair clavate. Abdomen : Relative length index of the segments 13 : 24 : 8 : 130 : 12 : 5; rami of retinaculum each with 4 teeth. Manubrium: mucrodens 110 : 148; dentes stout; mucro plump with 6-9 teeth. Body length 2.5-4 mm.

Material examined : Tripura : 5 exs, Sepahijola, 1.V.1995, Coll. A.K. Hazra; 6 exs, Rest House at rubber plantation, 29.IV.1995, Coll. A.K. Hazra.

Distribution : India : Manipur, Tripura and Uttaranchal.

Remarks : Parona (1892) first brought the species, *Entomobrya lineate* to light from Italy. Later Salmon (1957) described the same species as *Handschinphysa lineata*. During the study

of Indian fauna of collembola, Mitra (1974) determined its systematic position as *Callyntrura (Handschinphysa) lineata* on the basis of his own collections and the types of Parona (1892) and Salmon (1957). The study of specimens of Tripura state, the authors could not only confirm Mitra (1974) but also put two more species *Paronella borneri* and *Paronella phanolepis* described by Imms (1912) as new synonyms of the present species.

69. *Callyntrura (Handschinphysa) borneri* (Imms)
(Fig. 71)

1912. *Paronella borneri* Imms, *Proc. Zool. Soc. London* : 80-125.

1957. *Handschinphysa borneri* Salmon, *Acta. Zool. Cracov.*, 11 (14) : 313-362.

1966. *Callyntrura borneri* Yosii, *J. Coll. Arts & Sci. Chiba Univ.*, 4(4) : 416-531.

Diagnostic characters : Ground colour brown, ornamented with purple patches to form a lateral stripes from antennal basis of head, posterior eye field and extending to body. Legs are banded. Body is clothed with brownish scales. Ocelli in black fields. Unguis and unguiculus elongate, scale-like swelling of dentes, mucro with seven teeth.

Material examined : Sikkim : 10 exs, P.W.D Rest House and Mangan Chungthang Road, 3.XI.92; 12 exs, Kabi, Alt. 5400 ft. 7.XI.92; 40 exs, River Rongpo and its tributary, 12.XI.1992; 70 exs, Tikjuk, Geyzing, 5.V.1998; 210 exs, Pelling Girls Hostel Road, Pelling, 6.V.1998; 4 exs, upper hill slope on Rangeet River, Legship, 9.V.1998; 5 exs, Monstry campus, Pemayangtse, 10.V.1998, Coll. A.K. Hazra.

Distribution : Nepa, India : Sikkim, West Bengal.

Remarks : Imms (1912) described the species as *Paronella borneri*. In the subsequent year, Salmon (1966) discovered the species as *Handschinphysa borneri*. Later Yosii (1966) made generic transfer of the species to *Callyntrura* keeping the species of Imms (1912) and Salmon (1966) in synonyms with his species. The present collections of collembolan insects opine same with Yosii (1966) in all aspects.

***70. *Callyntrura (Handschinphysa) delamarei* Mitra**
(Fig. 72)

1974. *Callyntrura (Handschinphysa) delamarei* Mitra, *Rev. Ecol. Biol. Sol.*, 11(3) : 397-439.

Diagnostic characters : Coloration : Pale yellow in spirit, dark violet to blue black patches covering head. Thoracic II, III and abdominal segments I, II and IV with a narrow middle transverse stripe extending anteriorly; abdominal segment III with dark patches extending posteriorly general surface of segment IV and V with two dark patches one on each

side. Clothing : Body clothed with scales, usually lanceolate in shape; antenna clothed with scales and setae. Head : Pear shaped in outline; frontal spines 4 + 4 dark, finely ciliated; ocelli 8 + 8. Thorax : Relative length index of thoracic I : II : III 11.5 : 6. Legs similar; unguis little curved with inner paired basal and distal unpaired teeth; unguiculus lanceolate, tenent hair well developed. Abdomen : Relative length index of abdominal segments I : II : III : IV : V : VI 3.5 : 7 : 2.5 : 33 : 4 : 2; rami of retinaculum with 4 teeth. Manubrium: mucodens = 26 : 36; mucro deeply lobed into six teeth, dental scale appendages large with 2 spiniform dorsal setae near base of each mucrone. Body length 2-2.5 mm.

Material examined : Orissa : 14 exs, Baphlimali hill top (Rayagada), 22.II.96, Coll. A.K. Hazra.

Distribution : India : Orissa.

Remarks : The species, *Callyntrura (Handschinphysa) delamarei* described by Mitra (1974) conforms fully with those collected during the present study in respect to morphology and types.

71. *Callyntrura japonica* (Kinoshita)

(Fig. 73)

1917. *Paronella japonica* Kinoshita, *Zool. Mag. Tokyo.*, 28 : 451-460, 495-498.

1954. *Hanschinphysa japonica* Yosii, *Kontyu*, 20 : 62-70.

1969. *Callyntrura japonica* Yosii, *Forest Res. Centre, Sepilok, Sand East Malayasia*, pp : 1-37.

Diagnostic characters : Creamy white, head dark, the base of the antennae deeper in colour. Thorax dusky along the marginal area of each segment. Abdominal segment IV with a narrow transverse patch. Antennae scaled. Dens without spines but with prominent dorsal vesicle. Mucro elongated with teeth.

Material examined : Arunachal : 24 exs, Tenga valley, 1.IV.1999; 10 exs, Mara village (Upper Subansiri Dist.), 26.III.1999, Coll. A.K. Hazra. Manipur : 92 exs, Knowpuibung village (Churachandpur Dist.), 1.IV.1992; 12 exs, Checkalpahai Reserve Forest, 3.IV.1992, Coll. A.K. Hazra. Meghalaya : 5 exs, near Mousami cave, Cherapunji, 27.III.1991 : 4 exs, Botanical garden, Shillong, 28.III.1991; 10 exs, Norgstoin, 20.III.1991; 5 exs, Govt. Poultry farm, Nongstoin, 21.III.1991, Coll. A.K. Hazra : Mizoram : 4 exs, D.F.O. complex, Lawngtlai, 3.III.1994; 2 exs, Kwankwan village, Lawngtali, 4.IV.1994, Coll. A.K. Hazra.

Distribution : Japan, India : Arunachal, Manipur, Meghalaya and Mizoram.

Remarks : Kinoshita (1917) described the species as *Paronella japonica* following generic transfer to *Handschinphysa* by Yosii (1954). The same author (1969) could determine the systematic status by making retransfer of the species South East Asia to *Callyntrura* after

consideration of characters involving the diagnosis of the genus. The specimens taken from the various places of the study areas conform fully with those of Yosii (1969).

72. *Callyntrura (Handschinphysa) longicornis* (Oudemans)

(Fig. 74)

1890. *Entomobrya longicornis* Oudemans, *Zool. Ergeb*, 1 : 73-91.

1911. *Campylothorax ceylonicus* Ritter, *Neue Thysanuren und Collembolen aus Ceylon und Bombay, gesammelt von Dr. Uzel. Ann. K. K. Naturhist. Hofmus. Wien*, 24 : 379-398.

1957. *Handschinphysa longicornis* Salmon, *Acta. Zool. Cracov.*, 2(14) : 313-363.

Diagnostic characters : Coloration : Yellowish to brown with blue black ocellar fields with a narrow edging to the thoracic and abdominal terga. Abdominal segments III and IV with lateral blue-black shading and V and VI each with ventro-lateral blue black pigment blotches. Clothing : Body with pointed scales except across the dorsal surface of the thorax and anterior part of the abdomen. Body : Antennae longer than the body; ratio of length of antennal segments I-IV 66 : 75 : 52 : 110, segment IV annulated. Body length, to 3.5 mm. Legs : Claw with two long outer pseudonychia reaching the level of the inner teeth. Legs with one distal tooth and a pair of basal teeth. Furcula : Manubrium : dens to mucro as 110 : 135 : 718; dens with many spines like ciliated setae. Mucro with 7-9 teeth, one of them always with a lateral ridge and two subapical and two or three plate like teeth on the posterior face.

Material examined : Assam : 30 exs, Tezpur, 2.XI.1998, Coll. G.P. Mandal. Sikkim : 28 exs, Pelling, 6.V.1998; 14 exs, Legship, 9.V.1998, Coll. A.K. Hazra.

Distribution : India : Assam and Sikkim.

Remarks : Salmon (1957) recorded this species Gangtok (Sikkim) from the collection by T. Clay (1952) amongst dry and rotting leaves, an altitude of 6000 ft. The specimens of the study areas made during this investigation appear similar to those of Salmon (1957) so far description and types are concerned.

Key to the species of *Callyntrura*

1. Dental scale appendage present (*Handschinphysa*) 2
- Dental scale appendage absent (*Callyntrura*) 5
2. Thoracic II, III and abdominal segments I-II with deep blue-black pigment, IV with or without median dark blue-black patches 3
- Thoracic II, III and abdominal segments I-III pigmented, IV-VI at least with a pair of pigmented spots or patches *lineata*

3. Abdominal segments IV-VI with or without transverse pigmented bands or spots ...
..... *vestita*
- Abdominal segments IV-VI with either median transverse pigmented bands or patches;
.....4
4. Abdominal segment III with lateral purple patches extending to the body; legs with
bands *borneri*
- Abdominal segment III with a lateral conspicuous pigmented spot, IV with with a
narrow transverse patch, others with darker pigmented streaks *delamarei*
5. Ventral side of mucro with many serrations; thoracic II, III and abdominal tergites III,
IV with dark blue-black pigment *serrata*
- Ventral side of mucro with distinct teeth; thoracic and abdominal tergites without pigments
..... 6
6. Abdominal segments I, II, III, lateral margins of head, thoracic II, III, with purple
pigment *semiviolacea*
- Abdominal segment IV with dorsal pigmented patches 7
7. Body with faint purple to blue pigment with a narrow lateral stripe extending to abdominal
segment IV *zaheri*
- Body with variable pattern of pigments 8
8. Thorax dusky; abdominal segment IV with transverse patch *japonica*
- Thorax with blue-black pigment; abdominal segments III and IV with lateral patch...
..... *longicornis*

Genus *Alloscopus* Börner

1906. *Alloscopus* Börner, Mitt. Naturhist. Mus. Hamburg, 23 : 147-188.

Type species : *Alloscopus tetracantha* Börner, 1906.

73. *Alloscopus tetracantha* (Börner)

(Fig. 75)

1906. *Heteromurus (Alloscopus) tetracantha* Börner, Mitt. Nat. Hist. Mus. Hamburg, 23 : 177.

1959. *Alloscopus tetracantha* Yosii, Contr. Biol. Lab. Kyoto. Univ., 10 : 38.

1969. *Alloscopus tetracantha* Prabhoo, Orient. Ins., 5(1) : 33.

Diagnostic characters : Body length upto 1.6 mm (excluding antennae & furca) Coloration : Whitie in colour. Clothing : Antennal segments II and III with many hyaline scales. Legs scaled near the unscaled femur and tibiotarsus. Head : Head without eyes, Ant./Head as 20 : 9. Antennal segment I basally subdivided subdivided; ratio of length of antennal segments I-V 1 : 4 : 7 : 10 : 10, distal half of segment IV and V distinctly annulated. Thorax : Thoracic segment II not hanging over the head. Unguis broad, dorsally carinate with a pair of well developed winged ventral teeth; unguiculus lanceolate and with a prominent outer tooth. Abdomen : Relative length of abdominal segment III/IV 6 : 7. Furca well developed. Distally dentes annulated distally to smooth .Mucro bidentate without basal spine.

Material examined : Sikkim : 8 exs, river bed, Jorethang (South) 12.V.1998; 10 exs, Bull rearing farm, Jorethang, 13.V.1998; 20 exs, District Industries Centre Campus, Jorethang, 14.V.1998; 5 exs, Govt. Secondary School Campus, Jorethang, 14.V.1998, Coll. A.K. Hazra. Tripura : 30 exs, Sepahiljola WLS, 26.IV.1995; 12 exs, Hatiposa village (South), 4.V.1995, Coll. A.K. Hazra.

Distribution : Cosmopolitan, India : Sikkim and Tripura.

Remarks : Borner (1906) recorded the species as *Heteromurus (Alloscopus) tetracantha*. Yosii (1959) transferred the species to the genus *Alloscopus* which was so far treated as a subgenus of *Heteromurus*. Prabhoo (1969) confirmed the generic status of the species which fully tally with the specimens collected from the different locations of the study areas in respect to the descriptions and types of the previous authors.

Genus *Yosiia* Mitra

1967. *Yosiia dehradunia* Mitra, *Proc. Zool. Soc. Calcutta*, 20 : 43-47.

Type species : *Yosiia dehradunia* Mitra, 1967.

74. *Yosiia dehradunia* Mitra

(Fig. 76)

1967. *Yosiia dehradunia* Mitra, *Proc. Zool. Soc. Calcutta*, 20 : 43-47.

Diagnostic characters : Coloration : Pale yellow with dust of blue pigment over the body and a pair of dark blue-black patches one on each side on abdominal segments III and IV. Clothing : Scales absent; head and body clothed with setae, mostly ciliated; longer setae broad, cylindrical and blunt or slender acuminate; setae arising in clusters from the cervix and decumbent on posterior margin of head, similar setae also present anteriorly on mesotergum, head capsule and body. Head : Pear-shaped; ocelli 8 + 8 in pigmented ocellar fields each group of 8 ocelli arranged in two longitudinal parallel rows. Thorax : Segment I reduced; the

relative length index of segments II : III = 23 : 11. Legs similar; each tibio-tarsus with two large tibio-tarsal lobes; unguiculus of the "truncate" type; trochanteral organ with 24 short spines. Abdomen : Relative length index of segments I : II : III : IV : V : VI = 6 : 15 : 4 : 67 : 9 : 6; Ventral tube short, anterior face with 4 + 4 long ciliated setae; rami of tenaculum each with 4 + 4 teeth; dens and manubrium subequal, dens crenulated; mucro vestigial; dental scale appendages greatly enlarged, dorsal in relation to dens and with longitudinal striations. Body length 1.14 mm.

Material examined : Sikkim : 2 exs, Benjong (South distt.), 9.XI.1992; 2 exs, Jorethang, 9.XI.1992; 20 exs, Mamring, Rongpo, 13.XI.1992, Coll. A.K. Hazra. Tripura : 6 exs, Zoo garden, 27.V.1995, Coll. A.K. Hazra.

Distribution : India : Sikkim, Tripura and Uttaranchal.

Remarks : Mitra (1967) described the species from Dehradun in his own genus *Yosiia* and present specimens from Sikkim and Tripura are found to be same as types and morphology of Mitra (1967).

Genus *Pseudoparonellids* Salmon

1941. *Pseudoparonellids* Salmon, *Trans. R. Soc. N. Z.*, **70** : 282-431.

Type species : *Pseudoparonellids badia* Salmon, 1941.

*75. *Pseudoparonellids bulbosa* Salmon

(Fig. 77)

1957. *Pseudoparonellids bulbosa* Salmon, *Acta. Zool. Cracov*, **11**(14) : 314-362.

Diagnostic characters : Color : Yellow in colour with dark bluish shading extending along the sides of the head, thorax and abdomen; antennae medium violet or blue; legs and furcula yellow; legs with pale blue shading around the segments. Clothing : Body and appendages with short ciliated setae and a pair of lasiotrichia on abdominal segment IV posteriorly. Body : Antennae shorter than the body; ocelli, 8 to each side; abdominal segment IV 9 times longer than III; rami of tenaculum each with four barbs. Body length 1.7 mm. Legs : Claw with a pair of short, outer teeth about one fifth down; a pair of inner teeth at one third down and a single, inner tooth at two thirds down.; tenent single stout and clavate. Tenent hair, nearly twice as long as the claw, to each foot. Furcula : Manubrium : dens 42 : 47 : 2.5, dens swollen or distended apically; mucro small, parallel sided, plate like teeth across the apex and surrounded by strong ciliated setae arising from the apex of the dens.

Distribution : India : Manipur.

Remarks : Salmon (1957) described this species from collection of Dr. T. Clay of Manipur at the edge of a lake (14.1.1952), which is recognized by the above diagnostic characters and the types retained in NZC, Calcutta.

Genus *Heteromuricus* Imms

1912. *Heteromuricus* Imms, *Proc. Zool. Soc. London*, 80-125.

Type species : *Heteromuricus cercifer* Imms 1912.

76. *Heteromuricus cercifer* Imms
(Fig. 78)

1912. *Heteromuricus cercifer* Imms, *Proc. Zool. Soc. London*, 80-125.

1929. *Heteromuricus cercifer* Handschin, *Rev. Suisse. Zool.*, 36 : 256.

Diagnostic characters : Coloration : Ground colour of the body and furcula varies from whitish to dull ochre-yellow; the legs, antennae bluish-violet. Head : Inclined at an angle of 45° with the with the long axis of the body; invested with scales and scattered setae. The eyes eight in number on each side; post antennal organs wanting. Antennae : Equal in length to the furcula; five jointed, relative length index of Ant. I : II : III : IV : V as 1 : 10 : 12 : 25 : 14. Body : Densely clothed with scales. The segments mutually related in length as 6 : 6 : 5 : 6 : 8 : 12 : 4 : 1. Arising from the dorsal aspect of the fifth abdominal segment is a prominent median circus nearly equal in length to the third abdominal segment. The circus densely clothed with scales and provided ventrally with long slender setae. Furcula : The dentes related in length to the manubrium as 4 : 3. The mucrones small, armed with a curved terminal tooyh, a single dorsal tooth and a basal spiniform tooth.

Distribution : India : Calcutta (W.B), Nilgiris (Tamil Nadu) and Kerala.

Remarks : Imms (1912) described this species under dried leaves in Calcutta followed by Handschin (1929) from several localities in Nilgiris (1600 to 2590m) and the types retained in NZC, Calcutta conform with our specimens.

B. ZOO-GEOGRAPHICAL NOTES

Collembola are very archaic group of insects, earliest fossil of collembolan was discovered from the middle Devonian of Scotland which does not differ markedly from existing forms. According to Salmon (1947) these collembolan species were very ancient cosmopolitan forms and they along with the prototypes of other more primitive genera such as *Ceratrimeria*, *Triacanthella* and *Megalothorax* attained world-wide distribution in the early geological times.

In order to explain the anomalous relationships of the fauna of different lands, biologists are prone to postulate the prior existence of large land masses to suit their convenience, spanning oceans-in places. As an example it was most unreasonable to expect dry land ever to exist with Gondwanaland and across the great ocean deeps of the present day. Salmon (1947) suggested endeavour to account for the distribution of animals and plants through migration along the land routes which could be expected to exist above the sea for intervals during geological time and that small soil inhabiting animals such as Collembola might use the such possible routes for migration.

Range of Diversity : The species-wise distribution list of Collembola in the different states of eastern parts and north east India is given in Table 1. It includes 76 species, under 38 genera of 4 families representing 36.19% of the species and 44.18% of the genera of known Indian collembolans. Out of 76 species, 28 species are endemic to the said region i.e.14.28% of total species of India and their zoogeographical relationship has been interpreted in Table 2. It is evident that most of the species are endemic to Indian subregion except a few which prevail in the oriental region. There are only very few species like, *Isotomina thermophila*, *Isotomiella minor*, *Sinella curviseta* and *Alloscopus tetracantha* which are occurred beyond the Oriental region with *Cryptopygus thermophilus* prevailing in the Nearctic region, *Lepidocyrtus curvicollis* in both Oriental and Palaearctic regions and *Callyntrura (H) lineata* in Ethiopian and Australian regions. Similarly, *Salina celebensis* of Palaearctic and Nearctic regions were also found in places other than the Oriental regions. There are 28 species endemic to east and north eastern parts of India while others also occurred in other parts of India.

The east and north eastern parts of India represent a unique admixture of various ecological diversities with large number of difficult terrains. The richest diversity of species is found in Sikkim Himalaya with 39 species in 26 genera followed by the second largest of 29 species of 21 genera in West Bengal and 28 species in 15 genera in Arunachal Pradesh. It appears interesting to note that the diversity of total litterine micro-arthropods decreased with the increase in altitude in the east and north eastern parts of India. but the diversity of springtails as one of the constituents of micro-arthropods population increased with the elevation. This is apparent from the Table 3 that fauna of east and north eastern parts of India is a complex admixture of Oriental, Ethiopian, Nearctic, Palaearctic Neotropical and Australian elements. There is a preponderance of Oriental species while the Ethiopian, Neotropical and Nearctic elements represent rather poorly constituting about 7.89%, 6.57% and 9.21% respectively. The Australian elements were represented by 7.89% and Palaearctic elements were poor by 10.5% from east and north eastern India.

From this study it may be concluded that the species diversity of collembola from east and north eastern parts of India shows that this group has a mosaic distribution pattern represented by both cosmopolitan and species endemic to Oriental region and the latter forming the bulk of the collembolan fauna in this region.

Cont'd.

Sl. No.	Name of the Species	Assam	Tripura	Sikkim	Meghalaya	Manipur	Mizoram	Nagaland	Arunachal	Orissa	W.B.
19.	<i>Cryptopygus thermophilus</i> (Axelson, 1900)	+	—	—	—	+	—	—	—	+	+
20.	<i>Parafolsomia trioculata</i> Salmon, 1956	—	—	+	—	—	—	—	—	—	—
21.	<i>Papillomurus transequatoria</i> Salmon, 1956	—	—	+	—	—	—	—	—	—	—
22.	<i>Rhodanella plumosa</i> Salmon, 1969	—	—	+	—	+	—	—	—	—	—
	Family : ENTOMOBRYIDAE										
	Subfamily : ENTOMOBRYINAE										
23.	<i>Lepidocyrtus</i> (S. Str) <i>magnificus</i> Carpenter, 1924	+	+	+	+	+	+	+	+	—	+
24.	<i>Lepidocyrtus</i> (S. Str) <i>medius</i> Schaeffer, 1898	—	+	+	—	+	+	+	—	+	+
25.	<i>Lepidocyrtus</i> (Acrocyrtus) <i>malayanus</i> Yosii, 1959	—	+	+	—	+	+	+	+	—	—
26.	<i>Lepidocyrtus</i> (A) <i>heterolepis</i> Yosii, 1959	—	—	—	—	+	—	—	+	+	+
27.	<i>Lepidocyrtus curvicollis</i> Yosii, 1959	—	—	—	—	—	—	—	+	—	—
28.	<i>Lepidocyrtus exploratus</i> Carpenter, 1924	—	—	—	+	—	—	—	—	—	+
29.	<i>Lepidocyrtus caudatus</i> Carpenter, 1917	+	—	+	—	+	—	—	+	+	—
30.	<i>Lepidocyrtus cyaneus</i> Tullberg, 1869	—	—	—	—	+	—	—	+	—	+
31.	<i>Lepidosira unguiserrata</i> Salmon, 1970	—	—	+	—	—	—	—	+	—	—
32.	<i>Sinella curviseta</i> Brook, 1882	+	—	+	—	—	—	—	+	—	+
33.	<i>Dicranocentrus indicus</i> Bonet, 1930	—	—	+	—	+	+	+	+	—	+
34.	<i>Dicranocentrus simplex</i> Yosii, 1959	—	—	—	—	—	—	—	+	—	—
35.	<i>Setogaster manipuri</i> Salmon, 1969	—	—	—	—	+	—	—	—	—	—
36.	<i>Homidia cingula</i> Börner, 1906	—	—	+	—	+	+	+	+	+	+

Sl. No.	Name of the Species	Assam	Tripura	Sikkim	Meghalaya	Manipur	Mizoram	Nagaland	Arunachal	Orissa	W.B.
57.	<i>Salina javana</i> (Handschin, 1928)	-	-	-	-	-	-	-	-	+	+
58.	<i>Salina biformis</i> Mitra, 1966	-	-	-	-	+	+	-	-	-	-
59.	<i>Dicranocentroides indica</i> (Handschin, 1929)	+	-	-	+	+	+	+	+	+	+
60.	<i>Dicranocentroides flavescens</i> Yosii, 1966	+	+	+	-	+	+	+	+	+	+
61.	<i>Dicranocentroides fasciculatus</i> Imms, 1912	-	-	+	-	+	+	+	+	+	-
62.	<i>Dicranocentroides salmoni</i> Mitra, 1973	+	-	+	+	+	+	+	+	+	-
63.	<i>Dicranocentroides gisini</i> , Mitra, 1975	-	-	-	-	-	-	+	-	+	-
64.	<i>Callyntrura</i> (<i>Callyntrura</i>) <i>serrata</i> (Salmon, 1957)	-	+	-	-	-	-	+	-	-	-
65.	<i>Callyntrura</i> (<i>Callyntrura</i>) <i>zaheri</i> Mitra, 1974	-	-	-	-	-	-	-	-	-	+
66.	<i>Callyntrura</i> (<i>Callyntrura</i>) <i>semiviolacea</i> (Handschin, 1925)	-	-	-	-	-	-	-	-	+	-
67.	<i>Callyntrura japonica</i> (Kinoshita, 1917)	-	-	-	+	+	+	-	+	-	-
68.	<i>Callyntrura</i> (<i>Handschinphysa</i>) <i>vestita</i> (Handschin, 1925)	-	-	+	+	+	-	+	-	+	+
69.	<i>Callyntrura</i> (<i>Handschinphysa</i>) <i>lineata</i> (Parona, 1892)	-	+	+	-	+	-	-	-	-	-
70.	<i>Callyntrura</i> (<i>Handschinphysa</i>) <i>borneri</i> (Imms, 1912)	-	-	+	-	-	-	-	-	-	-
71.	<i>Callyntrura</i> (<i>Handschinphysa</i>) <i>longicornis</i> (Oudemans, 1890)	+	-	+	-	-	-	-	-	-	-
72.	<i>Callyntrura</i> (<i>Handschinphysa</i>) <i>delamarei</i> Mitra, 1974	-	-	-	-	-	-	-	-	+	-
73.	<i>Alloscopus tetracantha</i> Börner, 1906	-	+	+	-	-	-	-	-	-	-
74.	<i>Yosiia dehradunia</i> Mitra, 1967	-	+	+	-	-	-	-	-	-	+
75.	<i>Pseudoparonellides bulbosa</i> Salmon, 1957	-	-	-	-	+	-	-	-	-	-
76.	<i>Heteromuricus cercifer</i> Imms, 1912	-	-	-	-	-	-	-	-	-	+

Table 2 : Distribution of species occurring in different Zoogeographical realms

Sl. No.	Name of the Species	INDIA	ORIENTAL	PALAERCTIC	ETHIOPIAN	AUSTRALIAN	NEOTROPICAL	NEARCTIC
	Family : HYPOGASTRURIDAE							
1.	<i>Ceratophysella indovaria</i> Salmon, 1970	+	+	-	-	-	-	-
2.	<i>Ceratophysella indica</i> Salmon, 1956	+	+	-	-	-	-	-
3.	<i>Xenylla obscura</i> Imms, 1912	+	+	-	-	-	-	-
4.	<i>Neanura sikkimensis</i> Yosii, 1966	+	+	-	-	-	-	-
5.	<i>Lobella (Lobella) assamensis</i> Yosii, 1966	+	+	-	-	-	-	-
6.	<i>Lobella kraepelini</i> Börner (1906)	+	+	-	-	-	-	-
7.	<i>Pronura indiana</i> Salmon, 1969	+	+	-	-	-	-	-
8.	<i>Spinanurida mandibulata</i> , Salmon, 1969	+	+	-	-	-	-	-
9.	<i>Uchidanurida altitudina</i> Salmon, 1970	+	+	-	-	-	-	-
	Family : ONYCHIURIDAE							
10.	<i>Onychiurus indicus</i> Choudhuri & Roy	+	+	-	-	-	-	-
11.	<i>Mesaphorura choudhuri</i> Yosii 1966	+	+	-	-	-	-	-
12.	<i>Spelaphorura clayae</i> Salmon, 1963	+	+	-	-	-	-	-
	Family : ISOTOMIDAE							
13.	<i>Isotomurus balteatus</i> (Reuter, 1876)	+	+	-	-	-	-	-
14.	<i>Isotoma (Desoria) trispinata</i> MacGillivray, 1896	+	+	+	-	-	-	+
15.	<i>Isotoma (D) of mazda</i> Yosii, 1971	+	+	-	-	-	-	-
16.	<i>Isotomina thermophila</i> (Axelson, 1900)	+	+	+	+	+	+	+
17.	<i>Isotomiella minor</i> (Schaeffer, 1898)	+	+	+	+	+	+	+
18.	<i>Ballistrura bengalensis</i> Yosii, 1966	+	+	-	-	-	-	-

Cont'd.

Sl. No.	Name of the Species	INDIA	ORIENTAL	PALAERCTIC	ETHIOPIAN	AUSTRALIAN	NEOTROPICAL	NEARCTIC
19.	<i>Cryptopygus thermophilus</i> (Axelson, 1900)	+	+	+	+	+	+	+
20.	<i>Parafolsomia trioculata</i> Salmon, 1956	+	+	—	—	—	—	—
21.	<i>Papillomurus transequatoria</i> Salmon, 1969	+	+	—	—	—	—	—
22.	<i>Rhodanella plumosa</i> Salmon, 1969	+	+	—	—	—	—	—
	Subfamily : ENTOMOBRYINAE							—
23.	<i>Lepidocyrtus</i> (S. Str) <i>magnificus</i> Carpenter, 1924	+	+	—	—	—	—	—
24.	<i>Lepidocyrtus</i> (S.Str) <i>medius</i> Schaeffer, 1898	+	+	—	—	—	—	—
25.	<i>Lepidocyrtus</i> (<i>Acrocyrtus</i>) <i>malayanus</i> Yosii, 1959	+	+	—	—	—	—	—
26.	<i>Lepidocyrtus</i> (A) <i>heterolepis</i> Yosii, 1959	+	+	—	—	—	—	—
27.	<i>Lepidocyrtus curvicollis</i> Yosii, 1959	+	+	+	—	—	—	—
28.	<i>Lepidocyrtus exploratus</i> Carpenter, 1917	+	+	—	—	—	—	—
29.	<i>Lepidocyrtus caudatus</i> Carpenter, 1917	+	+	—	—	—	—	—
30.	<i>Lepidocyrtus cyaneus</i> Tullberg, 1869	+	+	—	—	—	—	—
31.	<i>Lepidosira unguiserrata</i> Salmon, 1970	+	+	—	—	—	—	—
32.	<i>Sinella curviseta</i> Brook, 1882	+	+	+	+	+	+	+
33.	<i>Dicranocentrus indicus</i> Bonet, 1930	+	+	—	—	—	—	—
34.	<i>Dicranocentrus simplex</i> Yosii, 1959	+	+	—	—	—	—	—
35.	<i>Setogaster manipuri</i> Salmon, 1969	+	+	—	—	—	—	—
36.	<i>Homidia cingula</i> Börner, 1906	+	+	—	—	—	—	—
37.	<i>Seira indica</i> (Ritter, 1911)	+	+	—	—	—	—	—

Cont'd.

Sl. No.	Name of the Species	INDIA	ORIENTAL	PALAERCTIC	ETHIOPIAN	AUSTRALIAN	NEOTROPICAL	NEARCTIC
38.	<i>Seira arunachala</i> Mitra, 1975	+	+	-	-	-	-	-
	Subfamily : CYPHODERINAE							
39.	<i>Cyphoderus javanus</i> Börner, 1906	+	+	-	-	-	-	-
40.	<i>Pesudocyphoderus annendalei</i> Imms, 1912	+	+	-	-	-	-	-
41.	<i>Delamarerus immsi</i> Mitra, 1973	+	+	-	-	-	-	-
42.	<i>Cyphoderopsis kempfi</i> Carpenter, 1917	+	+	-	-	-	-	-
43.	<i>Cyphoderopsis gracilis</i> Carpenter, 1924	+	+	-	-	-	-	-
44.	<i>Cyphoderopsis ceylonica</i> Carpenter, 1924	+	+	-	-	-	-	-
	Subfamily : TOMOCERINAE							
45.	<i>Tomocerus mitrai</i> Prabhoo 1980	+	+	-	-	-	-	-
46.	<i>Tomocerus petalospinus</i> Salmon, 1969	+	+	-	-	-	-	-
47.	<i>Tomocerus serratospinus</i> Salmon, 1969	+	+	-	-	-	-	-
	Subfamily : PARONELLINAE							
48.	<i>Salina indica</i> (Imms, 1912)	+	+	-	-	-	-	-
49.	<i>Salina choudhuri</i> Mitra, 1973	+	+	-	-	-	-	-
50.	<i>Salina striata</i> (Handschin, 1928)	+	+	-	-	-	-	-
51.	<i>Salina tricolor tricolor</i> (Handschin, 1928)	+	+	-	-	-	-	-
52.	<i>Salina tricolor sikkimensis</i> Mitra, 1973	+	+	-	-	-	-	-
53.	<i>Salina montana</i> (Imms, 1912)	+	+	-	-	-	-	-
54.	<i>Salina celebensis</i> (Schaeffer, 1898)	+	+	+	-	-	-	+
55.	<i>Salina yosii</i> Salmon, 1964	+	+	-	-	-	-	-

Cont'd.

Sl. No.	Name of the Species	INDIA	ORIENTAL	PALAERCTIC	ETHIOPIAN	AUSTRALIAN	NEOTROPICAL	NEARCTIC
56.	<i>Salina bengalensis</i> Mitra, 1973	+	+	-	-	-	-	-
57.	<i>Salina javana</i> (Handschin, 1928)	+	+	-	-	-	-	-
58.	<i>Salina biformis</i> Mitra, 1966	+	+	-	-	-	-	-
59.	<i>Dicranocentroides indica</i> (Handschin, 1929)	+	+	-	-	-	-	-
60.	<i>Dicranocentroides flavescens</i> Yosii, 1966	+	+	-	-	-	-	-
61.	<i>Dicranocentroides fasciculatus</i> Imms, 1912	+	+	-	-	-	-	-
62.	<i>Dicranocentroides salmoni</i> Mitra, 1973	+	+	-	-	-	-	-
63.	<i>Dicranocentroides gisini</i> , Mitra, 1975	+	+	-	-	-	-	-
64.	<i>Callyntrura (Callyntrura) serrata</i> (Salmon, 1957)	+	+	-	-	-	-	-
65.	<i>Callyntrura (Callyntrura) zaheri</i> Mitra, 1974	+	+	-	-	-	-	-
66.	<i>Callyntrura (Callyntrura) semiviolacea</i> (Handschin, 1925)	+	+	-	-	-	-	-
67.	<i>Callyntrura japonica</i> (Kinoshita, 1917)	+	+	-	-	-	-	-
68.	<i>Callyntrura (Handschinphysa) vestita</i> (Handschin, 1925)	+	+	-	-	-	-	-
69.	<i>Callyntrura (Handschinphysa) lineata</i> (Parona, 1892)	+	+	-	+	+	-	-
70.	<i>Callyntrura (Handschinphysa) borneri</i> (Imms, 1912)	+	+	-	-	-	-	-
71.	<i>Callyntrura (Handschinphysa) longicornis</i> (Oudemans, 1890)	+	+	-	-	-	-	-
72.	<i>Callyntrura (Handschinphysa) delamarei</i> Mitra, 1974	+	+	-	-	-	-	-
73.	<i>Alloscopus tetracantha</i> Börner, 1906	+	+	+	+	+	+	+
74.	<i>Yosii dehradunia</i> Mitra, 1967	+	+	-	-	-	-	-
75.	<i>Pseudoparonellides bulbosa</i> Salmon, 1957	+	+	-	-	-	-	-
76.	<i>Heteromuricus cercifer</i> Imms, 1912	+	+	-	-	-	-	-

Table 3 : Zoogeographical analysis of Collembola from East & North East India.

Name of Family	Total Number		Endemic		Zoogeographical realms					
	Genera	Species	Genera	Species	ORIENTAL	PALAERTIC	ETHIOPIAN	AUSTRALIAN	NEOTROPICAL	NEARCTIC
HYPOGASTRURIDAE	7	9	6	6	9	0	—	—	—	—
ONYCHIURIDAE	3	3	3	3	3	0	—	—	—	—
ISOTOMIDAE	9	10	5	5	10	4	3	3	3	4
ENTOMOBRYIDAE	19	54	9	14	54	4	3	3	2	3
TOTAL 38	76	23	28	76	8	6	6	5	7	

C. ECOLOGICAL STUDY

Methods of samplings : Soil samples were collected at random at the rate of 3 samples per plot every month during January 2000 with the use of a stainless steel corer (8.5 sq./cm) from a depth of 5 cm. Separate sample units thus collected were kept immediately in sterile polythene packet at 4°C for estimations of soil parameters in the laboratory.

Extraction of Collembola : Extraction of soil samples were carried out by "Expedition Funnel Apparatus" (Macfadyen, 1953) with a 40-watt bulbs for heat and light for a period varying from 36 hrs to 72 hours dependent to the moisture content of the sample.

Analysis of soil factors : Soil samples were dried in hot air oven at about 105°C for further bacterial action. Some of samples were kept separately were then allowed to cool and stored in a desiccator and dried soil was passed through the 2 mm sieve, mixed and fractionated analysis of nitrate and estimation of moisture.

Mechanical analysis : The size of particle in soil being the most important physical properties for determination was done following Folk and Word (1957) and Shepard (1954). At first, the sample was weighed (25 gm) and soaked in H₂O₂ (30% strength) in a beaker and kept for about 12 hrs. After boiling for some time, the samples were cooled and the ammonia was added and washed in distilled water before its transfer of the material to 1000cc by addition of distilled water. The mixture was separately pipetted and weighed + 230 (ASTM) materials were separately taken in a beaker, dried and weighed in order to know the sand silt percentage. If the weight happened equal or more than 5% of the bulk, the + 230 fraction. experimental samples were sieved for estimation of the percentage of different fraction of the coarse.

Pipetting : To find out the sand-silt clay ratio, 8 moisture free beakers (for each sample) were weighed for each sample. Before experiment the sample in cylinder and the temperature of the day were recorded with variation of temperature during pipetting. 4, 4.05, 5, 5.05, 6, 7, 8 and 9 pH fractions were pipetted by 20 cc pipette from the cylinder put in the dry beakers and were allowed to dry. The difference of weight between the last and the first one (empty dry beaker) would give the weight at different pH fraction which was multiplied by 50 in order to know the position in total 1000cc. sample (taken in the cylinder).

Temperature : Soil-thermometer was used to record the temperature of the soil.

Hydrogen Ion Concentration (pH) : A soil suspension was prepared in a glass bottle with stopper in which one part of soil was mixed with five parts of deionized double distilled water shaken in mechanical shaker for one hour and the ratio was determined after CSIR (Piper, 1942). Before taking the reading of the pH of the soil solution electronic pH meter, "WTW-pH 320" which was standardized everytime with the aid of standard Beckman buffer solution to avoid the instrumental error.

Moisture : Moisture of the soil sample was measured by the 'Oven Dry Method' (Dowdeswell, 1959) and has been expressed in percentage of the weight difference before and after drying soil sample at 105°C for 4 hours.

Organic Carbon : Organic Carbon content of the soil was determined by 'Rapid Titration Method' (Walkely and Black, 1934). Organic matter of the soil (1 gm) was digested with excess 1 (N) $K_2Cr_2O_7$ and conc. H_2SO_4 and the residual utilized dichromate had then been titrated with 1(N) $Fe (NH_4)_2 SO_4$ using Diphenyle Amine indicator.

Nitrate : Extraction of soil sample : Natural moist soil and coarse stone was mixed with 100 ml of 0.025 M $CaCl_2$ solution in a 50 gm glass bottle. A spatula tip activated charcoal meant soil test was added was shaken in a shaker for one hour. The suspension was thereafter allowed to settle and filtered through a fluted filter.

Measurement : Nitrate content of the soil was determined by using the microprocessor of standard single beamed photometer SQ 118, (E-Merck, Germany make) employing tungsten halogen lamp as the light source. Measurement was taken against a blank solution after selection of desired number at 515 nm expressed in mg/l.

Phosphate : Extraction of soil sample : 10 gm. of soil was mixed with 100 ml. Ca-lactate Ca-acetate extraction solution. A spatula tip of activated charcoal (for soil) was added and the bottle was shaken for an hour and the suspension was allowed to settle and filtered through filtered paper (Whatmen No. 1).

Measurement : Phosphate content of the soil was measured by SQ 118 photometer. The solution was acidified with Sulfuric acid (H_2SO_4), the Orthophosphate ion and Molybdate ion form Molybdophosphoric acid. Ascorbic acid reducing this to phosphomolybdenum blue (PMB), was determined photometrically at 712 nm wavelength against a blank solution.

OBSERVATIONS

Analysis of Collembolan fauna : The present investigation involves extraction of soil microfauna from the sampling plots of two different habitats, such as :

Site I : Beathuadhari Reserve Forest (BRF), Nadia District.

Site II : Dhapa (DP), East Kolkata.

SITE I : BETHUADHARI RESERVE FOREST (BRF)

Location and Characteristic of sampling site : (Map 6).

It is a man made forest located at Bethuadhari (Nadia) by the side of NH-34 of the eastern part of West-Bengal (120 km north of Kolkata). Annual rainfall of the site and its surroundings

ranges from 77-84.70 cm and the forest comprises major trees like, *Shorea robusta*, *Tectona grandis*, *Ficus religiosa*, *Mangifera indica* and *Azadirachta indica* under growths like, *Sporobolus diander*, *Dichanthium annulatum*, *Eragrostis brachyphylla*, *Digitaria marginata*, *D. royleana*, *Euphorbia hirta* and *Lanata camara*. The sampling site was maintained with coverage of litter of the fallen leaves and dried twigs of the above trees.

Soil factors : Soils are alluvial, blackish brown in colour and sandy silt in texture. Mechanical analyses of soil showed maximum percentage of medium silt 33.6% and more or less equal percentage of fine sand and fine silt (Tab. 4). During May, soil moisture content was 27% in 2000, 28% in 2001 and 27.5% in 2002. Maximum moisture content in soil (35%) was recorded in July and August, 2000 and 34.5% in the same period of 2001. During May other soil factors such as temperature, organic carbon, nitrate and phosphate were found 36°C, 2%, 1.75 ppm. and 5.3 ppm; 34°C, 1.3% 2.46 ppm and 6.4 ppm; 35°C, 1.25%, 1.80 ppm and 5.5 ppm in 2000, 2001 and 2002 respectively. Mean values of others revealed more or less identical characteristics (Tab. 5).

Collembolan Fauna : The Collembolana fauna obtained from this site belong to 24 species in 17 genera. Amongst them, the genus *Lepidocyrtus medius* was found to be most dominant (11.73%) followed by species *Lepidocyrtus magnificus* (10.04%) of the total fauna recorded from this site. The species *Homidia sp.* contributed 8.35%, *Yosiia dehradunia*, 6.09%, *Isotomina thermophila*, 4.74% *Cyphoderus javanus*, 4.28%, *Cryptopygus thermophilus*, 4.17%, *Ballistrura bengalensis*, 3.72%, *Salina montana*, 3.61%, *Xenylla obscura*, 3.61% and *Salina bengalensis* was 2.37% (Table 6 to 8, Figure 1). Abundance of other species appeared numerically low and highly irregular in distribution pattern. Percentage of springtails was maximum in August in both the years which coincided with the maximum concentration of soil factors like-moisture, organic carbon and other edaphic factors (Figures 4. I -VI).

Seasonal changes : Seasonal changes of each predominant species of collembola from this site revealed that *Lepidocyrtus magnificus* reached its peak in August in both the years, while *Homidia sp* showed maximum in January 2000 but maximum population of the species reached in December and February. *Yosiia dehradunia* had its highest population in January 2000 and higher in August 2001. It became apparent that predominant forms exhibited an irregular trend of fluctuation being minimum in May, little higher in December/January/February. The peak of population of other genera/species varied in the years as well as month of observation due to their irregular occurrence.

SITE II: DHAPA (DP), EAST KOLKATA

Location and Characteristic of sampling site : (Map 6)

The site is a dumping ground of wastes of Kolkata city essentially main constituting of the house hold wastes, industrial effluents and the residues of vegetables. Cultivation of

seasonal vegetables (cauliflower, cabbage, maize, peas etc) practised in the sampling site through mixing the decomposing materials with the soil.

Soil factors : Soil was blackish in colour and silty sand to sandy in texture and it analyses mechanically showed maximum percentage of coarse sand. The soil organic carbon and nitrate content were maximum in March of each sampling year (3.85%, 3.7 ppm in 2000; 3.85%, 3.5 ppm in 2001 and 3.66%, 3.5 ppm in 2002) and the soil moisture were 35.5%, 35.6% and 32.5% in 2000, 2001 and 2002 respectively in the same month when the soil pH recorded minimum (5.9 in 2000, 5.8 on 2001 and 5.9 in 2002). In May, the soil moisture was minimum in 2000 (26%), 2001 (25.5%) and 2002 (26.5%) when the soil temperature read maximum and phosphate ion, the minimum in May (39°C, 4.5 ppm in 2000, 39°C, 5.75 ppm in 2001 and 38°C, 6.2ppm in 2002) (Table 9).

Collembolan Fauna : The Collembolan fauna belong to 14 species under 12 genera. *Lepidocyrtus cyaneus* was found the most dominant with 21.85% of the total fauna recorded from this site whereas *Xenylla obscura*, *Cyphoderus javanus*, *Cryptopygus thermophilus*, *Frisea sp*, *Isotomurus balteatus*, *S. indica*, *Ballistrura bengalensis* and *Isotomiella minor* represented 15.48%, 13.90%, 12%, 6.04%, 4.22%, 3.22%, 3.22% and 2.56% respectively. Population of other species was numerically low and highly irregular in distribution pattern (Table 10 to 12, Figure 2). The population was found maximum in March coinciding with the highest population of soil factors like organic carbon and nitrate (Figure 5. I to VI).

Seasonal changes : *L. cyaneus* indicate single peak of each of the predominant species in March in a year while *X. obscura* showed its peak in February. *C. javanus* exhibited higher population in March. It became apparently evident that predominant form of collembola in this site which showed maximum population in February and March and minimum in May. The population maxima of other genera and species varied during the years as well as months of observation due to their irregular occurrence in this field.

Table 4 : Mechanical analysis of soil (%) in two sampling sites

Sampling site	Coarse sand	Medium sand	Fine sand	Coarse to Medium site	Fine site	Clay
Site-I : B.R.F	4.3684	2.4573	20.4777	33.5962	21.6687	17.4317
Site-II : D.P	57.9562	3.9447	8.5943	9.0118	1.0002	9.492

Table 5 : Values of edaphic factors per month (Jan 2000-Jun 2002) at Site I : BRF

Year	Month	Temperature (0°C)	Moisture (%)	pH	Organic carbon (%)	Nitrate (ppm)	Phosphate (ppm)
2000	JAN	19	29.5	6.3	3.1	2.3	7.8
	FEB	21	30	6.5	3	2.26	7.6
	MAR	28	28	6.7	2.9	2.15	7
	APR	37	28.5	7	2.6	1.9	5.7
	MAY	36	26.5	7	2	1.75	5.3
	JUN	32	27	6.8	1.3	2	2.5
	JUL	33	32	6.4	3	2.4	2.8
	AUG	32.5	35	6.6	3.5	2.57	3.5
	SEPT	30.5	33	6.5	2.98	2.45	3.9
	OCT	31	31	6.3	3.12	2.3	4.5
	NOV	28.5	30	6.4	3	2	6
	DEC	26	29	6.9	2.92	2.2	8.1
2001	JAN	19	28	6.7	3.4	2.15	8.6
	FEB	21	27	6.2	3.52	1.9	8.6
	MAR	26	28	6.1	3.52	1.84	7.9
	APR	33.5	26.5	6.2	1.52	2.35	8.3
	MAY	34	28	6	1.3	2.46	6.4
	JUN	32	33	6.3	2.7	2.5	6
	JUL	32.5	34.5	6.5	2.75	2.3	2.4
	AUG	33	33	6.7	3.12	3.35	2.5
	SEP	30	31	6.2	3.1	2.5	3.5
	OCT	28	30	6	3.22	2.1	3.1
	NOV	26	26.5	7	3.42	2.15	7.7
	DEC	23	25.5	6.9	2.8	2.1	7.8
2002	JAN	20	26	6.3	2.95	2.15	7.5
	FEB	21	27.5	6.5	2.66	1.9	8.5
	MAR	28.5	27	6.6	2	1.7	8.2
	APR	36.5	25	6.8	3	1.85	7
	MAY	35	27.5	6.5	1.25	1.8	5.5
	JUN	33	27	6.4	2.4	1.95	5

Table 6 : Abundance (no. /sq.m.)Of individual Collembolan species obtained per month from site I, BRF (Year 2000).

figures in parenthesis showing %

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1. <i>Lepidocyrtus medius</i>	1403.5 0.67	1871.34 0.9	935.67 0.45	463.6 0.22	0	0	2339.18 1.12	3742.68 1.8	2807.01 1.35	1403.5 0.67	1169.59 0.56	701.75 0.33
2. <i>L. magnificus</i>	1169.59 0.56	935.67 0.45	463.6 0.22	0	0	0	2573.09 1.24	4210.52 2.03	2807.01 1.35	935.67 0.45	0	0
3. <i>L. heterolepis</i>	0	0	0	0	0	0	935.67 0.45	2339.18 1.12	1403.5 0.67	0	0	0
4. <i>L. exploratorius</i>	935.67 0.45	0	0	0	0	0	463.6 0.22	1403.5 0.67	935.67 0.45	0	0	0
5. <i>Homidia sp</i>	2339.18 1.12	0	0	463.6 0.22	0	0	935.67 0.45	1403.5 0.67	463.6 0.22	0	0	1871.34 0.9
6. <i>Sinella curviseta</i>	0	0	0	0	0	0	463.6 0.22	935.67 0.45	0	0	0	463.6 0.22
7. <i>Seira indica</i>	0	0	0	0	0	0	935.67 0.45	1169.59 0.56	0	0	0	0
8. <i>Dicranocentrus indicus</i>	0	0	0	0	0	0	463.6 0.22	935.67 0.45	463.6 0.22	0	0	463.6 0.22
9. <i>Yosiia dehradunia</i>	2807.01 1.35	935.67 0.45	0	0	0	0	935.67 0.45	1403.5 0.67	0	0	0	0
10. <i>Salina bengalensis</i>	935.67 0.45	0	0	0	0	0	463.6 0.22	701.75 0.33	0	0	0	463.6 0.22
11. <i>S.indica</i>	0	935.67 0.45	0	0	0	0	0	0	463.6 0.22	0	0	463.6 0.22
12. <i>S. montana</i>	463.6 0.22	0	0	0	0	0	0	635.67 0.45	701.75 0.33	0	701.75 0.33	0

Cont'd.

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
13. <i>S. javana</i>	0	463.6 0.22	0	0	0	0	0	0	935.67 0.45	0	0	0
14. <i>Callyntrura (H) vestita</i>	0	0	0	0	0	0	0	1403.5 0.67	0	0	0	463.6 0.22
15. <i>Dicranocentroides indica</i>	0	0	0	0	0	0	0	1871.34 0.9	0	0	0	0
16. <i>D. flavescens</i>	935.67 0.45	463.6 0.22	0	0	0	0	0	0	1169.59 0.56	0	0	0
17. <i>Isotomurus balteatus</i>	0	0	0	0	0	0	0	1637.42 0.79	701.75 0.33	0	0	0
18. <i>Isotomiella minor</i>	0	463.6 0.22	0	0	0	463.6 0.22	0	0	935.67 0.45	0	0	0
19. <i>Isotomina thermophila</i>	0	0	1403.5 0.67	0	0	935.67 0.45	1169.59 0.56	463.6 0.22	0	0	0	0
20. <i>Ballistrura bengalensis</i>	0	0	935.67 0.45	0	0	0	463.6 0.22	935.67 0.45	0	0	0	0
21. <i>Cryptopygus thermophilus</i>	1403.5 0.67	0	935.67 0.45	463.6 0.22	0	0	0	463.6 0.22	0	0	0	0
22. <i>Xenylla obscura</i>	0	463.6 0.22	0	0	935.67 0.45	0	0	1403.5 0.67	0	0	0	0
23. <i>Onychiurus indicus</i>	0	0	0	0	0	0	935.67 0.45	1871.34 0.9	0	0	0	0
24. <i>Cyphoderus javanus</i>	0	0	463.6 0.22	935.67 0.45	0	0	0	1403.5 0.67	0	0	0	0

Table 7 : Abundance (no. /sq.m.) of individual Collembolan species obtained per month from site I, BRF (Year 2001).

figures in parenthesis showing %

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1. <i>Lepidocyrtus medius</i>	935.67 0.45	1403.5 0.67	0	0	0	0	463.6 0.22	935.67 0.45	63.6 0.22	0	0	0
2. <i>L. magnificus</i>	463.6 0.22	0	0	0	0	0	935.67 0.45	2807.01 1.35	1403.5 0.67	0	0	0
3. <i>L. heterolepis</i>	0	0	0	0	0	0	0 0.67	1403.5 0.22	463.6	0	0	0
4. <i>L. exploratorius</i>	0	0	0	0	0	0 0.45	935.67 0.9	1871.34	0	0	0 0.22	463.6
5. <i>Homidia sp</i>	1871.34 0.9	935.67 0.45	0	0	0	0	0	935.67 0.45	0	0	0	2807.01 1.35
6. <i>Sinella curviseta</i>	0	0	0	0	0	0	0	1403.5 0.67	463.6 0.22	0	0	0
7. <i>Seira indica</i>	0	0	463.6 0.22	0	0	0	463.6 0.22	935.67 0.45	0	0	0	0
8. <i>Dicranocentrus indicus</i>	0	0	0	935.67 0.45	0	0	0	463.6 0.22	0	0	463.6 0.22	935.67 0.45
9. <i>Yosiia dehradunia</i>	935.67 0.45	463.6 0.22	0	0	0	0	0	1871.34 0.9	935.67 0.45	0	0	436.6 0.22
10. <i>Salina bengalensis</i>	0	935.67 0.45	0	0	0	0	463.6 0.22	0	463.6 0.22	0	0	0
11. <i>S.indica</i>	463.6 0.22	0	463.6 0.22	463.6 0.22	0	463.6 0.22	0	0	0	0	0	0
12. <i>S. montana</i>	935.67 0.45	0	463.6 0.22	0	0	0	935.67 0.45	1403.5 0.67	0	463.6 0.22	0	0

Cont'd.

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
13. <i>S. javana</i>	0	0	0	0	0	0 0.22	463.6 0.45	935.67	0	0 0.45	935.67 0.67	1403.5
14. <i>Callyntrura (H) vestita</i>	463.6 0.22	935.67 0.45	0	0	0	0	0	463.6 0.22	935.67 0.45	0	0	0
15. <i>Dicranocentroides indica</i>	0	0	463.6 0.22	0	463.6 0.22	0	0	1403.5 0.67	0	0	0	0
16. <i>D. flavescens</i>	463.6 0.22	463.6 0.22	0	0	0	0	0	463.6 0.22	0	0	0	0
17. <i>Isotomurus balteatus</i>	0	0	935.67 0.45	0	463.6 0.22	0	1169.59 0.56	935.67 0.45	463.6 0.22	0	0	0
18. <i>Isotomiella minor</i>	0	0	0	463.6 0.22	0	0	0	463.6 0.22	0	1403.5 0.67	0	463.6 0.22
19. <i>Isotomina thermophila</i>	463.6 0.22	935.67 0.45	0	0	0	463.6 0.22	1871.34 0.9	935.67 0.45	0	0	0	0
20. <i>Ballistrura bengalensis</i>	0	0	0	0	935.67 0.45	463.6 0.22	1403.5 0.67	0	0	0	0	463.6 0.22
21. <i>Cryptopygus thermophilus</i>	1403.5 0.67	463.6 0.22	0	463.6 0.22	0	0	463.6 0.22	0	935.67 0.45	0	0	0
22. <i>Xenylla obscura</i>	1169.59 0.56	701.75 0.33	0	0	0	463.6 0.22	1871.34 0.9	0	0	463.6 0.22	0	0
23. <i>Onychiurus indicus</i>	0	0	463.6 0.22	0	0	0	0	0	0	463.6 0.22	701.75 0.33	0
24. <i>Cyphoderus javanus</i>	0	0	935.67 0.45	0	0	0	935.67 0.45	463.6 0.22	0	0	0	0

Table 8 : Abundance (no. /sq.m.)of individual Collembolan species obtained per month from site I, BRF (Year-2002).

figures in parenthesis showing %

SPECIES	JAN	FEB	MAR	APR	MAY	JUN
1. <i>Lepidocyrtus medius</i>	1403.5 0.67	935.67 0.45	0	0	0	935.67 0.45
2. <i>L. magnificus</i>	0	935.67 0.45	0	0	0	1169.59 0.56
3. <i>L. heterolepis</i>	0	0	0	935.67 0.45	0	436.6 0.22
4. <i>L. exploratorius</i>	0	0	463.6 0.22	0	0	1403.5 0.67
5. <i>Homidia sp</i>	1403.5 0.67	1871.34 0.9	0	0	0	463.6 0.22
6. <i>Sinella curviseta</i>	463.6 0.22	0	0	0	0	0
7. <i>Seira indica</i>	935.67 0.45	0	0	0	0	0
8. <i>Dicranocentrus indicus</i>	0	463.6 0.22	0	0	463.6 0.22	0
9. <i>Yoslia dehradunia</i>	463.6 0.22	0	935.67 0.45	0	0	463.6 0.22
10. <i>Salina bengalensis</i>	0	0	0	463.6 0.22	0	0
11. <i>S.indica</i>	0	935.67 0.45	0	0	0	0
12. <i>S. montana</i>	0	0	463.6 0.22	0	0	0
13. <i>S. javana</i>	0	0	0	463.6 0.22	0	0
14. <i>Callyntrura (H) vestita</i>	463.6 0.22	0	0	0	0	463.6 0.22
15. <i>Dicranocentroides indica</i>	0	935.67 0.45	0	0	0	0
16. <i>D. flavescens</i>	0	0	935.67 0.45	463.6 0.22	0	0
17. <i>Isotomurus balteatus</i>	0	0	0	935.67 0.45	463.6 0.22	935.67 0.45
18. <i>Isotomiella minor</i>	0	0	0	1403.5 0.67	0	0
19. <i>Isotomina thermophila</i>	0	0	1169.59 0.56	0	0	0
20. <i>Ballistrura bengalensis</i>	0	0	2106.26 1.01	0	0	0
21. <i>Cryptopygus thermophilus</i>	0	0	0	1169.59 0.56	463.6 0.22	0
22. <i>Xenylla obscura</i>	0	0	0	0	0	0
23. <i>Onychiurus indicus</i>	0	0	0	0	0	0
24. <i>Cyphoderus javanus</i>	0	0	1637.42 0.79	1169.59 0.56	0	0

Table 9 : Values of edaphic factors per month (JAN 2000-JUN 2002) at site II, DP, KOLKATA.

Year	Month	Temperature (0°C)	Moisture (%)	pH	Organic carbon (%)	Nitrate (ppm)	Phosphate (ppm)
2000	JAN	21.5	24.5	6.1	3.72	3.1	10.5
	FEB	26	30.5	6	3.8	3.56	8.2
	MAR	35	35.5	5.9	3.85	3.7	8.5
	APR	37	31	6	3.71	3.5	5.6
	MAY	39	26	6.2	3.7	3.1	4.5
	JUN	35	28.5	6.7	3.57	2.7	14.1
	JUL	34.5	32	6.5	3.28	2.75	13.6
	AUG	33.4	35.6	6.4	3.5	2.8	14.6
	SEP	33.2	34.5	6.4	3.63	3	14.5
	OCT	30	27	6.6	3.5	3	14
	NOV	26.5	26	6.3	3.57	3.12	12.5
	DEC	25.5	24.1	6.2	3.47	3.2	12.3
2001	JAN	20.5	25.3	6.1	3.85	3.3	7.5
	FEB	24	32.5	6.6	3.95	3.42	11
	MAR	34	35.6	5.8	3.85	3.5	11.3
	APR	36	35	6.3	3.2	3.8	10.6
	MAY	39	25.5	6.2	3.3	3.75	5.75
	JUN	35.5	30.2	6.1	3.4	2.9	12.3
	JUL	33.2	28.4	6.3	3.95	2.92	14.5
	AUG	34	31.5	6.2	3.65	2.82	14.1
	SEPT	32	32.5	6.7	3.85	2.95	14.5
	OCT	30	28.7	6.5	3.6	3.1	12.5
	NOV	28	26.6	6.4	3.8	3.5	11.8
	DEC	24	25	6.5	3.98	3.2	10.8
2002	JAN	20	24	6.3	4.2	3.25	7.2
	FEB	25.5	27	6.1	4	3.4	9.3
	MAR	34	32.5	5.9	3.66	3.5	11.1
	APR	36	28.5	6.2	3.3	2.9	9.1
	MAY	33.8	26.5	6.7	3.5	2.95	6.2
	JUN	36.5	30	6.8	3.6	3	8.8

Table 10 : Abundance (no. /sq.m.) of individual Collembolan species obtained per month from site II, DP, Kolkata, 2000.

figures in parenthesis showing %

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1. <i>Lepidocyrtus cyaneus</i>	2807.01 0.99	3742.68 1.32	5146.19 1.82	1871.34 0.66	0	0	0	2339.18 0.82	1403.5 0.49	0	0	0
2. <i>L. exploratorius</i>	0	0	2339.18 0.82	0	0	0	0	935.67 0.33	1637.42 0.57	0	0	935.67 0.33
3. <i>L. heterolepis</i>	0	0	2807.01 0.99	0	0	0	0	1637.42 0.57	1169.59 0.41	0	0	0
4. <i>Selra Indica</i>	0	0	5380.11 1.9	0	0	0	0	1169.59 0.41	2573.09 0.99	0	0	0
5. <i>Calx</i> sp	0	0	935.67 0.33	0	0	0	0	0	1403.5 0.49	0	0	0
6. <i>Cyphoderus javanus</i>	0	2573.09 0.91	4210.52 1.49	0	0	0	0	1637.42 0.57	1169.59 0.41	0	0	0
7. <i>Cryptopygus thermophilus</i>	0	0	3040.93 1.07	0	0	0	0	2105.26 0.74	1169.59 0.41	0	0	935.67 0.33
8. <i>Ballistrura bengalensis</i>	0	0	0	0	2573.09 0.91	0	0	0	0	1403.5 0.49	0	0
9. <i>Isotomurus balteatus</i>	0	0	0	0	0	0	0	3040.93 1.07	1637.42 0.57	0	0	0
10. <i>Isotomiella minor</i>	0	0	3976.6 1.4	0	0	0	0	0	0	0	0	0
11. <i>Friesea</i> sp	0	0	3040.93 1.07	0	0	0	0	2573.09 0.91	0	0	0	0
12. <i>Archerontiella</i> sp	0	0	0	0	0	0	0	0	0	0	0	0
13. <i>Willemia</i> sp	0	0	1871.34 0.66	0	0	0	1637.42 0.57	0	0	0	0	0
14. <i>Xenylla obscura</i>	0	3274.85 1.15	2339.18 0.82	0	0	0	935.67 0.33	0	0	0	0	0

Table 11 : Abundance (no. /sq.m.) of individual collembolan species obtained per month from site II, DP, Kolkata, 2001.

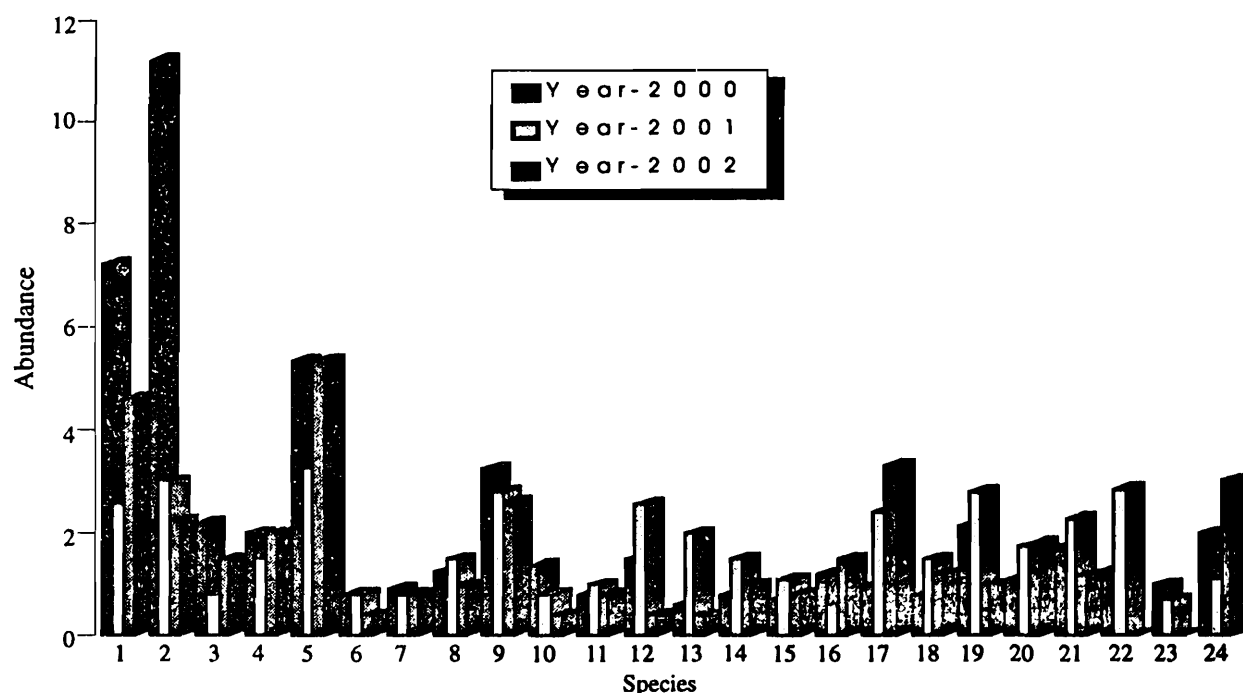
figures in parenthesis showing %

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1. <i>Lepidocyrtus cyaneus</i>	1871.34 0.66	2807.01 0.99	7953.21 2.81	1637.42 0.57	467.83 0.16	1637.42 0.57	1169.6 0.41	2573.1 0.91	3040.9 1.07	0	0	2339.18 0.82
2. <i>L. exploratorius</i>	0 0	1871.34 0.66	4678.36 1.65	0	0	0	0	1403.5 0.49	0	0	0	0
3. <i>L. heterolepis</i>	0	0	1403.5 0.49	0	0	0	2339.2 0.82	0	0	0	0	0
4. <i>Seira indica</i>	0	0	0	0	0	0	0	0	0	0	0	0
5. <i>Calx</i> sp	0	0	0	0	0	0	3040.9 1.07	0	0	0	0	0
6. <i>Cyphoderus javanus</i>	1403.5 0.49	3040.93 1.07	3976.6 1.4	0	0	0	2339.2 0.82	0	3274.9 1.15	0	1169.6 0.41	0
7. <i>Cryptopygus thermophilus</i>	1871.34 0.66	1637.42 0.57	3742.68 1.32	467.83 0.16	935.67 0.33	2105.26 0.74	1169.6 0.41	1403.5 0.49	0	1169.6 0.41	0	0
8. <i>Ballistrura bengalensis</i>	0	0	935.67 0.33	0	0	0	0	2807 0.99	1403.5 0.49	0	0	0
9. <i>Isotomurus balteatus</i>	0	0	1637.42 0.57	0	0	0	0	1169.6 0.41	0	0	0	0
10. <i>Isotomiella minor</i>	0	0	1169.59 0.41	0	0	2105.26 0.74	0	0	0	0	0	0
11. <i>Friesea</i> sp	0	0	3274.85 1.15	0	0	0	2573.1 0.91	0	0	1871.3 0.66	0	0
12. <i>Archerontiella</i> sp	0	0	0	0	0	0	2807 0.99	0	0	0	0	0
13. <i>Willemia</i> sp	0	0	0	0	0	0	0	0	0	0	0	0
14. <i>Xenylla obscura</i>	2573.09 0.91	3976.6 1.4	2105.26 0.74	0	0	0	1169.6 0.41	0	0	1403.5 0.49	2105.3 0.74	1169.59 0.41

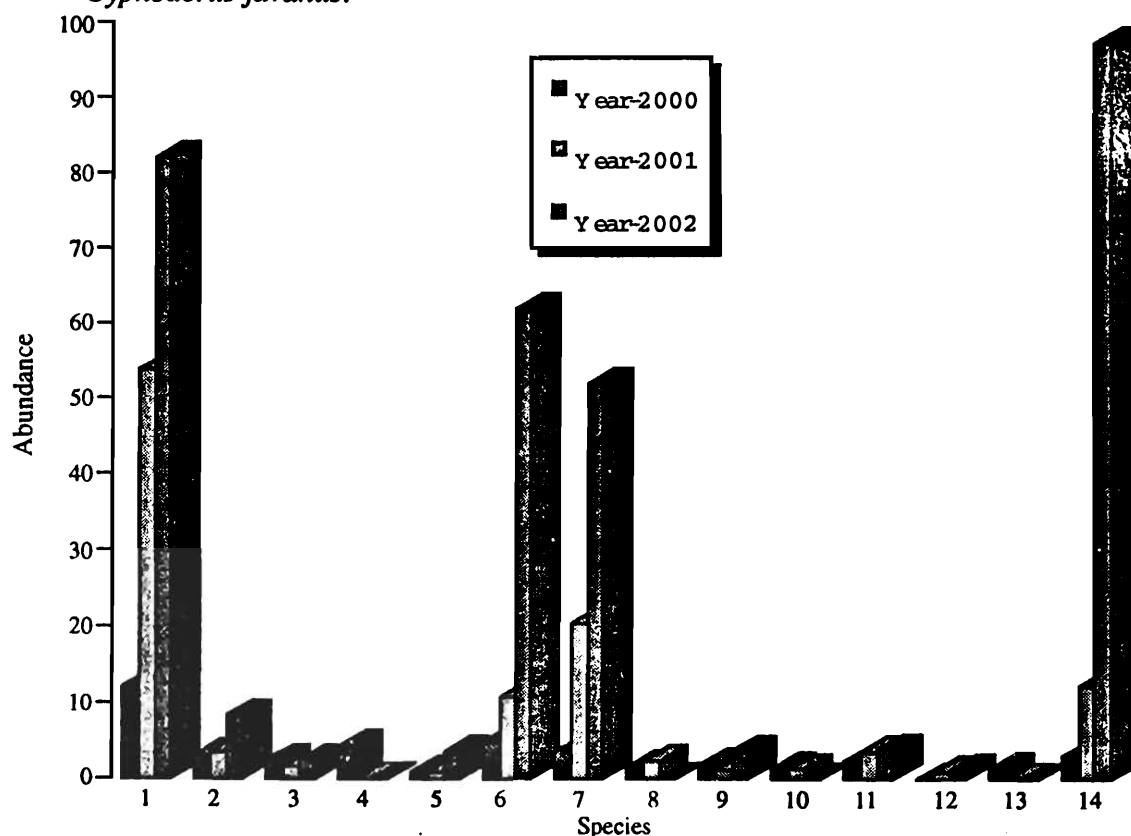
Table 12 : Abundance (no. /sq.m.) of individual Collembolan species obtained per month from site II, DP, Kolkata, 2002.

figures in parenthesis showing %

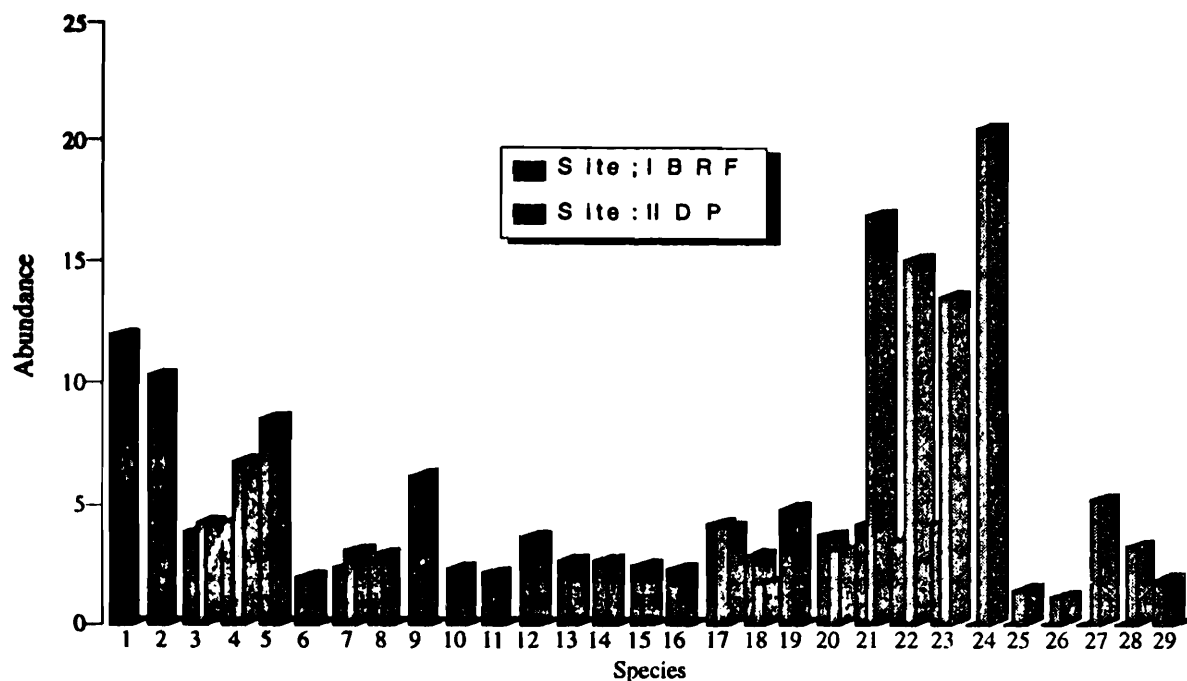
SPECIES	JAN	FEB	MAR	APR	MAY	JUN
1. <i>Lepidocyrtus cyaneus</i>	1871.34 0.66	4912.27 1.73	6783.62 2.4	2807.01 0.99	1637.42 0.57	1169.59 0.41
2. <i>L. exploratorius</i>	935.67 0.33	2807.01 0.99	2105.26 0.74	0	0	0
3. <i>L. heterolepis</i>	0	0	3040.93 1.07	0	0	0
4. <i>Seira indica</i>	0	0	0	0	0	0
5. <i>Calx sp</i>	0	0	4210.52 1.49	0	0	0
6. <i>Cyphoderus javanus</i>	1637.42 0.57	2807.01 0.99	3742.68 1.32	3040.93 1.07	1169.59 0.41	2105.26 0.74
7. <i>Cryptopygus thermophilus</i>	1169.59 0.41	1871.34 0.66	4912.27 1.73	935.67 0.33	701.75 0.24	2573.09 0.91
8. <i>Ballistrura bengalensis</i>	0	0	0	0	0	0
9. <i>Isotomurus balteatus</i>	0	0	0	0	0	4444.44 1.57
10. <i>Isotomiella minor</i>	0	0	0	0	0	0
11. <i>Friesea sp</i>	0	0	2339.18 0.82	1403.5 49	0	0
12. <i>Archerontiella sp</i>	0	0	0	0	1403.5 0.49	0
13. <i>Willemia sp</i>	0	0	0	0	0	0
14. <i>Xenylla obscura</i>	3274.85 1.15	7485.37 2.64	6315.78 2.23	2573.09 0.91	1169.59 0.41	1871.34 0.6



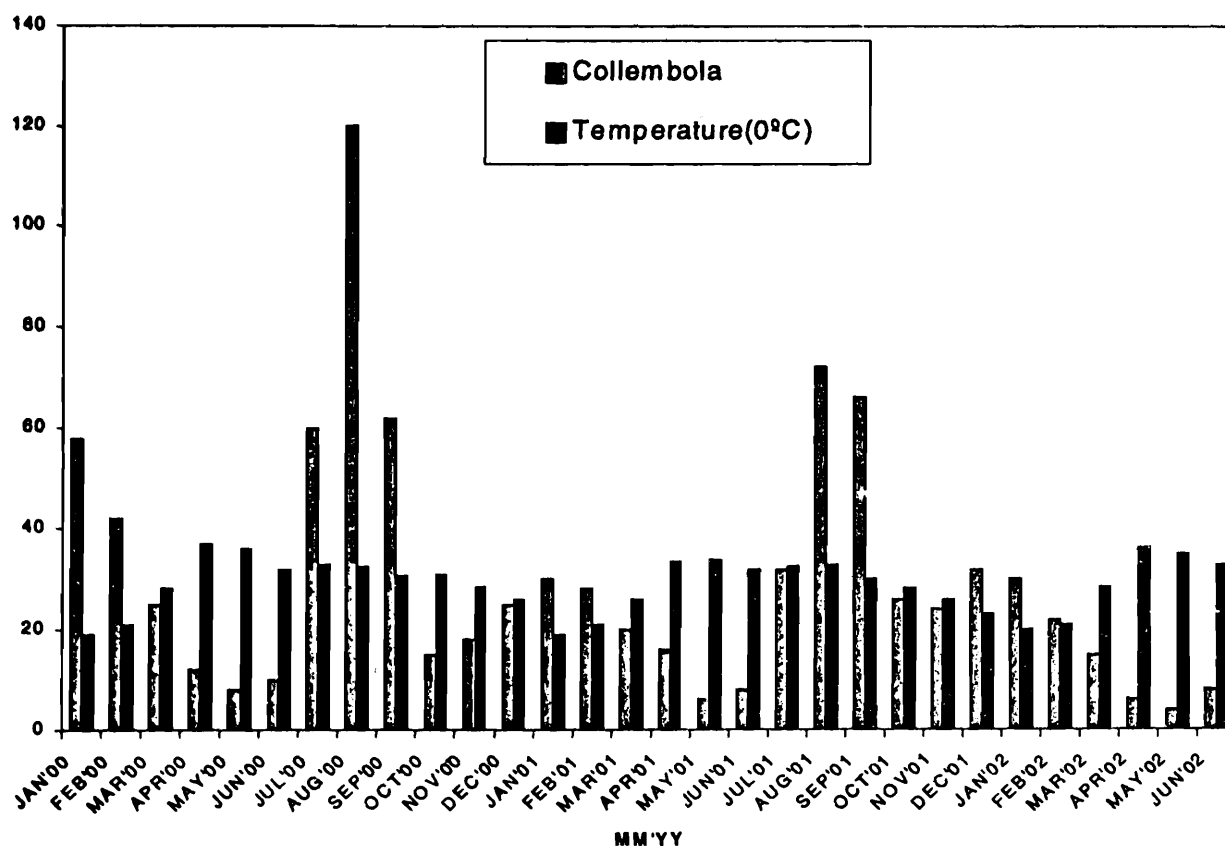
Graph-1 : Relative abundance of Collembolan species obtained from Site-1.B.R.F, Nadia. 1. *Lepidocyrtus medius*, 2. *L. magnificus*, 3. *L. heterolepis*, 4. *L. exploratorius*, 5. *Homidia sp.*, 6. *Sinella curviseta*, 7. *Seira indica*, 8. *Dicranocentrus indicus*, 9. *Yosiia dehradunia*, 10. *Salina bengalensis*, 11. *S. indica*, 12. *S. montana*, 13. *S. javana*, 14. *Callyntrura (H) vestita*, 15. *Dicranocentroides indica*, 16. *D. flavescens*, 17. *Isotomurus balteatus*, 18. *Isotomiella minor*, 19. *Isotomina thermophila*, 20. *Ballistrura bengalensis*, 21. *Cryptopygus thermophilus*, 22. *Xenylla obscura*, 23. *Onychiurus indicus*, 24. *Cyphoderus javanus*.



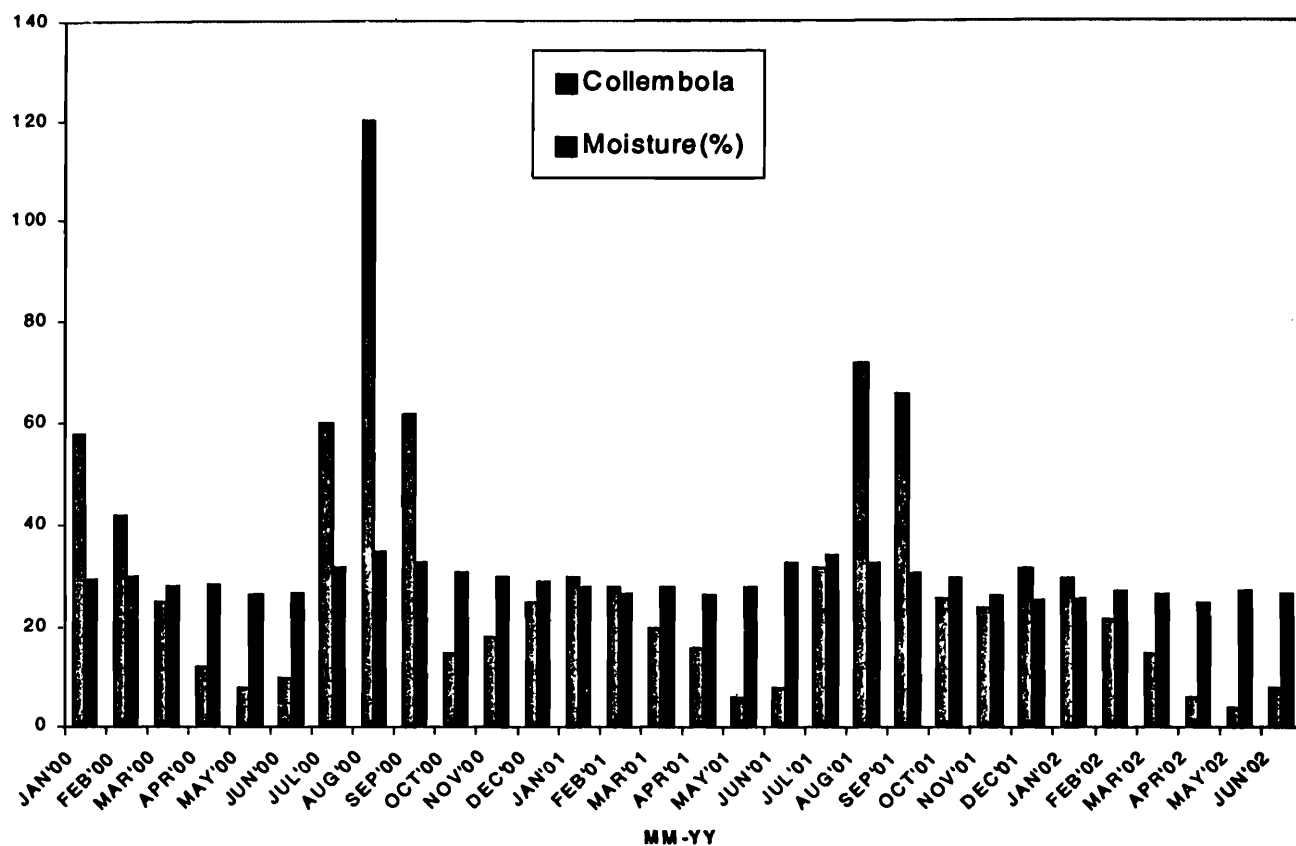
Graph 2 : Relative abundance of Collembolan species obtained from Site-II, DP, Kolkata. 1. *Lepidocyrtus cyaneus*, 2. *L. exploratorius*, 3. *L. heterolepis*, 4. *Seira indica*, 5. *Homidia sp.*, 6. *Cyphoderus javanus*, 7. *Cryptopygus thermophilus*, 8. *Ballistrura bengalensis*, 9. *Isotomurus balteatus*, 10. *Isotomiella minor*, 11. *Friesea sp.*, 12. *Archerontiella sp.*, 13. *Willemia sp.*, 14. *Xenylla obscura*



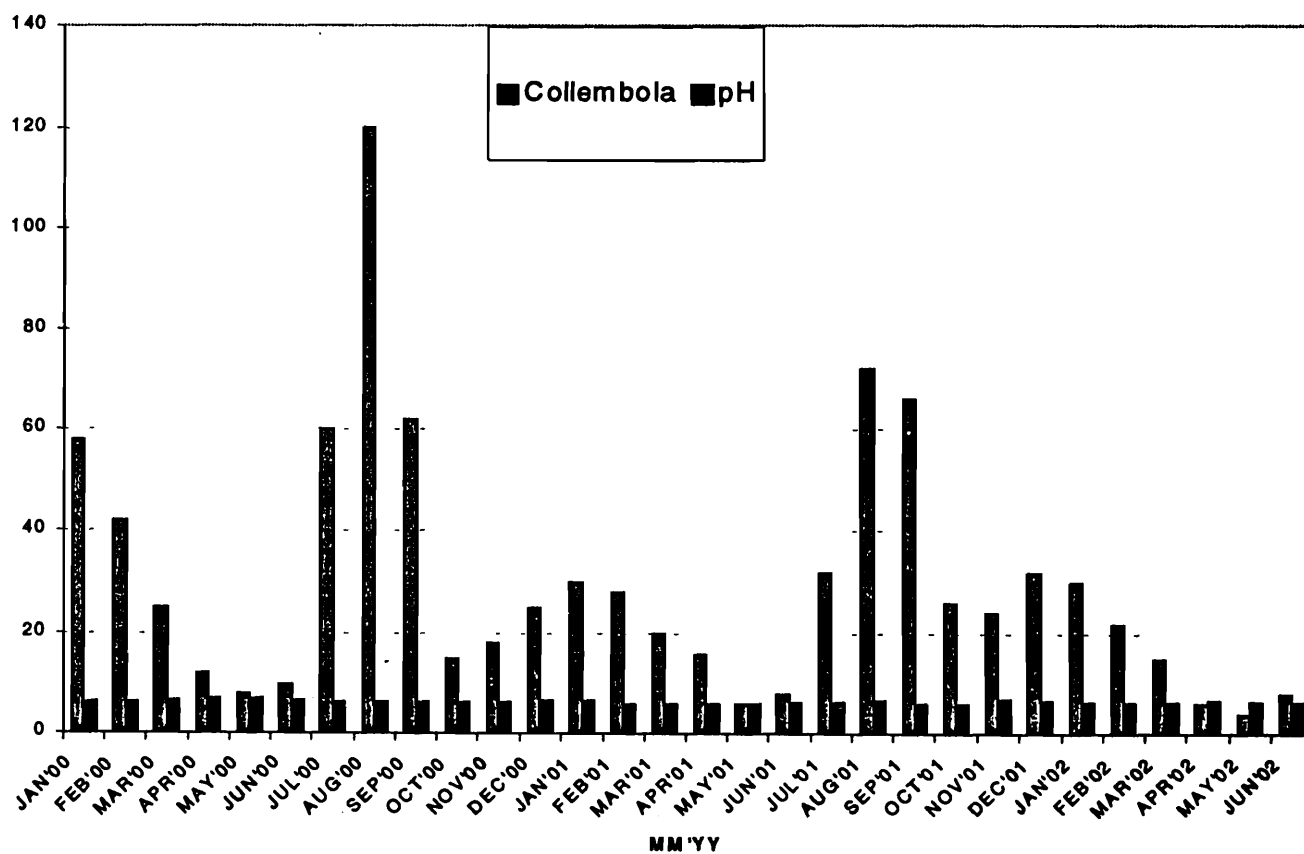
Graph 3 : Relative abundance of Collembolan species in two different sampling sites. 1. *Lepidocyrtus medius*; 2. *L. magnificus*; 3. *L. heterolepis*; 4. *L. exploratorius*; 5. *Homidia* sp; 6. *Sinella curviseta*; 7. *Seira indica*; 8. *Dicranocentrus indicus*; 9. *Yosiia dehradunia*; 10. *Salina bengalensis*; 11. *S. indica*; 12. *S. montana*; 13. *S. javana*; 14. *Callyntrura (H) vestita*; 15. *Dicranocentroides indica*; 16. *D. flavescens*; 17. *Isotomorus balteatus*; 18. *Isotomiella minor*; 19. *Isotomina thermophila*; 20. *Ballistrura bengalensis*; 21. *Cryptopygus thermophilus*; 22. *Xenylla obscura*; 23. *Cyphoderus javanus*; 24. *Lepidocyrtus cyaneus*; 25. *Archerontiella* sp; 26. *Willemia* sp ; 27. *Friesia* sp; 28. *Calx* sp; 29. *Onychiurus indicus*



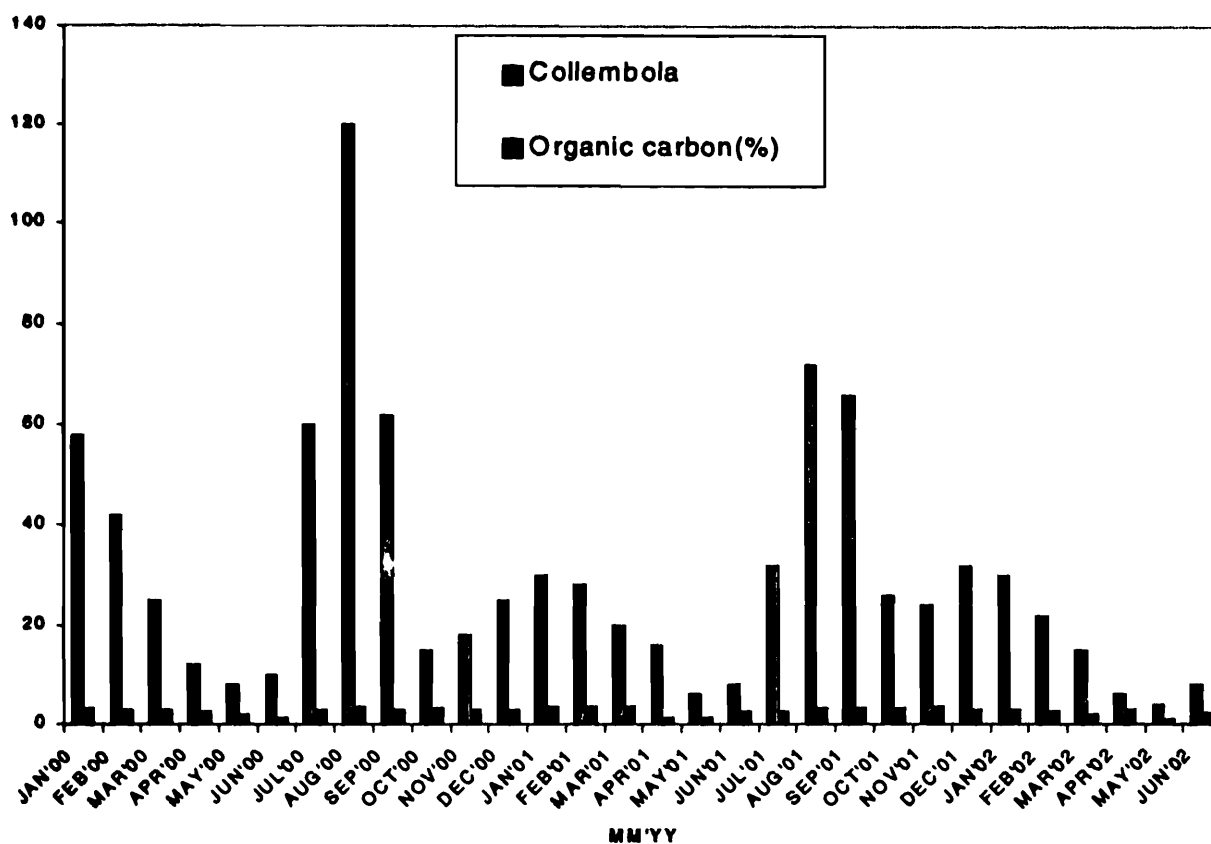
Graph 4-i : Monthly variation in population of Collembola with Temperature, at Site-I (B.R.F.).



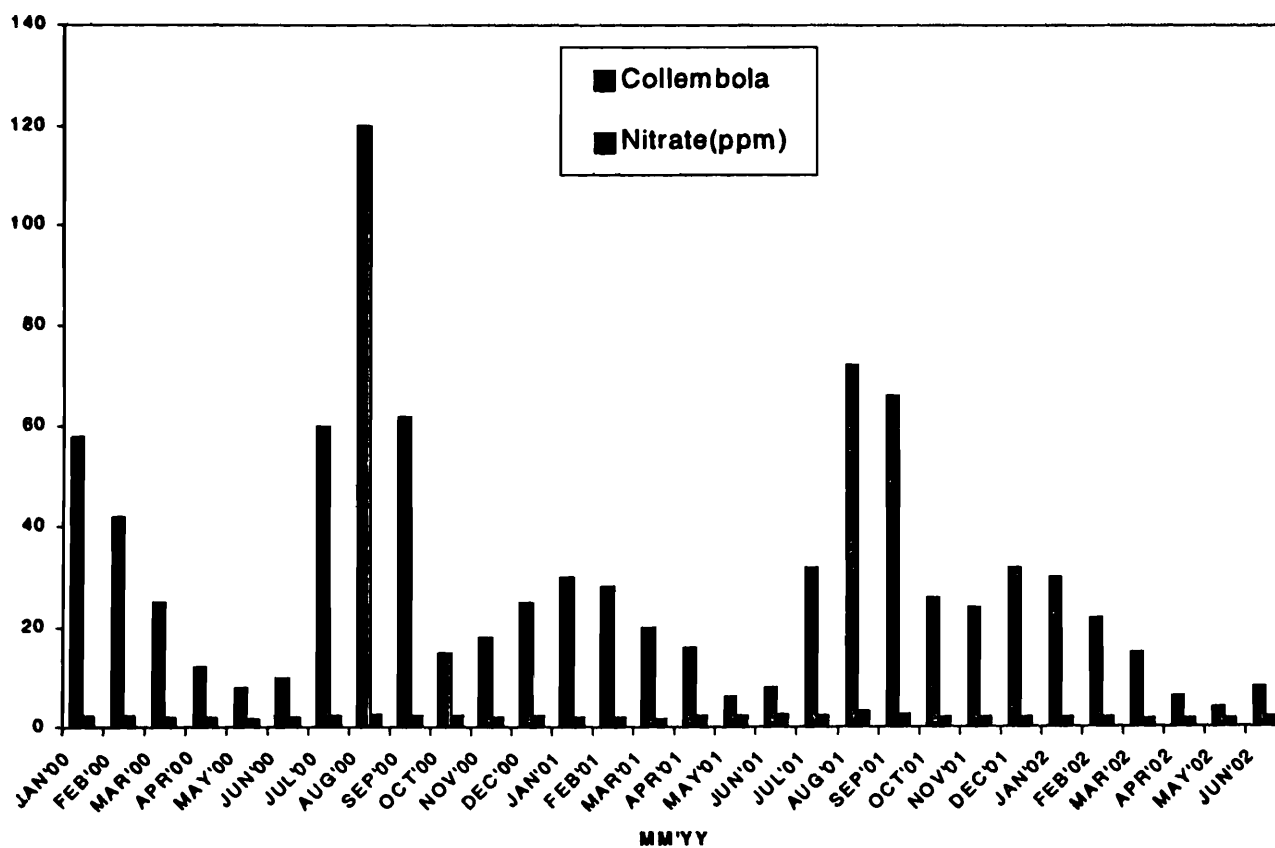
Graph 4-ii : Monthly variation in population of Collembola with Moisture, at Site-I (B.R.F.).



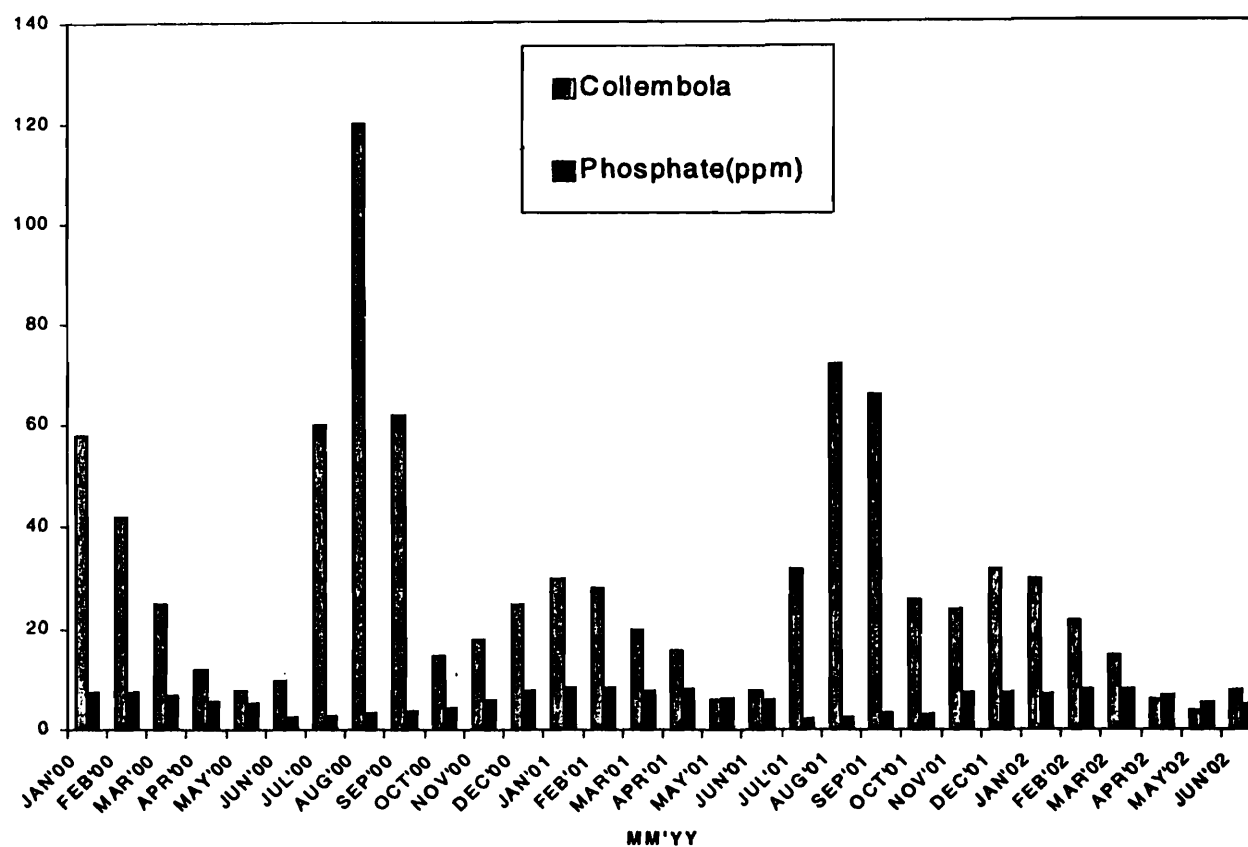
Graph 4-iii : Monthly variation in population of Collembola with pH, at Site-I (B.R.F.).



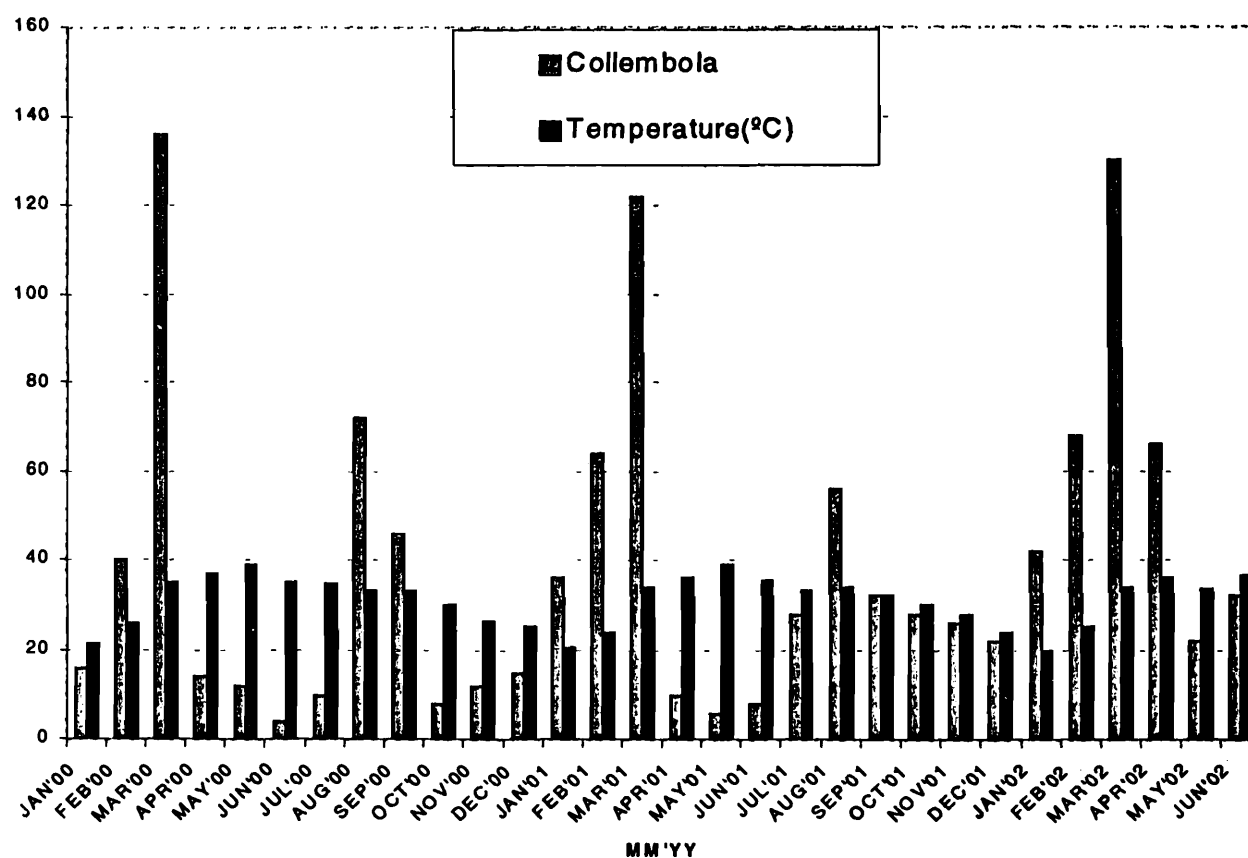
Graph 4-iv : Monthly variation in population of Collembola with Organic Carbon, at Site-I (B.R.F.).



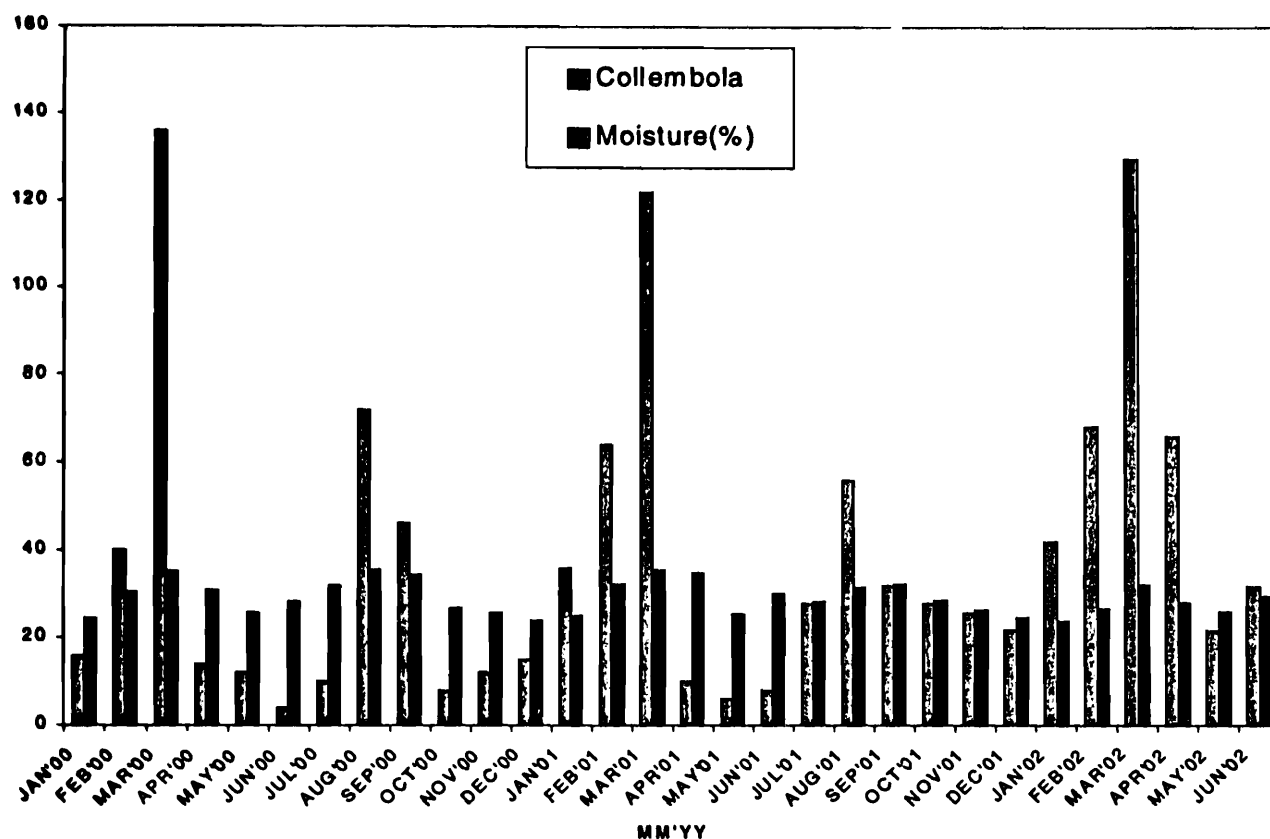
Graph 4-v : Monthly variation in population of Collembola with Nitrate, at Site-I (B.R.F.).



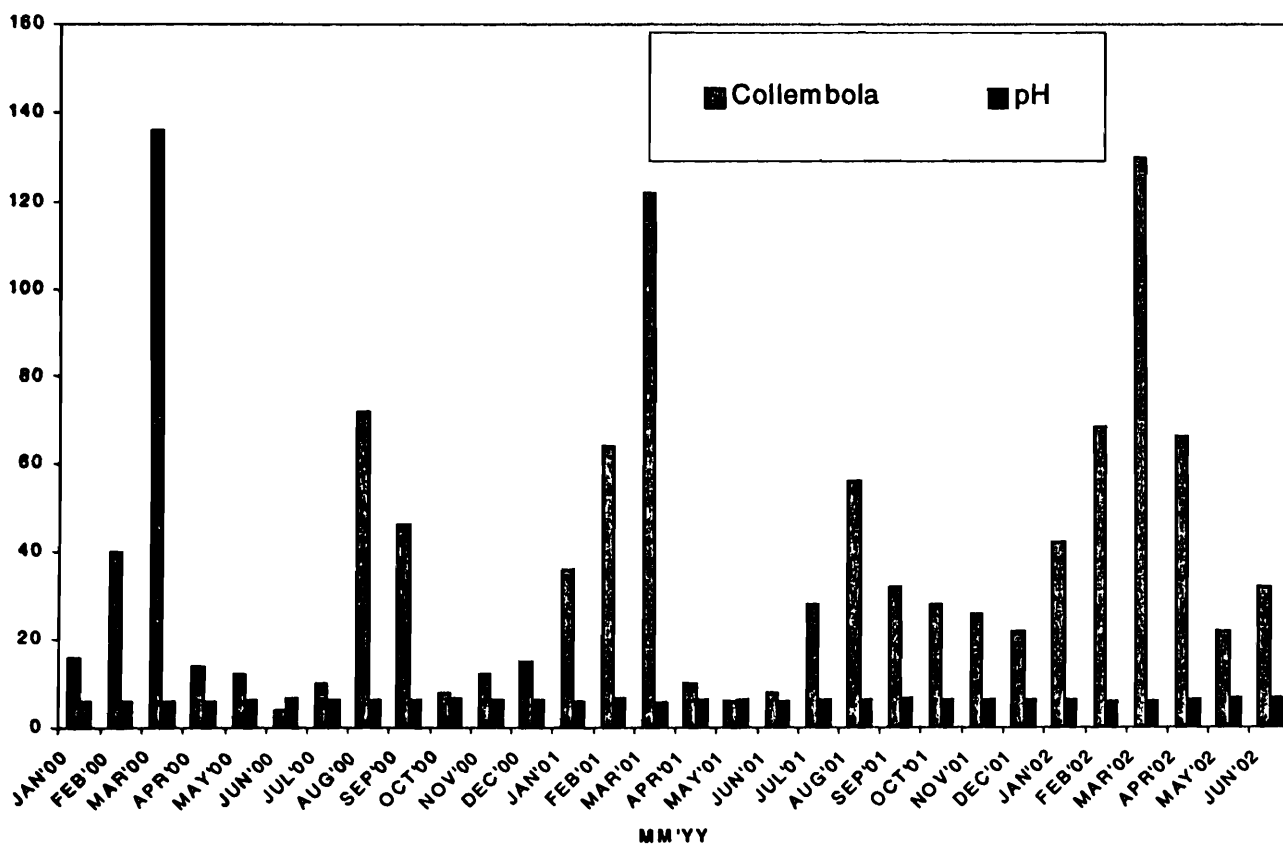
Graph 4-vi : Monthly variation in population of Collembola with Phosphate, at Site-I (B.R.F.).



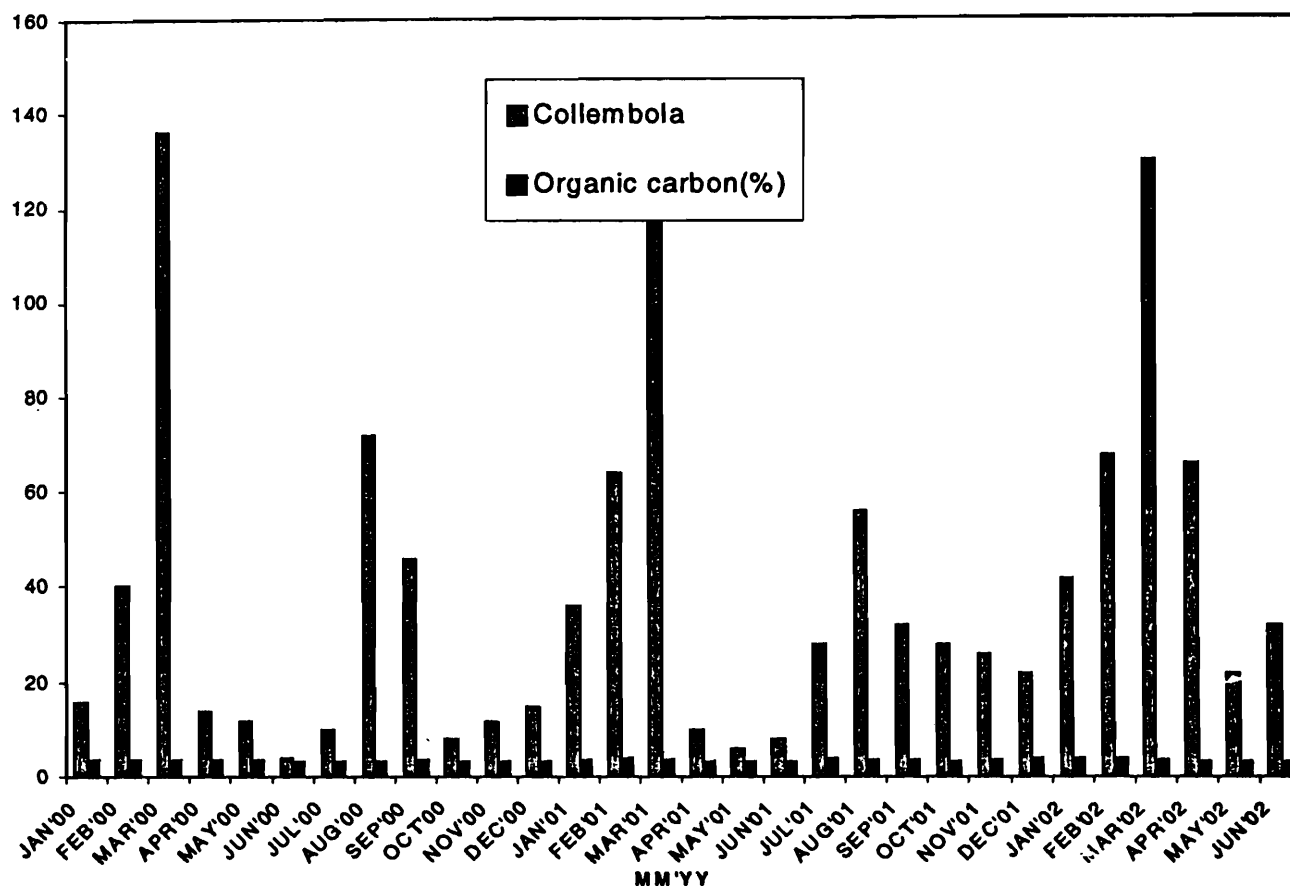
Graph 5-i : Monthly variation in population of Collembola with Temperature, at Site-II (D.P.).



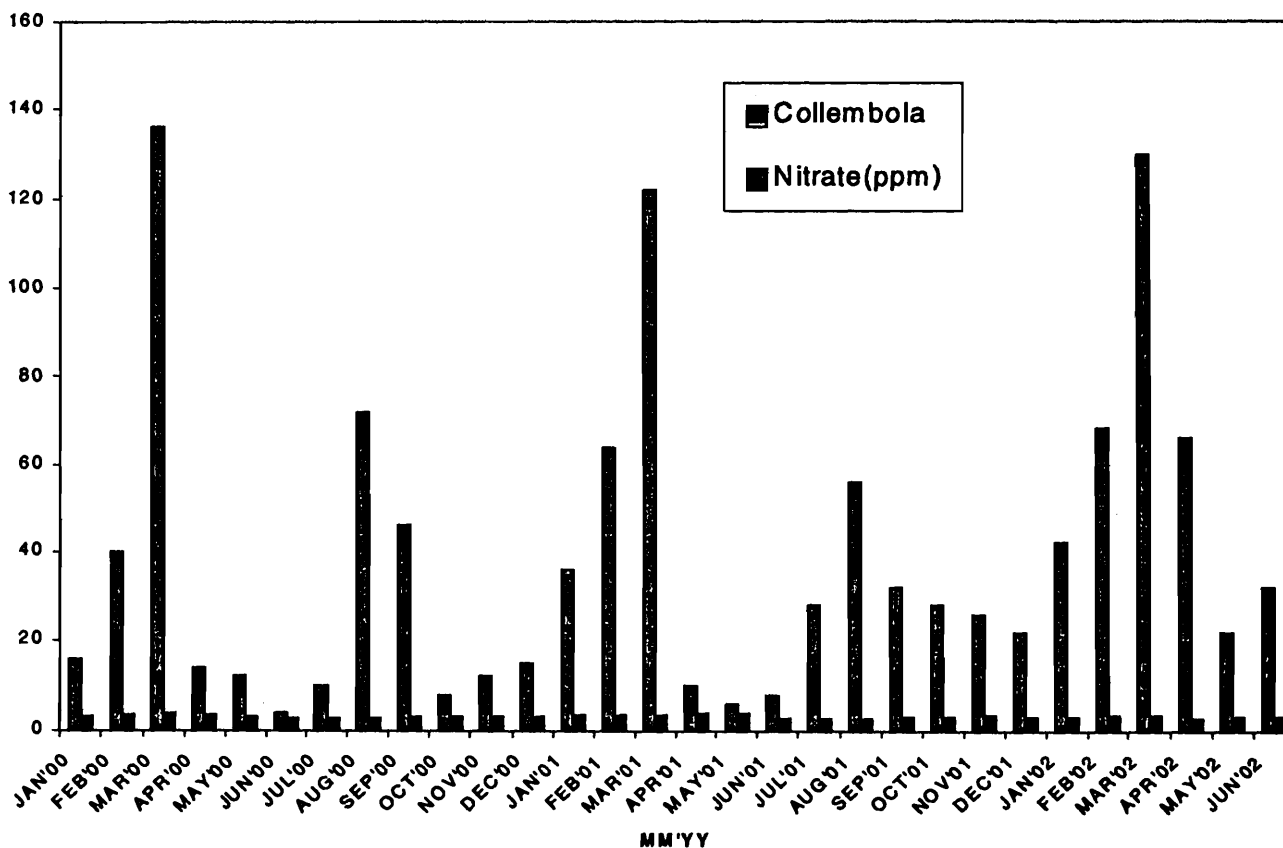
Graph 5-ii : Monthly variation in population of Collembola with Moisture, at Site-II (D.P.).



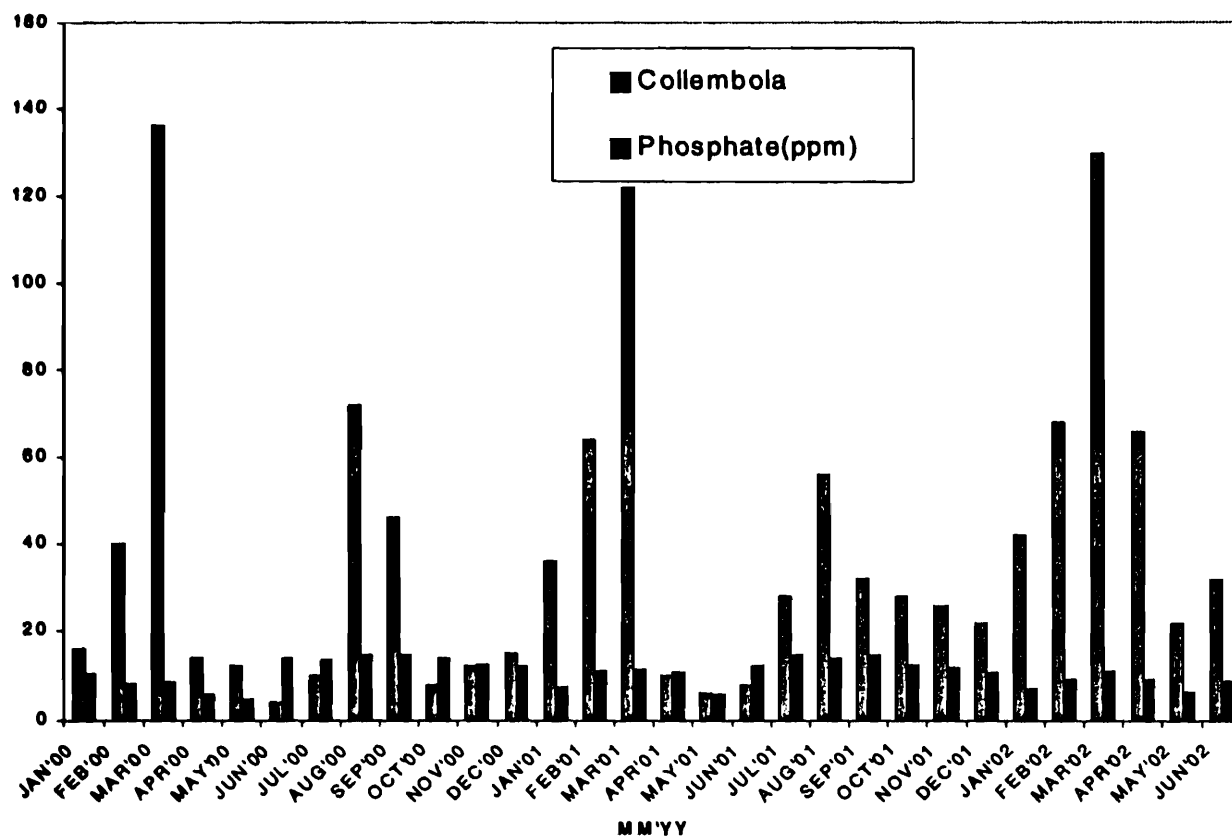
Graph 5-iii : Monthly variation in population of Collembola with pH, at Site-II (D.P.).



Graph 5-iv : Monthly variation in population of Collembola with Organic Carbon, at Site-II (D.P.).



Graph 5-v : Monthly variation in population of Collembola with Nitrate, at Site-II (D.P.).



Graph 5-vi : Monthly variation in population of Collembola with Phosphate, at Site-II (D.P.).

STATISTICAL ANALYSIS OF DATA

The statistical analysis of the complex soil faunal communities has been conducted to show the relationship between the soil factors and Collembola. The application of LINEAR CORRELATION and STEP WISE REGRESSION were undertaken in the present study involving the data of soil factors and collembolan population densities of soil separately for each site. All the analysis have been carried out by using BMDP statistical software.

LINEAR CORRELATION

The correlation coefficient ('r' value) of each variable (*i.e.*, total population of Collembola and six edaphic factors (temperature, moisture, pH, organic carbon, nitrate and phosphste) on each other in individual site were shown (Table 13 a & b). The correlation revealed identical relationship between the biotic variables in two sites. The correlation coefficient data mentioned in the above table broadly indicated that the edaphic factors like moisture, organic carbon, nitrate and phosphste with the biotic variables showed strong positive correlation in almost two sites except in reserve forest site (Site-I, BRF), where the phosphate content of soil was negatively correlated with the total number of Collembolan population. The correlation coefficient ('r' value) in respect of other variables like temperature and pH with the biotic variables was found to be negatively significant correlated in waste disposal site (Site-II) but in case of site I, BRF, where pH found to be positively correlated with the population densities of Collembola.

STEP REGRESSION ANALYSIS

To determine the effects of soil factors on the Collembolan community usually the linear regression technique is followed. But, in that case, the factors are assumed to be independent, which is rather inapplicable. Therefore, stepwise linear regression analysis was carried out, with the inclusion of a new factor already considered at every stage. However, there is no a priori theory about which factor or factors (biotic/abiotic) are most important. The steps were not been repeated until all the factors were included in the mode. In this study, the species of Collembola in a given site were considered as dependable variables and the observations of analysis were continued till the factors considered the improvement value up to 1% level. The results of tests are showed in the tables 14 a, b, c.

Table 14a showed that effects of the following six factors namely, temperature, moisture, organic carbon, pH, nitrate and phosphste were most important on the population density of the collembolan species. Moisture was dominant in the population of the species like, *L. heterolepis*, *L. exploratorius*, *Seira indica*, *Isotomurus balteatus*, *Isotomiella minor*. Temperature played an important role in the distribution of the species of *Ballistrura bengalensis* whereas nitrate plays most important role in the distribution of collembolan species like, *Cryptopygus thermophilus*, *Xenylla obscura* and *Cyphoderus javanus* found in both the sites.

Table 14b showed that effects of the following six factors namely, temperature, moisture, pH, organic carbon, nitrate and phosphste were most important on the population density of the collembolan species. Moisture plays an important role in the distribution of the species like *Lepidocyrtus medius*, *L. magnificus*, *Isotomina thermophila*, *S. montana*, and *Onychiurus indicus* whereas temperature was influenced in the species like, *Homidia sp* and *D. flavescens*. Nitrate plays important role in the distribution of the species like, *Sinella curviseta*, *Dicranocentrus indicus* and *Yosiia dehradunia*. Organic carbon was dominant on the distribution of the species of *Salina bengalensis* and *Callyntrura (H) vestita*. Phosphate was influenced by *S. indica* as well as nitrate plays important role in the distribution of *Dicranocentroides indica*. pH plays important role in the distribution of *S. javana* found in site I (BRF).

Table 14c showed that effects of the following six factors namely, temperature, moisture, pH, organic carbon, nitrate and phosphste were most important on the population density of the collembolan species. Ph plays an important role in the distribution of species like *Lepidocyrtus cyaneus* and *Calx sp* whereas moisture was dominant *Friesea sp* and *Willemia sp*. Nitrate plays important role in the distribution of the collembolan species like, *Archerontiella sp* occur only in site II (DP).

Table 13a : Correlations between Collembola and soil parameters in the sampling site I (BRF) :

	C	T	M	PH	OC	N	P
C	1.00						
T	-0.036	1.00					
M	0.605*	0.196	1.00				
pH	0.071	0.138	-0.211	1.00			
OC	0.425**	-0.471*	0.330	-0.021	1.00		
N	0.555*	0.097	0.670*	-0.159	0.218	1.00	
P	-0.318	-0.586*	-0.640	0.054	0.065	-0.442**	1.00

Table 13b : Correlations between Collembola and soil parameters in the sampling sitell (DP) :

	C	T	M	PH	OC	N	P
C	1.00						
T	-0.054	1.00					
M	0.548*	-0.095	1.00				
pH	-0.474*	0.283	-0.132	1.00			
OC	0.364**	-0.184	-0.151	-0.132	1.00		
N	0.286	-0.153	0.100	-0.526*	0.184	1.00	
P	0.018	-0.282	0.331	0.307	-0.118	-0.509*	1.00

Explanations * = significant at 1%, ** = significant at 5%, C = total collembolan population, T = temperature, M = moisture, pH = pH, OC = organic carbon, N = nitrate, P = phosphate.

Table 14a : Summary table of Step Regression Analysis of Collembola found in both sites :

Variable used = T, M, pH, OC, N, P, C1, C2, C3,

C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18, C19, C20,
C21, C22, C23, C24, C25, C26, C27, C28, C29.

Independent variable = T to P.

Dependent variable = C3 (*L. heterolepis*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	M	0.5191	0.2695	0.2695	0.2569	21.39	1
2	OC	0.5375	0.2889	0.0194	0.2639	11.58	2
3	T	0.5562	0.3093	0.0205	0.2723	8.36	3
4	pH	0.5637	0.3177	0.0084	0.2681	6.40	4
5	N	0.5651	0.3194	0.0017	0.2563	5.07	5
6	P	0.5660	0.3203	0.0010	0.2434	4.16	6

Dependent variable = C4 (*L. exploratorius*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	M	0.4650	0.2162	0.2162	0.2027	16.00	1
2	N	0.5325	0.2836	0.0673	0.2584	11.28	2
3	pH	0.5496	0.3020	0.0185	0.2646	8.08	3
4	T	0.5624	0.3163	0.0142	0.2666	6.36	4
5	P	0.5629	0.3169	0.0006	0.2536	5.01	5
6	OC	0.5630	0.3169	0.0000	0.2396	4.10	6

Dependent variable = C7 (*Seira indica*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	M	0.4370	0.1910	0.1910	0.1770	13.69	1
2	N	0.4482	0.2009	0.0099	0.1728	7.16	2
3	pH	0.4524	0.2046	0.0038	0.1620	4.80	3
4	OC	0.4535	0.2056	0.0010	0.1479	3.56	4
5	P	0.4553	0.2073	0.0016	0.1339	2.82	5
6	T	0.4553	0.2073	0.0000	0.1176	2.31	6

Dependent variable = C17 (*Isotomurus balteatus*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	M	0.5191	0.2695	0.2695	0.1383	10.47	1
2	OC	0.5375	0.2889	0.0194	0.1489	6.16	2
3	T	0.5562	0.3093	0.0205	0.1542	4.58	3
4	pH	0.5637	0.3177	0.0084	0.1486	3.57	4
5	N	0.5651	0.3194	0.0017	0.1467	3.03	5
6	P	0.5660	0.3203	0.1334	0.1334	2.51	6

Dependent variable = C18 (*Isotomiella minor*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	M	0.2576	0.0663	0.0663	0.0503	4.12	1
2	pH	0.3312	0.1097	0.0434	0.0785	3.51	2
3	T	0.3503	0.1227	0.0130	0.0757	2.61	3
4	P	0.3587	0.1287	0.0059	0.0653	2.03	4
5	N	0.3598	0.1294	0.0007	0.0488	1.61	5
6	OC	0.3636	0.1322	0.0028	0.0340	1.35	6

Dependent variable = C20 (*Ballistrura bengalensis*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	T	0.2112	0.0446	0.0446	0.0281	2.71	1
2	N	0.2244	0.0503	0.0057	0.0170	1.51	2
3	P	0.2423	0.0587	0.0084	0.0083	1.16	3
4	pH	0.2515	0.0632	0.0045	0.0049	0.93	4
5	OC	0.2589	0.0670	0.0038	0.0194	0.78	5
6	M	0.2613	0.0683	0.0012	0.0372	0.65	6

Dependent variable = C21 (*Cryptopygus thermophilus*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	N	0.4220	0.1781	0.1781	0.1639	12.57	1
2	M	0.4788	0.2292	0.0511	0.2022	8.48	2
3	pH	0.5094	0.2595	0.0303	0.2198	6.54	3
4	P	0.5403	0.2919	0.0324	0.2404	5.67	4
5	OC	0.5440	0.2959	0.0040	0.2307	4.54	5
6	T	0.5485	0.3009	0.0049	0.2217	3.80	6

Dependent variable = C22 (*Xenylla obscura*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	N	0.4651	0.2164	0.2164	0.2028	16.01	1
2	T	0.5089	0.2590	0.0426	0.2330	9.96	2
3	P	0.5168	0.2671	0.0081	0.2279	6.80	3
4	OC	0.5252	0.2758	0.0087	0.2232	5.24	4
5	pH	0.5294	0.2802	0.0044	0.2136	4.20	5
6	M	0.5304	0.2813	0.0011	0.2000	3.46	6

Dependent variable = C24 (*Cyphoderus javanus*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	N	0.4360	0.1901	0.1901	0.1762	13.62	1
2	M	0.5100	0.2601	0.0700	0.2341	10.02	2
3	OC	0.5378	0.2892	0.0291	0.2511	7.59	3
4	P	0.5427	0.2945	0.0053	0.2432	5.74	4
5	T	0.5440	0.2959	0.0014	0.2307	4.54	5
6	pH	0.5451	0.2971	0.0012	0.2176	3.73	6

Explanations : T = temperature, M = moisture, pH = pH, OC = organic carbon, N = nitrate, P = phosphate.

Table 14 b : Summary table of Step Regression Analysis of Site I (BRF)

Variable used = T, M, pH, OC, N, P, C1, C2, C3,

C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18, C19, C20, C21, C22, C23, C24, C25, C26, C27, C28, C29.

Independent variable = T to P.

Dependent variable = C1 (*Lepidocyrtus medius*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	M	0.5584	0.3118	0.3118	0.2873	12.69	1
2	T	0.6329	0.4006	0.0887	0.3562	9.02	2
3	OC	0.6496	0.4220	0.0214	0.3553	6.33	3
4	pH	0.6532	0.4267	0.0047	0.3350	4.65	4
5	N	0.6536	0.4272	0.0005	0.3079	3.58	5
6	P	0.6538	0.4275	0.0002	0.2781	2.86	6

Dependent variable = C2 (*L. magnificus*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	M	0.7187	0.5165	0.5165	0.4993	29.91	1
2	N	0.7486	0.5603	0.0438	0.5278	17.20	2
3	pH	0.7601	0.5778	0.0175	0.5291	11.86	3
4	OC	0.7670	0.5883	0.0104	0.5224	8.93	4
5	P	0.7772	0.6040	0.0157	0.5215	7.32	5
6	T	0.7776	0.6046	0.0007	0.5015	5.86	6

Dependent variable = C5 (*Homidia sp*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	T	0.5844	0.3415	0.3415	0.3180	14.52	1
2	pH	0.6509	0.4236	0.0821	0.3809	9.92	2
3	N	0.6916	0.4783	0.0547	0.4181	7.95	3
4	OC	0.6933	0.4806	0.0023	0.3975	5.78	4
5	P	0.6935	0.4810	0.0004	0.3728	4.45	5
6	M	0.6935	0.4810	0.0000	0.3456	3.55	6

Dependent variable = C6 (*Sinella curviseta*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	N	0.7204	0.5190	0.5190	0.5018	30.21	1
2	pH	0.7483	0.5599	0.0409	0.5273	17.18	2
3	OC	0.7571	0.5732	0.0133	0.5240	11.64	3
4	P	0.7652	0.5856	0.0123	0.5193	8.83	4
5	M	0.7737	0.5986	0.0130	0.5149	7.16	5
6	T	0.7742	0.5994	0.0009	0.4949	5.74	6

Dependent variable = C8 (*Dicranocentrus indicus*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	N	0.3048	0.0929	0.0929	0.0605	2.87	1
2	pH	0.4081	0.1665	0.0736	0.1048	2.70	2
3	P	0.4420	0.1953	0.0288	0.1025	2.10	3
4	OC	0.4666	0.2177	0.0224	0.0925	1.74	4
5	T	0.4696	0.2205	0.0028	0.0581	1.36	5
6	M	0.4719	0.2227	0.0022	0.0199	1.10	6

Dependent variable = C9 (*Yosiia dehradunia*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	N	0.4502	0.2027	0.2027	0.1742	7.12	1
2	T	0.5857	0.3431	0.1404	0.2944	7.05	2
3	pH	0.5897	0.3478	0.0047	0.2725	4.62	3
4	P	0.5942	0.3530	0.0053	0.2495	3.41	4
5	M	0.5944	0.3533	0.0003	0.2186	2.62	5
6	OC	0.5945	0.3534	0.0001	0.1847	2.10	6

Dependent variable = C10 (*Salina bengalensis*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	OC	0.3703	0.1371	0.1371	0.1063	4.45	1
2	M	0.3932	0.1546	0.0175	0.0920	2.47	2
3	pH	0.4028	0.1622	0.0076	0.0656	1.68	3
4	N	0.4109	0.1688	0.0066	0.0358	1.27	4
5	P	0.4141	0.1715	0.0026	0.0012	0.99	5
6	T	0.4141	0.1715	0.0000	0.0447	0.79	6

Dependent variable = C11 (*S. indica*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	P	0.4079	0.1664	0.1664	0.1366	5.59	1
2	M	0.5734	0.3288	0.1624	0.2791	6.61	2
3	OC	0.5939	0.3528	0.0240	0.2781	4.72	3
4	T	0.6164	0.3799	0.0272	0.2807	3.83	4
5	pH	0.6182	0.3822	0.0023	0.2535	2.97	5
6	N	0.6192	0.3835	0.0013	0.2226	2.38	6

Dependent variable = C12 (*S. montana*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	M	0.5766	0.3324	0.3324	0.3086	13.94	1
2	OC	0.5997	0.3597	0.0272	0.3122	7.58	2
3	N	0.6116	0.3740	0.0143	0.3018	5.18	3
4	pH	0.6202	0.3847	0.0107	0.2863	3.91	4
5	T	0.6275	0.3937	0.0090	0.2674	3.12	5
6	P	0.6293	0.3961	0.0023	0.2385	2.51	6

Dependent variable = C13 (*S. javana*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	pH	0.4007	0.1606	0.1606	0.1306	5.36	1
2	N	0.5570	0.3102	0.1497	0.2591	6.07	2
3	T	0.5825	0.3393	0.0291	0.2631	4.45	3
4	M	0.5975	0.3570	0.0177	0.2541	3.47	4
5	OC	0.6121	0.3747	0.0177	0.2444	2.88	5
6	P	0.6197	0.3841	0.0094	0.2234	2.39	6

Dependent variable = C14 (*Callyntrura (H) vestita*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	OC	0.3819	0.1458	0.1458	0.1153	4.78	1
2	N	0.4395	0.1931	0.0473	0.1334	3.23	2
3	P	0.4412	0.1946	0.0015	0.1017	2.09	3
4	pH	0.4428	0.1961	0.0014	0.0675	1.52	4
5	M	0.4443	0.1974	0.0013	0.0302	1.18	5
6	T	0.4444	0.1975	0.0002	0.0118	0.94	6

Dependent variable = C15 (*Dicranocentroides indica*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	N	0.4850	0.2352	0.2352	0.2079	8.61	1
2	M	0.4967	0.2467	0.2467	0.1909	4.42	2
3	pH	0.5054	0.2554	0.2554	0.1695	4.42	3
4	P	0.5105	0.2606	0.2606	0.1423	2.20	4
5	T	0.5139	0.2640	0.0035	0.1107	1.72	5
6	OC	0.5173	0.2676	0.0035	0.0765	1.40	6

Dependent variable = C16 (*D. flavescens*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	T	0.2651	0.0703	0.0703	0.0371	2.12	1
2	M	0.2997	0.0898	0.0195	0.0224	1.33	2
3	P	0.3314	0.1098	0.0200	0.0071	1.07	3
4	pH	0.3425	0.1173	0.0075	0.0239	0.83	4
5	OC	0.3469	0.1203	0.0030	0.0629	0.66	5
6	N	0.3487	0.1216	0.0012	0.1076	0.53	6

Dependent variable = C19 (*Isotomina thermophila*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	M	0.3343	0.1117	0.1117	0.0800	3.52	1
2	pH	0.3731	0.1392	0.0275	0.0754	2.18	2
3	OC	0.3901	0.1522	0.0130	0.0543	1.56	3
4	T	0.4006	0.1605	0.0083	0.0261	1.19	4
5	P	0.4237	0.1795	0.0191	0.0086	1.05	5
6	N	0.4311	0.1859	0.0063	0.0265	0.88	6

Dependent variable = C23 (*Onychiurus indicus*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	M	0.3786	0.1433	0.1433	0.1127	4.68	1
2	OC	0.4483	0.2010	0.0577	0.1418	3.40	2
3	T	0.4903	0.2403	0.0393	0.1527	2.74	3
4	pH	0.4937	0.2437	0.0034	0.1227	2.01	4
5	P	0.4952	0.2452	0.0015	0.0880	1.56	5
6	N	0.4957	0.2458	0.0005	0.0490	1.25	6

Explanations : T = temperature, M = moisture, pH = pH, OC = organic carbon, N = nitrate, P = phosphate.

Table 14c : Summary table of Step Regression Analysis of Site II (DP)

Variable used= T, M, pH, OC, N,

P, C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18, C19, C20, C21, C22, C23, C24, C25, C26, C27, C28, C29.

Independent variable = T to P.

Dependent variable = C25 (*Lepidocyrtus cyaneus*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN RSQ	ADJUST RSQ	F RATIO	DF
		R	RSQ				
1	pH	0.5842	0.3413	0.3413	0.3178	14.51	1
2	M	0.7055	0.4977	0.1564	0.4605	13.38	2
3	OC	0.8030	0.6449	0.1471	0.6039	15.74	3
4	P	0.8057	0.6492	0.0043	0.5931	11.57	4
5	T	0.8090	0.6544	0.0052	0.5824	9.09	5
6	N	0.8100	0.6561	0.0017	0.5664	7.31	6

Dependent variable = C26 (*Calx sp*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN	ADJUST	F RATIO	DF
		R	RSQ	RSQ	RSQ		
1	pH	0.2595	0.0673	0.0673	0.0340	2.02	1
2	P	0.3883	0.1508	0.0834	0.0879	2.40	2
3	T	0.4278	0.1830	0.0322	0.0887	1.94	3
4	OC	0.5211	0.2716	0.0886	0.1550	2.33	4
5	M	0.5291	0.2799	0.0084	0.1299	1.87	5
6	N	0.5437	0.2956	0.0157	0.1119	1.61	6

Dependent variable = C27 (*Friesea sp*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN	ADJUST	F RATIO	DF
		R	RSQ	RSQ	RSQ		
1	M	0.4905	0.2406	0.2406	0.2134	8.87	1
2	pH	0.5920	0.3505	0.1099	0.3024	7.28	2
3	P	0.6112	0.3736	0.0231	0.3013	5.17	3
4	OC	0.6112	0.3928	0.0192	0.2956	4.04	4
5	T	0.6267	0.4460	0.0532	0.3305	3.86	5
6	N	0.6683	0.4466	0.0006	0.3022	3.09	6

Dependent variable = C28 (*Archerontiella sp*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN	ADJUST	F RATIO	DF
		R	RSQ	RSQ	RSQ		
1	N	0.2149	0.0462	0.0462	0.0121	1.36	1
2	OC	0.2847	0.0810	0.0349	0.0130	1.19	2
3	T	0.3698	0.1368	0.0557	0.0372	1.37	3
4	M	0.4184	0.1751	0.0383	0.0431	1.33	4
5	P	0.4500	0.2025	0.0274	0.0363	1.22	5
6	pH	0.4504	0.2028	0.0004	0.0051	0.98	6

Dependent variable = C29 (*Willemia sp*)

STEP No.	VARIABLE ENTERED	MULTIPLE		CHANGE IN	ADJUST	F RATIO	DF
		R	RSQ	RSQ	RSQ		
1	M	0.3287	0.1080	0.1080	0.0762	3.39	1
2	P	0.3432	0.1178	0.0098	0.0525	1.80	2
3	OC	0.3467	0.1202	0.0024	0.0187	1.18	3
4	pH	0.3508	0.1231	0.0028	0.0173	0.88	4
5	N	0.3550	0.1260	0.0029	0.0561	0.69	5
6	T	0.3582	0.1283	0.0023	0.0991	0.56	6

Explanations : T = temperature, M= moisture, pH = pH, OC = organic carbon, N = nitrate, P = phosphate.

DISCUSSION

The present study reveals first consolidated taxonomic diversity and species richness of the east and north eastern states of India. During this investigation, altogether 76 species under 38 genera of four families and six subfamilies of collembolans have been found to occur in the study areas representing 36.19% of the species and 44.18% of the genera of Collembola so far known from India. Out of 76 species, 28 species (marked with*) are endemic to the said regions i.e. 36.84% of total species of 13.3% of total Indian Collembolan fauna.

The richest diversity of Collembolan species has been from the Sikkim Himalaya with 39 species of 26 genera viz., *Xenylla*, *Ceratophysella*, *Pronura*, *Neanura*, *Spinanurida*, *Uchidanurida*, *Mesaphorura*, *Spelaphorura*, *Lepidocyrtus*, *Lepidosira*, *Sinella*, *Homidia*, *Dicranocentrus*, *Tomocerus*, *Cyphoderus*, *Cyphoderopsis*, *Salina*, *Alloscopus*, *Callyntrura*, *Dicranocentroides*, *Yosiia*, *Isotoma*, *Isotomina*, *Parafolsomia*, *Papillomurus* and *Rhodanella*. Of the 39 species, 19 are recorded for the first time with the maximum diversity in the north districts representing 21 species at an average altitude of 1850 m. The species, *Lepidocyrtus magnificus* shows maximum abundance at Namchi (Sikkim), at altitude of 1521 m. It is worth mentioning that the diversity of total litterine micro-arthropods decreased with the increase of altitude. The collembolans, one of the constituents of micro-arthropod population appear to increase with the elevation corroborating Hazra *et al.* (2001).

The second maximum diversity with 29 species under 22 genera has been encountered in West Bengal and 28 (27 newly recorded) species of 15 genera were recorded from Arunachal and occupying the third position in order of dominance. While the fourth position has been occupied in Manipur with 27 species in 14 genera of collembola of which 18 species were previously not known from the state.

Orissa with 21 species under 10 genera holds fifth position followed by new records of 20 species of 10 genera in the tiny state of Mizoram and Assam ranks in seventh position in the species richness with 20 species under 15 genera, followed by Nagaland bounding eighth position with new records of 18 species under 10 genera. Another two north eastern states, Tripura and Meghalaya are represented by 11 species.

Only two species viz, *Lepidocyrtus magnificus* and *Dicranocentroides flavescens* made its presence in all the nine states. The reason of which might be due to ability of tolerance of different environmental conditions and varied soil factors as well. The species may therefore, be termed as "ubiquitous species" (Table 15).

The species, *Dicranocentroides indica* and *Dicranocentroides salmoni* had been taken from the eight different states making its absence in Tripura, Sikkim and West Bengal (Table 16). The collembolan species, *Xenylla obscura*, *Isotomurus balteatus*, *Lepidocyrtus medius* and *E. (Homidia) cingula* were distributed in seven states only (Table 17), and seven species, *Ceratophysella indovaria*, *Lepidocyrtus malayanus*, *Dicranocentrus indicus*, *Cyphoderus javanus*, *Salina indica*, *Dicranocentroides fasciculatus* and *Callyntrura (H) vestita* were noticed in the six states only (Table 18); *Lepidocyrtus caudatus*, *Salina striata* and *S. montana* are prevalent in the five different states (Table 19); *Cryptopygus thermophilus*, *Sinella curviseta*, *Salina tricolor tricolor*, *Callyntrura japonica*, *Lepidocyrtus heterolepis* and *Salina indica* are found to occur in the four states only (Table 20); while *I. (Desoria) trispinata*, *Lepidocyrtus cyaneus*, *Callyntrura (H) lineata* and *Isotomina thermophila* have been found in three different states (Table 21).

The species, *Lobella kraepelini*, *Pronura indiana*, *Isotomina thermophila*, *Rhodanella plumosa*, *Lepidosira unguiserrata*, *Tomocerus mitrai*, *Salina choudhuri*, *Salina tricolor sikkimensis*, *Salina yosii*, *S. javana*, *Callyntrura (C) serrata*, *C. longicornis*, *Alloscopus tetracantha*, *Yosiia dehradunia*, *Cyphoderopsis ceylonica*, *Cyphoderopsis kempi*, *Lobella assamensis*, *Salina biformis*, *Dicranocentroides gisini* and *Lepidocyrtus exploratorius* made its presence in two states only (Table 22). Twelve species, *Hypogastrura indica*, *Neanura sikkimensis*, *Spinanurida mandibulata*, *Uchidanurida altitudina*, *Mesophorura choudhuri*, *Spelaphorura clayae*, *Isotoma (Desoria) cf mazda*, *Parafolsomia trioculata*, *Papillomurus transequatoria*, *Tomocerus petalospinus*, *Tomocerus serratospinus*, and *Callyntrura borneri* are restricted only in the state of Sikkim; *Onychiurus indicus*, *Isotomiella minor*, *Ballistrura bengalensis*, *Salina bengalensis*, *Callyntrura zaheri* and *Heteromuricus cercifer* were found restricted to West Bengal; *Pseudocyphoderus annandelai*, *Delamarerus immsi*, *Callyntrura (C) semiviolacea* and *Callyntrura (Handschinphysa) delamarei* occur only Orissa; *Lepidocyrtus curvicollis*, *Dicranocentrus simplex* and *Seira arunachala* had been recorded from Arunachal. Two species, *Setogaster manipuri*, and *Pseudoparonellides bulbosa* are present only in Manipur. The species, *Salina celebensis* Assam *Cyphoderopsis gracilis* are found in Assam and Meghalaya respectively (Table no.23). The distribution of the above species are restricted to one state only ('Stenocous' species) due to edaphic factors of the states not conducive for their living which corroborate to the similar observations of Hagvor (1982), Hazra & Choudhuri (1990).

The collembolan species, *Ceratophysella indica*, *Neanura sikkimensis*, *Lobella assamensis*, *Pronura indiana*, *Spinanurida mandibulata* *Uchidanurida altitudina*, of the family-Hypogastruridae and *Onychiurus indica*, *Mesophorura choudhuri*, *Spelaphorura clayae*

(Onychiuridae), *Ballistrura bengalensis*, *Parafolsomia trioculata*, *Papillomurus transequatoria*, *Rhodanella plumose* (Isotomidae), *Lepidosira unguiserrata*, *Setogaster manipuri*, *Entomobrya*(*Homidia*) *cingula*, *Seira arunachala*, *Cyphoderopsis kempi*, *Cyphoderopsis gracilis*, *Tomocerus petalospinus*, *Tomocerus serratospinus*, *Salina choudhuri*, *Salina tricolor sikkimensis*, *Salina bengalensis*, *Dicranocentroides salmoni*, *Callyntrura*(*Handschinphysa*) *delamarei*, *Callyntrura*(*C*) *zaheri*, *Pseudoparonellides bulbosa*(Entomobryidae) were found endemic to north eastern states. The members of Entomobryidae show range of species diversity in maxima with 54 species followed those belonging to the family Isotomidae with 10 species, the family Hypogastruridae with 9 species and family Onychiuridae with 3 species only.

To evaluate the species diversity, the Shannon-Wiener diversity index is followed here. The higher the value of H' , the greater is the diversity. The maximum value of H' is more than 1. Total diversity depends upon the number of species or number of parts, called the variety component and the evenness component or the distribution of relative abundance. The Shannon-Wiener diversity index using the formula: $H_s = -\sum p_i \ln p_i$ is the proportion of individuals and "ln" denotes the natural logarithm.

At each of ten study sites sampling within the control plot (10 samples) was carried out in similar conditions, i.e. same bedrock, exposure, slope and elevation. Hundred (100) soil cores of 250 cm³ of the A horizon to 5 cm depth were then collected just below the organic layers in autumn, the most favorable period for high diversity of soil fauna.

The species diversity index evaluated by Shannon-Wieners method showed that diversity values ranged between 2.051 to 2.942 (Table 24) in 10 sites (states) i.e., there are some variations between the values of 10 sites. The species diversity index of Tripura and Meghalaya is 2.051 and 2.060 i.e. more or less similar. The diversity indices of other six states namely Assam, Sikkim, Mizoram, Nagaland, Orissa and West Bengal are 2.791, 2.615, 2.557, 2.540, 2.764 & 2.558 respectively indicating little variation between these sites which is again substantiated by the occurrence of more or less same number of species. The diversity index of Manipur is maximum i.e., 2.942 as well as in Arunachal diversity index is 2.381.

Hill's first diversity number; the number of abundant species (N1) is maximum in Manipur (18.95) and the minimum number of abundant species is in Tripura (7.7).

From the above study it is clear that the number of abundant species (N1) is maximum in Manipur (18.95) and the number of abundant species minimum in Tripura (7.7) due to differences in climatic and edaphological factors as well as vegetational cover.

The ecological studies of this investigation were based on the sample survey of six plots of two contrasting habitats of West Bengal over a period of 30 months (January'2000 to

June'2002). Three sampling plots in the polluted environment were chosen in the forest floor of the Gangetic plains having more or less identical nature of soil with humidity and low temperature during winter.

The fauna of the two experimental sites belonged 29 species in 21 genera of 4 families: Hypogastruridae, Onychiuridae, Isotomidae and Entomobryidae (Table-25).

The occurrence of the number of 24 species in 17 genera was found to vary in two different sampling sites, maximum extracted from the forest floor of B.R.F and minimum of 14 species of 12 genera from the polluted field D.P. Out of them, the predominant ones may be expressed in order of dominance as, *Lepidocyrtus* (5 species), *Xenylla* (1 species), *Cyphoderus* (1 species), *Cryptopygus* (1 species) and *Isotomurus* (1 species).

The genus *Lepidocyrtus* was found to represent by 5 species, *Lepidocyrtus cyaneus* (12.6%), *L. exploratorius* (5.82%), *L. medius* (4.96%), *L. magnificus* (4.25%) and *L. heterolepis* (4.15%). The genus was widely distributed in all sampling plots comprising 31.8 % of total population of collembola and was numerically dominant over other forms. The wide distribution range and numerical dominance suggest its capability to dwell in varying ecological conditions. The species, *Lepidocyrtus cyaneus* appeared most dominant taxon occupying first position in order of dominance in respect to the total number of collembola which showed maximum genera and species in March. The second predominant one was *Xenylla obscura* with 10.45% of the total population in all the sites. The species were recorded in maxima from the site II reaching its peak in February followed by third numerical dominant *Cyphoderus javanus* extracted in maximum number (9.83%) in February from all the sampling sites though the insects came in maximum number in March. Another dominant genus *Cryptopygus sp* taken from both the sites comprised 8.69% of total population occupying fourth position but the maximum populations come in view in January in the site I and in March the site II.

The fifth important collembolan genus, *Isotomurus balteatus* (4.20%) was taken out in maximum numbers from all the sites in August and sixth genus, *Salina* representing the species, *bengalensis*, *javana*, *montana* and *indica* were identified maximum of 4.77% are identified only in the forest floor (site-I) with its maximum number in January. Other genera were *Homidia*, *Friesea*, *Ballistrura*, *Seira*, *Isotomiella*, *Yosiia*, *Dicranocentroides*, *Isotomina*, and *Calx* constituting 3.53%, 3.48%, 3.43%, 2.86%, 2.72%, 2.57%, 2.14%, 2.05%, and 1.95% respectively. The species, *Ballistrura bengalensis* was noted to occur in both the sites with maximum population in August.

Yosiia dehradunia was identified in highest number only in the forest floor in January and lowest in April while *Seira indica* made its appearance in both the sites showing dominancy in August at BRF (site- I).

The member *Isotomiella minor* constituted only 2.72% of total Collembolan population with numerically maximum in the site I in August and in the site II in March. *Dicranocentroides* with two species, *indica* and *flavescens* were observed only in the BRF reading maximum in August and *Isotomina thermophila* came to light in the forest floor only reaching its peak in July.

The other Collembolan forms *Dicranocentrus* (1.24%), *Callyntrura* (1.14%), *Sinella* (0.85%), *Archerontiella* (0.85%), *Onychiurus* (0.81%) and *Willemia* (0.71%) viewed in poor number in relation to the total community were more or less localized in either BRF or Dhapa. Variations of the faunal components may be due to the differences in the ecological conditions with some genera being widespread occurring regularly in the sampling sites for its ability to tolerate wide variety of habitats and were aptly called “ubiquist” or “ecological generalized groups” whereas, some forms were localized or restricted to ecological specialized group.

The eight ‘ubiquists’ genera, *Lepidocyrtus*, *Seira*, *Cyphoderus*, *Cryptopygus*, *Ballistrura*, *Isotomurus*, *Isotomiella* and *Xenylla* seemed to have wider tolerance to different encountered during the present discourse (Table.26).

According to Addison(1980), such faunal groups possessed the capacity to utilize different food sources and microhabitat for their survival while 12 genera, *Homidia* sp, *Sinella curviseta*, *Yosiia dehradunia*, *Salina javana*, *Salina montana*, *Salina bengalenis*, *Salina indica*, *Callyntrura* (H) *vestita*, *Dicranocentroides indica*, *D. flavescens* *Onychiurus indicus*, *Friesea* sp., *Archerontiella* sp., *Willemia* sp, *Calx* sp, & *Lepidocyrtus cyaneus* were restricted to the single site of two contrasting habitats and as such they are “stenocious” (Table 26).

Hazra & Choudhuri (1990) studied the distribution pattern of soil arthropods particularly Collembola and Acari in 14 ecosystems of West Bengal discovering 2 “ubiquists” genera, *Lepidocyrtus* and *Cyphoderus* and 23 “stenocious” species. Hazra & Sanyal (1996) recorded 4 “ubiquists” and 11 “Stenocious” species from a deciduous reserve forest floor as well as two mangrove areas (one natural & another artificially raised) in a silt deposited island in the river Hooghly. Reserve forest floor showed maximum number (9) of “stenocious species conforming Hazra & Choudhuri (1990) and Hazra & Sanyal (1996).

The ubiquitous genera, *Lepidocyrtus* showed high abundance in all the sites. The community was found a high level of dominance within a particular habitat i.e. *Lepidocyrtus cyaneus* in DP and *Lepidocyrtus medius* and *L. magnificus* in BRF with 21.85%, 11.73% & 10.04% respectively which appeared similar to Takeda (1987). The distribution pattern of various

species and their numerical importance of the total collembolan fauna are expressed in terms of relative abundance (figure 3).

The total population of collembolan showed numerical variation with the change of season with minimum in May in both sites except a few waste disposal sites. In course of this investigation, a general pattern of fluctuation with maximum in monsoon and minimum in premonsoon (May) was observed like that of the control site of forest floor site which is in agreement with Hazra & Choudhuri (1990) and Hazra & Sanyal (1996).

According to Mitra *et al.* (1977) and Hazra & Choudhuri (1990), surface soil vegetations of the surface soil exert an indirect influence on the collembolan population through its effect on the porosity of soil, humus formation and soil moisture inspite of different vegetation in most of the sampling sites. According to Wallwork (1970), the Collembolan fauna of certain locality is determined by complex ecological and historical factors. Therefore, it is evident that the degree of similarity in the species composition between two sites may be used as an index of overall ecological similarity and the influence of vegetation type exert indirectly through its effect on soil type, micro floral composition or soil moisture. Hagvar (1982) observed increase of number of springtails with the increase of soil fertility in coniferous forest floor but the species diversity and number appeared maximum in medium rich soil. He also measured the fertility-scale in accordance to vegetation types and noted that the soil moisture, the vegetation would better indicated collembolan fauna in more extreme environmental condition. Hazra & Sanyal (1996) found increase of the diversity of collembolan members in artificially raised mangrove forest of an island of the river Hooghly (West Bengal) and also said that the number increased with high concentration of moisture and nitrate.

During this investigation, only three predominant species *Lepidocyrtus magnificus*, *L. medius* and *Isotomurus balteatus* were found to attain maximum population in August while, *Xenylla obscura* and *Lepidocyrtus cyaneus* in February. The species, *Yosiia dehredumia* & *Homidia sp.* reached its peak in January followed by *Lepidocyrtus heterolepis*, *L. exploratorius*, *Seira indica*, *Isotomiella minor*, *Cryptopygus thermophilus*, *Cyphoderus javanus*, *Lepidocyrtus cyaneus*, and *Friesea sp.* and *Calx sp.* in March whereas *Sinella curviseta*, *Callyntruna vestita* and *Dicronocentroides indica* appear largest population in the month of August. Individuals of *Ballistrura bengalensis*, *Onychiurus indicus* *Salina bengalensis*, *S. indica*, *S. montana*, *S. javana*, *D. flavescens*, *Isotomina thermophila*, *Archerontiella* & *Willemia* were numerically low in May with a very irregular trend of fluctuation and they were altogether absent in most of the sampling months. Thus, most of the predominant forms were noted to exhibit a single

peak in a year. According to Straalen (1997) some species have had a sharp peak of collembolan community in respective months whereas others tended to fluctuate gradually throughout the year. Indication of the single peak suggests probability of single generation per year (Bellinger, 1954 & Hale (1966). Bellinger (1954) suggested that the habitat preference of soil animal might be determined by soil micro-flora with many edaphic factors. According to Torne (1961 and 1967a, b), certain micro-floral symbionts of the gut played an important role in the digestion of plant material of the host. Satchell (1974) and Parkinson (1983) reviewed the interactive roles of the litter microflora and fauna in decomposition processes and they reiterated that soil invertebrate biomass acted as a reservoir of plant nutrients" and served as a brake of nutrient leaching from decomposing litter. Tadros and Varney (1983) stated that collembola and mites constituted 75 to 80% of soil arthropods and they fed on soil bacteria and fungi. Humus forms were considered as a driving force which explained most of the observed variations in terrestrial ecosystems (Ponge, 2003) depending on a complex of factors like humus integrate physical, chemical and biological properties of the site.

The species diversity index, abundance of species (n1) and relative abundance (RA) of two sampling sites have been given in table 27. The species diversity index evaluated by Shannon-Wiener method indicates that diversity index values 2.118 to 3.191 (Table 27). The number of abundant species (n1) is maximum in site I, B.R.F (24.31) and minimum in site II (8.31). The occurrence of different number of species in two different sites was due to environmental conditions and edaphological factors as well as vegetation cover.

The role of edaphic factors on the distribution and population pattern of different groups of soil inhabiting microfauna have assumed as the factors so far analysed in this study exerted both significant and insignificant effects either singly or in cumulative way depending on the nature of the site. The population was maximum in significantly high content of the factors like moisture, organic carbon, nitrate, and phosphate and other optimum conditions (Table 13 a, b and 14 a, b, c). Temperature and soil moisture appeared as the main driving variables for seasonal fluctuation of micro-arthropod population especially in temperature climate with dry summer period (Straalen, 1985, Satamou *et al.*, 1993). Soil temperature was significantly high in the summer months yielding minimum population due to lesser water content and physical stability of the humus layer in the climate in West Bengal.

Of the edaphic factors studied, temperature showed wide variation with the change of season, ranging between 19°C and 39°C (Table 5 & 9). Population of springtails indicated negative correlation with temperature in waste disposing site (DP) as well as reserve forest site (BRF) confirming Pal *et al.* (1992) and Guru *et al.* (1988). Takeda (1978) also found both positive and negative correlation between temperature and different species of springtails.

According to Hazra & Choudhuri (1983) the temperature had direct influence on the distribution pattern of Collembola. It assumed difficult to evaluate because collembolan are known to withstand a wide range of temperature, as low as -50°C (Paclt, 1956) and as high as 55°C (Dunger, 1964). Conclusion may be drawn that temperature alone does not show significant correlation and is difficult to evaluate direct influence of temperature on the distribution pattern of soil arthropods.

Moisture content was recorded maximum (35.60%) and minimum (24%) respectively in waste disposal site and thus a range of variation had been observed in two different seasons. The value of correlation of collembola with moisture was highly significant both in BRF and DP site (Table 13 a & b). Mukherjee & Singh (1970), Choudhuri & Ray (1972), Hazra & Choudhuri (1983, 90) and Guru *et. al.* (1988) has found positive but not significant correlation between the soil organisms and moisture. Choudhuri & Roy (1972) and Singh & Pillai (1975) affirmed its influence of soil humidity on micro-arthropods and collembolan in particular. Highly significant positive correlation with collembola and its monsoon population reached its peak in the forest floor (BRF) similar to Agrell (1941), Poole (1961), Knight (1961), Christiansen *et al.* (1961), Davis (1963), Gupta and Mukherjee (1976), Mitra *et al.* (1977), Hazra and Choudhuri (1981, '83). Haarlov (1960) considered either moisture or organic matters as an important ecological factor in the life of collembola in Danish soil. However, Choudhuri & Roy (1967) and Nijima (1971) reported significant influence of organic matter and soil moisture on the population of Collembola. According to Singh & Pillai (1975), the ecological parameters like soil temperature, moisture, organic matter and CaCo_3 content of soil influenced composition of soil fauna either individually or in combination with others. As suggested by Hazra (1978a, b) and Hazra & Choudhuri (1990), organic matter and water content of soil together exerted direct or indirect influence on the microbial floral and faunal population by (i) maintaining soil reaction, (ii) controlling humification and (iii) stimulating the growth of micro and macro-flora.

The content of organic carbon was noted to vary between 1.25% and 4.20% exhibiting strong positive correlations with the population densities in both the sites (Table 13 a & b). The concentration of large population of flora and fauna in the litter and humus layer suggested their affinity to organic matter. High temperature and low moisture in the soil seemed to influence the of organic carbon as is evident here in the summer.

Soil pH was an another important variable factor affecting fluctuation of population of soil biota which read maximum of 7.0 at BRF (Table 5 & 9) and minimum of 5.8 at DP. However, the average value did not differ much in two different sites and was more or less neutral. Statistical analyses showed strong negative correlation with the population densities

of Collembola and pH at site II (DP) which agree with Agrell (1941), Bellinger (1954), Choudhuri et al (1978) and Pal et al (1992), while it indicates positive correlation with the population densities of Collembola and pH at the site I (BRF). According to Hazra & Choudhuri (1983), more or less neutral pH was favorable to soil organisms while Dhillon and Gibson (1962) opined for very little or no direct effect of soil pH on the floral and faunal make up.

Nitrate concentration was maximum of 3.80 ppm at DP site and minimum 1.7 ppm at BRF site. Analyses of correlation coefficient revealed positive and significant correlation between nitrate with the densities of Collembolan population in both the sites (BRF & DP) (Table 13 a & b). A strong positive significant correlation between the nitrate and collembola had also been noted by Choudhuri & Roy (1972), Hazra & Choudhuri (1990). Nitrate, the most essential macronutrients probably had its influence on collembolan population through vegetation.

The organic and inorganic forms of Phosphate appeared maximum of 14.6 ppm at DP site and minimum 2.4 ppm at BRF site and these played significant role in the growth of humus complex of vegetation of the soil. The analyses of correlation coefficient showed positive correlation between phosphate with the population densities at site II (DP) while (BRF) showed negative correlation site-I (Table 13 a & b). Choudhuri & Roy (1972) observed positive or negative correlation between collembolan population and phosphate contents but Hazra (1976) found either weak or negative correlation with collembolan population. The present study suggests that the relation between soil phosphate and collembola are not regular or consistent the reason of which is perhaps due to nonavailability of phosphate in soil of the living system. Finally, it may be assumed that phosphate as a single factor does not exert any significant influence on the population rather it does in combination with other factors in the population of soil biota.

The results of this investigation mostly confirm the findings of previous Indian workers but there appear striking differences in certain aspects from the earlier works which may be due to local environmental factors influencing the population pattern (Wallwork, 1970). Therefore, it is likely to be inferred that the factorial components evaluated here in conjunction with the other components (not considered here) collectively contribute to the population fluctuation and the distribution of soil arthropods in two different contrasting habitats of tropical climate of the study areas.

Table 15 : Showing the Collembolan species common in nine states of East and North-East India.

Name of the species	ASSAM	TRIPURA	SIKKIM	MEGHALAYA	MANIPUR	MIZORAM	NAGALAND	ARUNACHAL	ORISSA	W. BENGAL
1. <i>Lepidocyrtus magnificus</i>	+	+	+	+	+	+	+	+	–	+
2. <i>Dicranocentroides flavescens</i>	+	+	+	–	+	+	+	+	+	+

Table 16 : Showing the Collembolan species common in eight states of East and North-East India.

Name of the species	ASSAM	TRIPURA	SIKKIM	MEGHALAYA	MANIPUR	MIZORAM	NAGALAND	ARUNACHAL	ORISSA	W.BENGAL
1. <i>Dicranocentroides indica</i>	+	–	–	+	+	+	+	+	+	+
2. <i>Dicranocentroides salmoni</i>	+	–	+	+	+	+	+	+	+	–

Table 17: Showing the Collembolan species common in seven states of East and North-East India.

Name of the species	ASSAM	TRIPURA	SIKKIM	MEGHALAYA	MANIPUR	MIZORAM	NAGALAND	ARUNACHAL	ORISSA	W.BENGAL
1. <i>Xenylla obscura</i>	+	–	+	–	+	+	+	+	–	+
2. <i>Isotomurus balteatus</i>	+	+	–	–	+	+	–	+	+	+
3. <i>Lepidocyrtus medius</i>	–	+	+	–	+	+	+	–	+	+
4. <i>E.Homidia cingula</i>	–	–	+	–	+	+	+	+	+	+

Table 18 : Showing the Collembolan species common in six states of East and North-East India.

Name of the species	ASSAM	TRIPURA	SIKKIM	MEGHALAYA	MANIPUR	MIZORAM	NAGALAND	ARUNACHAL	ORISSA	W.BENGAL
1. <i>Ceratophysella indovaria</i>	+	–	+	–	+	+	–	+	–	+
2. <i>Lepidocyrtus malayanus</i>	–	+	+	–	+	+	+	+	–	–
3. <i>Dicranocentrus indicus</i>	–	–	+	–	+	+	+	+	–	+
4. <i>Cyphoderus javanus</i>	–	–	+	–	+	+	–	+	+	+
5. <i>Salina indica</i>	–	+	+	–	+	+	–	+	–	+
6. <i>Dicranocentroides fasciculatus</i>	–	–	+	–	+	+	+	+	+	–
7. <i>Callyntrura(H) vestita</i>	–	–	+	+	+	–	+	–	+	+

Table 19 : Showing the Collembolan species common in five states of East and North-East India.

Name of the species	ASSAM	TRIPURA	SIKKIM	MEGHALAYA	MANIPUR	MIZORAM	NAGALAND	ARUNACHAL	ORISSA	W.BENGAL
1. <i>Lepidocyrtus caudatus</i>	+	-	+	-	+	-	-	+	+	-
2. <i>Salina striata</i>	+	-	-	+	-	-	+	+	+	-
3. <i>S. montana</i>	-	-	-	-	+	+	-	+	+	+

Table 20 : Showing the Collembolan species common in four states of East and North-East India.

Name of the species	ASSAM	TRIPURA	SIKKIM	MEGHALAYA	MANIPUR	MIZORAM	NAGALAND	ARUNACHAL	ORISSA	W.BENGAL
1. <i>Cryptopygus thermophilus</i>	+	-	-		+	-	-		+	+
2. <i>Sinella curviseta</i>	+	-	+					+		+
3. <i>Salina tricolor tricolor</i>		-			+	+	+	+	-	
4. <i>Callyntrura japonica</i>	-	-		+	+	+		+	-	-
5. <i>Lepidocyrtus heterolepis</i>			-		+			+	+	+
6. <i>Salina indica</i>	+		-				+	+	+	+

Table 21 : Showing the Collembolan species common in three states of East and North-East India.

Name of the species	ASSAM	TRIPURA	SIKKIM	MEGHALAYA	MANIPUR	MIZORAM	NAGALAND	ARUNACHAL	ORISSA	W.BENGAL
1. <i>I.(Desoria) trispinata</i>	+	-	+	-	-	-	+	-	-	-
2. <i>Lepidocyrtus cyaneus</i>	-	-	-	-	+	-	-	+	-	+
3. <i>Callyntrura(H) lineata</i>	-	+	+	-	+	-	-	-	-	-
4. <i>Isotomina thermophila</i>	+		+							+

Table 22 : Showing the Collembolan species common in two states of East and North-East India.

Name of the species	ASSAM	TRIPURA	SIKKIM	MEGHALAYA	MANIPUR	MIZORAM	NAGALAND	ARUNACHAL	ORISSA	W.BENGAL
1. <i>Lobella kraepelini</i>						+		+		
2. <i>Pronura indiana</i>	+		+							
3. <i>Isotomina thermophila</i>	+									+
4. <i>Rhodanella plumosa</i>			+		+					
5. <i>Lepidosira unguiserrata</i>			+					+		
6. <i>Tomocerus mitrai</i>			+					+		
7. <i>Salina choudhuri</i>	+			+						
8. <i>Salina tricolor sikkimensis</i>			+				+			
9. <i>Salina yosii</i>								+	+	
10. <i>S. javana</i>								+	+	
11. <i>Callyntrura(C) serrata</i>		+					+			
12. <i>C. longicornis</i>	+	-	+							
13. <i>Alloscopus tetracantha</i>		+	+							
14. <i>Yosiia dehradunia</i>		+	+							
15. <i>Cyphoderopsis ceylonica</i>	+		+							
16. <i>Cyphoderopsis kemp</i>		+		+						
17. <i>Lobella assamensis</i>	+					+				
18. <i>Salina biformis</i>					+	+				
19. <i>Dicranocentroides gisini</i>							+	-	+	-
20. <i>Lepidocyrtus exploratorius</i>				+						+

Table 24 : Species diversity (H-) and relative abundance (RA) of ten sites of East & North East India.

SITE	TAXA/SPECIES	n1	Shannon-Wiener diversity Index	RA (%)
ASSAM	<i>Ceratophysella indovaria</i> Salmon, 1970	12	(H-) = 2.791	6.09
	<i>Xenylla obscura</i> Imms, 1912	2		1.01
	<i>Lobella (Lobella) assamensis</i> Yosii, 1966	14		7.1
	<i>Pronura indiana</i> Salmon, 1969	10		5.07
	<i>Isotomurus balteatus</i> (Reuter, 1876)	4		2.03
	<i>Isotoma (Desoria) trispinata</i> MacGillivray, 1896	3		1.52
	<i>Isotomina thermophila</i> (Axelson, 1900)	8		4.06
	<i>Cryptopygus thermophilus</i> (Axelson, 1900)	5		2.53
	<i>Lepidocyrtus (S.Str) magnificus</i> Carpenter, 1924	21		10.65
	<i>Lepidocyrtus caudatus</i> Carpenter, 1917	12		6.09
	<i>Seira indica</i> (Ritter, 1911)	9		4.56
	<i>Sinella curviseta</i> Brook, 1882	11		5.58
	<i>Cyphoderopsis ceylonica</i> Carpenter, 1924	8		4.06
	<i>Salina choudhuri</i> Mitra, 1973	12		6.09
	<i>Salina striata</i> (Handschin, 1928)	14		7.1
	<i>Salina celebensis</i> (Schaeffer, 1898)	5		2.53
	<i>Dicranocentroides indica</i> (Handschin, 1929)	16		8.12
	<i>Dicranocentroides flavescens</i> Yosii, 1966	12		6.09
	<i>Dicranocentroides salmoni</i> Mitra, 1973	6		3.04
	<i>Callyntrura (Handschinphysa) longicornis</i> (Oudemans, 1890)	13		6.59
	N	197		
TRIPURA	<i>Isotomurus balteatus</i> (Reuter, 1876)	60	(H-) = 2.051	28.7
	<i>Lepidocyrtus (S.Str) medius</i> Schaeffer, 1898	25		11.96
	<i>Lepidocyrtus (S.Str) magnificus</i> Carpenter, 1924	6		2.87
	<i>Lepidocyrtus (Acrocyrtus) malayanus</i> Yosii, 1959	7		3.34
	<i>Cyphoderopsis kempfi</i> Carpenter, 1917	12		5.74
	<i>Salina indica</i> (Imms, 1912)	16		7.65
	<i>Dicranocentroides flavescens</i> Yosii, 1966	21		10.04
	<i>Callyntrura (Callyntrura) serrata</i> (Salmon, 1957)	15		7.17
	<i>Callyntrura (Handschinphysa) lineata</i> (Parona, 1892)	14		6.69
	<i>Yosiia dehradunia</i> Mitra, 1967	11		5.26
	<i>Alloscopus tetracantha</i> Börner, 1906	22		10.52
	N	209		

Cont'd.

SITE	TAXA/SPECIES	n1	Shannon-Wiener diversity Index	RA (%)
SIKKIM	<i>Ceratophysella indica</i> Salmon, 1956	80	(H-) = 2.615	3.41
	<i>Ceratophysella indovaria</i> Salmon, 1970	6		0.25
	<i>Xenylla obscura</i> Imms, 1912	4		0.17
	<i>Neanura sikkimensis</i> Yosii, 1966	3		0.12
	<i>Pronura indiana</i> Salmon, 1969	6		0.25
	<i>Spinanurida mandibulata</i> , Salmon, 1969	8		0.34
	<i>Uchidanurida altitudina</i> Salmon, 1970	6		0.25
	<i>Mesaphorura choudhuri</i> Yosii, 1966	88		3.75
	<i>Spelaphorura clayae</i> Salmon, 1963	12		0.51
	<i>Isotoma (Desoria) trispinata</i> MacGillivray, 1896	128		5.46
	<i>Isotomina thermophila</i> (Axelson, 1900)	12		0.51
	<i>Isotoma (D) of mazda</i> Yosii, 1971	35		1.49
	<i>Parafolsomia trioculata</i> Salmon, 1956	10		0.42
	<i>Papillomurus transequatoria</i> Salmon, 1969	6		0.25
	<i>Rhodanella plumosa</i> Salmon, 1969	8		0.34
	<i>Lepidocyrtus (S.Str) magnificus</i> Carpenter, 1924	247		10.54
	<i>Lepidocyrtus(S.Str) medius</i> Schaeffer, 1898	267		11.4
	<i>Lepidocyrtus (Acrocyrtus) malayanus</i> Yosii, 1959	274		11.69
	<i>Lepidocyrtus caudatus</i> Carpenter, 1917	120		5.12
	<i>Lepidosira unguiserrata</i> Salmon, 1970	22		0.93
	<i>Sinella curviseta</i> Brook, 1882	511		21.81
	<i>Dicranocentrus indicus</i> Bonet, 1930	78		3.33
	<i>Homidia cingula</i> Borner, 1906	26		1.11
	<i>Cyphoderus javanus</i> Borner, 1906	12		0.51
	<i>Cyphoderopsis ceylonica</i> Carpenter, 1924	10		0.42
	<i>Tomocerus mitrai</i> Prabhoo, 1980	130		5.55
	<i>Tomocerus petalospinus</i> Salmon, 1969	100		4.26
	<i>Tomocerus serratospinus</i> Salmon, 1969	6		0.25
	<i>Yosiia dehradunia</i> Mitra, 1967	12		0.51
	<i>Salina indica</i> (Imms, 1912)	29		1.23
	<i>Salina tricolor sikkimensis</i> Mitra, 1973	5		0.21
	<i>Dicranocentroides flavescens</i> Yosii, 1966	6		0.25
	<i>Dicranocentroides fasciculatus</i> Imms, 1912	8		0.34
	<i>Dicranocentroides salmoni</i> Mitra, 1973	11		0.46
	<i>Alloscopus tetracantha</i> Borner, 1906	20		0.85
	<i>Callyntrura (Handschinphysa) vestita</i> (Handschin, 1925)	5		0.21

Cont'd.

SITE	TAXA/SPECIES	n1	Shannon-Wiener diversity Index	RA (%)
	<i>Callyntrura (Handschinphysa) lineata</i> (Parona, 1892)	13		0.55
	<i>Callyntrura (Handschinphysa) borneri</i> (Imms, 1912)	8		0.34
	<i>Callyntrura (Handschinphysa) longicornis</i> (Oudemans, 1890)	10		0.42
	N	2342		
MEGHALAYA	<i>Salina choudhuri</i> Mitra, 1973	16	(H-) = 2.060	6.6
	<i>Salina striata</i> (Handschin, 1928)	82		34.16
	<i>Dicranocentroides indica</i> (Handschin, 1929)	24		10
	<i>Dicranocentroides salmoni</i> Mitra, 1973	18		7.5
	<i>Callyntrura japonica</i> (Kinoshita, 1917)	27		11.25
	<i>Callyntrura (Handschinphysa) vestita</i> (Handschin, 1925)	13		5.41
	<i>Lepidocyrtus exploratus</i> Carpenter, 1917	12		5
	<i>Lepidocyrtus (S.Str) magnificus</i> Carpenter, 1924	14		5.83
	<i>Cyphoderopsis kemp</i> Carpenter, 1917	10		4.16
	<i>Cyphoderopsis gracilis</i> Carpenter, 1924	8		3.33
	<i>Cyphoderopsis ceylonica</i> Carpenter, 1924	16		6.6
	N	240		
MANIPUR	<i>Ceratophysella indovaria</i> Salmon, 1970	2	(H-) = 2.942	0.43
	<i>Xenylla obscura</i> Imms, 1912	10		2.16
	<i>Isotomurus balteatus</i> (Reuter, 1876)	27		5.84
	<i>Cryptopygus thermophilus</i> (Axelson, 1900)	2		0.43
	<i>Rhodanella plumosa</i> Salmon, 1969	6		1.29
	<i>Lepidocyrtus (S.Str) magnificus</i> Carpenter, 1924	58		12.55
	<i>Lepidocyrtus (S.Str) medius</i> Schaeffer, 1898	25		5.41
	<i>Lepidocyrtus (Acrocyrtus) malayanus</i> Yosii, 1959	20		4.32
	<i>Lepidocyrtus (A) heterolepis</i> Yosii, 1959	13		2.81
	<i>Lepidocyrtus cyaneus</i> Tullberg, 1869	22		4.76
	<i>Lepidocyrtus caudatus</i> Carpenter, 1917	15		3.24
	<i>Dicranocentrus indicus</i> Bonet, 1930	22		4.76
	<i>Setogaster manipuri</i> Salmon, 1969	12		2.59
	<i>Homidia cingula</i> Borner, 1906	22		4.76
	<i>Cyphoderus javanus</i> Borner, 1906	3		0.64
	<i>Callyntrura (Handschinphysa) lineata</i> (Parona, 1892)	5		1.08

Cont'd.

SITE	TAXA/SPECIES	n1	Shannon-Wiener diversity Index	RA (%)
	<i>Callyntrura (Handschinphysa) vestita</i> (Handschin, 1925)	7		1.51
	<i>Callyntrura japonica</i> (Kinoshita, 1917)	16		3.46
	<i>Salina montana</i> (Imms, 1912)	15		3.24
	<i>Salina tricolor tricolor</i> (Handschin, 1928)	22		4.76
	<i>Salina indica</i> (Imms, 1912)	39		8.44
	<i>Salina biformis</i> Mitra, 1966	34		7.35
	<i>Dicranocentroides indica</i> (Handschin, 1929)	21		4.54
	<i>Dicranocentroides fasciculatus</i> Imms, 1912	14		3.03
	<i>Dicranocentroides salmoni</i> Mitra, 1973	16		3.46
	<i>Dicranocentroides flavescens</i> Yosii, 1966	8		1.73
	<i>Pseudoparonellides bulbosa</i> Salmon, 1957	6		1.29
	N	462		
MIZORAM	<i>Ceratophysella indovaria</i> Salmon, 1970	132	(H-) = 2.557	24.26
	<i>Xenylla obscura</i> Imms, 1912	55		11.8
	<i>Lobella (Lobella) assamensis</i> Yosii, 1966	2		0.36
	<i>Lobella kraepelini</i> Börner (1906)	15		2.75
	<i>Isotomurus balteatus</i> (Reuter, 1876)	12		2.2
	<i>Lepidocyrtus (S.Str) magnificus</i> Carpenter, 1924	15		2.75
	<i>Lepidocyrtus(S.Str) medius</i> Schaeffer, 1898	24		4.41
	<i>Lepidocyrtus (Acrocyrtus) malayanus</i> Yosii, 1959	32		5.88
	<i>Dicranocentrus indicus</i> Bonet, 1930	37		6.8
	<i>Homidia cingula</i> Börner, 1906	32		5.88
	<i>Cyphoderus javanus</i> Börner, 1906	47		8.63
	<i>Salina indica</i> (Imms, 1912)	40		7.35
	<i>Salina tricolor tricolor</i> (Handschin, 1928)	6		1.1
	<i>Salina biformis</i> Mitra, 1966	10		1.83
	<i>Salina montana</i> (Imms, 1912)	12		2.2
	<i>Dicranocentroides flavescens</i> Yosii, 1966	11		2.02
	<i>Dicranocentroides fasciculatus</i> Imms, 1912	15		2.75
	<i>Dicranocentroides indica</i> (Handschin, 1929)	25		4.59
	<i>Dicranocentroides salmoni</i> Mitra, 1973	9		1.65
	<i>Callyntrura japonica</i> (Kinoshita, 1917)	13		2.38
	N	544		

Cont'd.

SITE	TAXA/SPECIES	n1	Shannon-Wiener diversity Index	RA (%)
NAGALAND	<i>Xenylla obscura</i> Imms, 1912	36	(H-) = 2.540	7.72
	<i>Isotoma (Desoria) trispinata</i> MacGillivray, 1896	4		0.85
	<i>Lepidocyrtus (S.Str) magnificus</i> Carpenter, 1924	38		8.15
	<i>Lepidocyrtus (S.Str) medius</i> Schaeffer, 1898	81		17.38
	<i>Lepidocyrtus (Acrocyrtus) malayanus</i> Yosii, 1959	50		10.72
	<i>Dicranocentrus indicus</i> Bonet, 1930	69		14.8
	<i>Homidia cingula</i> Börner, 1906	33		7.08
	<i>Seira indica</i> (Ritter, 1911)	12		2.57
	<i>Salina striata</i> (Handschin, 1928)	10		2.14
	<i>Salina tricolor tricolor</i> (Handschin, 1928)	18		3.86
	<i>Salina tricolor sikkimensis</i> Mitra, 1973	18		3.86
	<i>Dicranocentroides indica</i> (Handschin, 1929)	11		2.36
	<i>Dicranocentroides gisini</i> , Mitra, 1975	8		1.71
	<i>Dicranocentroides fasciculatus</i> Imms, 1912	6		1.28
	<i>Dicranocentroides flavescens</i> Yosii, 1966	13		2.78
	<i>Dicranocentroides salmoni</i> Mitra, 1973	11		2.36
	<i>Callyntrura (Callyntrura) serrata</i> (Salmon, 1957)	22		4.72
	<i>Callyntrura (Handschinphysa) vestita</i> (Handschin, 1925)	26		5.57
	N	466		
ARUNACHAL	<i>Ceratophysella indovaria</i> Salmon, 1970	14	(H-) = 2.381	0.86
	<i>Xenylla obscura</i> Imms, 1912	2		0.12
	<i>Lobella kraepelini</i> Börner (1906)	23		1.41
	<i>Isotomurus balteatus</i> (Reuter, 1876)	16		0.98
	<i>Lepidocyrtus (S.Str) magnificus</i> Carpenter, 1924	52		3.2
	<i>Lepidocyrtus (Acrocyrtus) malayanus</i> Yosii, 1959	100		6.15
	<i>Lepidocyrtus (A) heterolepis</i> Yosii, 1959	61		3.75
	<i>Lepidocyrtus curvicolis</i> Yosii, 1959	100		6.15
	<i>Lepidocyrtus caudatus</i> Carpenter, 1917	1		0.06
	<i>Lepidocyrtus cyaneus</i> Tullberg, 1869	22		1.35
	<i>Lepidosira unguiserrata</i> Salmon, 1970	220		13.54
	<i>Sinella curviseta</i> Brook, 1882	123		7.57
	<i>Dicranocentrus indicus</i> Bonet, 1930	500		30.78
	<i>Dicranocentrus simplex</i> Yosii, 1959	25		1.53

Cont'd.

SITE	TAXA/SPECIES	n1	Shannon-Wiener diversity Index	RA (%)
	<i>Homidia cingula</i> Borner, 1906	77		4.74
	<i>Seira indica</i> (Ritter, 1911)	1		0.06
	<i>Seira arunachala</i> Mitra, 1975	53		3.26
	<i>Cyphoderus javanus</i> Borner, 1906	22		1.35
	<i>Tomocerus mitrai</i> Prabhoo, 1980	101		6.21
	<i>Salina indica</i> (Imms, 1912)	2		0.12
	<i>Salina montana</i> (Imms, 1912)	4		0.24
	<i>Salina striata</i> (Handschin, 1928)	21		1.29
	<i>Salina tricolor tricolor</i> (Handschin, 1928)	12		0.73
	<i>Callyntrura japonica</i> (Kinoshita, 1917)	10		0.61
	<i>Dicranocentroides indica</i> (Handschin, 1929)	23		1.04
	<i>Dicranocentroides flavescens</i> Yosii, 1966	21		1.29
	<i>Dicranocentroides fasciculatus</i> Imms, 1912	11		0.67
	<i>Dicranocentroides salmoni</i> Mitra, 1973	7		0.43
	N	1624		
ORISSA	<i>Isotomurus balteatus</i> (Reuter, 1876)	6	(H-) = 2.764	1.84
	<i>Cryptopygus thermophilus</i> (Axelson, 1900)	27		8.3
	<i>Lepidocyrtus</i> (S.Str) <i>medius</i> Schaeffer, 1898	11		3.38
	<i>Lepidocyrtus</i> (A) <i>heterolepis</i> Yosii, 1959	14		4.3
	<i>Lepidocyrtus caudatus</i> Carpenter, 1917	12		3.69
	<i>Homidia cingula</i> Borner, 1906	23		7.07
	<i>Cyphoderus javanus</i> Borner, 1906	44		13.53
	<i>Pesudocyphoderus annendalei</i> Imms, 1912	35		10.76
	<i>Delamarerus immsi</i> Mitra, 1973	14		4.3
	<i>Salina striata</i> (Handschin, 1928)	10		3.07
	<i>Salina montana</i> (Imms, 1912)	8		2.46
	<i>Salina yosii</i> Salmon, 1964	14		4.3
	<i>Salina javana</i> (Handschin, 1928)	4		1.23
	<i>Callyntrura</i> (Handschinphysa) <i>vestita</i> (Handschin, 1925)	11		3.38
	<i>Callyntrura</i> (Handschinphysa) <i>delamarei</i> Mitra, 1974	21		6.46
	<i>Callyntrura</i> (Callyntrura) <i>semiviolacea</i> (Handschin, 1925)	17		5.23
	<i>Dicranocentroides indica</i> (Handschin, 1929)	9		2.76
	<i>Dicranocentroides flavescens</i> Yosii, 1966	13		4

Cont'd.

SITE	TAXA/SPECIES	n1	Shannon-Wiener diversity Index	RA (%)
	<i>Dicranocentroides fasciculatus</i> Imms, 1912	11		3.38
	<i>Dicranocentroides salmoni</i> Mitra, 1973	6		1.84
	<i>Dicranocentroides gisini</i> , Mitra, 1975	15		4.61
	N	325		
W. BENGAL	<i>Ceratophysella indovaria</i> Salmon, 1970	8	(H-) = 2.558	1.03
	<i>Xenylla obscura</i> Imms, 1912	219		28.4
	<i>Onychiurus indicus</i> Choudhuri & Roy	17		2.2
	<i>Isotomurus balteatus</i> (Reuter, 1876)	37		4.79
	<i>Isotomiella minor</i> (Schaeffer, 1898)	24		3.11
	<i>Ballistrura bengalensis</i> Yosii, 1966	72		9.33
	<i>Cryptopygus thermophilus</i> (Axelson, 1900)	43		5.57
	<i>Lepidocyrtus</i> (S.Str) <i>magnificus</i> Carpenter, 1924	12		1.55
	<i>Lepidocyrtus</i> (S.Str) <i>medius</i> Schaeffer, 1898	31		4.02
	<i>Lepidocyrtus</i> (A) <i>heterolepis</i> Yosii, 1959	34		4.4
	<i>Lepidocyrtus cyaneus</i> Tullberg, 1869	31		4.02
	<i>Lepidocyrtus exploratorius</i> Carpenter, 1917	23		2.98
	<i>Sinella curviseta</i> Brook, 1882	12		1.55
	<i>Dicranocentrus indicus</i> Bonet, 1930	15		1.94
	<i>Homidia cingula</i> Börner, 1906	8		1.03
	<i>Cyphoderus javanus</i> Börner, 1906	35		4.53
	<i>Salina indica</i> (Imms, 1912)	12		1.55
	<i>Salina montana</i> (Imms, 1912)	16		2.07
	<i>Salina yosii</i> Salmon, 1964	19		2.46
	<i>Seira indica</i> (Ritter, 1911)	10		1.29
	<i>Salina bengalensis</i> Mitra, 1973	21		2.72
	<i>Salina javana</i> (Handschin, 1928)	12		1.52
	<i>Dicranocentroides indica</i> (Handschin, 1929)	8		1.03
	<i>Dicranocentroides flavescens</i> Yosii, 1966	12		1.55
	<i>Callyntrura</i> (Callyntrura) <i>zaheri</i> Mitra, 1974	10		1.29
	<i>Callyntrura</i> (Handschinphysa) <i>vestita</i> (Handschin, 1925)	4		0.51
	<i>Yosiia dehradunia</i> Mitra, 1967	24		3.11
	<i>Heteromuricus cercifer</i> Imms, 1912	2		0.25
	N	771		

Table 25 : Taxonomic status of the Collembolan species from the two study sites (B.R.F & D.P)

Order	COLLEMBOLA
Family	HYPOGASTRURIDAE, Börner, 1913
Subfamily	Hypogastrurinae
Genus/species	<i>Xenylla obscura</i> Imms, 1912
	<i>Archerontiella</i> sp
	<i>Willemia</i> sp
Subfamily	Neanurinae
	<i>Friesea</i> sp
Family	ONYCHIURIDAE
Subfamily	Onychiurinae
	<i>Onychiurus indicus</i> Choudhury & Roy, 1965
Family	ISOTOMIDAE, Börner, 1913
	<i>Cryptopygus thermophilus</i> (Axelson, 1900)
	<i>Ballistrura bengalensis</i> Yosii, 1966
	<i>Isotomurus balteatus</i> (Reuter, 1876)
	<i>Isotomiella minor</i> (Schaeffer, 1898)
	<i>Isotomina thermophila</i> (Axelson, 1900)
Family	ENTOMOBRYIDAE, Tomosvary, 1882
Subfamily	Entomobryinae
	<i>Lepidocyrtus cyaneus</i> Tullberg, 1956
	<i>L. exploratorius</i> Carpenter, 1924
	<i>L. heterolepis</i> Yosii, 1959
	<i>L. medius</i> Schaeffer, 1898
	<i>L. magnificus</i> Carpenter, 1924
	<i>Homidia</i> sp
	<i>Calx</i> sp
	<i>Seira indica</i> (Ritter, 1911)
	<i>Sinella curviseta</i> Brook, 1882
	<i>Dicranocentrus indicus</i> Bonet, 1930
Subfamily	Cyphoderinae
	<i>Cyphoderus javanus</i> Börner, 1906
Subfamily	Paronellinae
	<i>Salina indica</i> (Imms, 1912)
	<i>S. bengalensis</i> Mitra, 1966
	<i>S. montana</i> (Imms, 1912)
	<i>S. javana</i> (Handschin, 1928)
	<i>Yosiia dehradunia</i> Mitra, 1967
	<i>Callyntrura</i> (H) <i>vestita</i> (Handschin, 1925)
	<i>Dicranocentroides indica</i> (Handschin, 1925)
	<i>D. flavescens</i> Yosii, 1966

Table 26 : UBIQUITUS & STENOCIOUS species of Collembola from the study sites (Site : I and Site : II) :

STENOCIOUS (Species restricted to)		UBIQUITUS Species (present in all sites)
SITE I BRF	SITE II DP	
<i>Homidia sp</i>	<i>Friesea sp</i>	<i>L. exploratorius</i> Carpenter, 1924
<i>Sinella curviseta</i> Brook, 1882	<i>Archerontiella sp</i>	<i>L. heterolepis</i> Yosii, 1959
<i>Yosiia dehradunia</i> Mitra, 1967	<i>Willemia sp</i>	<i>Seira indica</i> (Ritter, 1911)
<i>Salina montana</i> (Imms, 1912)	<i>Calx sp</i>	<i>Cyphoderus javanus</i> Börner, 1906
<i>S. javana</i> (Handschin, 1928)	<i>Lepidocyrtus cyaneus</i> Tullberg, 1956	<i>Cryptopygus thermophilus</i> (Axelson, 1900)
<i>Callyntrura(H) vestita</i> (Handschin, 1925)		<i>Ballistrura bengalensis</i> Yosii, 1966
<i>Dicranocentroides indica</i> (Handschin, 1925)		<i>Isotomurus balteatus</i> (Reuter, 1876)
<i>D. flavescens</i> Yosii, 1966		<i>Isotomiella minor</i> (Schaeffer, 1898)
<i>Onychiurus indicus</i> Choudhury & Roy, 1965		<i>Xenylla obscura</i> Imms, 1912

Table 27 : Species diversity index and relative abundance of two sampling sites.

Site I : BRF	TAXA/SPECIES	n1	Shannon-Wiener diversity Index	RA (%)
	<i>Lepidocyrtus(S.Str) medius</i> Schaeffer, 1898	104	H' = 3.191	11.73
	<i>Lepidocyrtus (S.Str) magnificus</i> Carpenter, 1924	89		10.04
	<i>Lepidocyrtus (A) heterolepis</i> Yosii, 1959	34		3.83
	<i>Lepidocyrtus exploratius</i> Carpenter, 1924	38		4.28
	<i>Homidia sp</i>	74		8.35
	<i>Sinella curviseta</i> Brook, 1882	18		2.03
	<i>Seira indica</i> (Ritter, 1911)	21		2.37
	<i>Dicranocentrus indicus</i> Bonet, 1930	26		2.93
	<i>Yosiia dehradunia</i> Mitra, 1967	54		6.09
	<i>Salina bengalensis</i> Mitra, 1973	21		2.37
	<i>Seira indica</i> (Ritter, 1911)	20		2.25
	<i>Salina montana</i> (Imms, 1912)	32		3.61
	<i>Salina javana</i> (Handschin, 1928)	24		2.7
	<i>Callyntrura (Handschinphysa) vestita</i> (Handschin, 1925)	24		2.7
	<i>Dicranocentroides indica</i> (Handschin, 1929)	22		2.48
	<i>Dicranocentroides flavescens</i> Yosii, 1966	23		2.59

Cont'd.

Site I : BRF	TAXA/SPECIES	n1	Shannon-Wiener diversity Index	RA (%)
	<i>Isotomurus balteatus</i> (Reuter, 1876)	37		4.17
	<i>Isotomiella minor</i> (Schaeffer, 1898)	26		2.93
	<i>Isotomina thermophila</i> (Axelson, 1900)	42		4.74
	<i>Ballistrura bengalensis</i> Yosii, 1966	33		3.72
	<i>Cryptopygus thermophilus</i> (Axelson, 1900)	37		4.17
	<i>Xenylla obscura</i> Imms, 1912	32		3.61
	<i>Onychiurus indicus</i> Choudhuri & Roy	17		1.91
	<i>Cyphoderus javanus</i> Börner, 1906	38		4.28
	N	782		
Site II : DP	<i>Lepidocyrtus (A) heterolepis</i> Yosii, 1959	53	H' = 2.118	4.38
	<i>Lepidocyrtus exploratus</i> Carpenter, 1917	84		6.95
	<i>Lepidocyrtus cyaneus</i> Tullberg, 1869	264		3.22
	<i>Seira indica</i> (Ritter, 1911)	39		4.22
	<i>Isotomurus balteatus</i> (Reuter, 1876)	51		2.56
	<i>Isotomiella minor</i> (Schaeffer, 1898)	31		3.22
	<i>Ballistrura bengalensis</i> Yosii, 1966	39		12
	<i>Cryptopygus thermophilus</i> (Axelson, 1900)	145		15.48
	<i>Xenylla obscura</i> Imms, 1912	187		13.9
	<i>Cyphoderus javanus</i> Börner, 1906	168		21.85
	<i>Calx</i> sp	41		3.39
	<i>Friesea</i> sp	73		6.04
	<i>Willemia</i> sp	15		1.24
	<i>Archerontiella</i> sp	18		1.49
	N	1208		

SUMMARY

The present investigation encompasses the diversity of collembola qualitatively from the states of east and north-east India and the results of ecological study involving the seasonal abundance and species diversity in two different ecological habitats of West Bengal.

A total 76 species of Collembola belonging to 38 genera and 6 sub families obtained from the soil and leaf-litter of the above mentioned states of India. Amongst them, 28 species were endemic to the said regions *i.e.* 36.84% total species recorded of these states and 14.28% of total Indian fauna of collembolan. Richest diversity of Collembolan fauna was found in the

state of Sikkim which includes 39 species under 26 genera, where as minimum diversity was observed in the state of Meghalaya with 11 species under 5 genera. The genus, *Salina* has been recorded as dominant with individual contribution of 10% or more to the total springtail fauna. The other dominant genera are *Callyntrura* by 9 species, *Lepidocyrtus*, 8 species, *Dicranocentroides*, 5 species and *Tomocerus* by 3 species. The other genera were either having 2 species or monotypic species. The genera, *Ceratophysella*, *Xenylla*, *Cyphoderus*, *Isotomurus*, *Lepidocyrtus*, *Salina*, *Dicranocentroides* and *Callyntrura* were found to occur in maximum number in the study sites.

Diversity indices of Tripura and Meghalaya was more or less similar being 2.051 and 2.060 which in other seven states were 2.791, 2.764, 2.615, 2.557, 2.558, 2.540 and 2.381 respectively i.e., there is little variation between these sites which is substantiated by the occurrence of more or less same number of species. The diversity index was maximum in Manipur showing 2.942. Hill's first diversity number; the number of abundant species (N1) was maximum in Manipur (18.95) and the number of abundant species minimum was in Tripura (7.7).

Soil factors like temperature, moisture, pH, organic carbon, nitrate and phosphate and its roles in the distribution of collembolan were noticed to have seasonal variation in two adjacent sites of Kolkata.

A total 540 soil samples have been used for samplings in various plots including two different sites, three polluted and three unpolluted soils of forest floor at monthly intervals over a period of 30 months (January, 2000 to June, 2002). Population density was found to be maximum in waste disposal site than that of the forest floor site.

The fauna of the experimental sites belong to 29 species of 21 genera under the families: Hypogastruridae, Onychiuridae, Isotomidae and Entomobryidae. Maximum diversity with 24 species in 17 genera comes in view from the forest floor site (BRF) and the minimum with 14 species in 12 genera in the polluted field site (DP). Species composition differs considerably in two different habitats with occurrence of only 9 in both the habitats.

Numerically the genus *Lepidocyrtus* occupies topmost position among all the springtails and followed by *Xenylla*, *Cyphoderus* and *Cryptopygus* as the second, third and fourth positions and the other genera, *Isotomurus*, *Salina*, *Homidia*, *Friesea*, *Ballistrura*, *Seira*, *Isotomiella*, *Yosiia*, *Dicranocentroides*, *Isotomina* in order of dominance. The peak of population also varies from site to site being minimum in summer months except the waste disposal site, DP and maximum during monsoon (August) in the forest floor site and March in waste disposal site.

Soil factors like, moisture, organic carbon, nitrate and phosphate also prove significant positive correlation with the population in both the sites while the temperature and pH indicate negative correlation.

From the present investigation it may be concluded that the diversity of the areas of investigation is very rich comprising 36% of the species occurring in India. The total species obtained here are 14.28% endemic in respect to total Indian Collembola.

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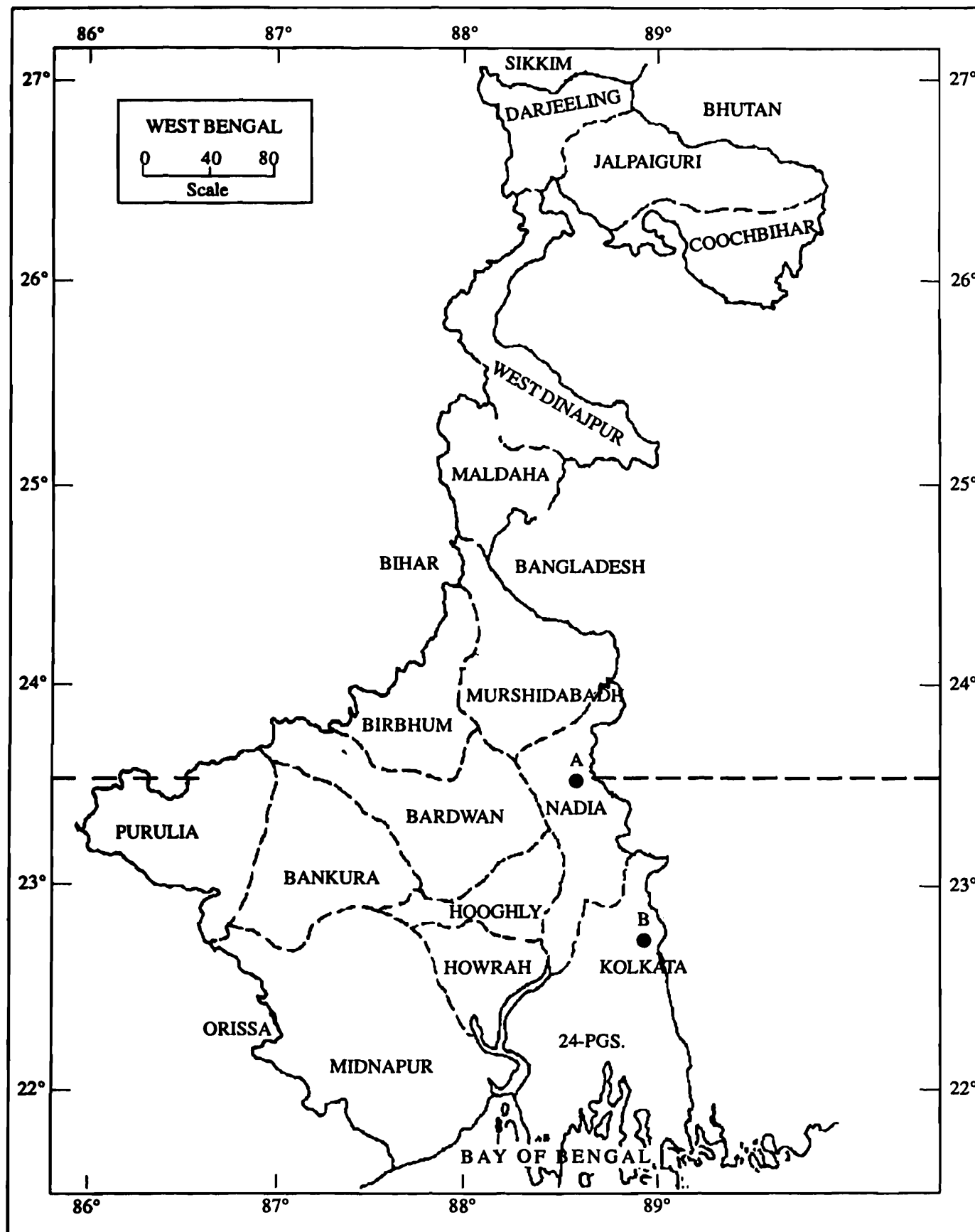
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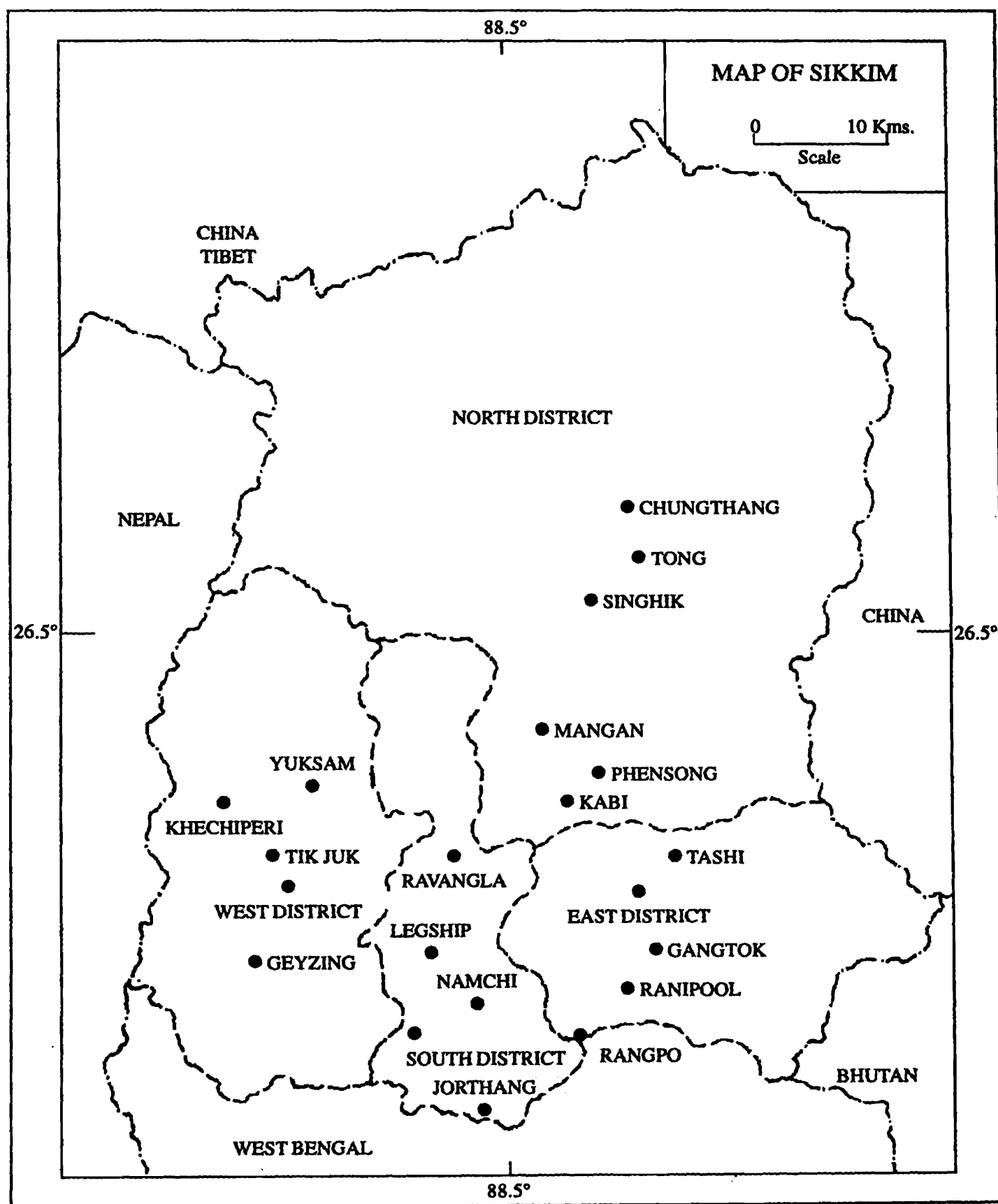
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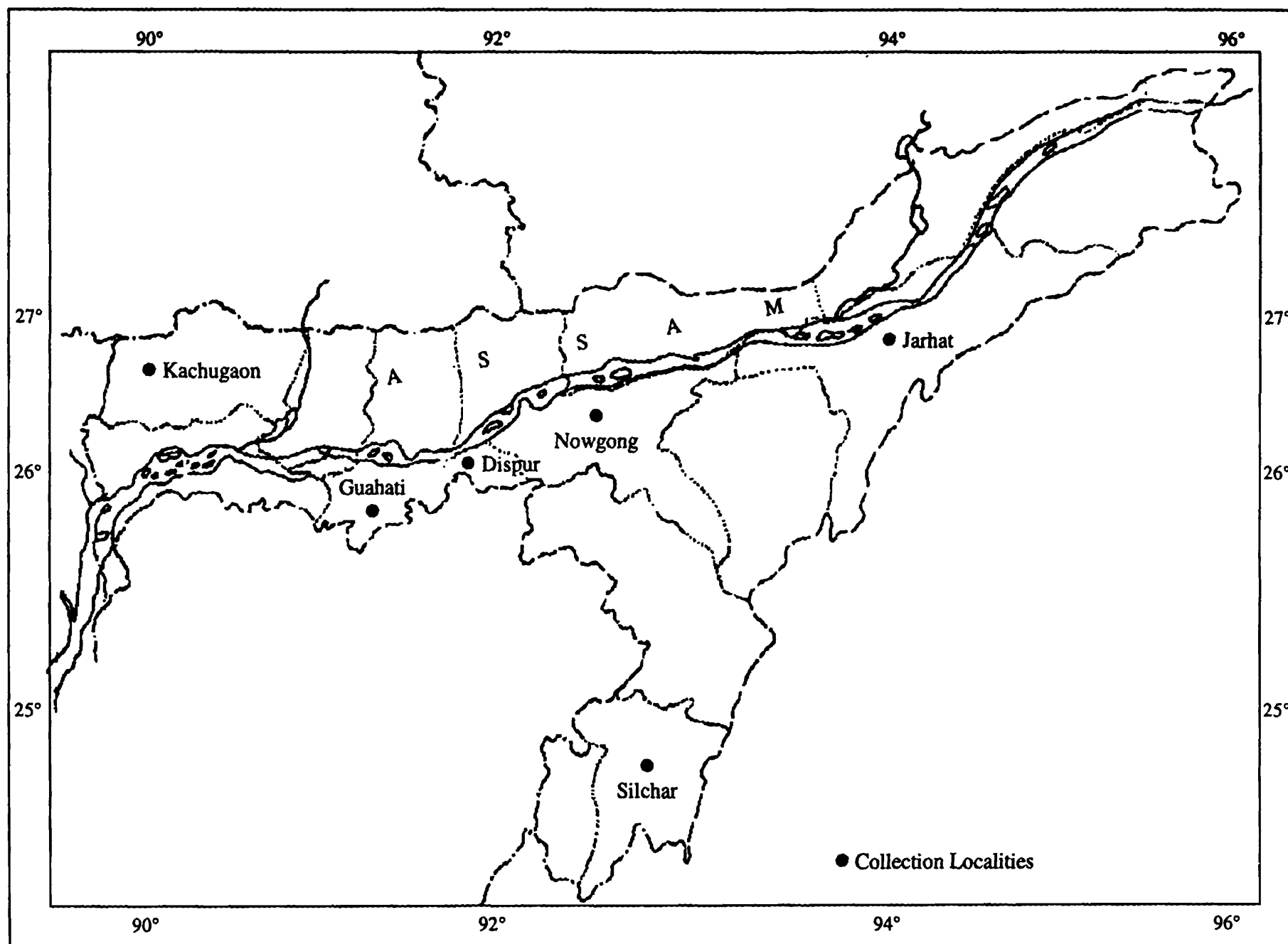
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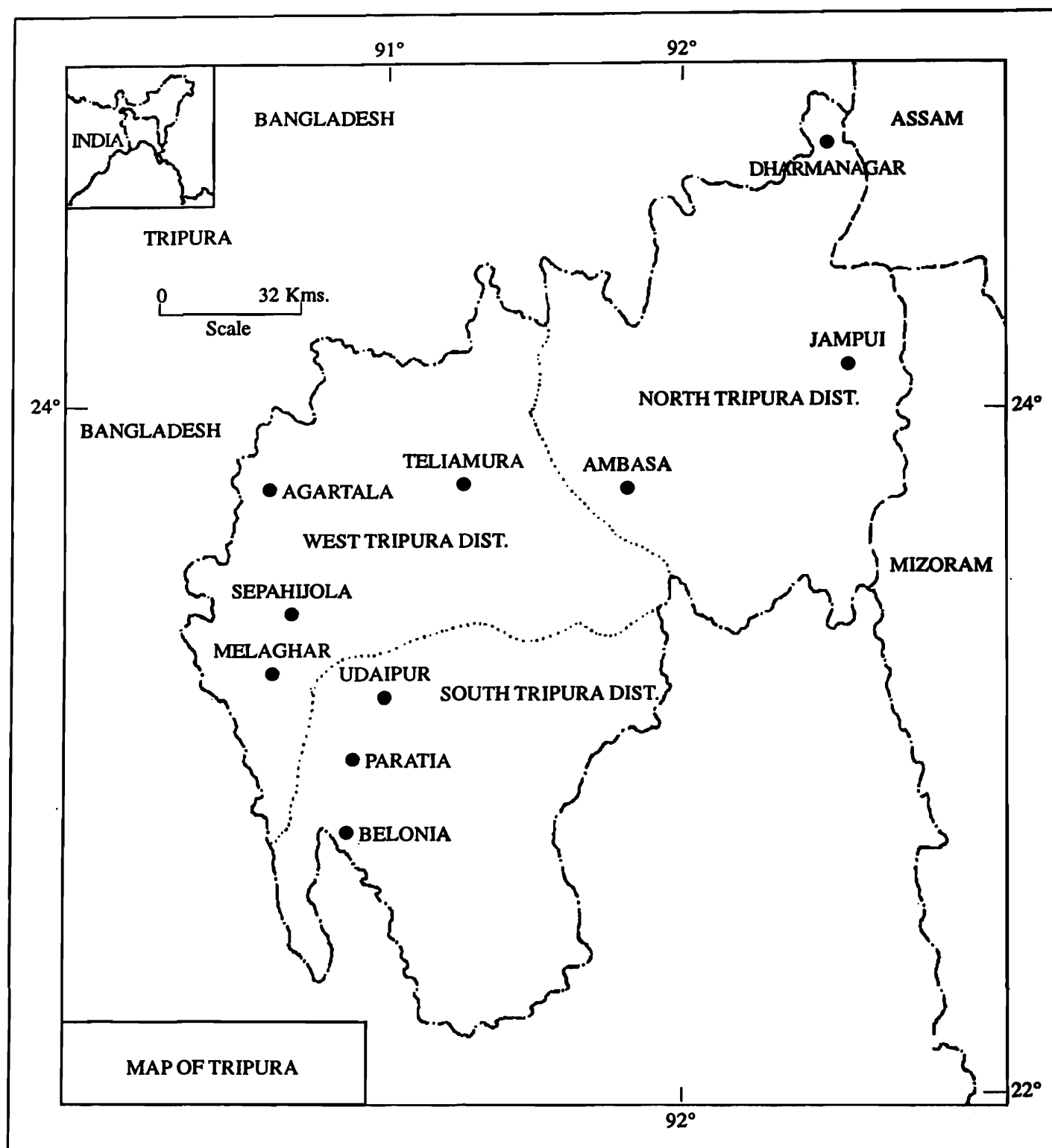
Map 1 : Map of West Bengal, Location of Sampling Sites : A = Bethuadahari-Reserve Forest, B = Dhapa, Kolkata.



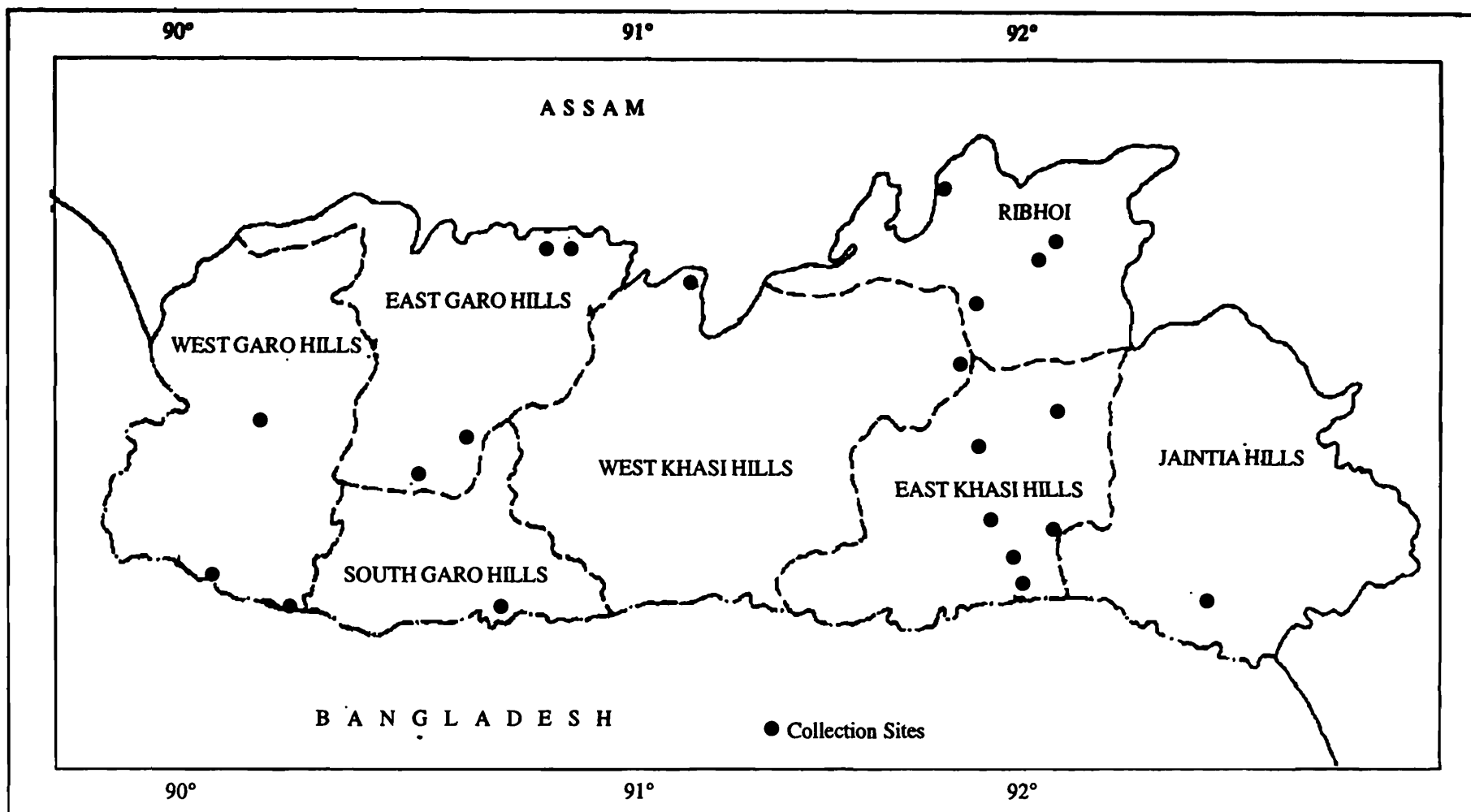
Map 2 : Map of Sikkim. Showing the collection localities (●) in different district of Sikkim.



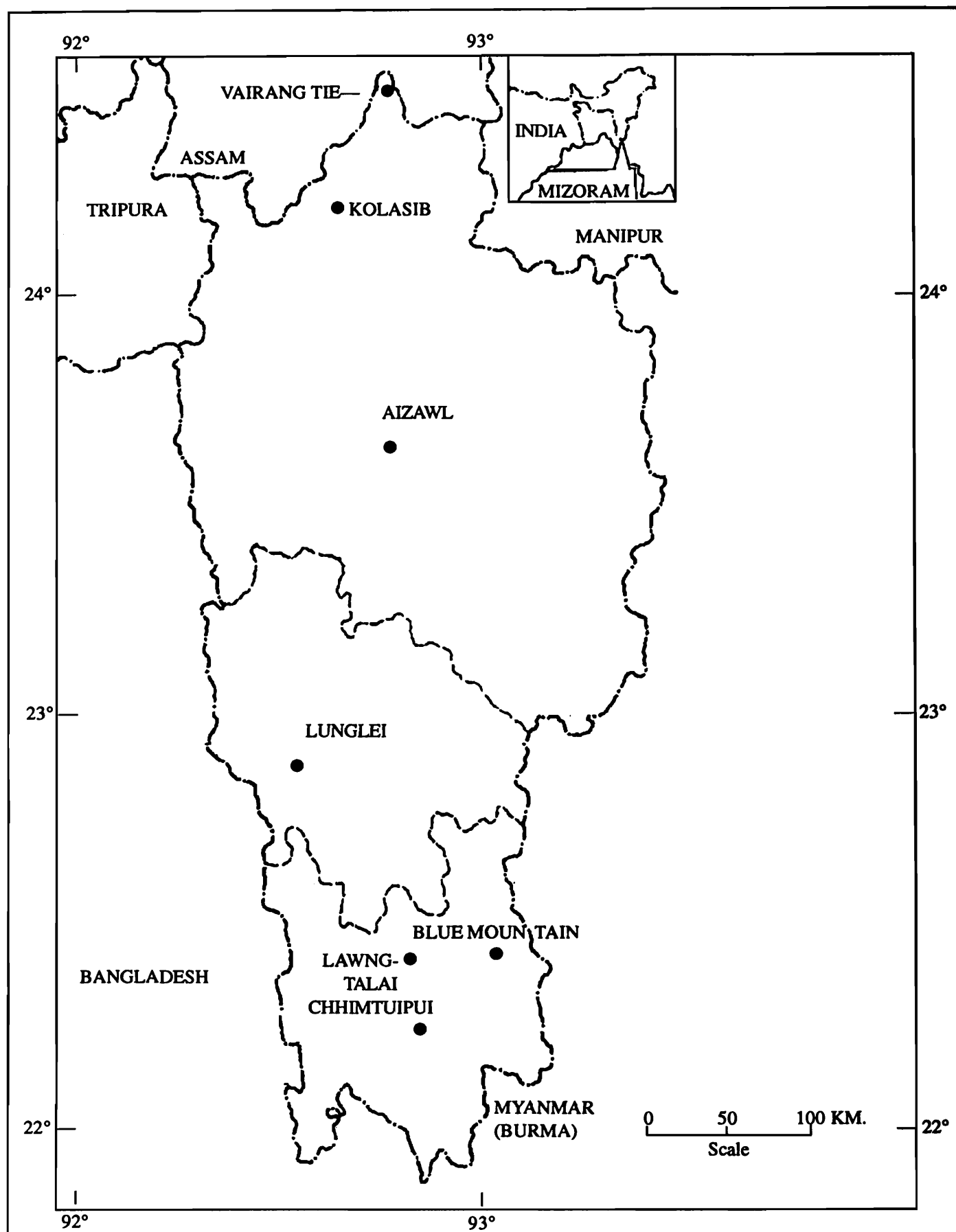
Map 3 : Map of Assam. Showing the collection localities and district boundaries.



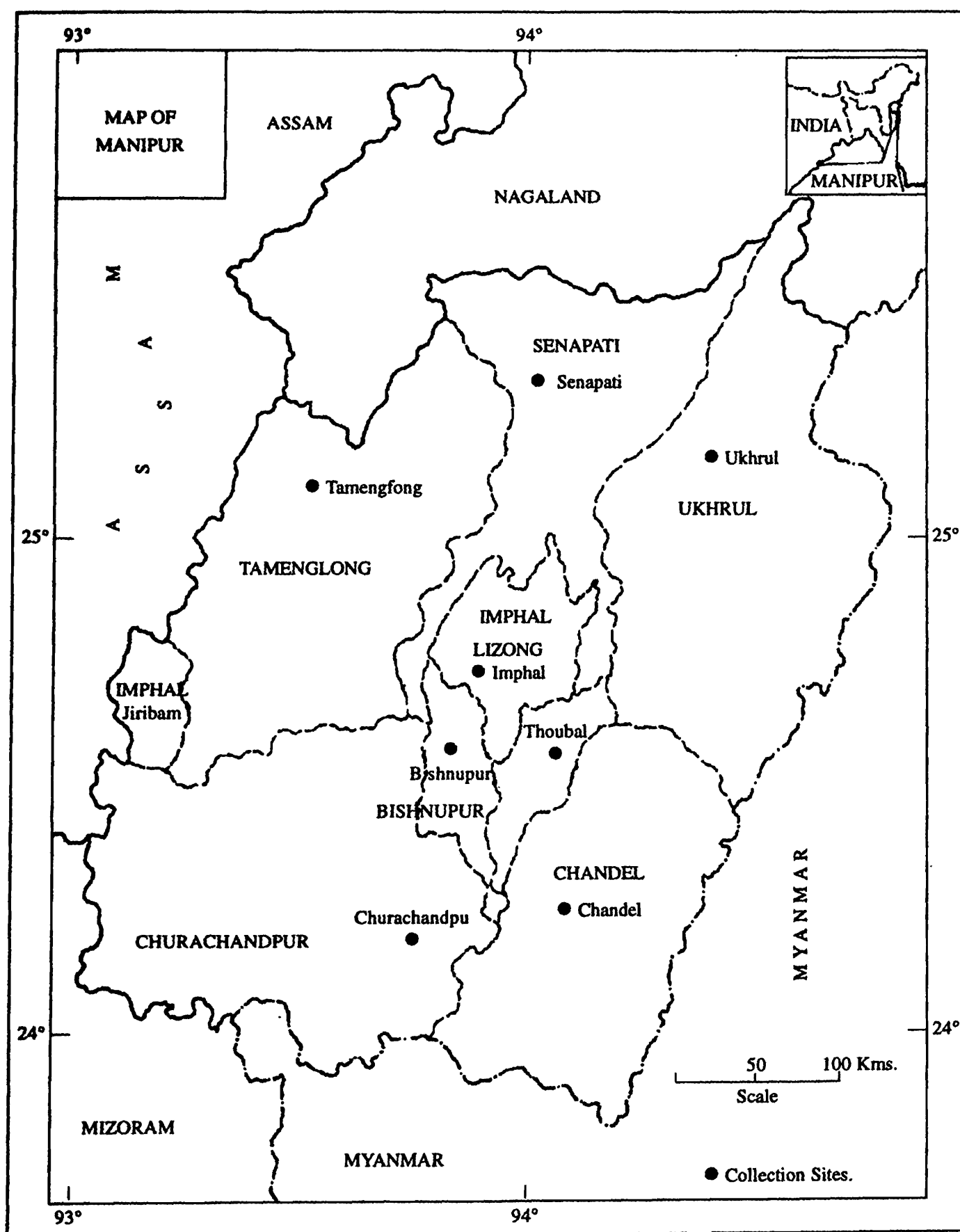
Map 4 : Showing the collection localities in different districts of Tripura.



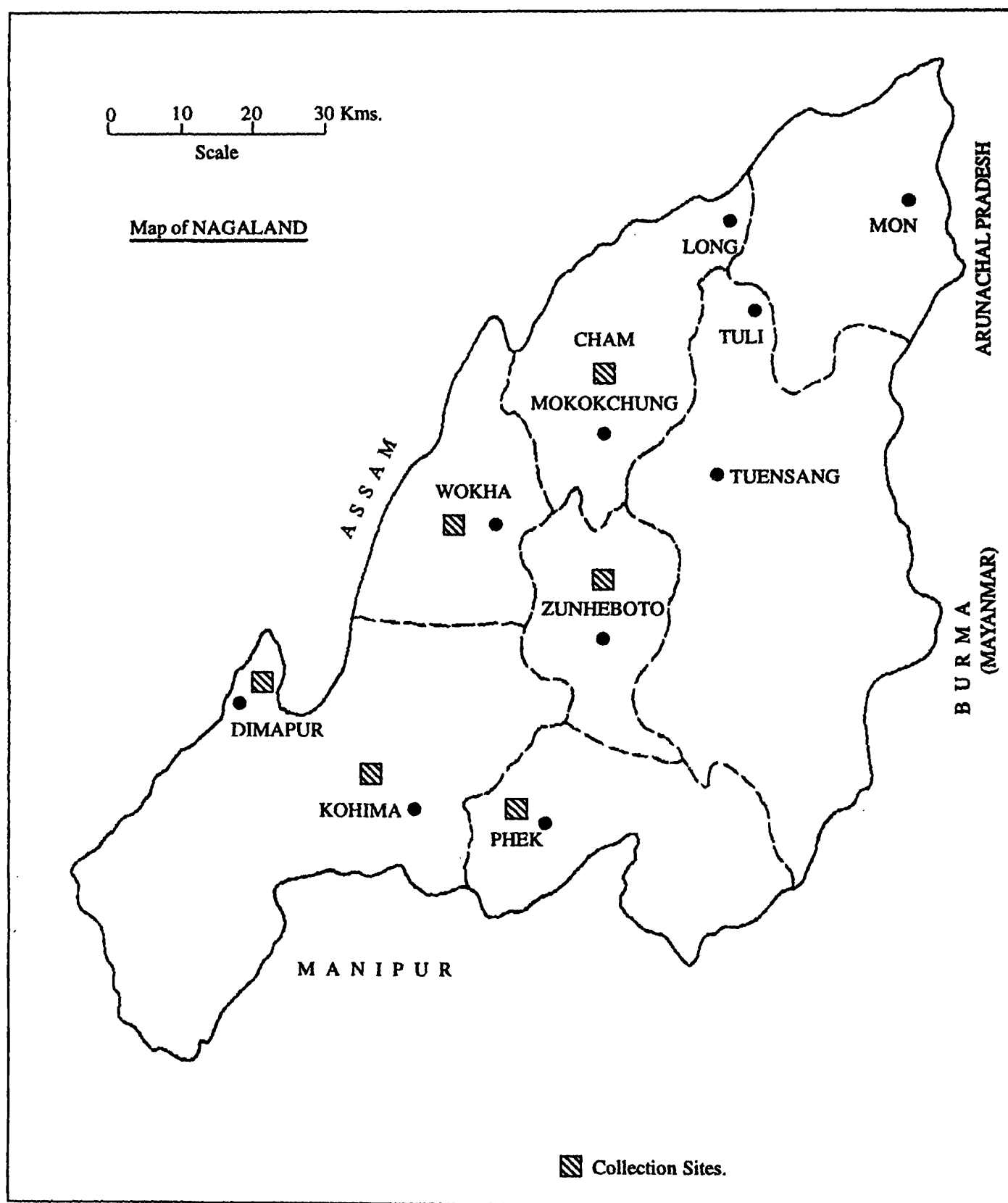
Map 5 : Map of Meghalaya. Showing the collection sites and district boundaries.



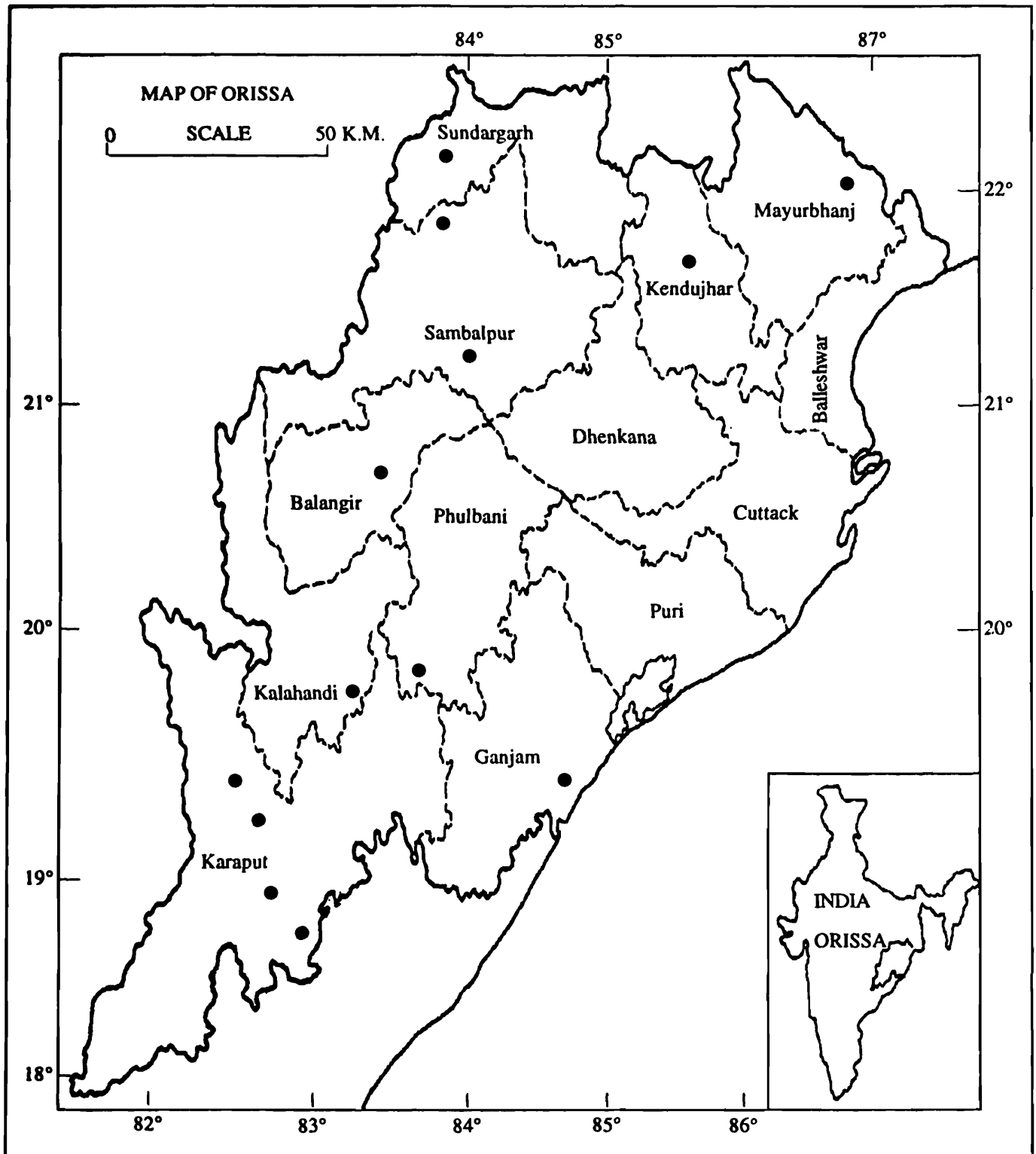
Map 6 : Map of Mizoram, showing the collection sites (●) in diff. districts.



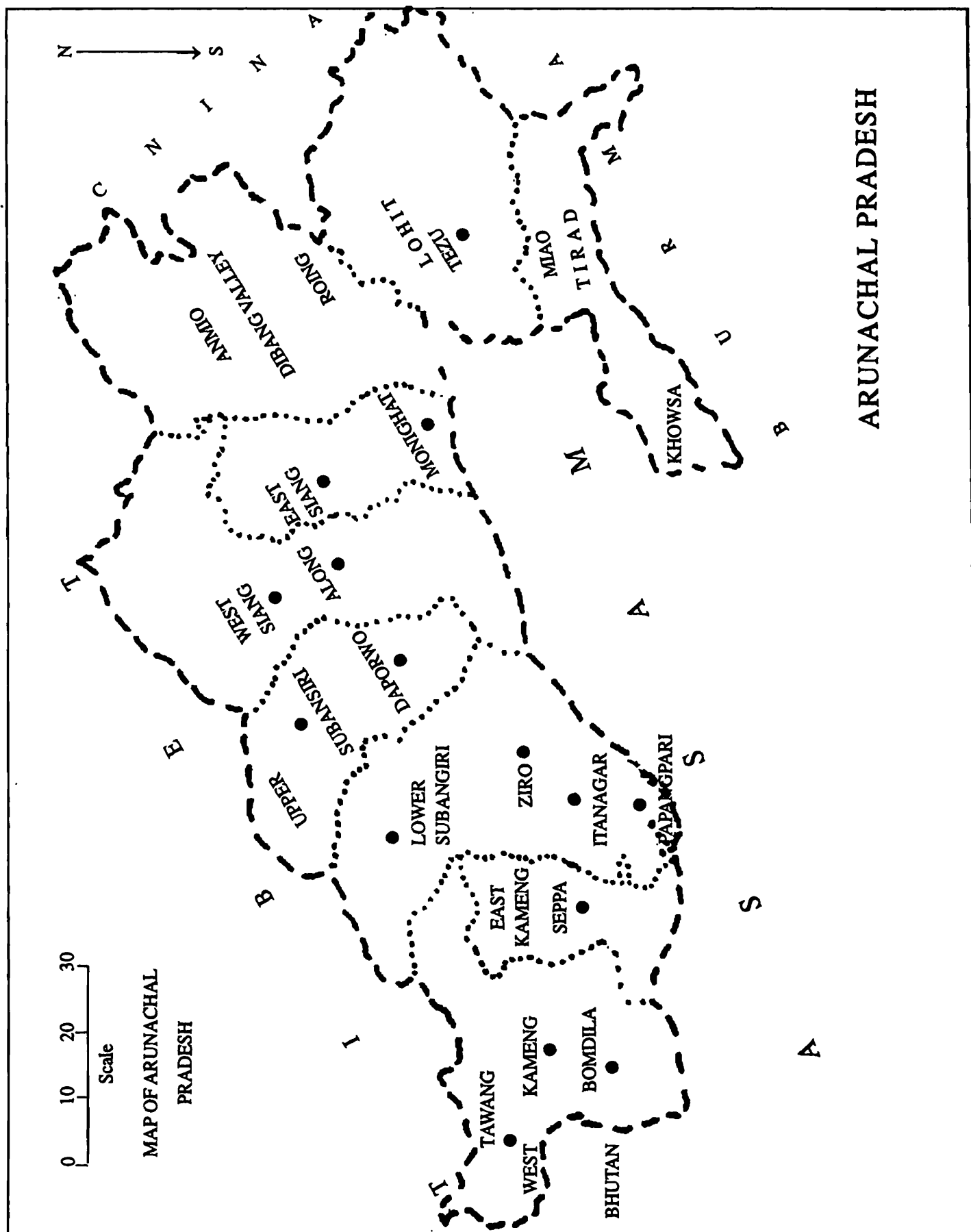
Map 7 : Map of Manipur. Showing the collection localities in different districts.



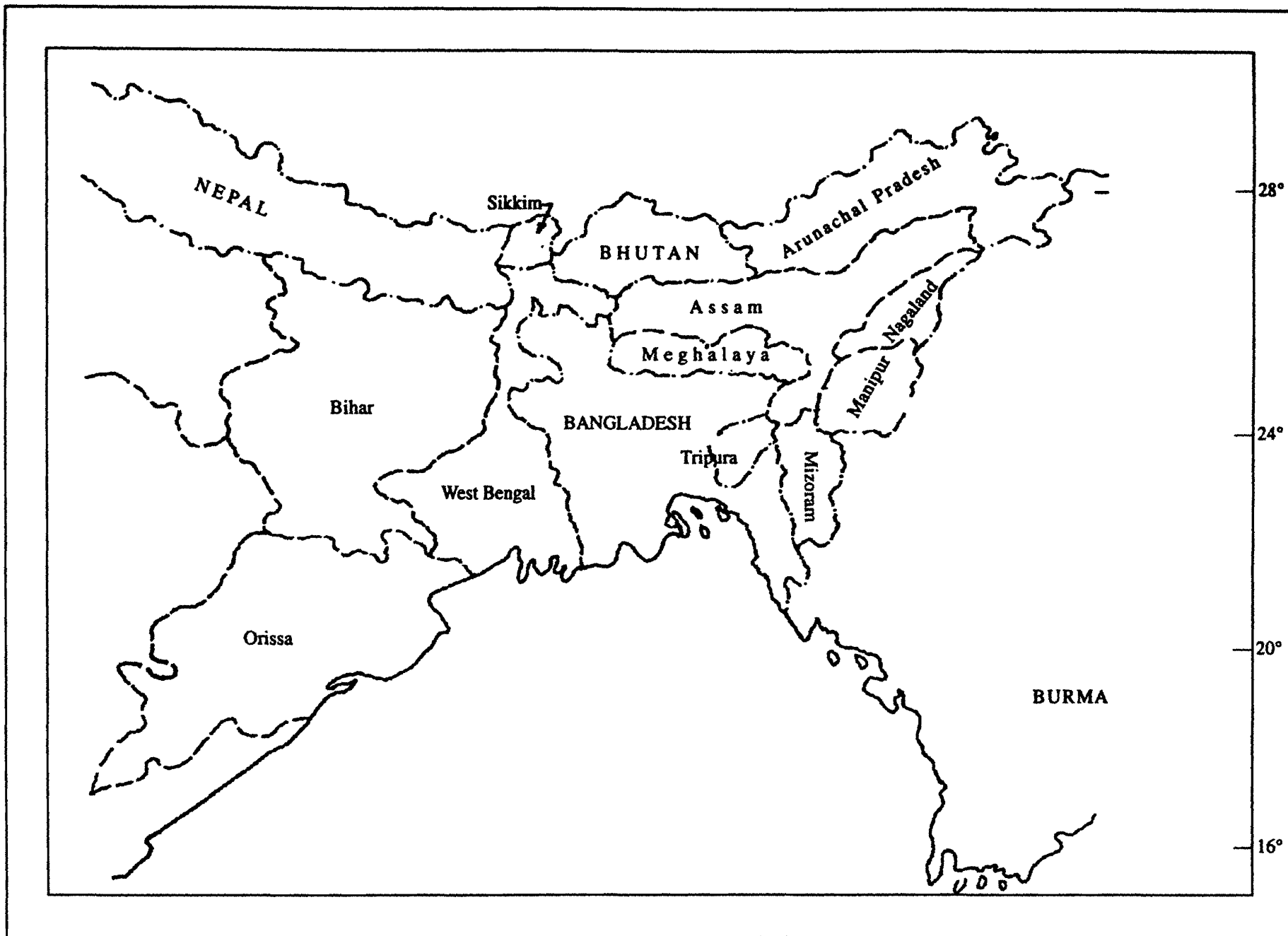
Map 8 : Map of Nagaland. Showing collection sites and district boundaries.



Map 9 : Showing collection sites in different districts of Orissa.



Map 10 : Showing Collection Sites (●) in different districts of Arunachal Pradesh.



Map 11 : Map Showing States of East & North East India.

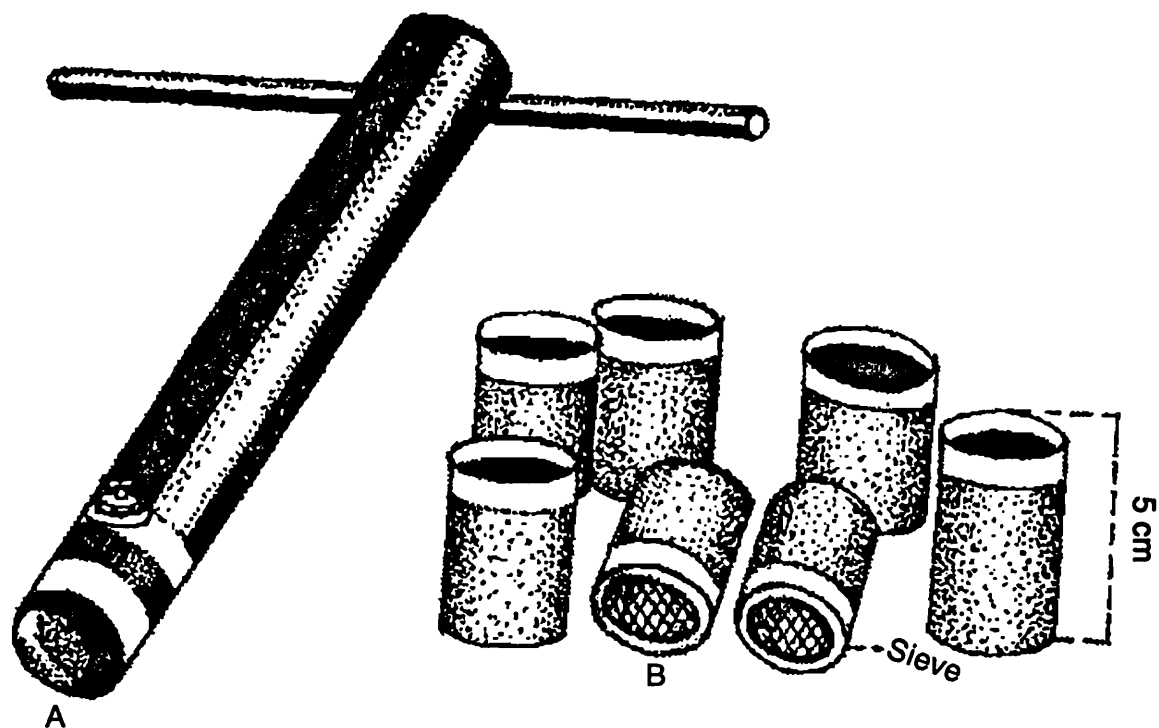


Fig. 1 : Stainless steel soil sampler. A. sample holder B. Stainless steel corer.

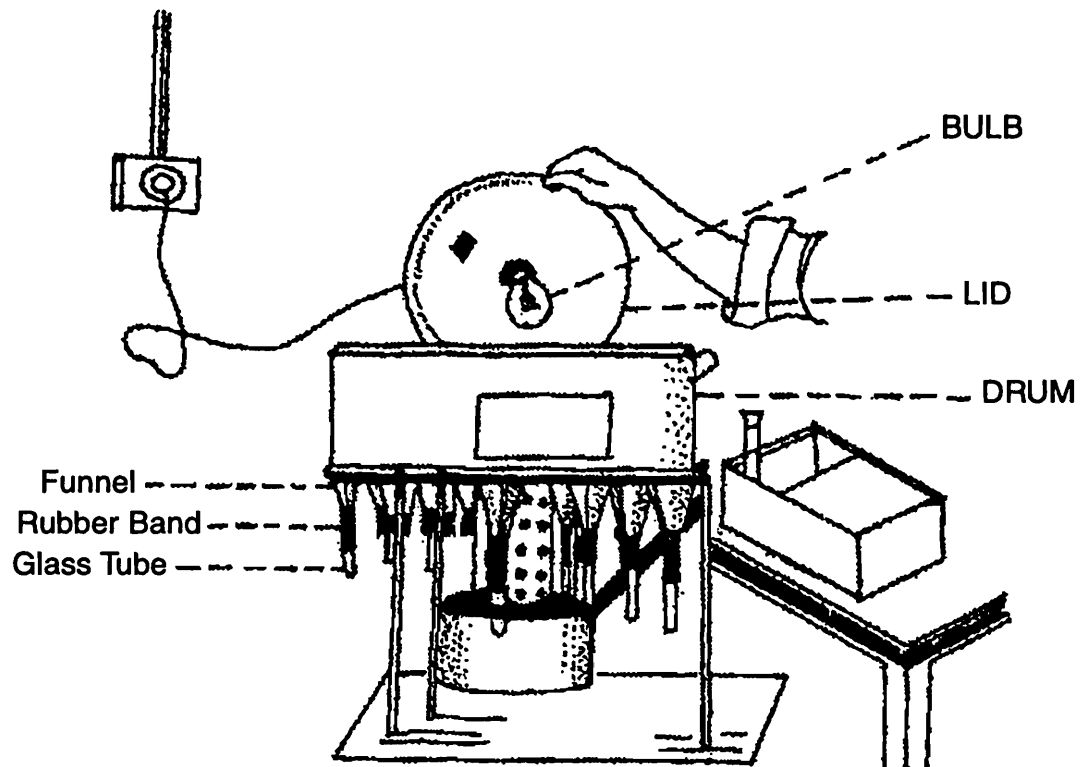


Fig. 2 : Soil sample extraction apparatus (modified).

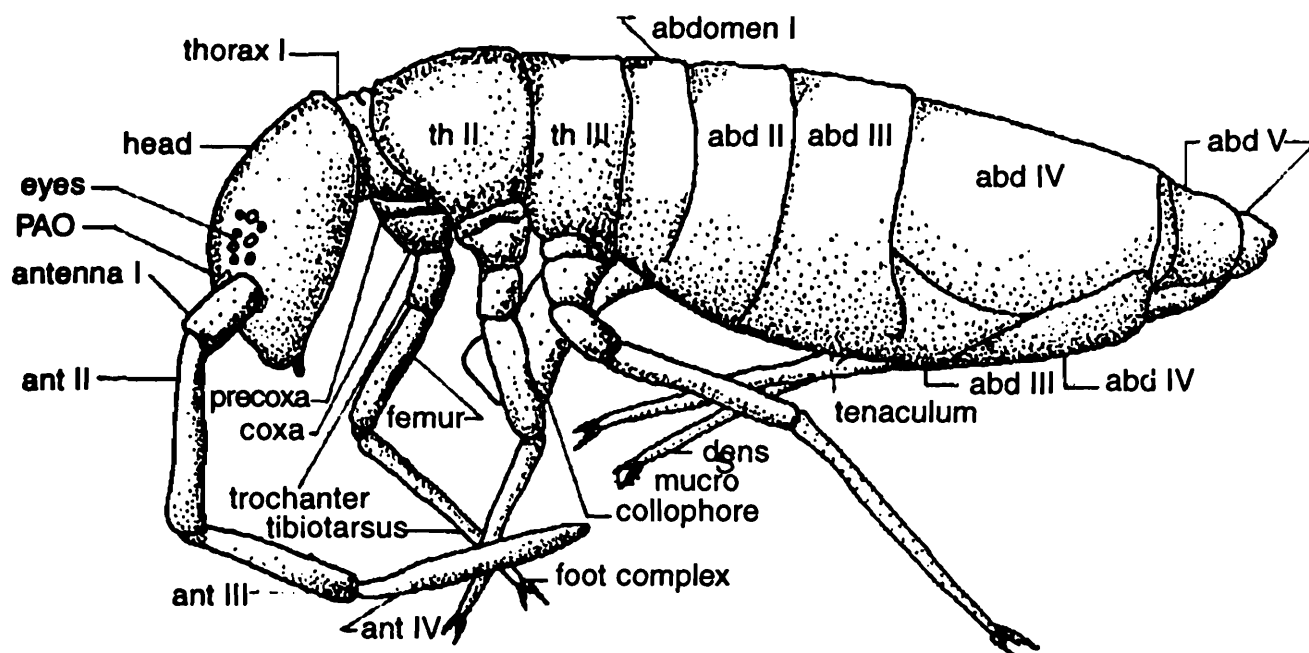


Fig. 3 : Showing schematic diagram of a typical Arthropleonid Collembola.

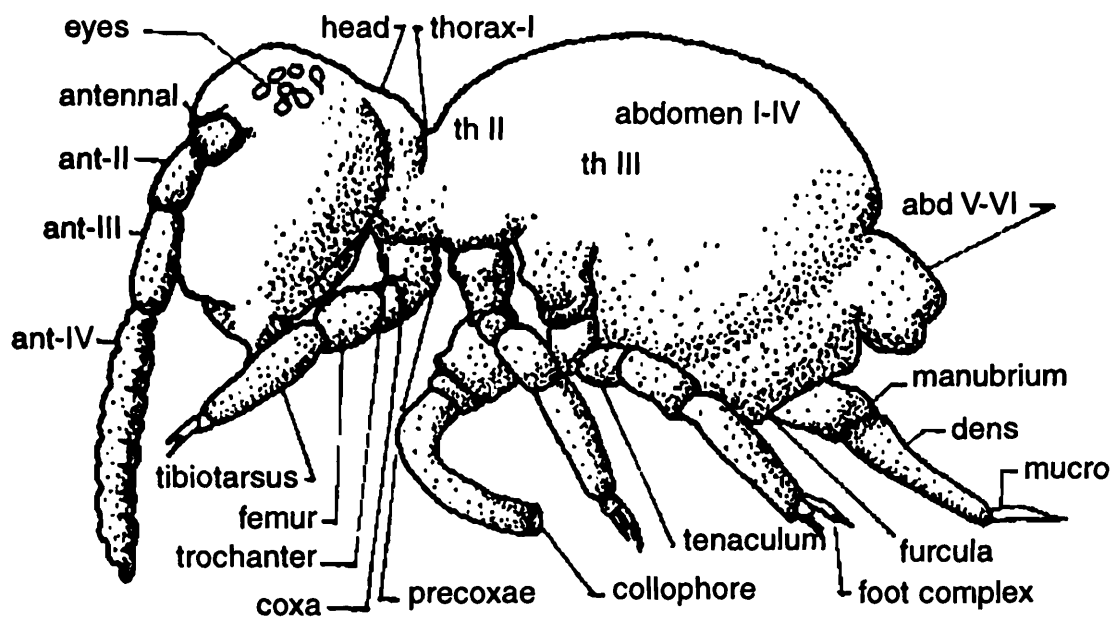


Fig. 4 : Showing schematic diagram of a typical Symphypleonid Collembola.

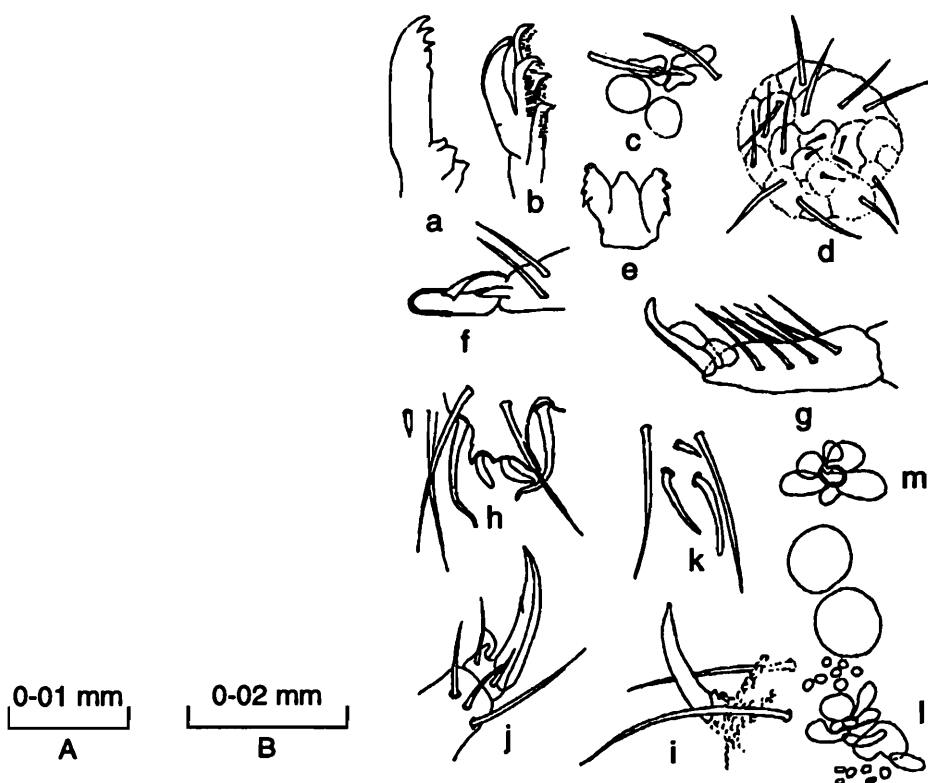


Fig. 5 : a-m : *Ceratophysella indovaria* : (a) Mandible, (b) Maxilla, (c) Anterior Ocelli & PAO showing two associated setae, (d) Male genital plate, (e) Tenaculum, (f) Mucro, (g) Mucro & Dens, (h) Sense organ Ant. III, (i) Anal spine, (j) Foot, (k) Sense rods, (l) PAO, (m) Another PAO. Fig. e, f, g, i, scale A; Fig. a, b, c, d, h, j, k, l, Scale B.

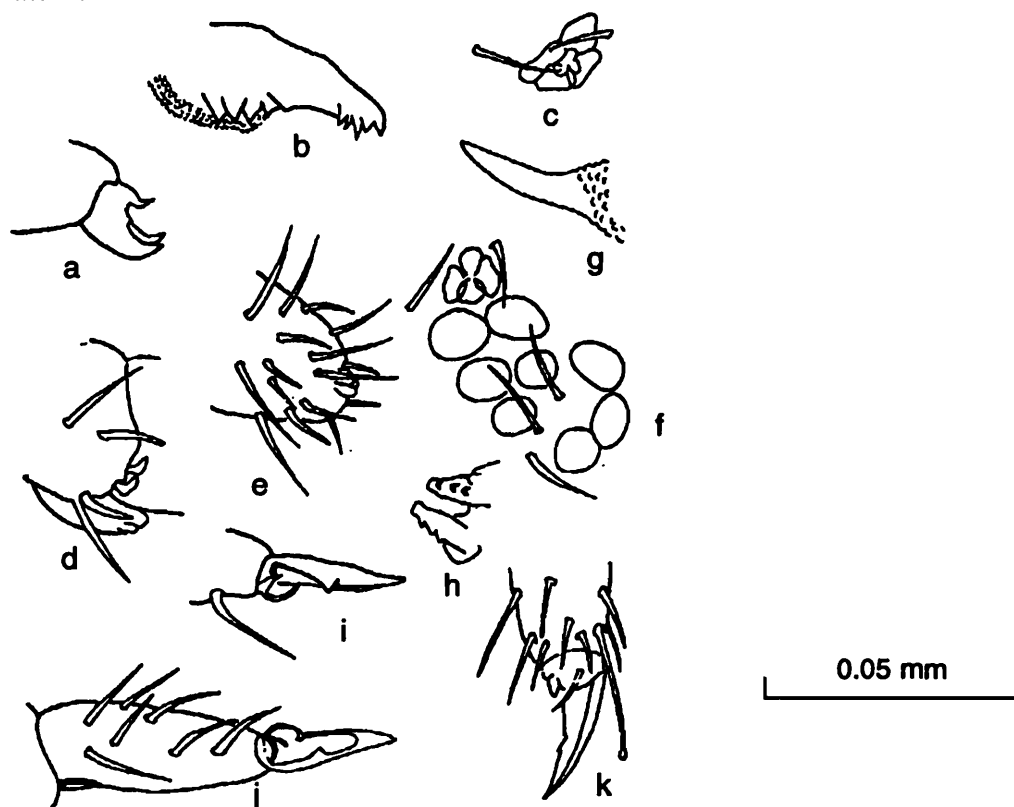


Fig. 6 : a-k. *Ceratophysella indica* : (a) Maxilla, (b) Mandible, (c) PAO, (d) Sense organ of Ant. III & Sensory sac, (e) Apex ant. IV., (f) Ocelli and post antennal organ, (g) Anal spine, (h) rami of tenaculum, (i) Mucro and Dens, (j) Dens & mucro from latero-posterior side, (k) Hind foot.

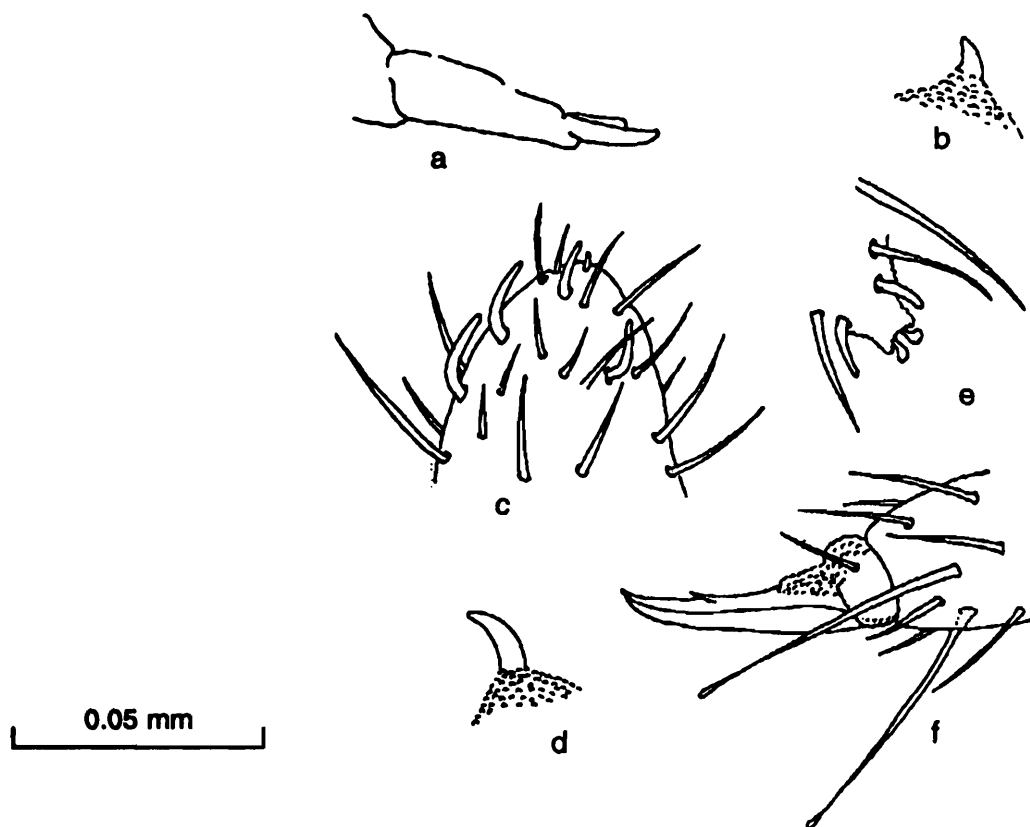


Fig. 7 : a-f. *Xenylla obscura* : (a) Mucro and Dens, (b) Anal spine, (c) Apex ant. IV, (d) Anal spine, (e) Sense organ of Ant. III, (f) Hind foot.

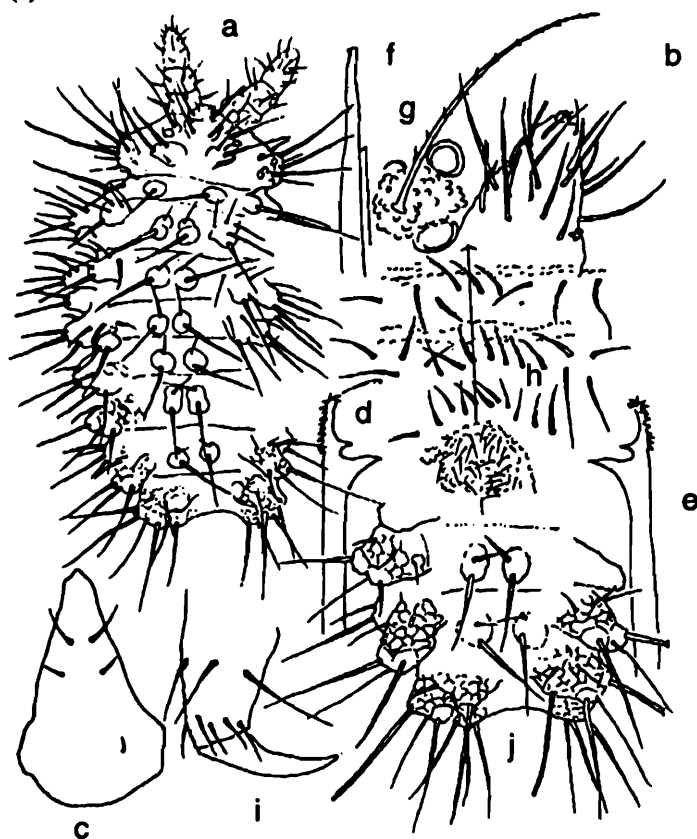


Fig. 8 : a-j. *Neanura sikkemensis* : (a) Dorsal view, (b) Antennal end, (c) Labrum, d, (e) Mandible, (f) Maxilla, (g) Eye, (h) Male genital orifice and ventral setae, (i) Fore claw, (j) Abdominal end.

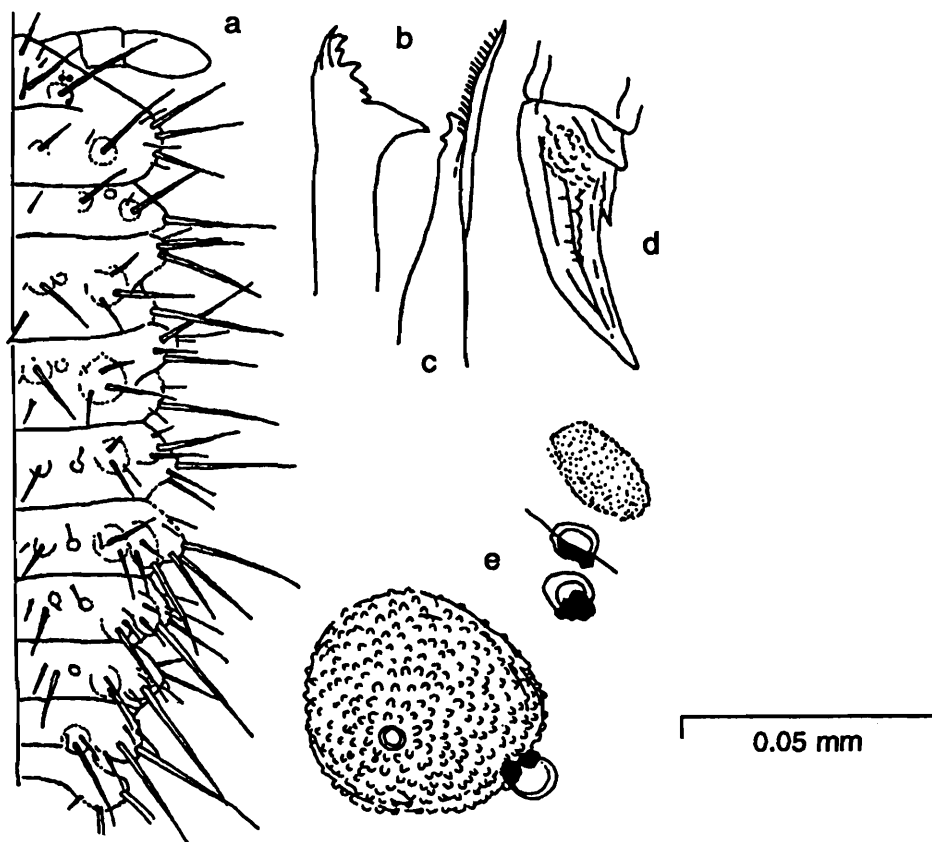


Fig. 9 : a-e. *Lobella kraepelini* : (a) Habitus, (b) Mandible, (c) Maxilla, (d) Middle claw, (e) Eyes and post antennal field.

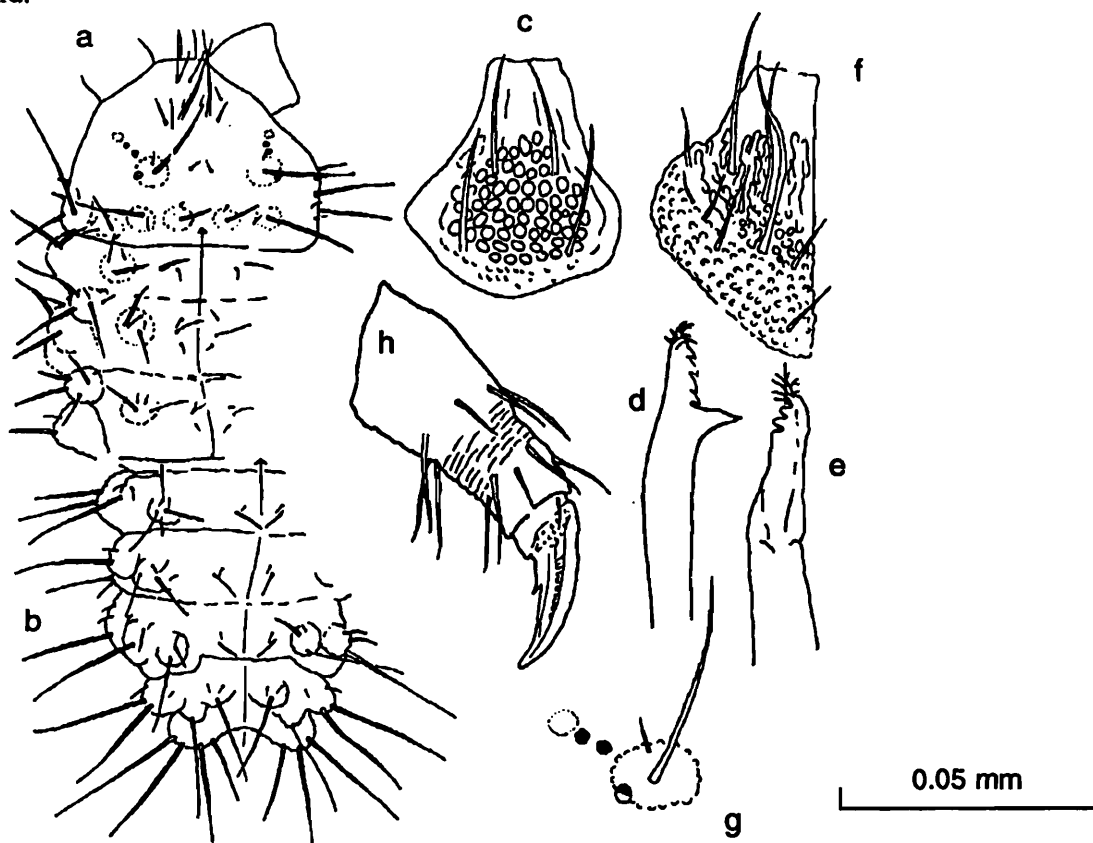


Fig. 10 : a-h. *Lobella* (s.str) *assamensis* : (a, b) Dorsal view (ant. and post part), (c) Labrum, (d) Mandible, (e) Maxilla, (f) Labium, (g) Eyes and postantennal field, (h) Hind claw.

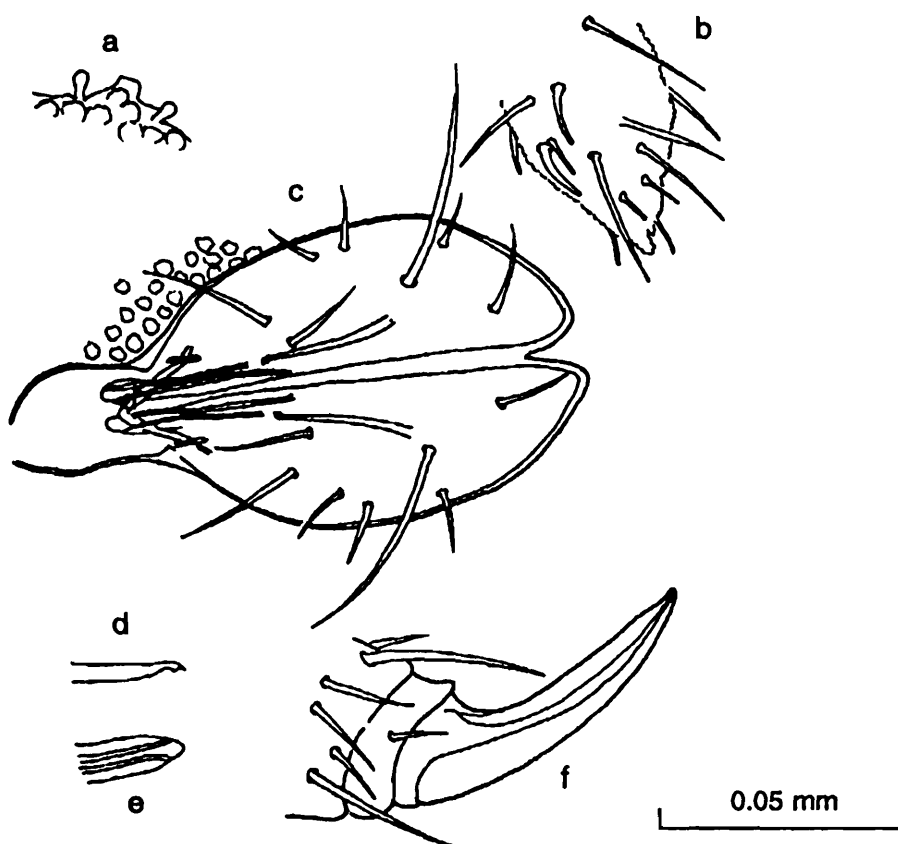


Fig. 11 : a-f. *Pronura indiana* : (a) Sense organ of Ant. III, (b) Apex of ant. IV, (c) Mouth parts, (d) Mandible, (e) Maxilla, (f) Hind claw.

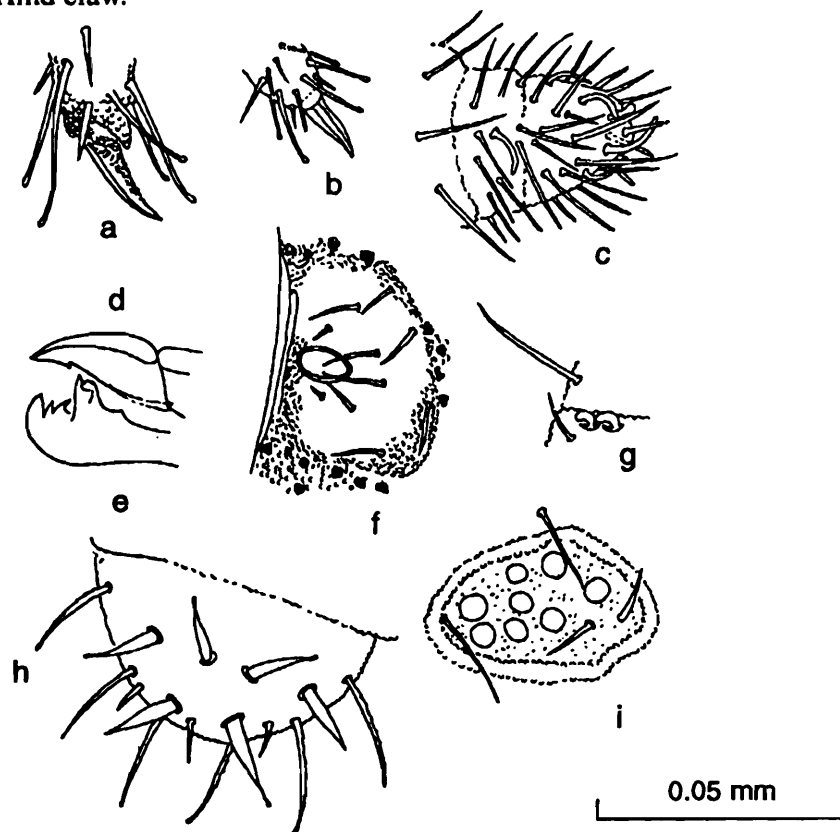


Fig. 12 : a-i. *Spinanurida mandibulata* : (a) Hind foot, (b) Hind foot showing tenent hairs, (c) Ant. II, III, IV, (d) Maxilla, (e) Mandible, (f) Genital aperture, (g) Sense organ of Ant. III, (h) Anal spines and setae, (i) Ocelli.

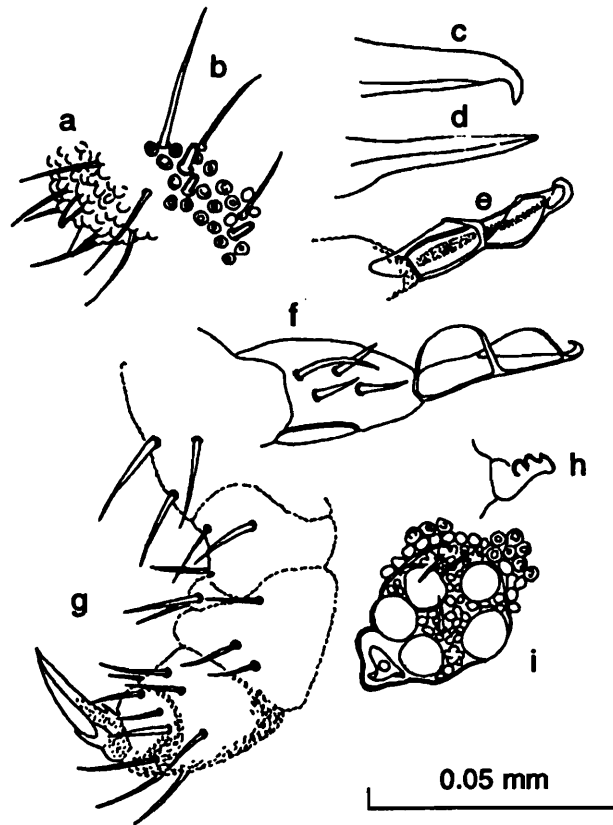


Fig. 13 : a-i. *Uchidanurida altitudina* : (a) Anal spines, (b) Sense organ of Ant. III, (c) Mandible, (d) Maxilla, (e) Mucro, (f) Mucro and Dens, (g) Hind leg and foot, (h) Tenaculum, (i) Ocelli and PAO.

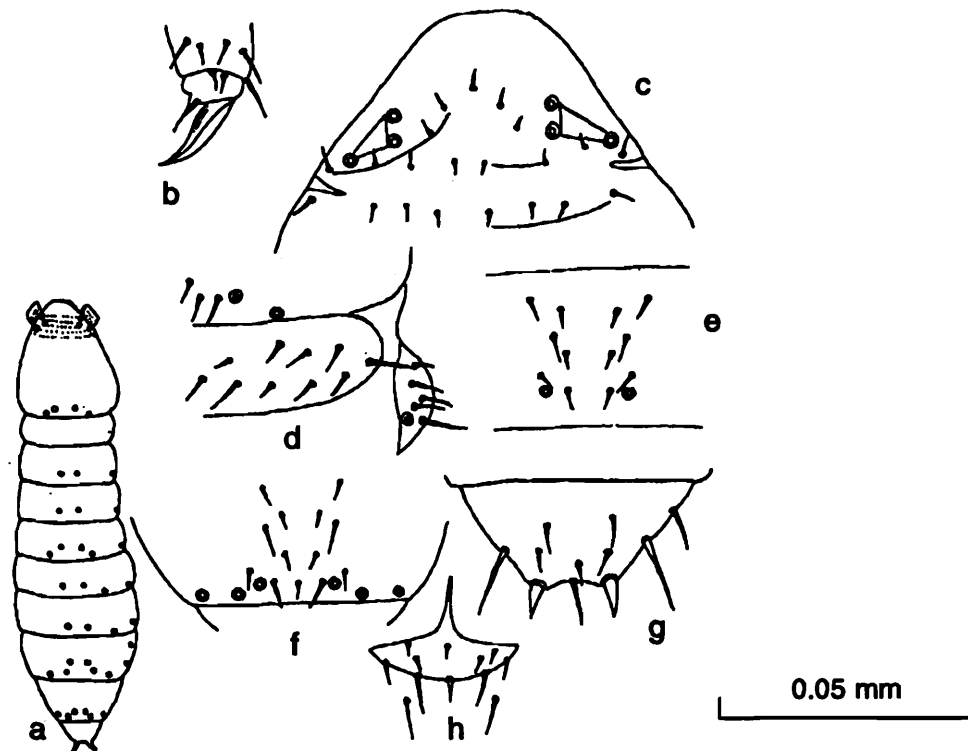


Fig. 14 : a-h. *Onychiurus indicus* : (a) Dorsal view, (b) Unguis & Unguiculus of foreleg, (c) Anterodorsal part of head, (d) Setal arrangement on right side of posterodorsal head, Th. I and Abdomen I., (e) Setal arrangement on dorsomedian part of Th. II, (f) Setal arrangement on lateral part of abdomen V., (g) Setal arrangement on tergite of Abd. VI., (h) Setae.

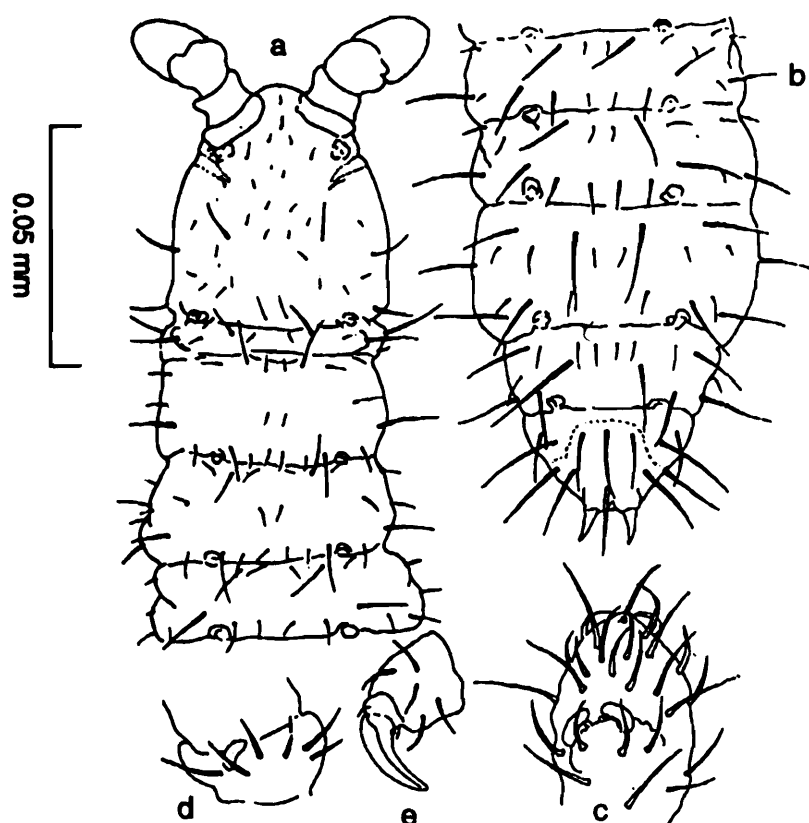


Fig. 15 : a-e. *Mesaphorura choudhuria* : (a, b) Chaetotaxy, (c) Antennae III & IV, (d) Ventral side of Antennae III, (e) Hind claw.

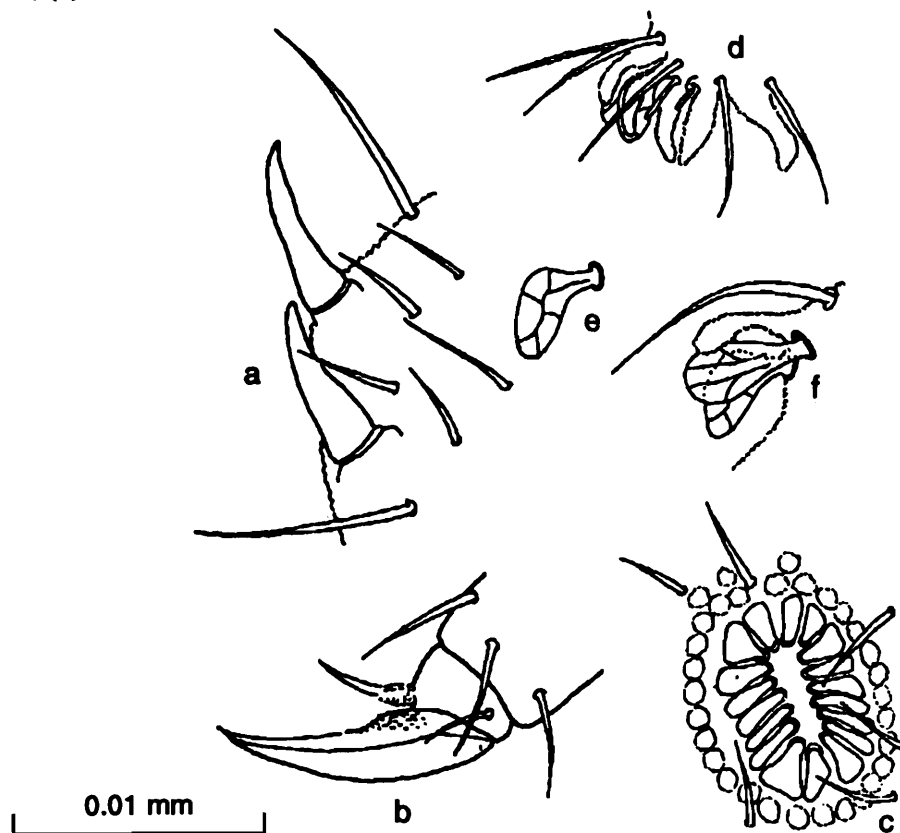


Fig. 16 : a-f. *Spelaphorura clayae* : (a) Anal spine, (b) Hind claw, (c) PAO, (d) Sense organ of Ant. III, (e) Sense club from sense organ of Ant. III, (f) Papilla and senseclubs from sense organ of ant. III.

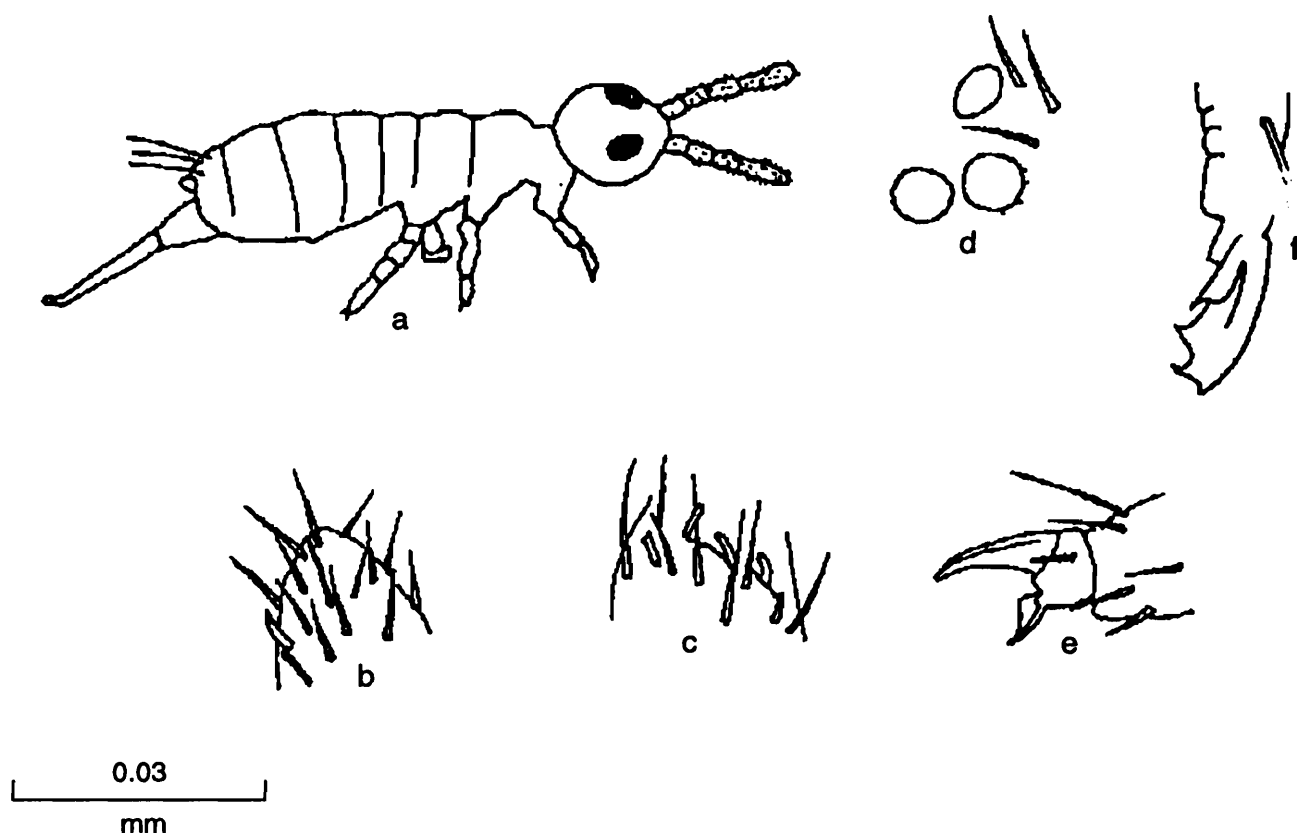


Fig. 17 : a-f. *Isotomurus balteatus* : (a) Habitus, (b) Apex of ant. IV, (c) Apex of ant. III, (d) Anterior ocelli and PAO, (e) Hind foot, (f) Mucro and tip of Dens.

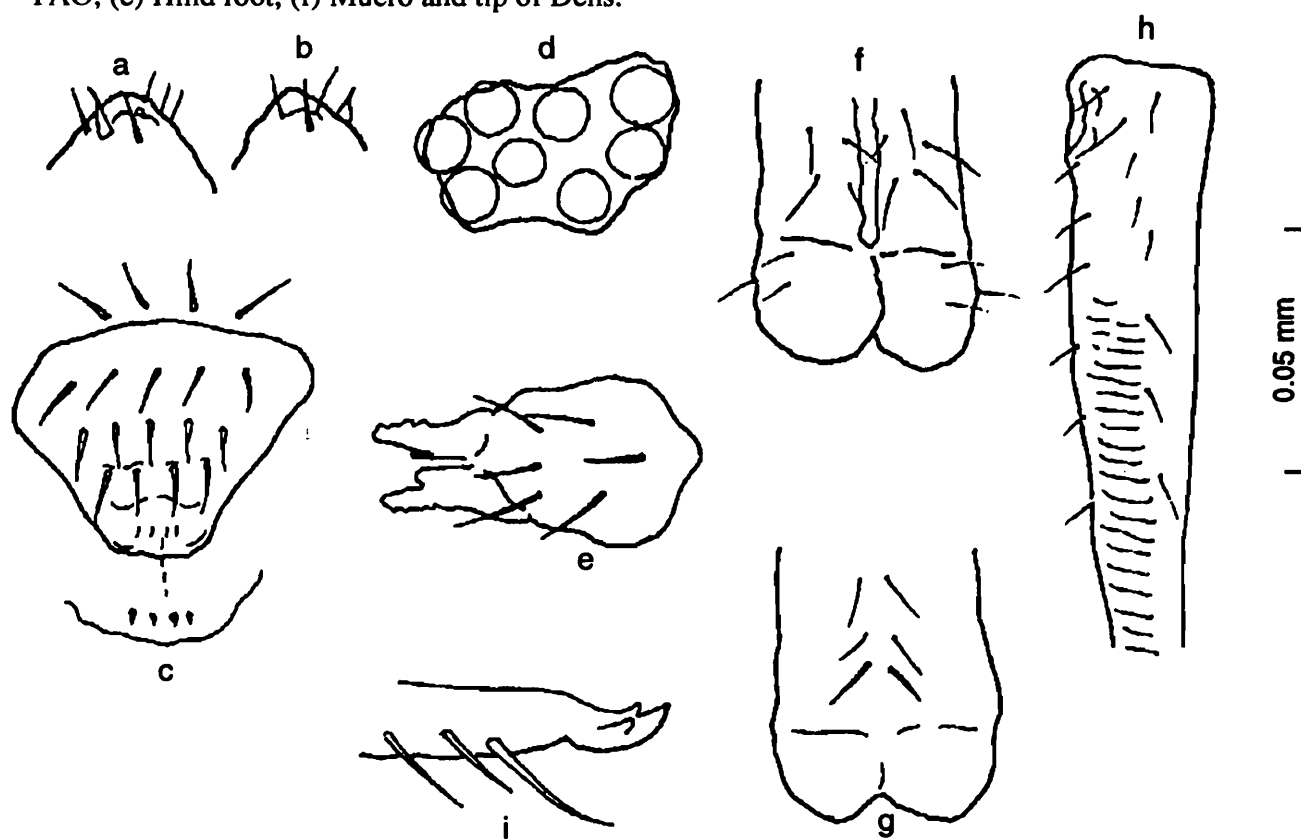


Fig. 18 : a-i. *Isotoma (Desoria) trispinata* : (a, b) Antennal end, (c) Labrum, (d) Eyes and PAO, (e) Tenaculum, (f, g) Ventral tube, (h) proximal part of dentes, (i) Mucro.

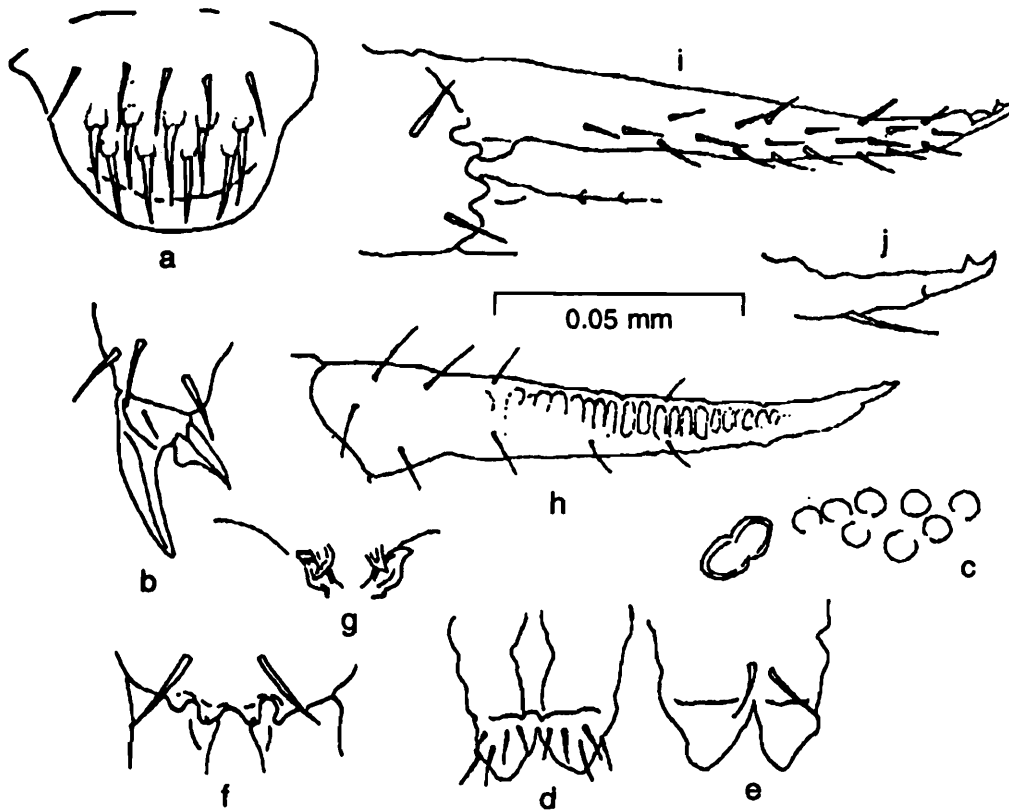


Fig. 19 : a-j. *Isotomina thermophila* : (a) Labrum, (b) Mid claw, (c) Eyes and PAO, (d) Ventral tube (anterior face), (e) Ventral tube (posterior face), (f) Terminal thickening of manubrium, (g) Hooks at the basis of manubrium, (h) Dentes in dorsal view, (i) Dentes in ventral view, (j) Mucro.

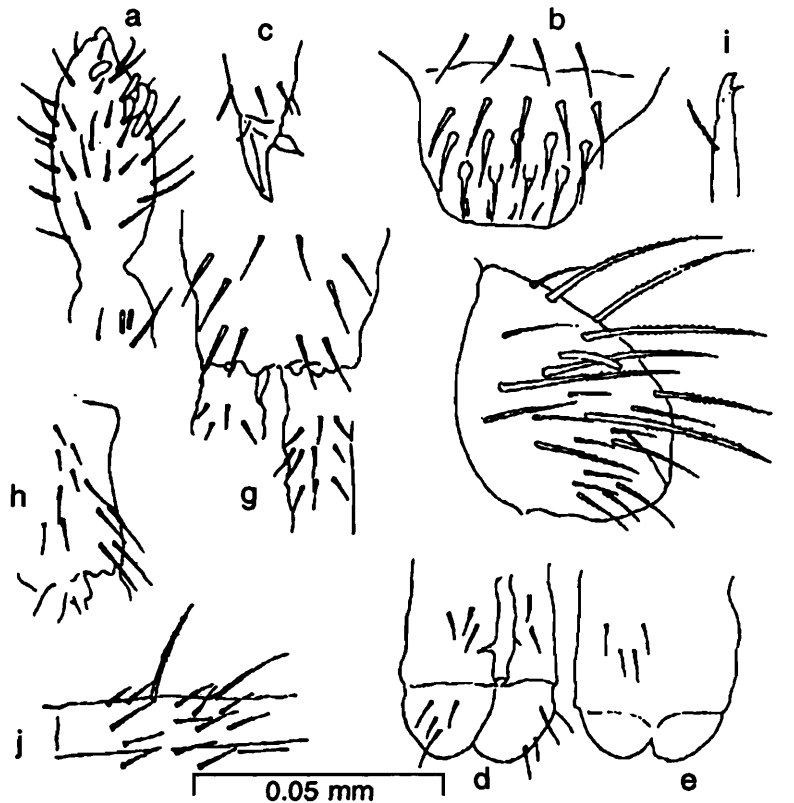


Fig. 20 : a-j. *Isotomiella minor* : (a) Ant. III & ant. IV, (b) Labrum, (c) Hind claw, (d, e) Ventral tube (anterior & posterior face), (f) Abd. V & VI. showing sensillate setae, (g, h) Manubrium, (i) Mucro, (j) Setae of Abd. III.

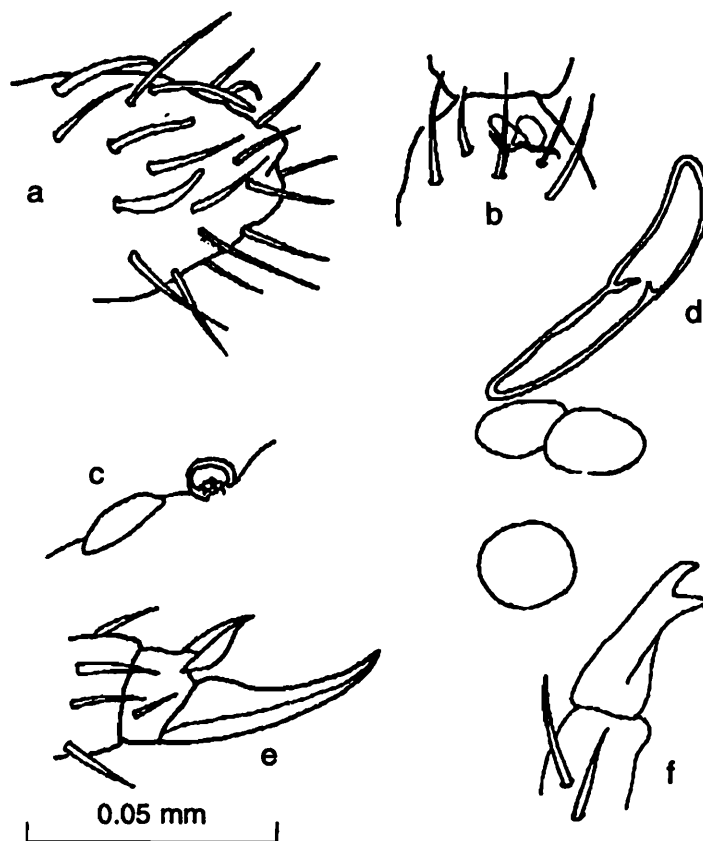


Fig. 21 : a-f. *Parafolsomia trioculata* : (a) Apex ant. IV, (b) Sense organ of Ant. III, (c) PAO and nearest eyes, (d) Ocelli and PAO, (e) Hind foot, (f) Mucro and apex of dens.

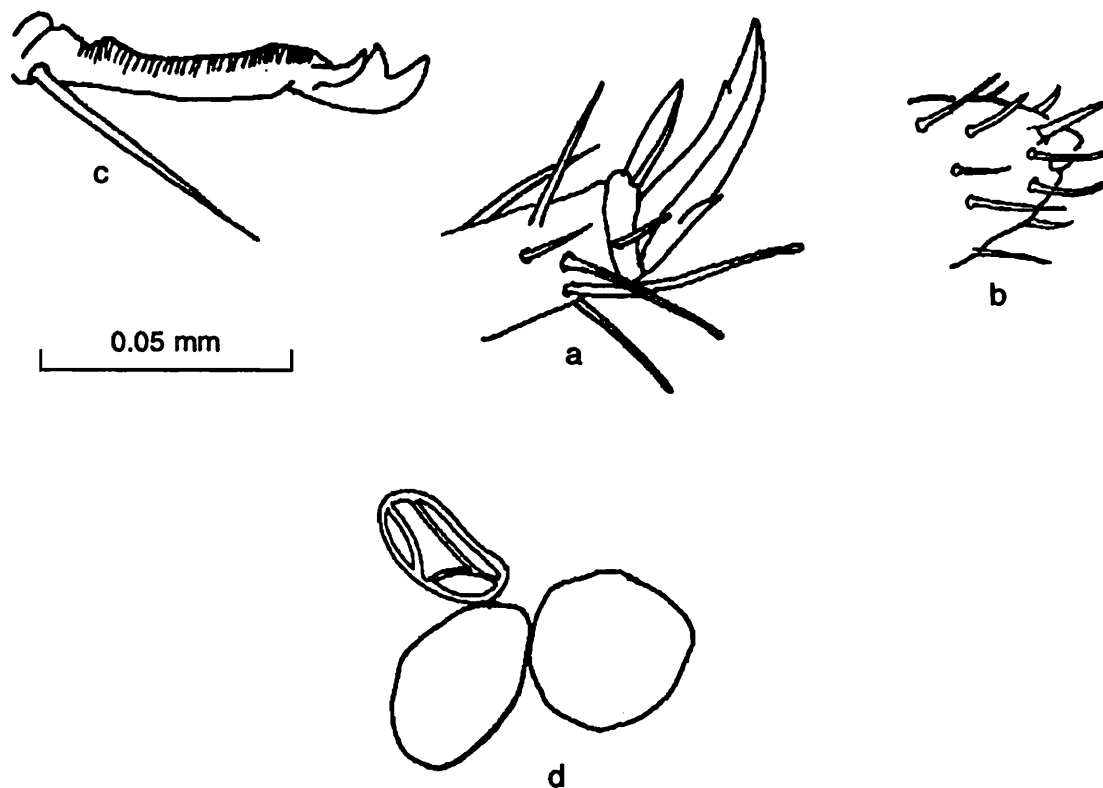


Fig. 22 : a-d. *Papillomurus transequatoria* : (a) Hind foot, (b) Apex of ant. IV, (c) Mucro and apex of dens, (d) Anterior ocelli and PAO.

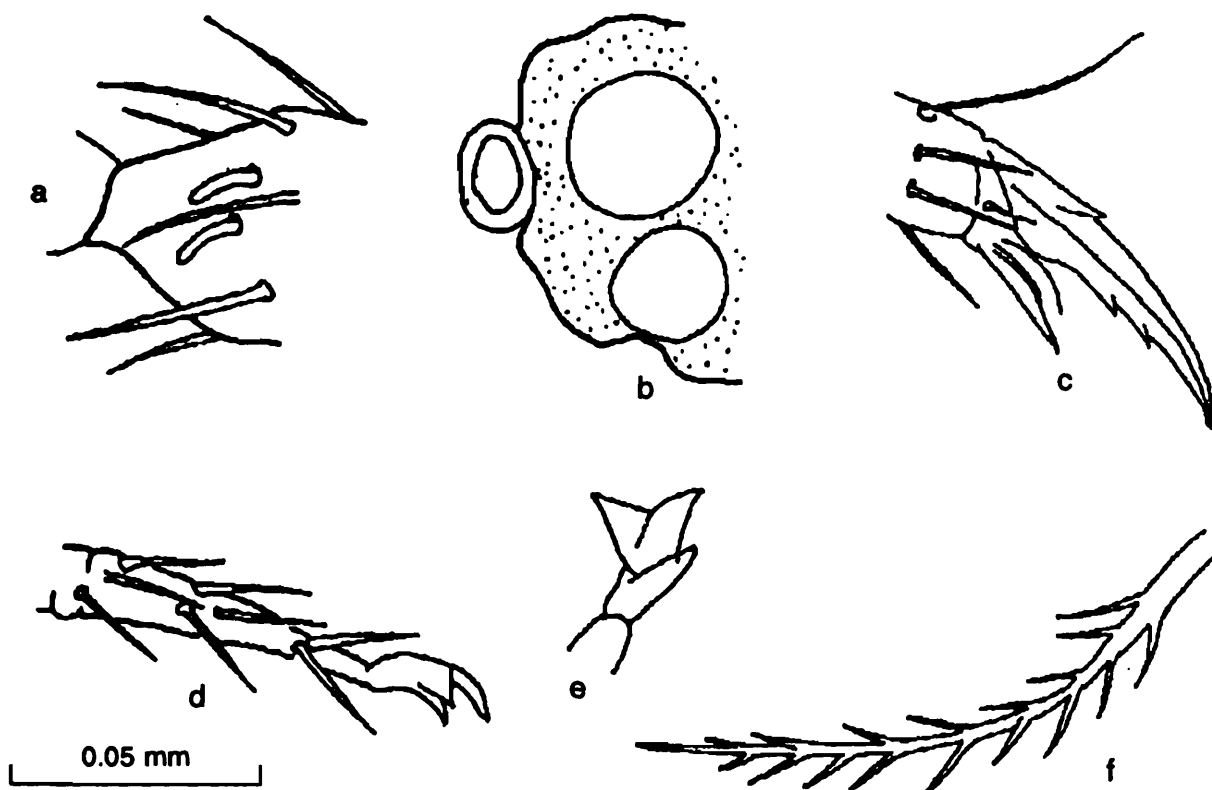


Fig. 23 : a-f. *Rhodanella plumosa* : (a) Sense organ of Ant. III, (b) Ocelli and PAO, (c) Hind foot, (d) Mucro and apex of dens, (e) Mucro from above, (f) Seta from body dorsum.

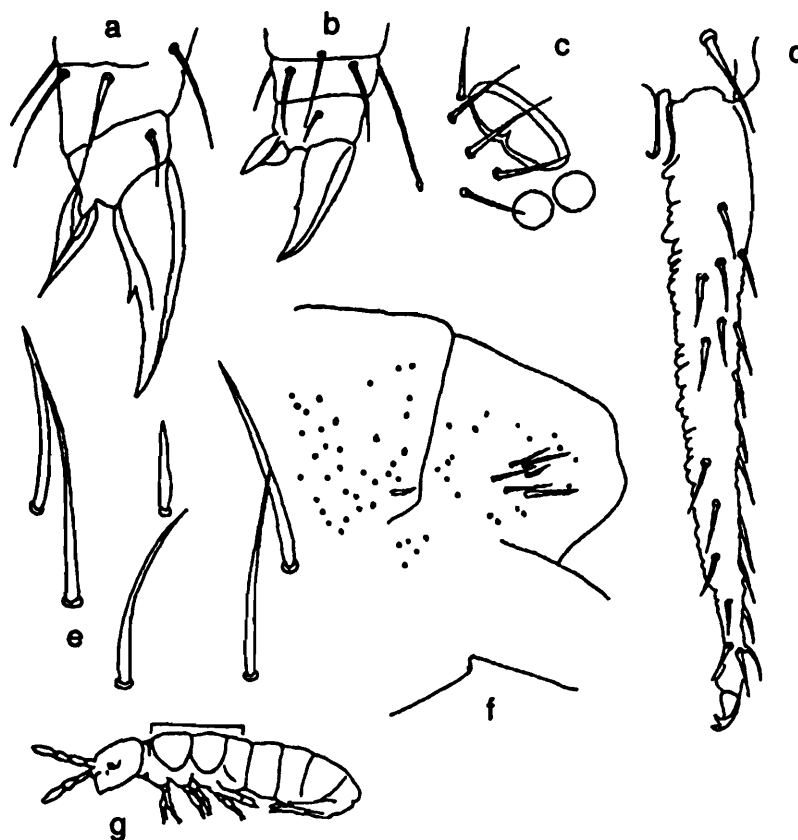


Fig. 24 : a-g. *Cryptopygus thermophilus* : (a) Hind foot complex, (b) Hind foot complex, (c) PAO and nearest eyes, (d) Dens and mucro, (e) Sensory and neighbouring normal setae, (f) IV, and fused V & VI abdominal segments, (g) Habitus.

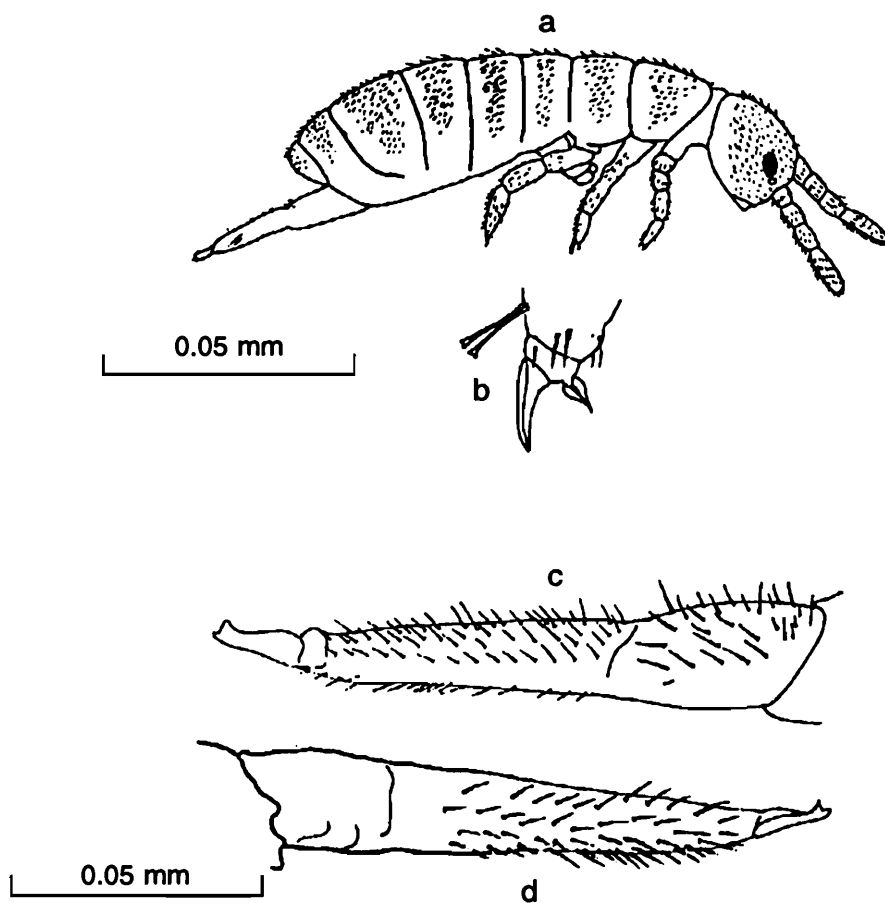


Fig. 25 : a-d. *Ballistrura bengalensis* : (a) Habitus, (b) Hind foot, (c) Dens and mucro in dorsal view, (d) Dens and mucro in ventral view.

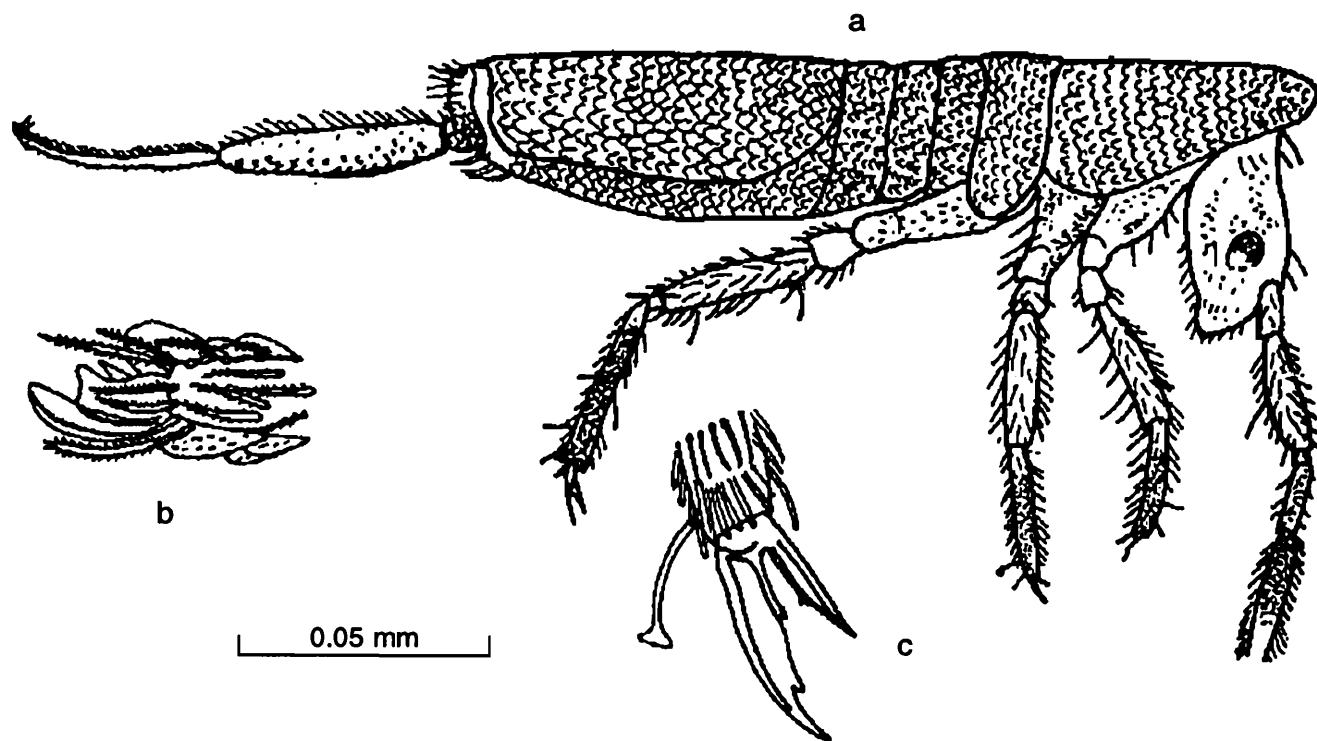


Fig. 26 : a-c. *Lepidocyrtus magnificus* : (a) Habitus, (b) Hind foot complex, (c) Mucro and apex of dens.



Fig. 27 : a-j. *Lepidocyrtus medius* : (a) Habitus, (b) Hind claw, (c) Middle claw, (d) Accessory scales of setae of Abd. IV, (e) Trochanteral organ, (f) Ventral view of the dental end of manubrium, (g) Dorsal view of the dental end of manubrium, (h) Mucro, (i, j) Ventral tube (anterior & posterior face).

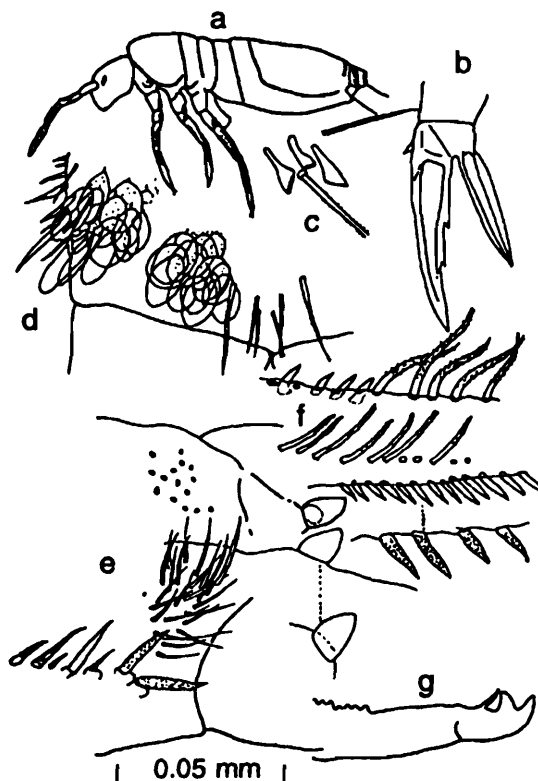


Fig. 28 : a-g. *Lepidocyrtus (Acrocyrtus) malayanus* : (a) Habitus, (b) Hind claw, (c) Accessory scales of setae of Abd. IV, (d) Dorsal view dental end of manubrium, (e) Ventral view of the dental end of manubrium, (f) Lateral view of the middle of the dentes, (g) Mucro.

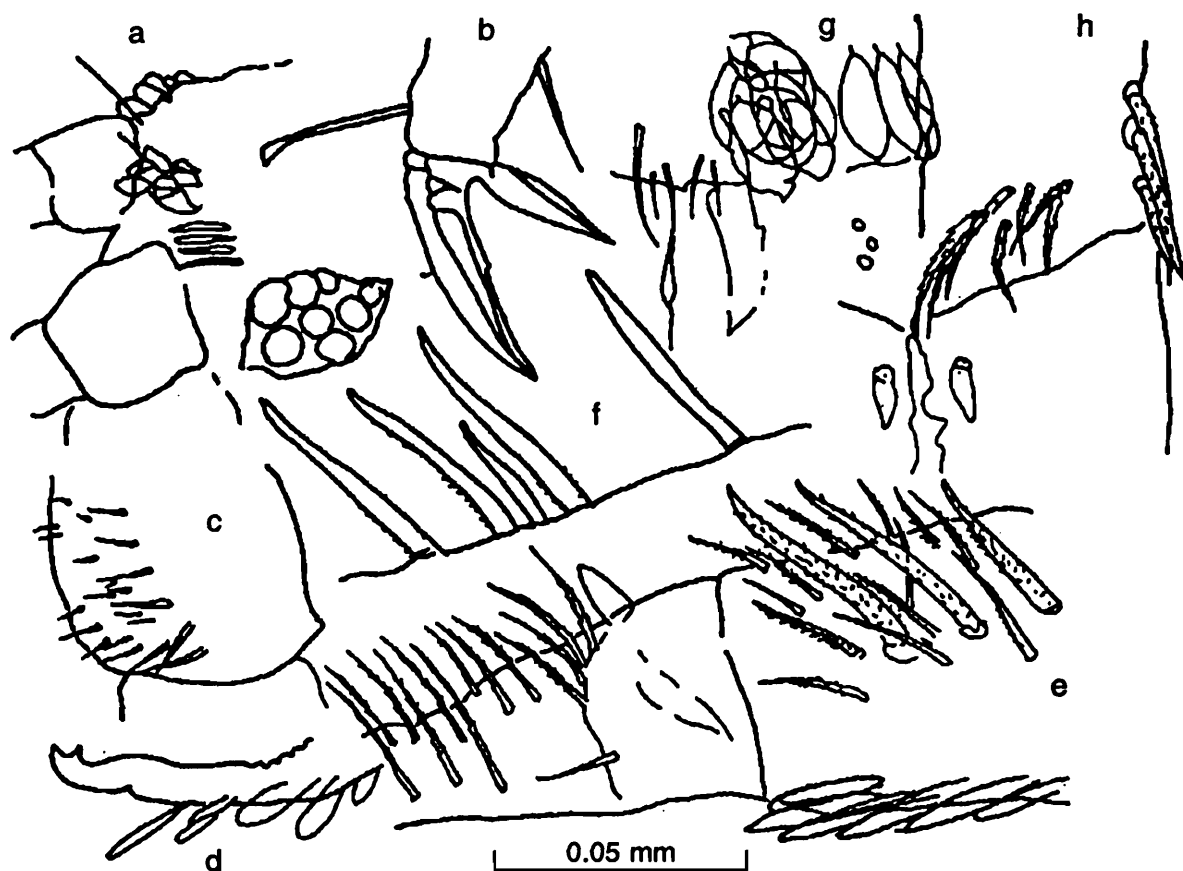


Fig. 29 : a-h. *Lepidocyrtus (Acrocyrtus) heterolepis* : (a) Anterior part of the head, showing specialized scales, eyes and antennal bases, (b) Hind claw, (c) Trochanteral organ, (d) Mucro, (e) Outer lateral view of the dentes and manubrium, (f) Ciliated setae along the lateral row of the manubrium, (g) Ventral view of the dental end of manubrium, (h) Dorsal view dental end of manubrium.

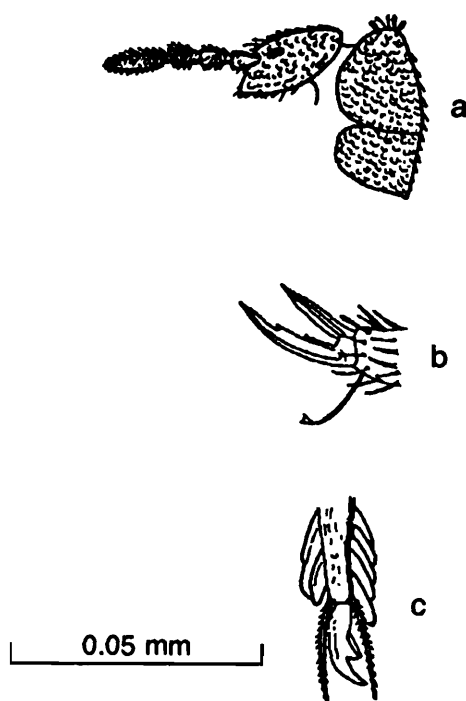


Fig. 30 : a-c. *Lepidocyrtus exploratorius* : (a) Side view of head and thorax, (b) Hind foot complex, (c) Mucro and apex of dens.

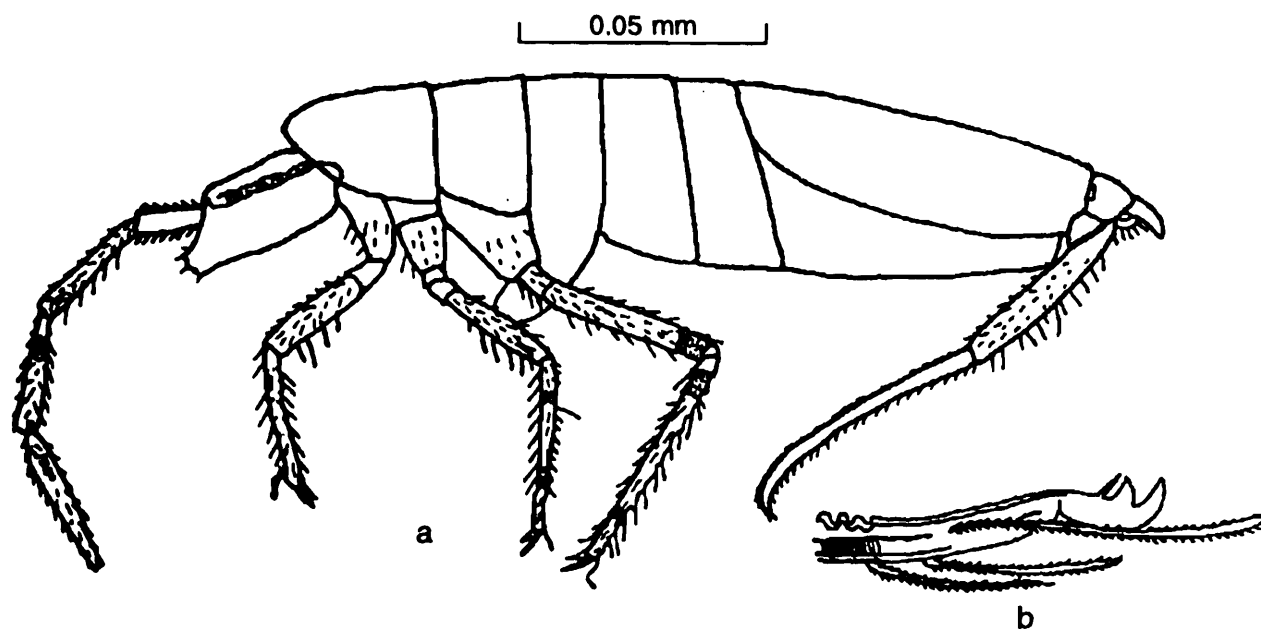


Fig. 31 : a-b. *Lepidocyrtus caudatus* : (a) Habitus, (b) Mucro and Dens.

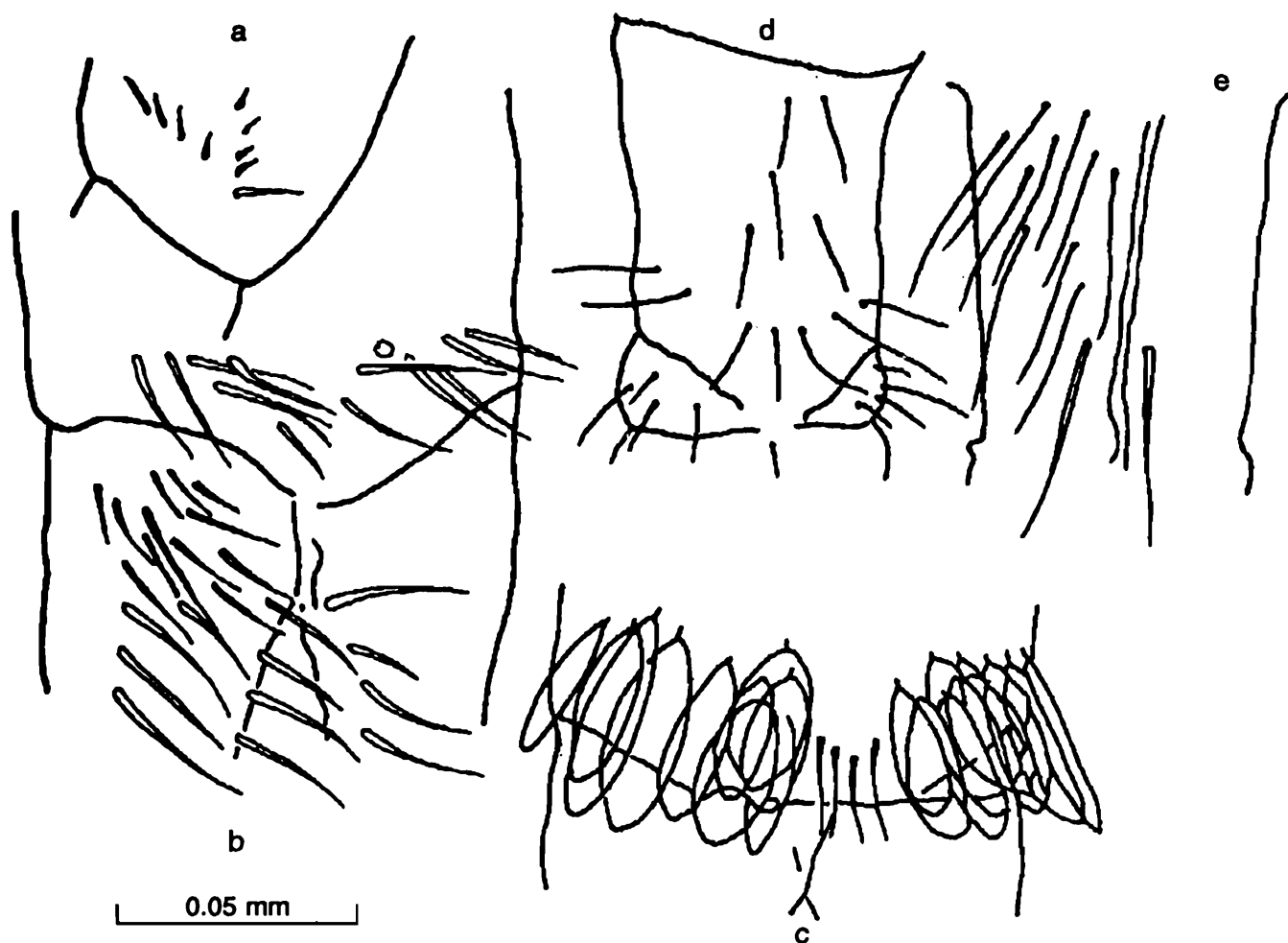


Fig. 32 : a-e. *Lepidocyrtus cyaneus* : (a) Trochanteral organ, (b) Dorsal view dental end of manubrium, (c) Ventral view of the dental end of manubrium, (d, e) Ventral tube (anterior and posterior face).

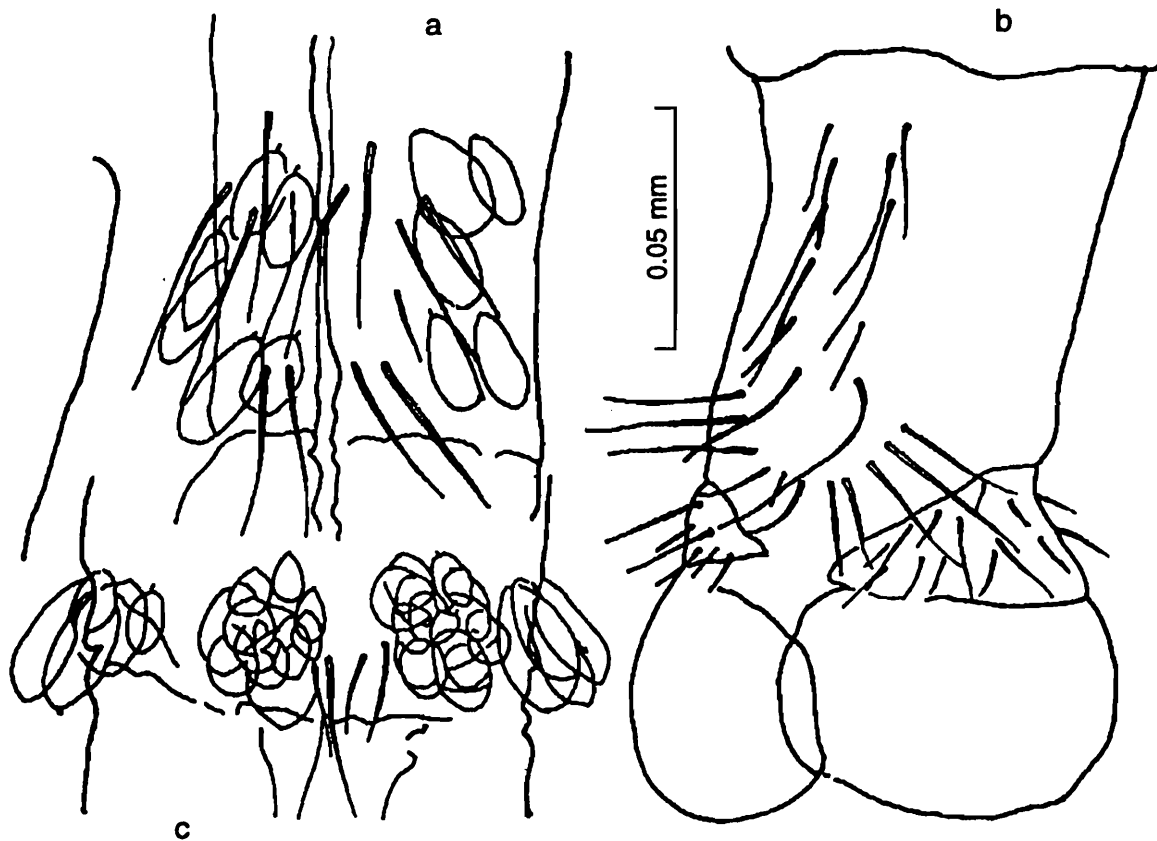


Fig. 33 : a-c. *Lepidocyrtus curvicollis* : (a, b) Ventral tube (anterior and posterior face), (c) dental end of manubrium.

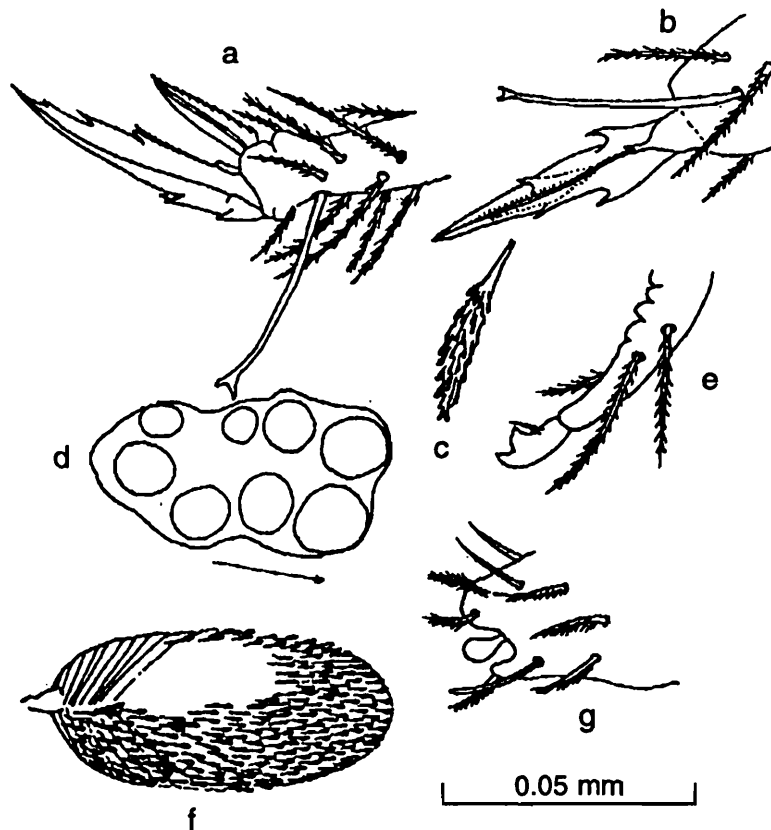


Fig. 34 : a-g. *Lepidosira unguiserrata* : (a) Hind foot, (b) Hind foot from the posterior face, (c) Scale from dens, (d) Ocelli, (e) Mucro and apex of dens, (f) Body scale, (g) Apex of ant. IV.

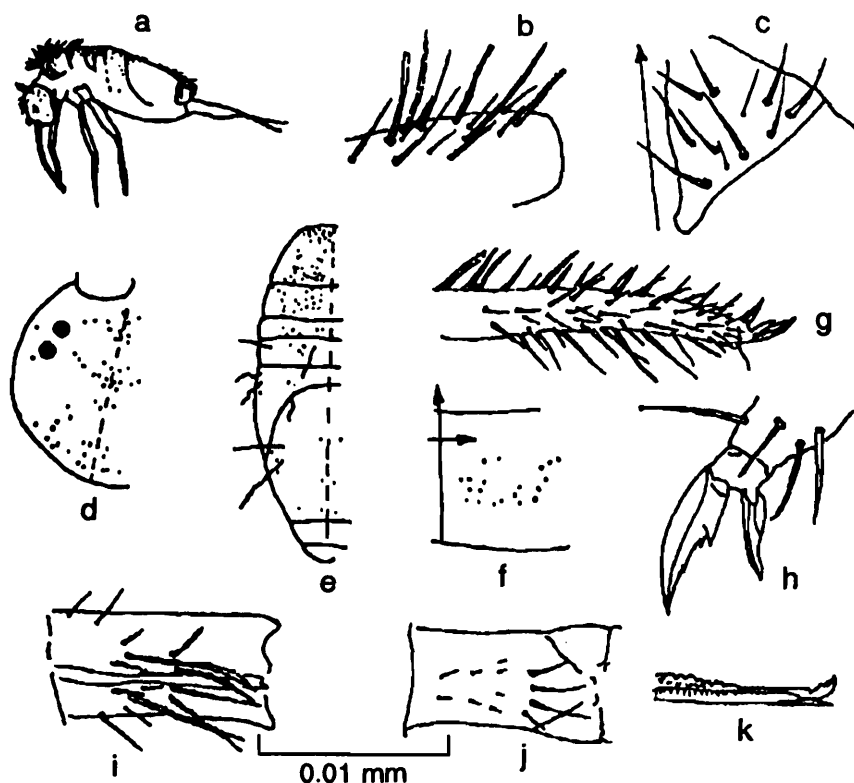


Fig. 35 : a-k. *Sinella curviseta* : (a) Habitus, (b) Apex of Ant. II, (c) Left labial triangle, (d) Cephalic macrochaetae, (e) macrochaetae of body dorsum, (f) macrochaetae of third thoracic segment, (g) Hind tibiotarsus and foot, (h) Hind foot complex, (i) Ventral tube (anterior face), (j) Ventral tube (posterior face), (k) Mucro and apex of dens.

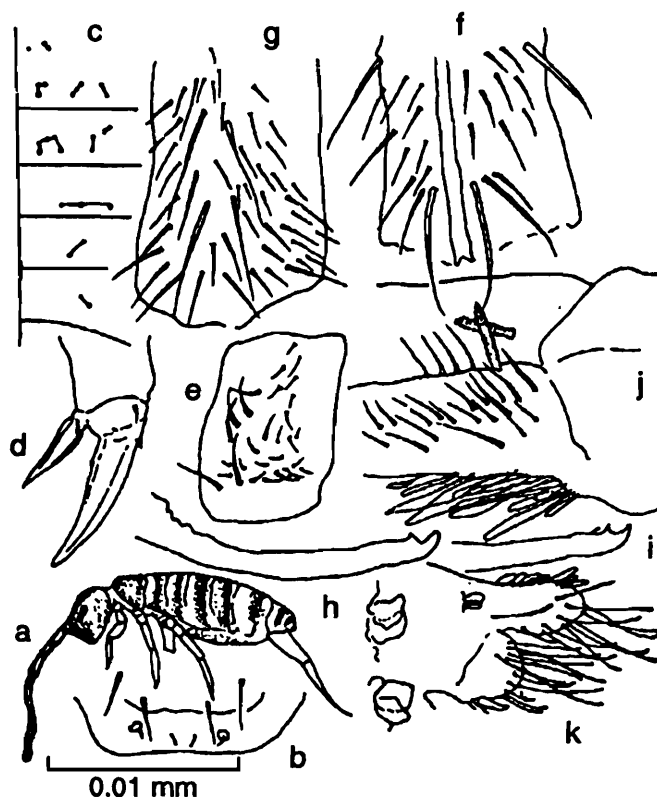


Fig. 36 : a-k. *Dicranocentrus indicus* : (a) Habitus, (b) Labral margin, (c) Chaetal arrangement of body, (d) Fore claw, (e) Trochanteral organ, (f) Ventral tube (anterior face), (g) Ventral tube (posterior face), (h, i) Two different types of mucro, (j) Dental basis of in dorso-lateral view, (k) Vesicles and abd. V, VI.

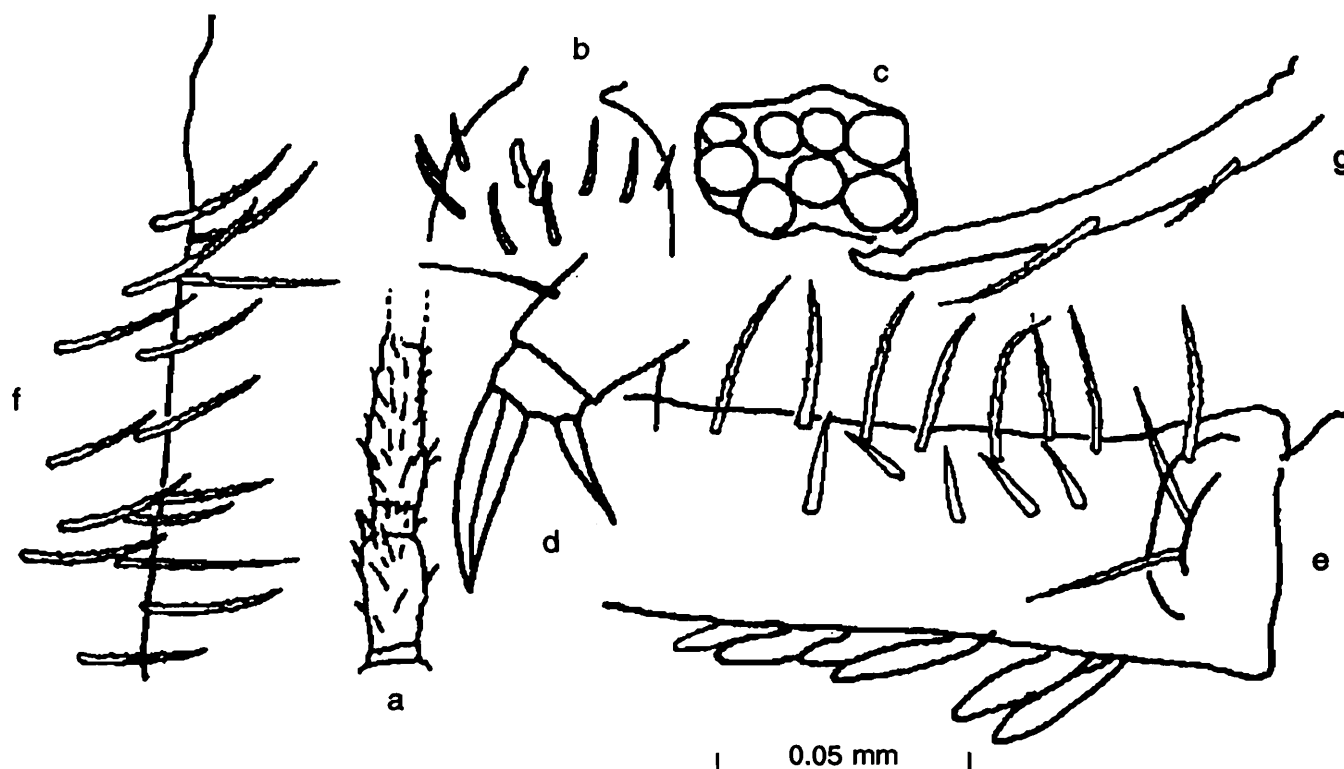


Fig. 37 : a-g. *Dicranocentrus simplex* : (a) Antennal segments, (b) Ant. III-organ, (c) Eyes, (d) Middle claw, (e) Dental spines, (f) Feathered setae of manubrium, (g) Mucronal end of furcula.

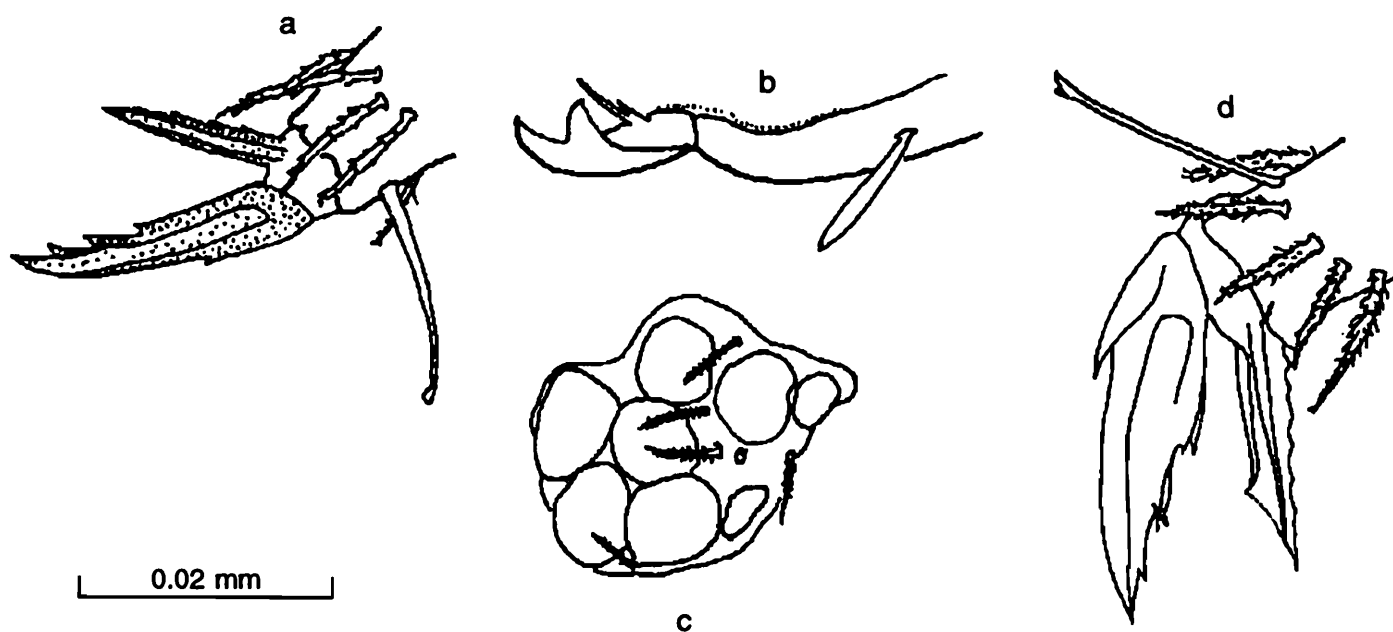


Fig. 38 : a-d. *Setogaster manipuri* : (a) Hind foot, (b) Mucro, (c) Ocelli, (d) Another hind foot complex.

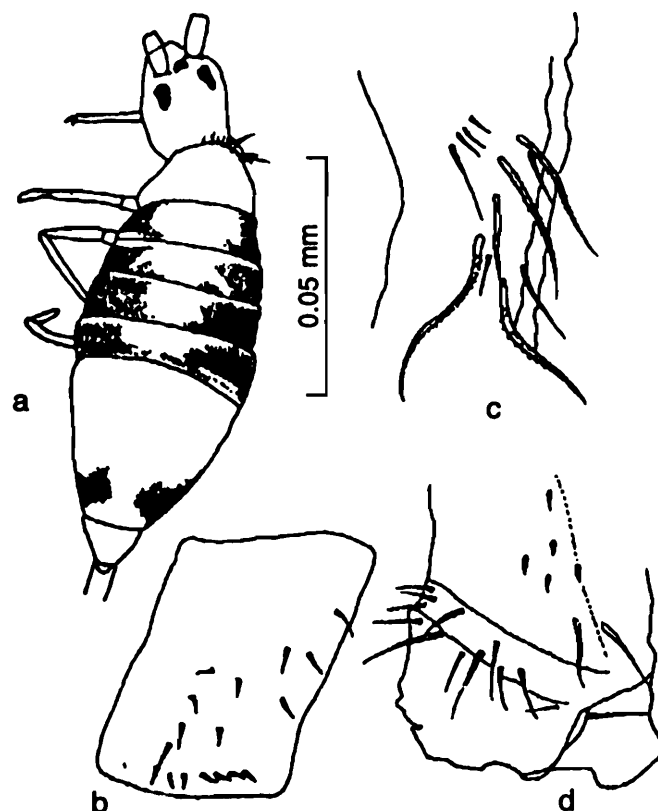


Fig. 39 : a-d. *Seira arunachala* : (a) Habitus, (b) Trochanteral organ, (c) Chaetotaxy of ventral ube (anterior face), (d) Chaetotaxy of ventral tube (posterior face).

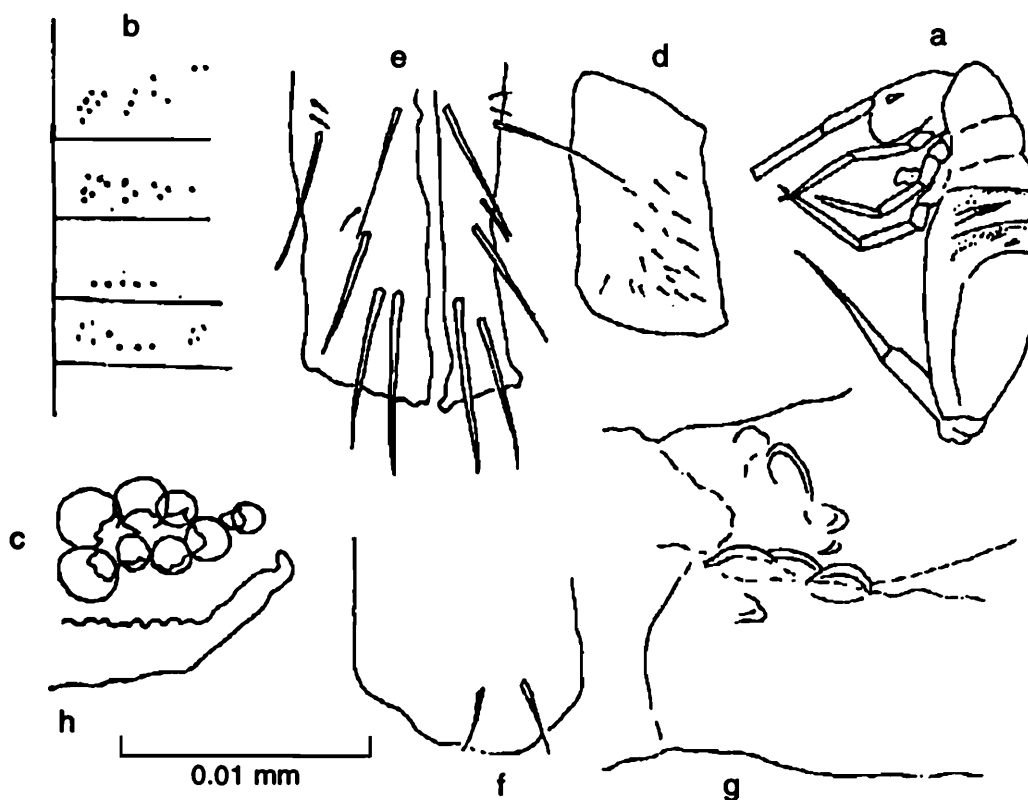


Fig. 40 : a-h. *Seira indica* : (a) Habitus, (b) Chaetal arrangement of body, (c) Eyes, (d) Trochanteral organ, (e) Ventral tube (anterior face), (f) Ventral tube (posterior face), (g) Basis of dentes, (h) Mucro.

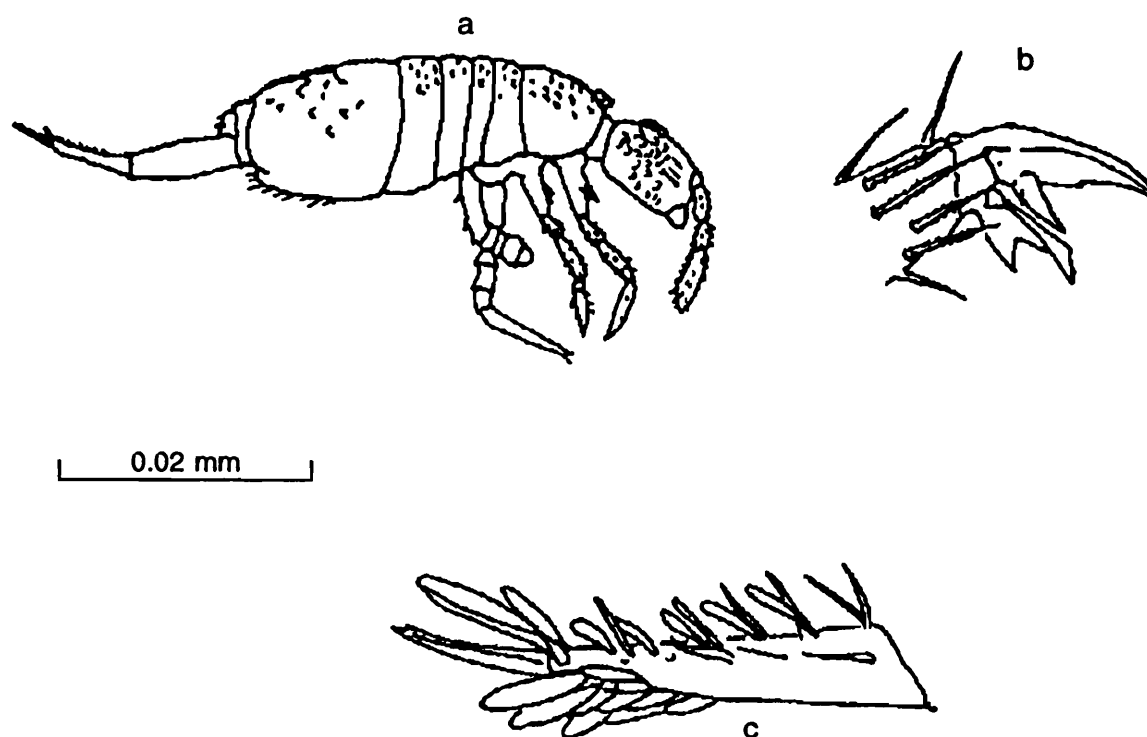


Fig. 41 : a-c. *Cyphoderus javanus* : (a) Habitus, (b) Hind foot, (c) Mucro and Dens.

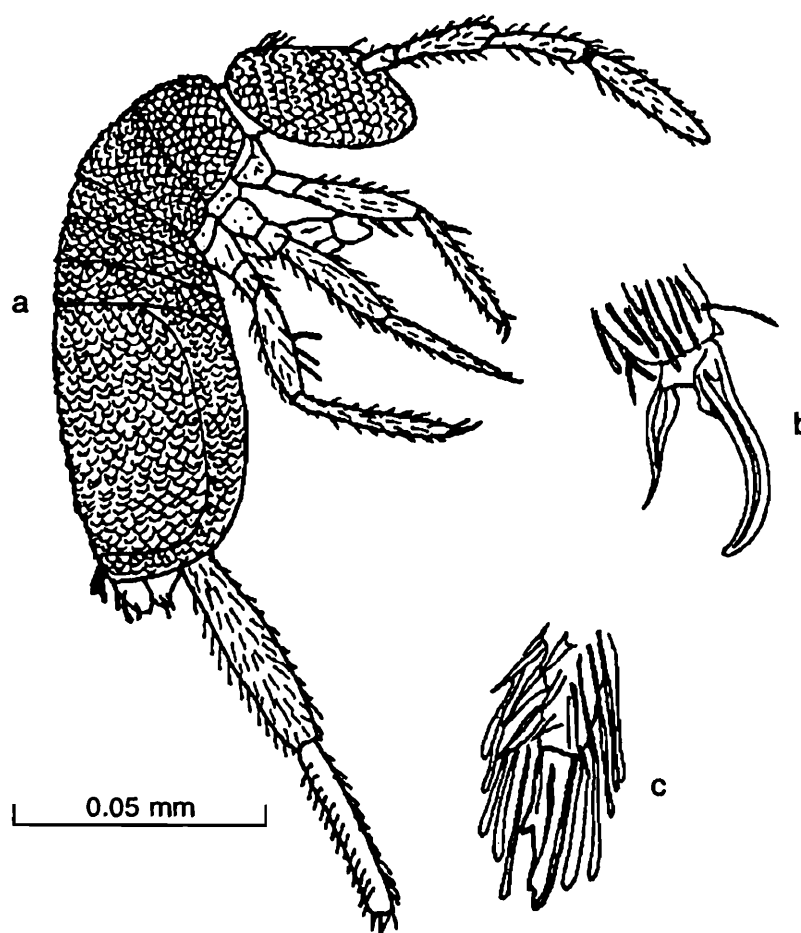


Fig. 42 : a-c. *Cyphoderopsis gracilis* : (a) Habitus, (b) Hind foot, (c) Mucro and Dens.

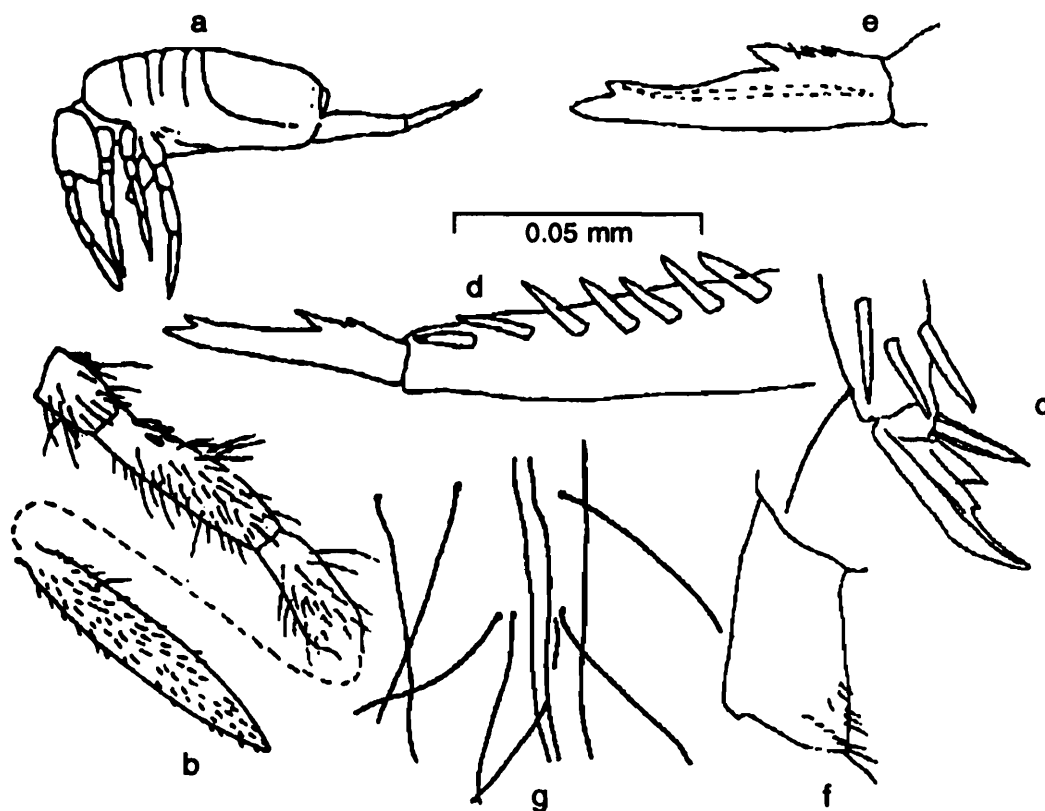


Fig. 43 : a-g. *Cyphoderopsis ceylonica* : (a) Habitus, (b) Antenna, (c) Mid-claw, (d) Mucro and Dens, (e) Mucro, (f) Trochanteral organ, (g) Ventral tube (anterior face).

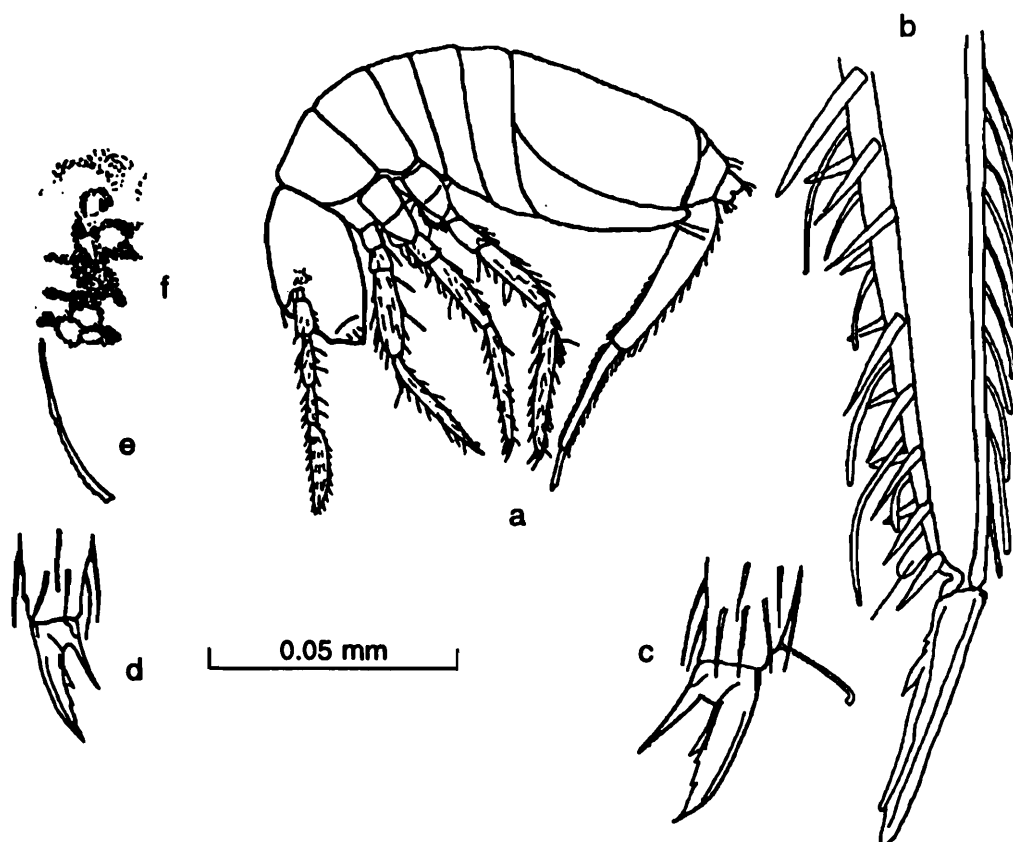


Fig. 44 : a-f. *Cyphoderopsis kempi* : (a) Habitus, (b) Mucro and Dens, (c, d) Hind foot, (e) Setae, (f) Ocelli.

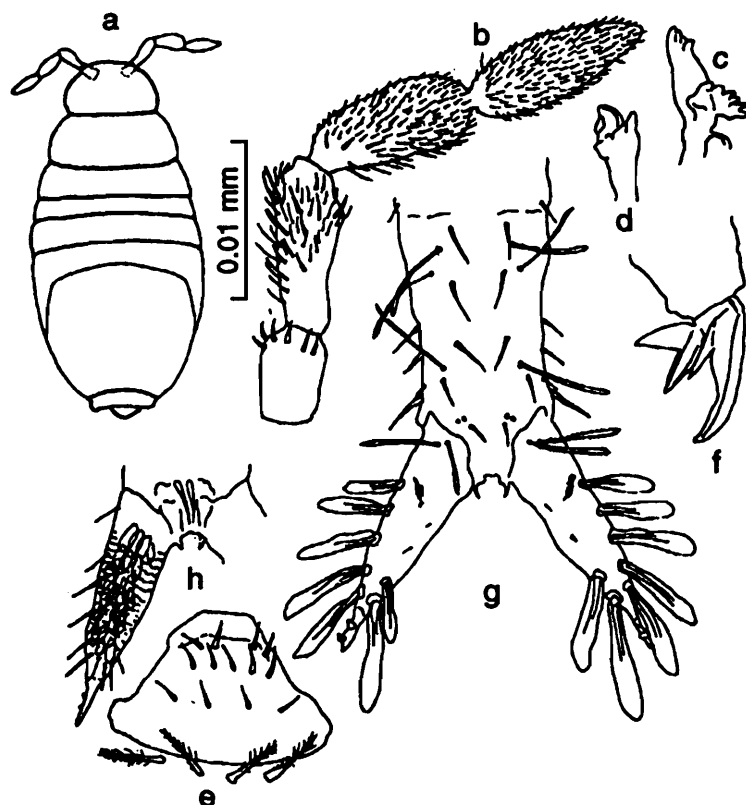


Fig. 45 : a-h. *Pseudocyphoderus annandalei* : (a) Dorsal view, (b) Antenna, (c) Mandible, (d) Maxilla, (e) Labrum, (f) Mid-claw, (g) Furcula in dorsal view, (h) Furcula in ventral view.

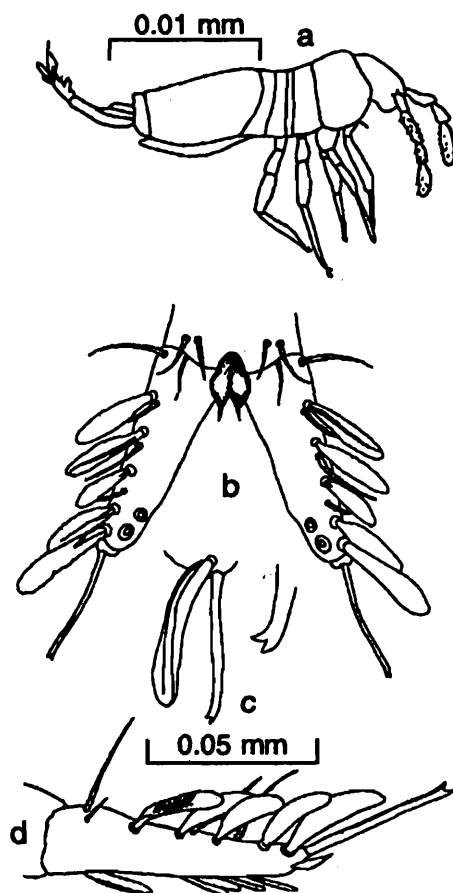


Fig. 46 : a-d. *Delamarerus immsi* : (a) Habitus, (b, d) Chaetotaxy of dorsal and ventral surfaces, (c) Mucrones.



Fig. 47 : a-g. *Tomocerus mitrai* : (a) Habitus, (b) Dorsal side of the head showing ocelli and chaetotaxy, (c) Fore claw, (d) Hind claw, (e) Outer view of the basal part of dens, (f) Inner view of the basal part of dens showing the arrangement of dental spines, (g) Outer view of Mucro.

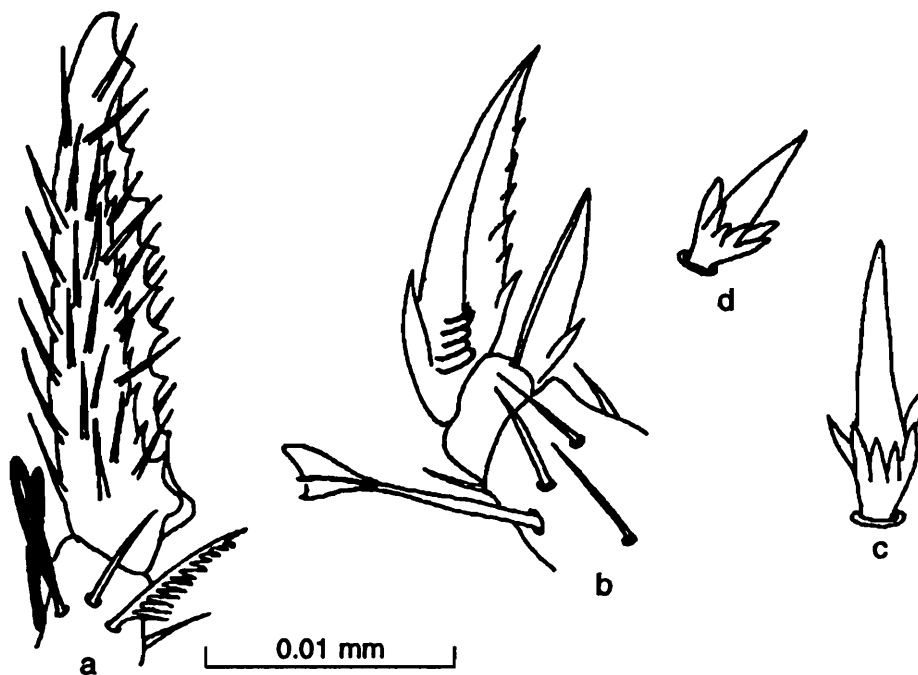


Fig. 48 : a-d. *Tomocerus petalospinus* : (a) Mucro and apex of dens, (b) Hind foot, (c) Large dental spines, (d) Small dental spines.

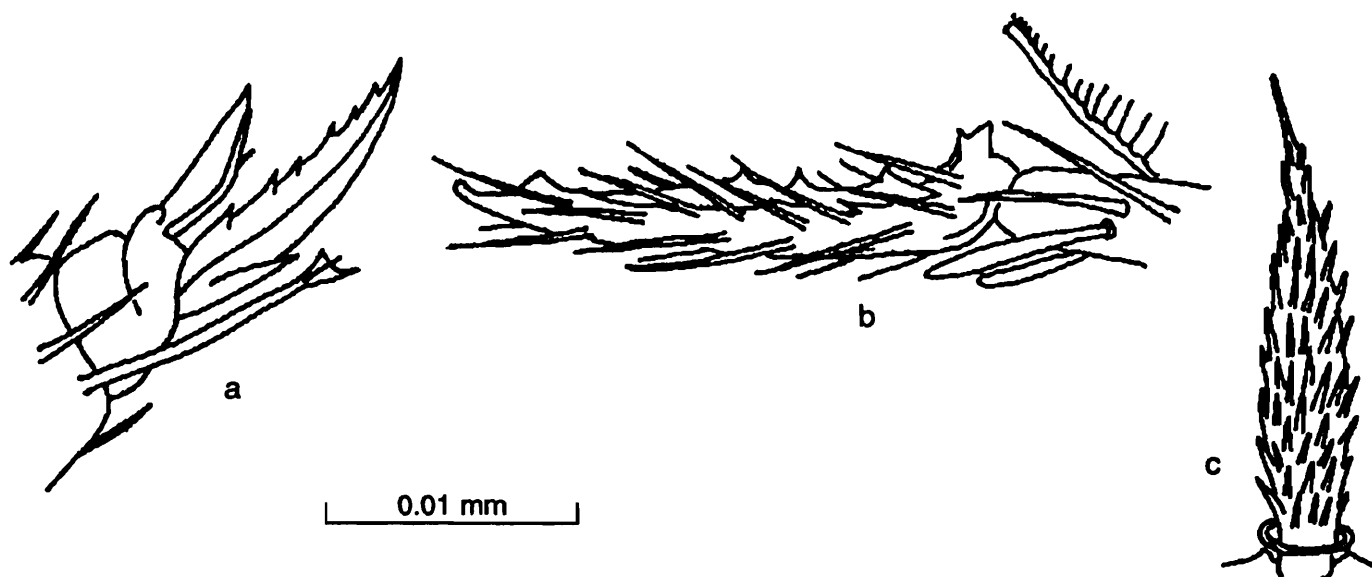


Fig. 49 : a-c. *Tomocerus serratospinus* : (a) Hind foot, (b) Mucro and apex of dens with serrate seta, (c) Dentrail spine.

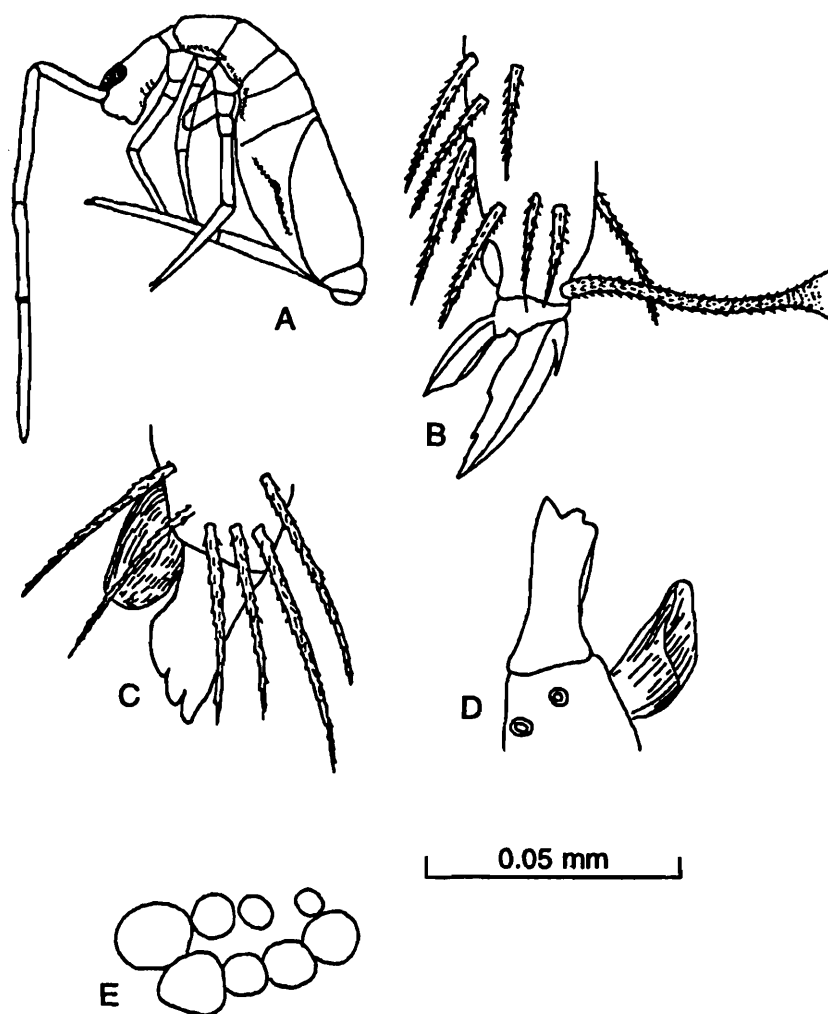


Fig. 50 : A-E. *Salina indica* : (A) Habitus, (B) Hind foot, (C) Mucro and apex of dens, (D) Mucro and apex of dens from another specimen, (E) ocelli.

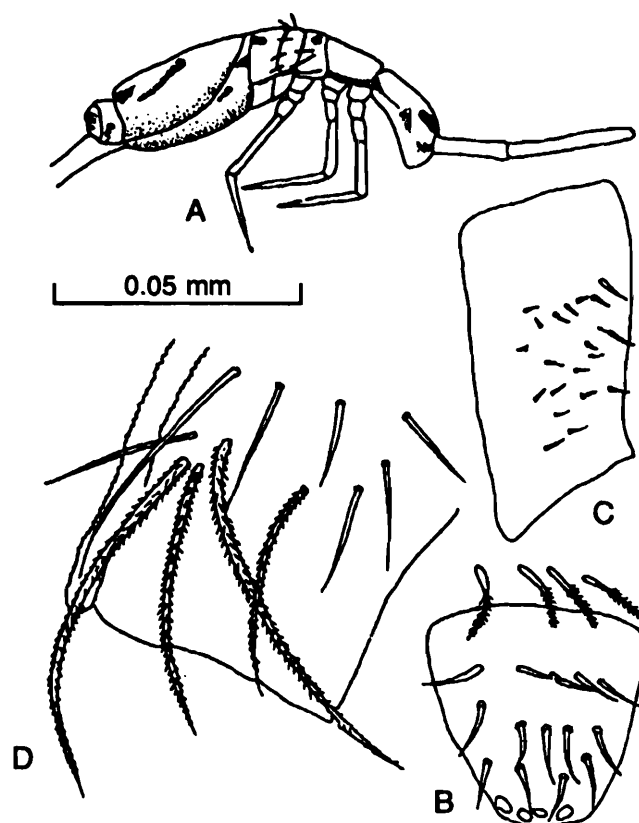


Fig. 51 : A-D. *Salina bengalensis* : (A) Habitus, (B) Labral chaetotaxy, (C) Trochanteral organ, (D) Chaetotaxy of anterior face of ventral tube.

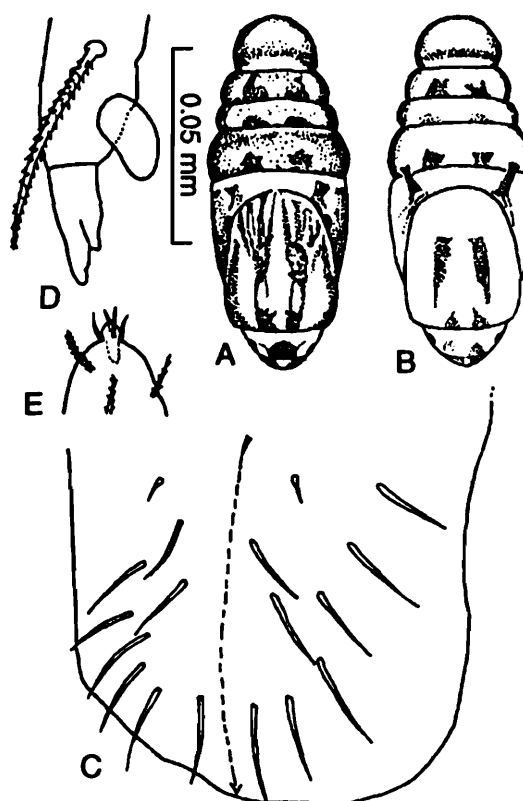


Fig. 52 : A-E. *Salina biformis* : (A, B) Habitus, (C) Chaetotaxy of posterior face of ventral tube, (D) Mucrodens complex, (E) Apex ant. IV.

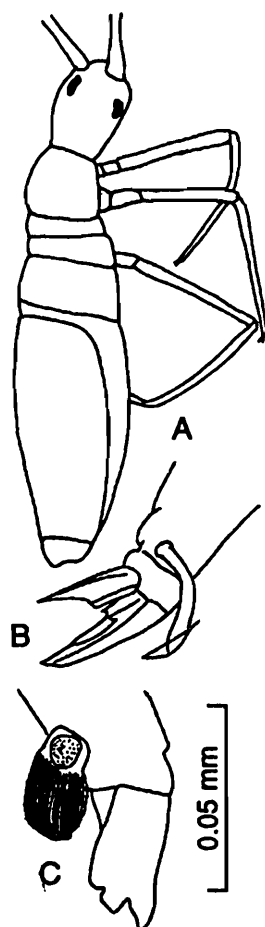


Fig. 53 : A-C. *Salina celebensis* : (A) Habitus, (B) Foot complex, (C) Mucrodens complex.

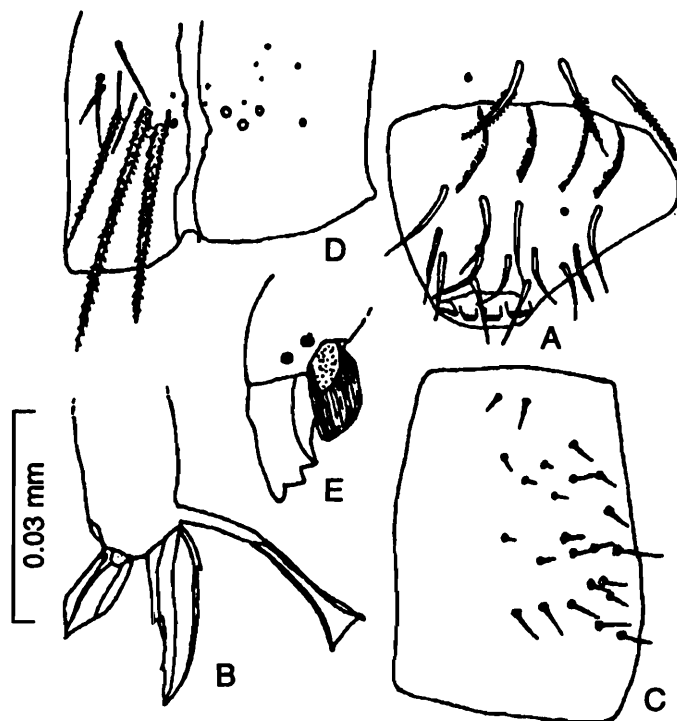


Fig. 54 : A-E. *Salina javana* : (A) Labral chaetotaxy, (B) Foot complex, (C) Trochanteral organ, (D) Chaetotaxy of anterior face of ventral tube, (E) Mucrodens complex.

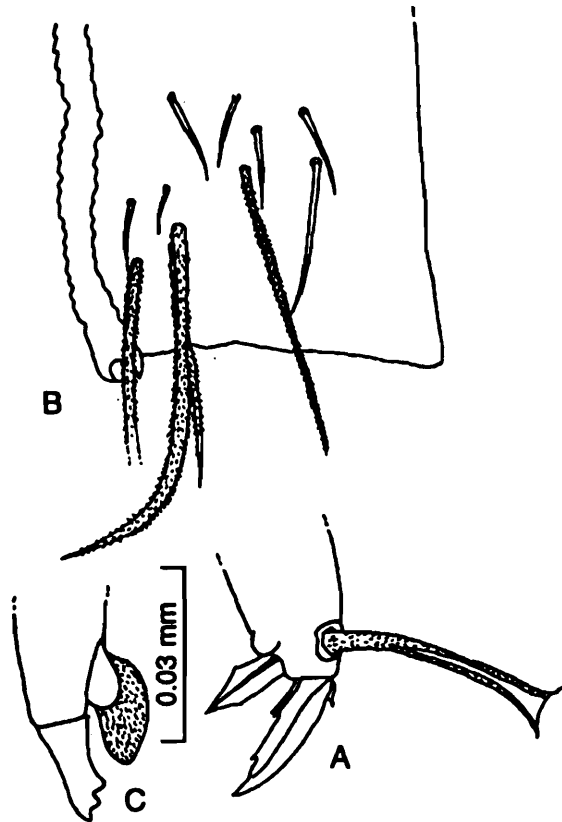


Fig. 55 : A-C. *Salina montana* : (A) Foot complex, (B) Chaetotaxy of anterior face of ventral tube, (C) Mucrodens complex.

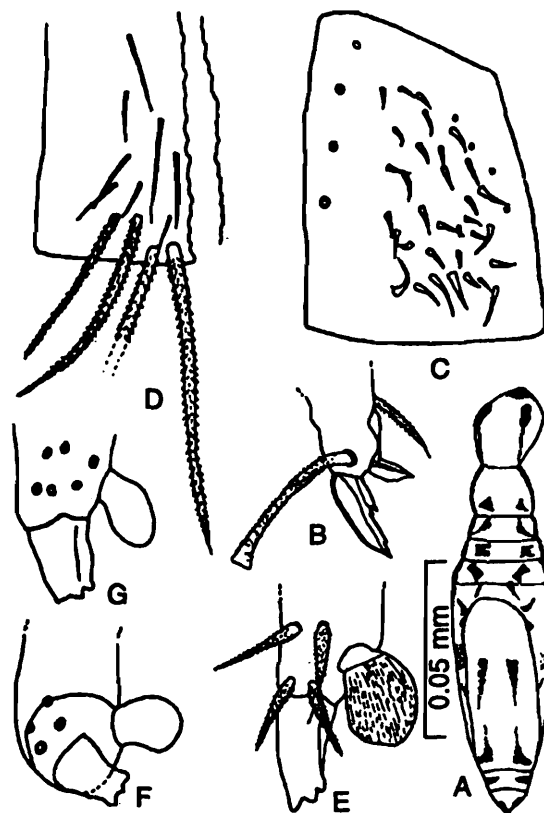


Fig. 56 : A-G. *Salina yosii* : (A) Habitus, (B) Foot complex, (C) Trochanteral organ, (D) Chaetotaxy of anterior face of ventral tube, (E, F) Mucrodens complex, (G) an abnormal mucrone.

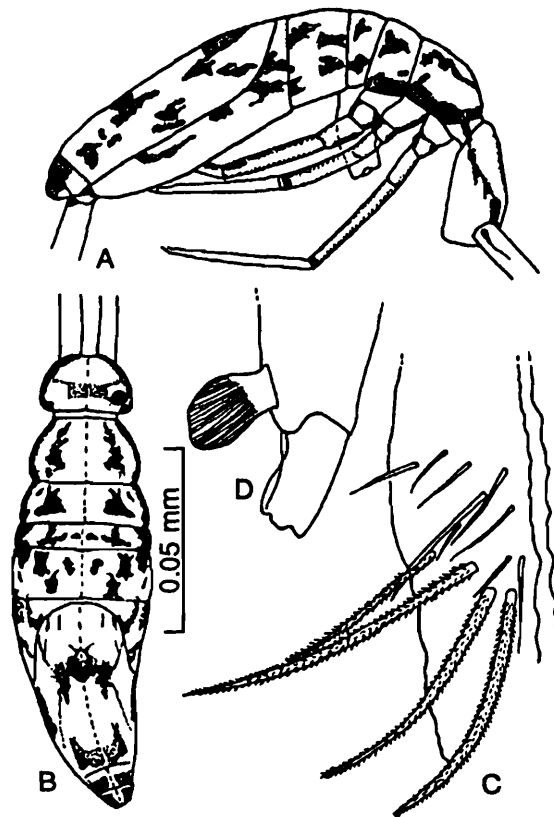


Fig. 57 : A-D. *Salina striata* : (A, B) Habitus, (C) Chaetotaxy of anterior face of ventral tube, (D) Mucrodens complex.

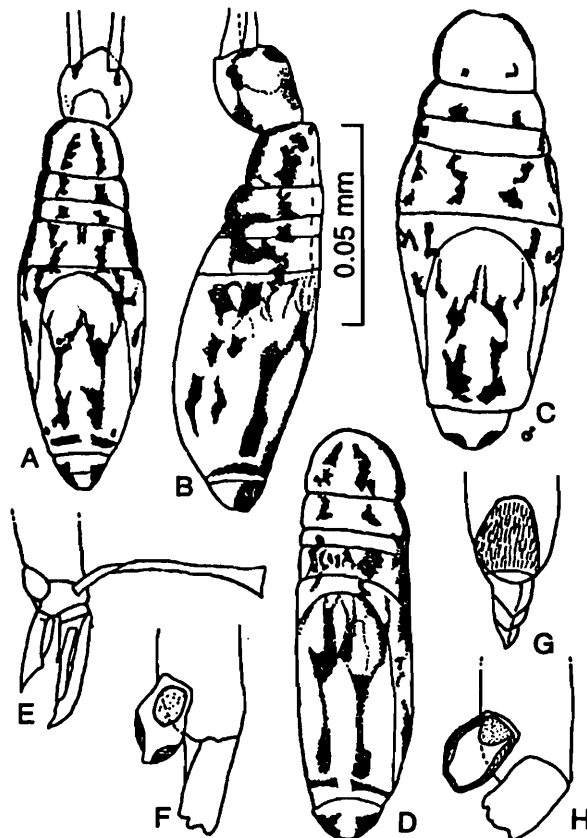


Fig. 58 : A-H. *Salina tricolor tricolor* : (A-D) Different colour forms; (E) Foot complex, (F, G) Mucrodens complex, (H) an abnormal mucrone.

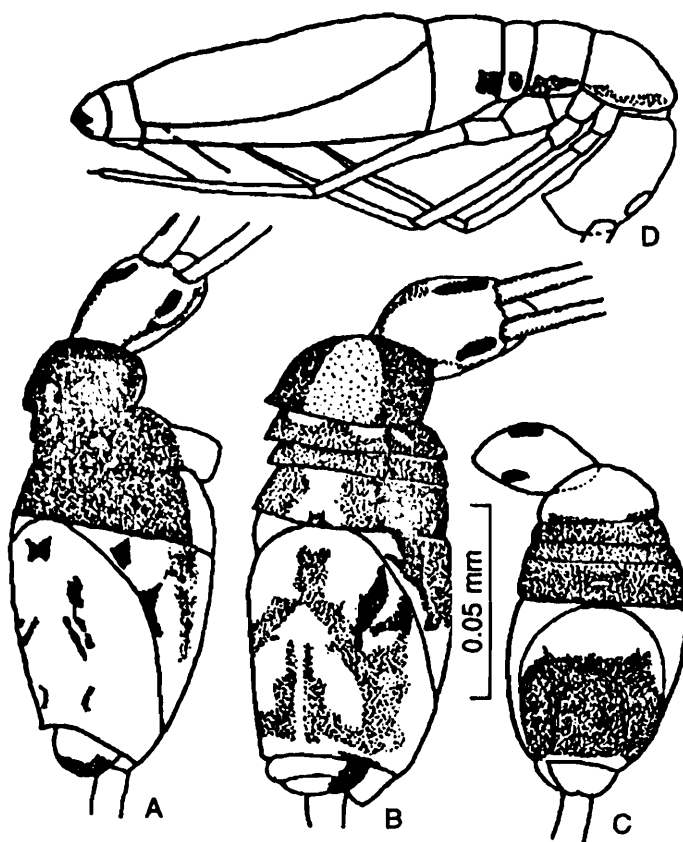


Fig. 59 : a-c. *Salina tricolor sikkimensis* : (A, B, C) Different colour forms; (D) Lighter form.

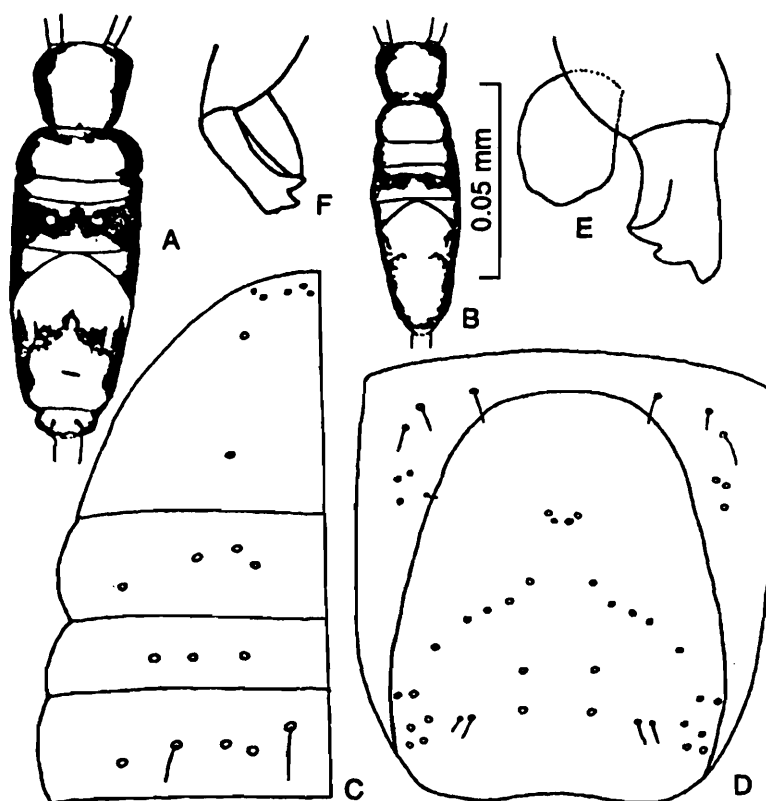


Fig. 60 : A-F. *Salina choudhurii* : (A, B) Habitus, (C) Chaetotaxy of Ths. II, III/Abds. I, II; (D) Chaetotaxy of Abds. III, IV; (E) Mucrodens complex; (F) an abnormal mucrone.

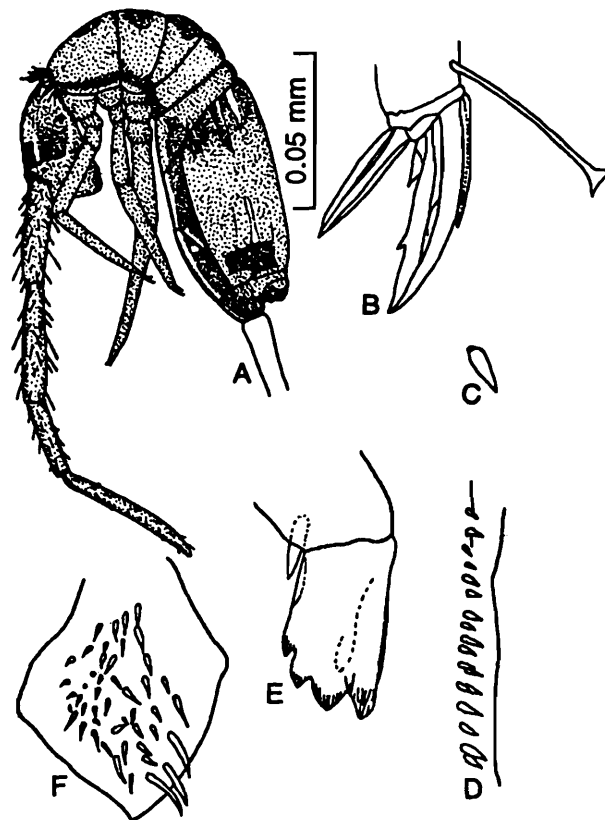


Fig. 61 : A-F. *Dicranocentroides indica* : (A) Habitus, (B) Foot complex, (C) A dental spine, (D) Portion of dentes showing spines, (E) Mucrodens complex, (F) Trochanteral organ.

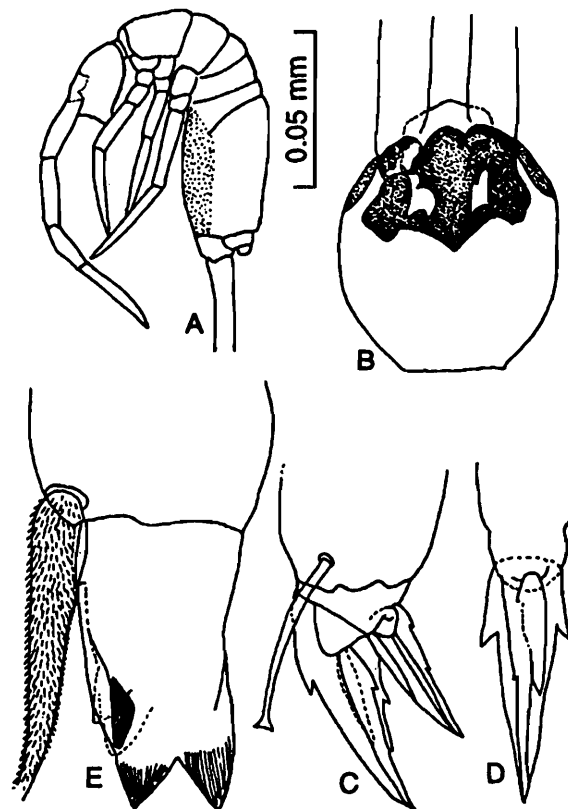


Fig. 62 : A-E. *Dicranocentroides flavescens* : (A) Habitus, (B) Head showing pigmentation, (C) Foot complex of leg III, (D) Foot complex of leg II, (E) Mucrodens complex.

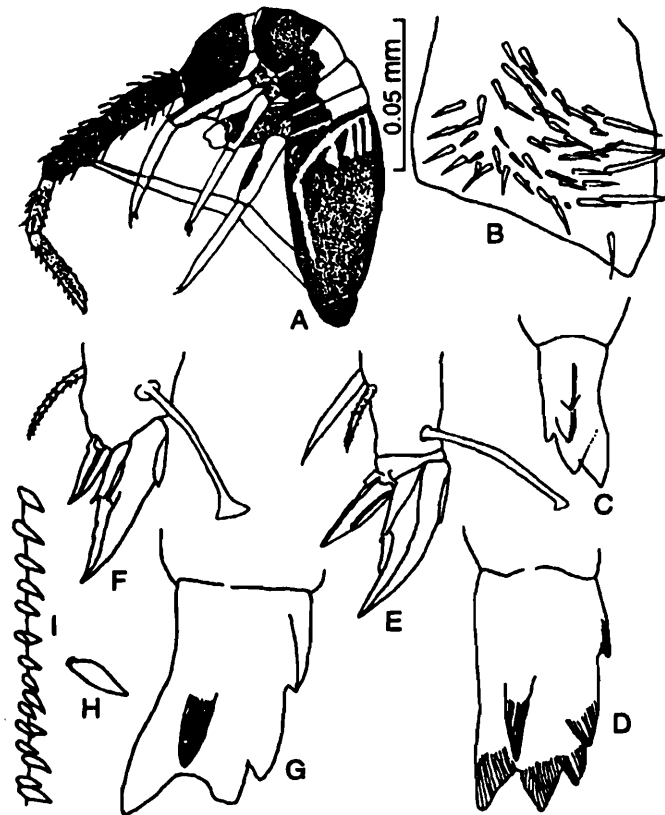


Fig. 63 : A-I. *Dicranocentroides fasciculatus* : (A) Habitus, (B) Trochanteral organ, (C) Mucrodens, (D, G) Mucrodens complex, (E, F) Foot complex, (H) A dental spine, (I) Portion of dentes showing spines.

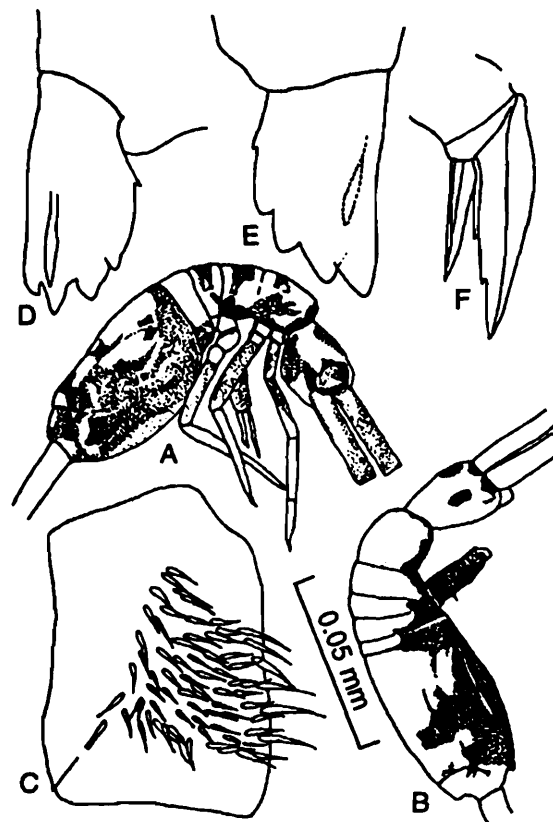


Fig. 64 : A-F. *Dicranocentroides salmoni* : (A, B) Habitus, (C) Trochanteral organ, (D, E) Mucrodens complex, (F) Foot complex.

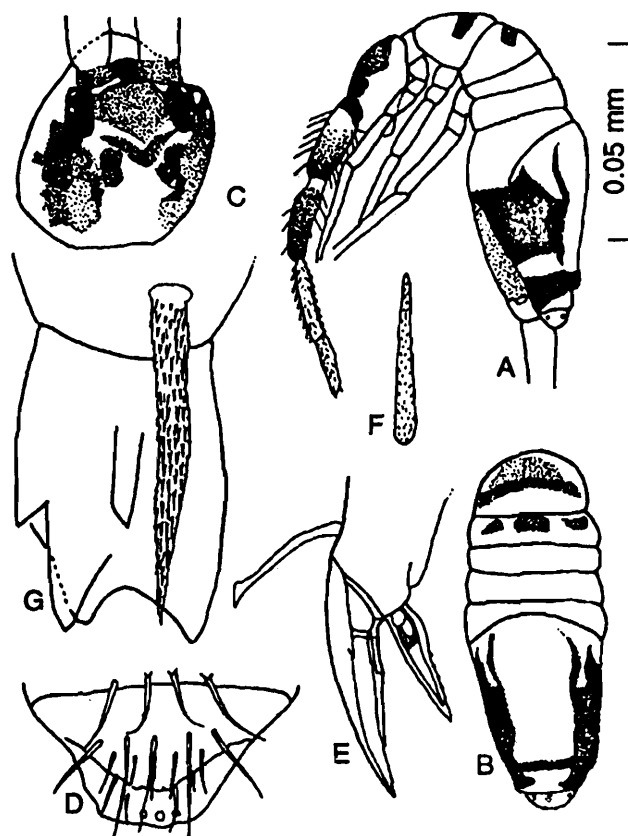


Fig. 65 : A-G. *Dicranocentroides gisini* : (A, B) Habitus, (C) Head showing pigmentation, (D) Labral chaetotaxy, (E) Foot complex, (F) Tibiotarsal spine, (G) Mucrodens complex.

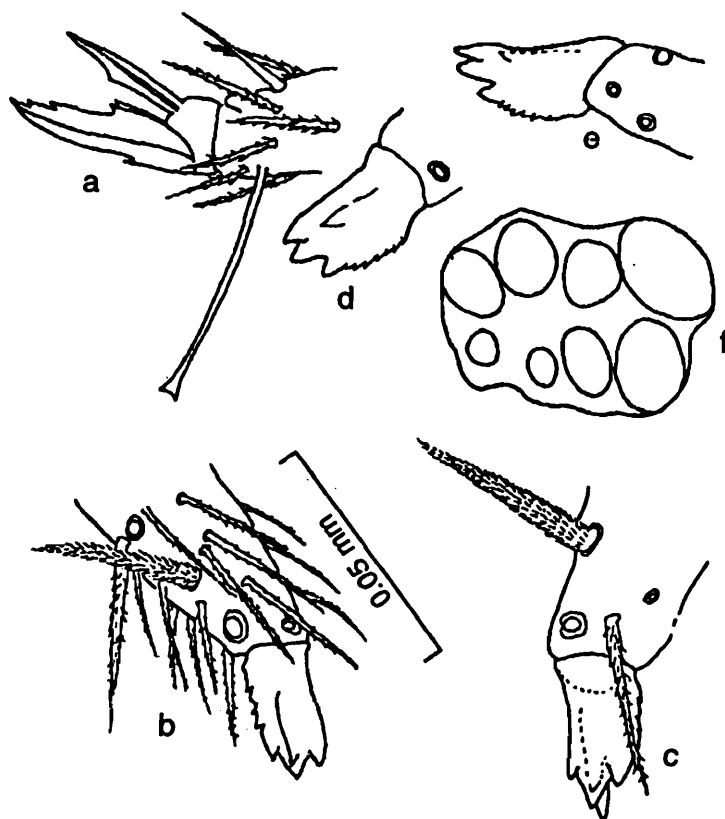


Fig. 66 : a-f. *Callyntrura (Handschinphysa) serrata* : (a) Foot complex, (B) Mucrodens complex, (c) Mucrodens complex from another specimen, (d) Mucro from inner side, (e) Mucro from outer side, (f) Ocelli.

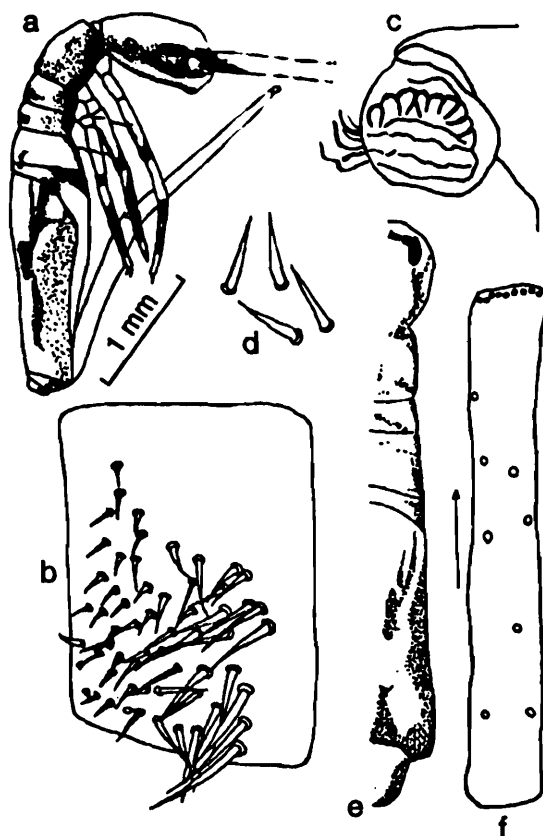


Fig. 67 : a-f. *Callyntrura (Callyntrura) zaheri* : (a) Habitus, (b) Trochanteral organ, (c) Male genital field, (d) Frontal spines, (e) Profile (dorsal), (f) Chaetotaxy of ant. I.

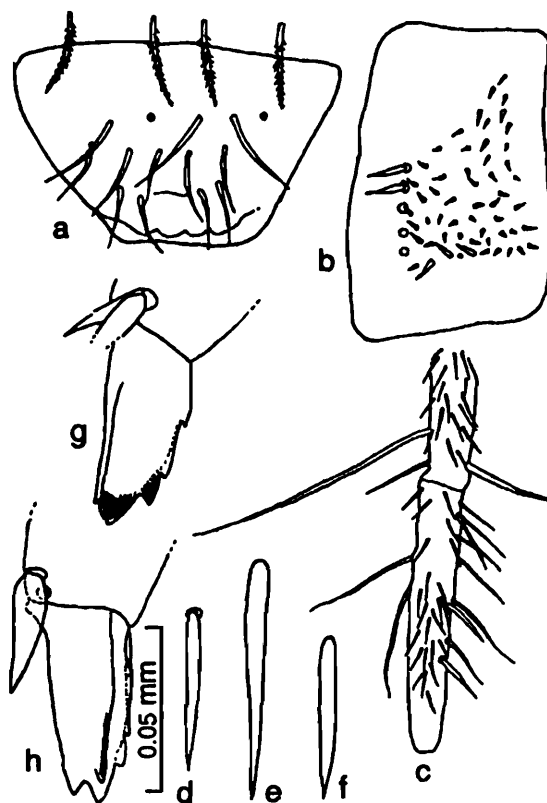


Fig. 68 : a-h. *Callyntrura (Callyntrura) semiviolacea* : (a) Labrum, (b) Trochanteral organ, (c) Hind tibiotarsus, (d, e, f) Spiniform setae from inner margin of tibiotarsus, (g, h) Mucrodens complex.

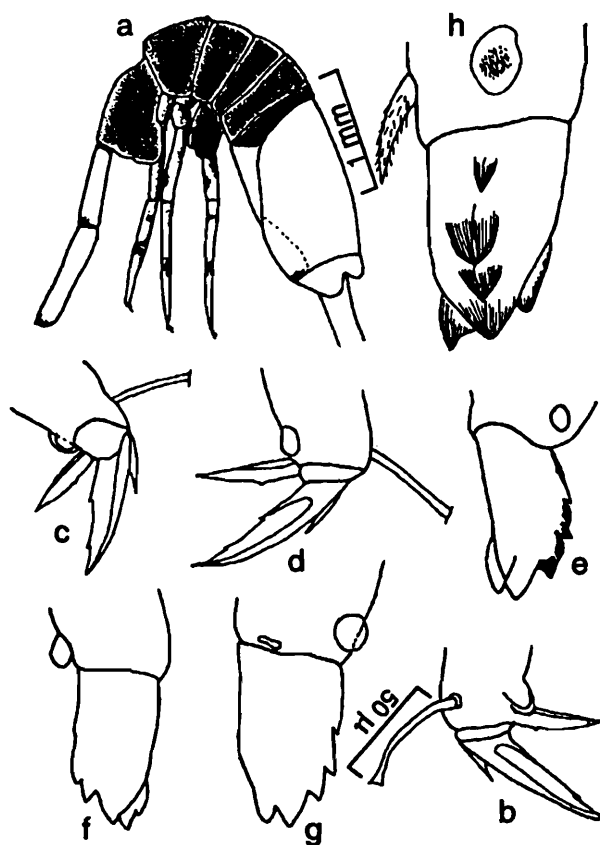


Fig. 69 : a-h. *Callyntrura (Handschinphysa) vestita* : (a) Habitus, (b, c, d) Foot complex, (e, f, g, h) Mucrodens complex.

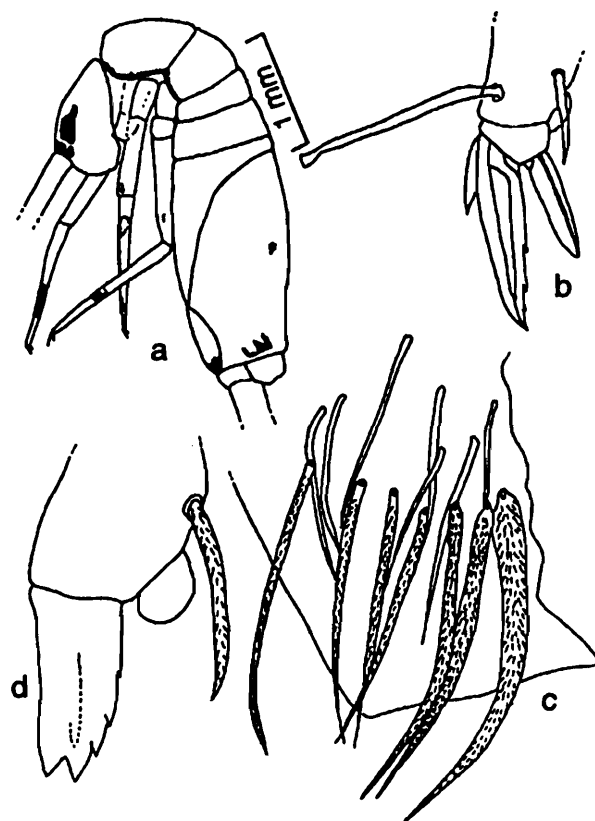


Fig. 70 : a-d. *Callyntrura (Handschinphysa) lineata* : (a) Habitus, (b) Foot complex, (c) Chaetotaxy of anterior face of ventral tube, (d) Mucrodens complex.

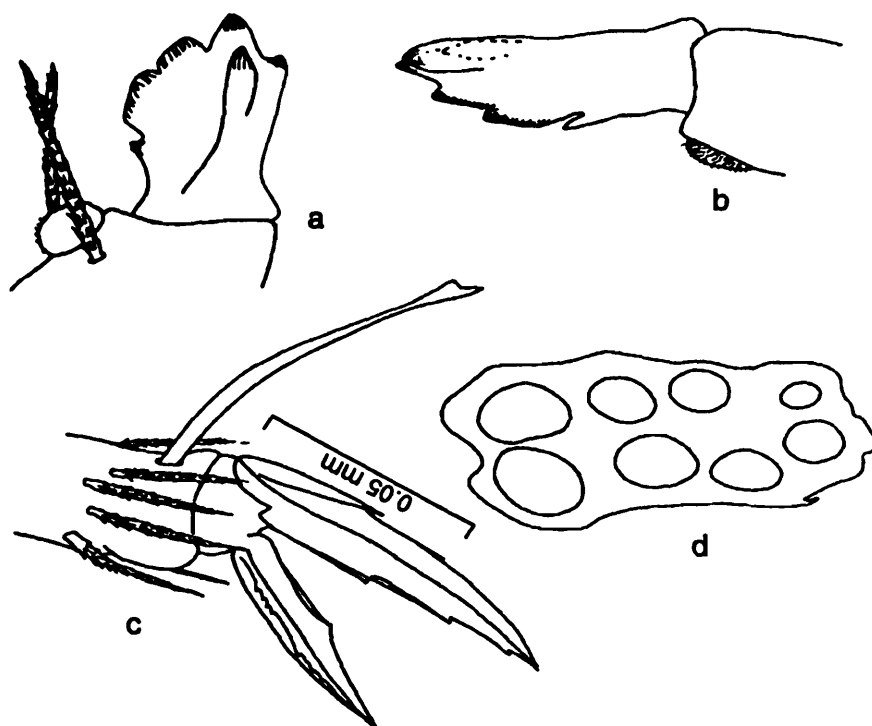


Fig. 71 : a-d. *Callyntrura (Handschinphysa) borneri* : (a, b) Mucrodens complex, (c) Foot complex, (d) Ocelli.

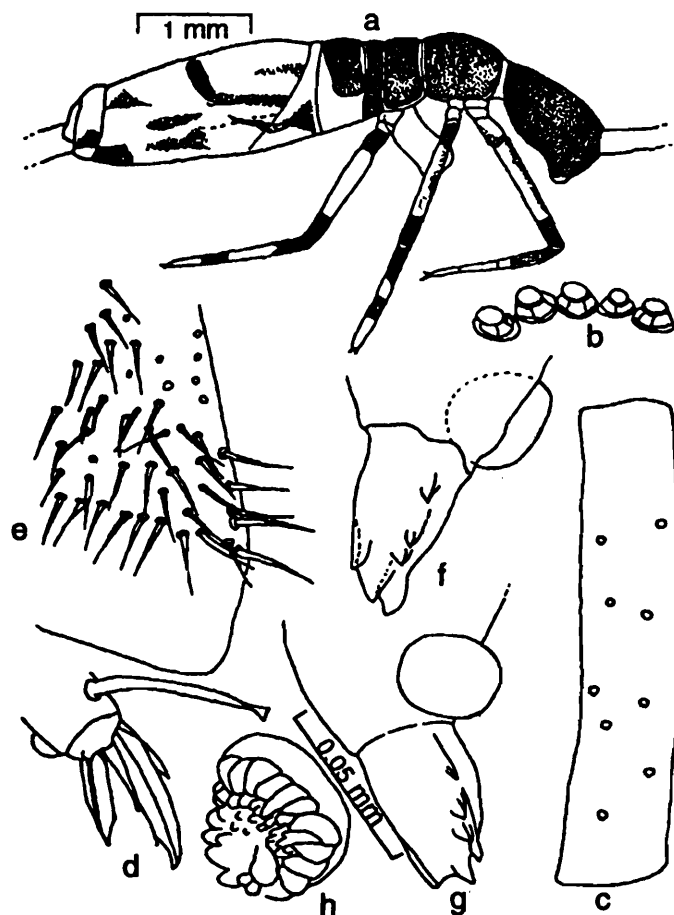


Fig. 72 : a-h. *Callyntrura (Handschinphysa) delamarei* : (a) Habitus, (b) Some flexed macrochaetal sockets, (c) Chaetotaxy of ant. I, (d) Foot complex, (e) Trochanteral organ, (f, g) Mucrodens, (h) Male genital field.

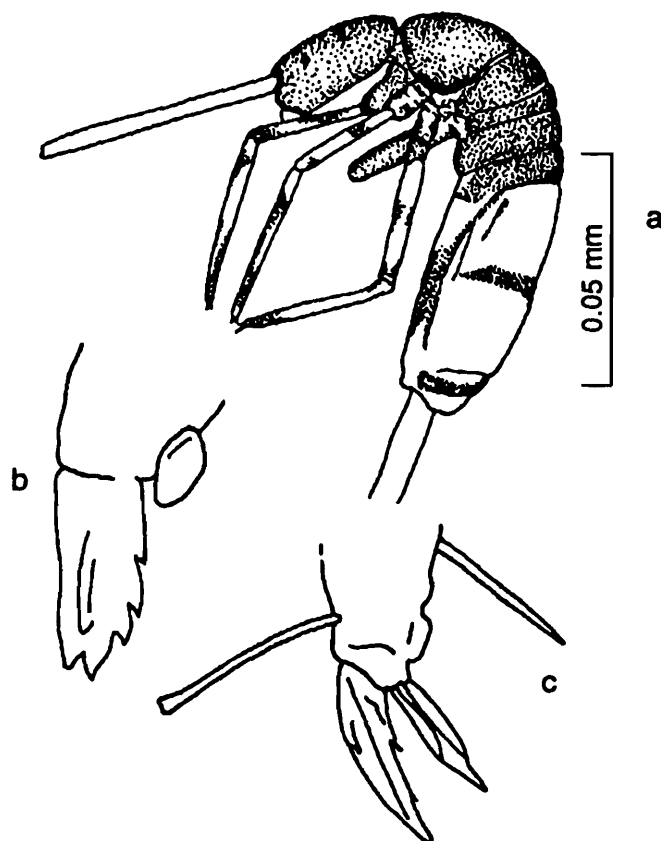


Fig. 73 : a-c. *Callyntrura japonica* : (a) Habitus, (b) Mucrodens complex, (c) Foot complex.

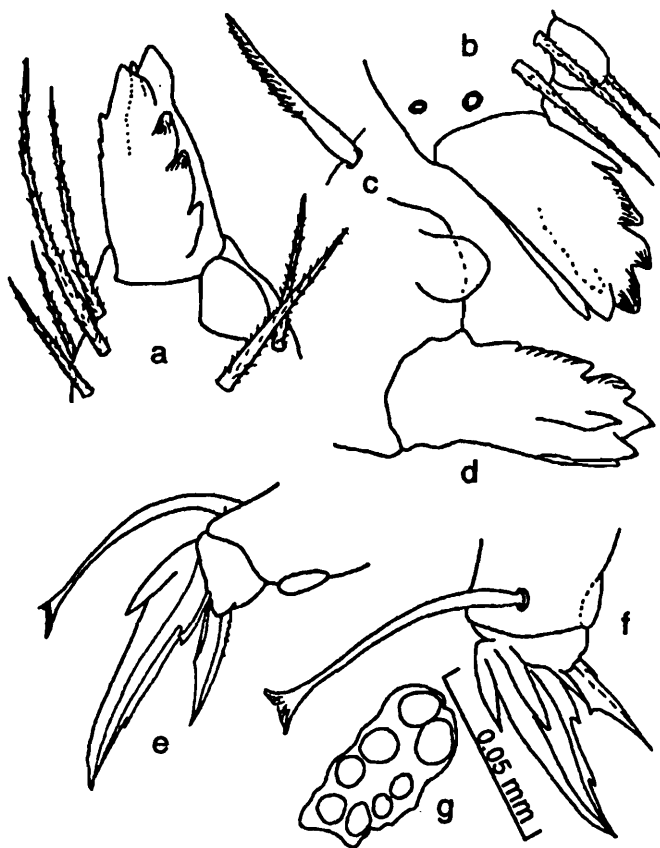


Fig. 74 : a-g. *Callyntrura (Handschinphysa) longicronis* : (a, b, d) Mucrodens complex, (c) Serrated spine-like setae from dens, (e, f) Foot complex, (g) Ocelli.

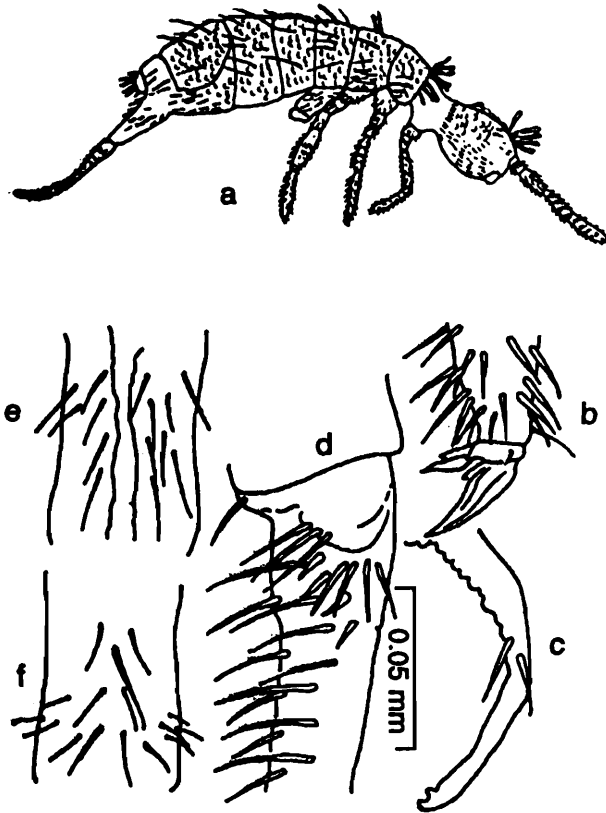


Fig. 75 : a-f. *Alloscopus tetracantha* : (a) Habitus, (b) Foot complex, (c) Mucronal end of furcula, (d) Dental spines and the setae, (e, f) Ventral tube (anterior & posterior face).

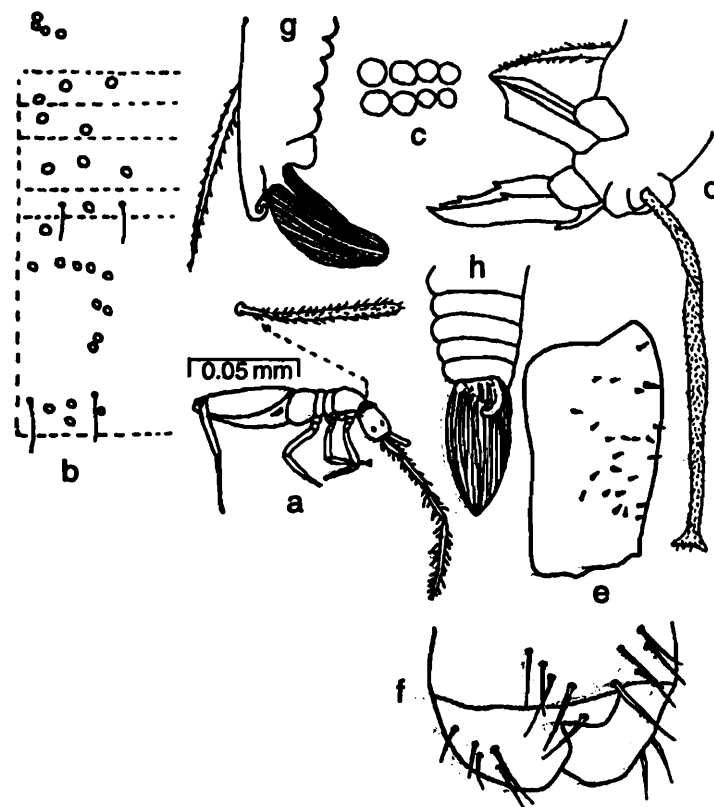


Fig. 76 : a-h. *Yosiia dehradunia* : (a) Habitus, (b) Body chaetotaxy (diagrammatic), (c) Ocelli, (d) tibio tarsus, (e) Trochanteral organ, (f) Chaetotaxy of anterior face of ventral tube, (g) Apical part of dentes (lateral view), (h) Apical part of dentes (dorsal view).

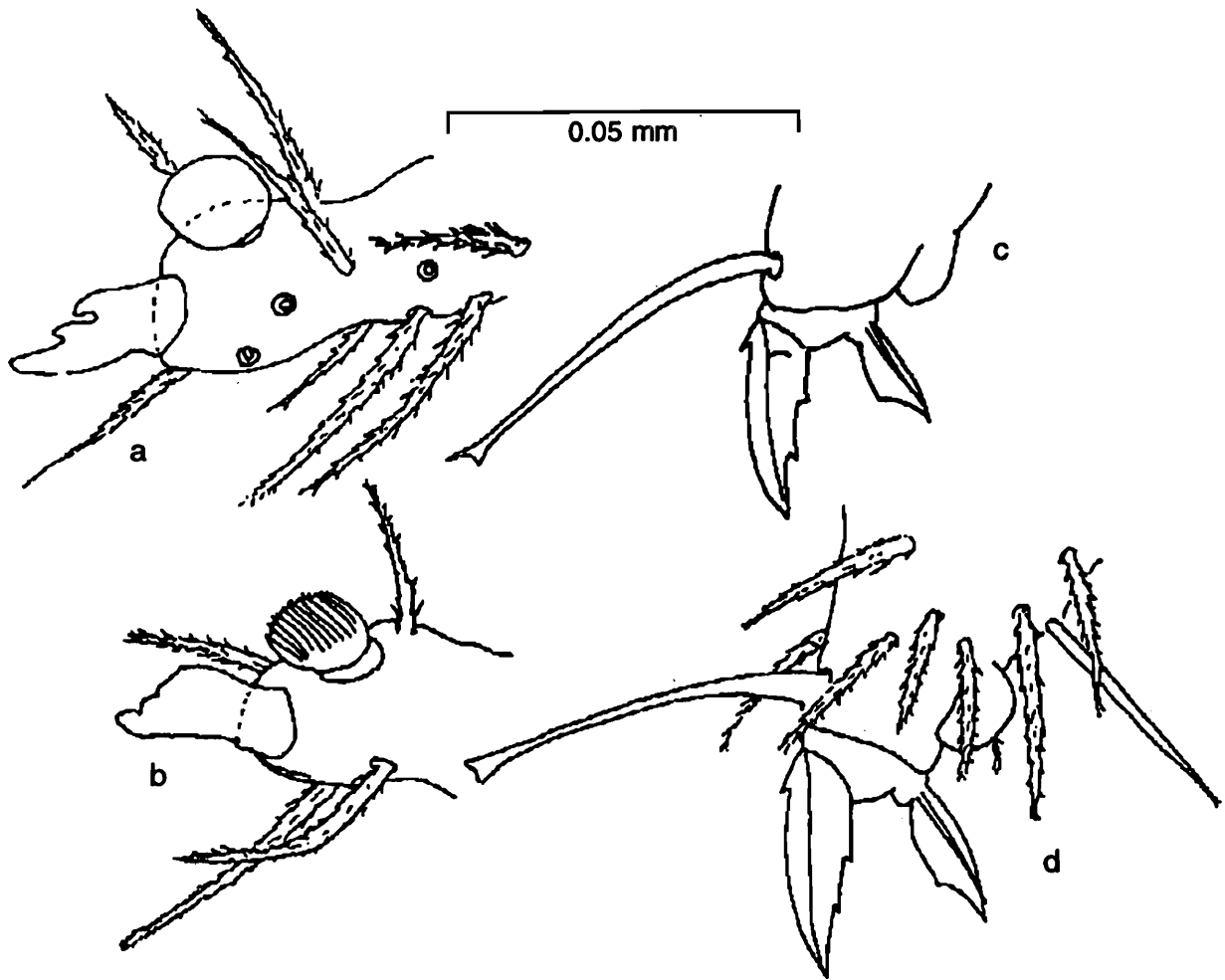


Fig. 77 : a-d. *Pseudoparonellides bulbosa* : (a, b) Mucrodens complex, (c, d) Foot complex.

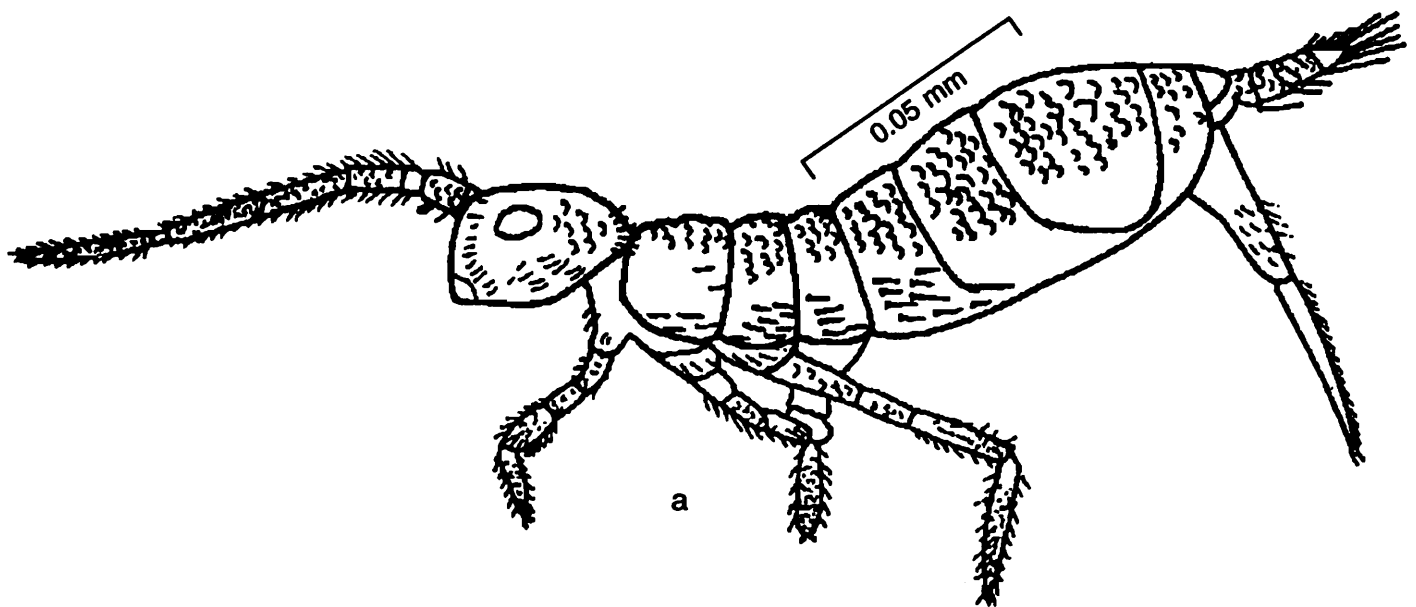


Fig. 78 : a. *Heteromuricus cercifer* : (a) Habitus.