I N T R O D U C T I O N

A. Locality surveyed :

As there is no account of soil oribatid fauna that lives in close association with forest and tea floors of Darjeeling, a survey was undertaken to explore the acarine fauna of forest and tea soils in the district of Darjeeling during the period of January, 1977 to December, 1978. Darjeeling is one of the 16 component districts of the State of West Bengal under the Indian political territory. Approximately, 35% of the area of this district is forest clad which exhibits luxuriant vegetation represented by coniferous and deciduous forests. There are 142 Tea Estates spread over the district of Darjeeling. The topography, climate and altitudinal modulations of the district of Darjeeling harbours the enriched faunal treasure of this group of soil micro-arthropods and consequently taxonomic study of soil oribatid mites seemed most interesting and of profound scientific interest. Samplings were done from the areas of forest and tea estates of this district as per locality indicated in the maps.

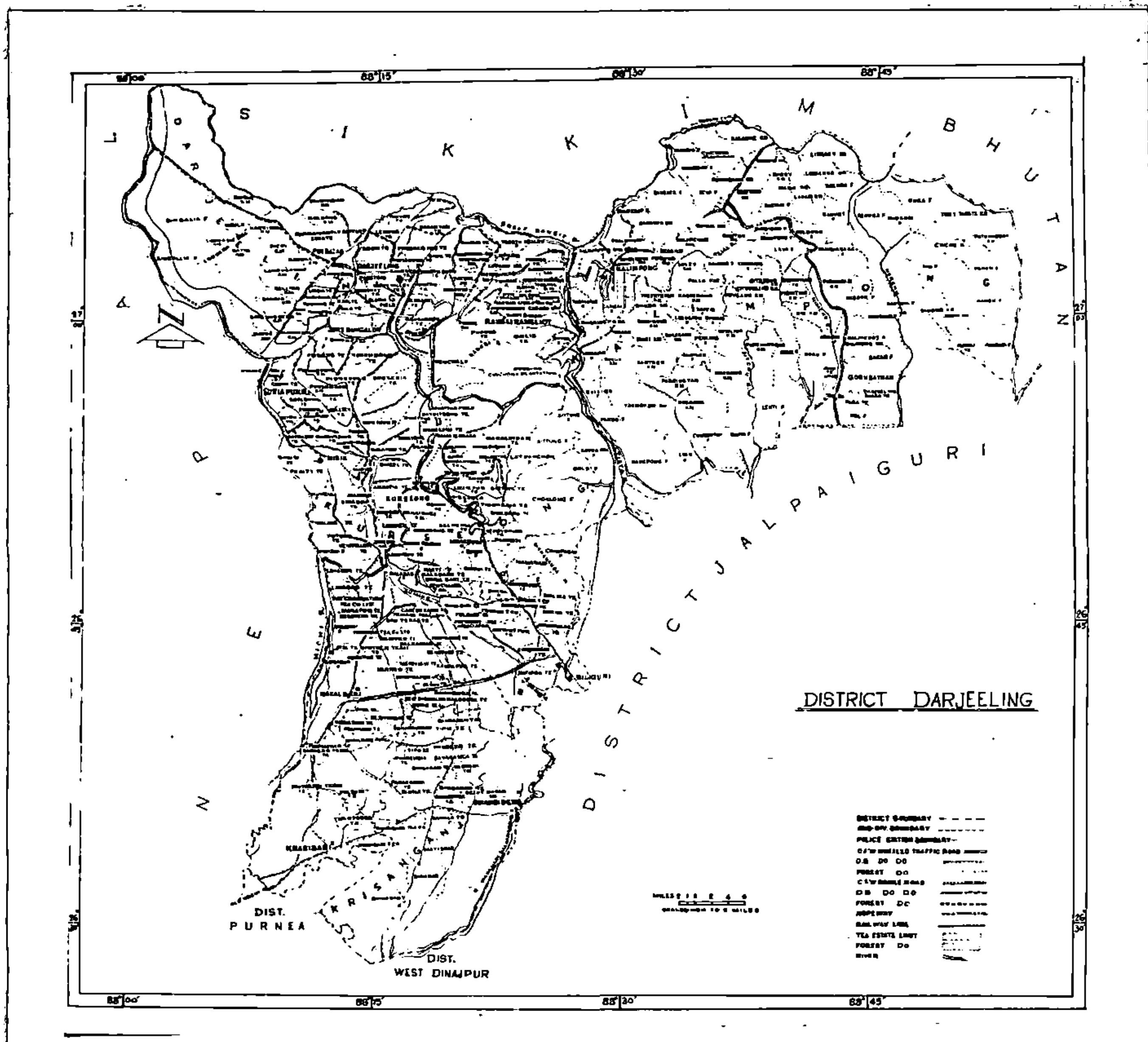
Geographical account :

The district of Darjeeling is situated in the eastern Himalayan region and is the northern most district of the State of West Bengal. It lies between 26°28' and 27°13'N latitude and 87°59' and 88°51' E longitude (vide map) and the area of the district is near about 3,108 Sq.Km. The district of Darjeeling is irregularly triangular in it's outer border and is bounded in the north by Sikkim Himalayas, in the east flanked by Bhutan hills and Jalpaiguri district, in the south by state of Bihar and Jalpaiguri and West Dinajpur districts and in the west by Nepal Himalayas.

The district of Darjeeling is mainly divided in to 2 regions i.e., (a) The Terai region, situated at the foot of the hills at an average height of 118 metre (approx.) above the sea level, (b) the deep valleys and ridges approaching towards Sandakphu-Phalut range, an altitude of 3618 metre (approx.) above the sea level. The highest ground of the district of Darjeeling is in the north-west where the Singalila ridge enters the district at Phalut. The ridge is nearly 3583 metre and 3618 metre high at Phalut and Sandakphu respectively and descends to Manebhanjang (2123 m.). The forests of Tonglu (3056 m.) and Singalila ranges are situated on the upper slopes of these ridges. The ridge undulates upto Ghum (2247 m.) from Manebhanjang eastward and then rises steeply to Senchal (2500 m.) and Tiger hill (2573 m). On both sides all along the upper slopes are forest clad. The Takdah-Peshoke (1600-1700 m.) ridge which originates from the former Singalila ridge descends to the junction of the Rangit with Tista river and is also covered with forests. Darjeeling town is on the spur emanating northward from Manebhanjang-Senchal ridge (2123-2500 m.) which divides below the town into Tukvar and

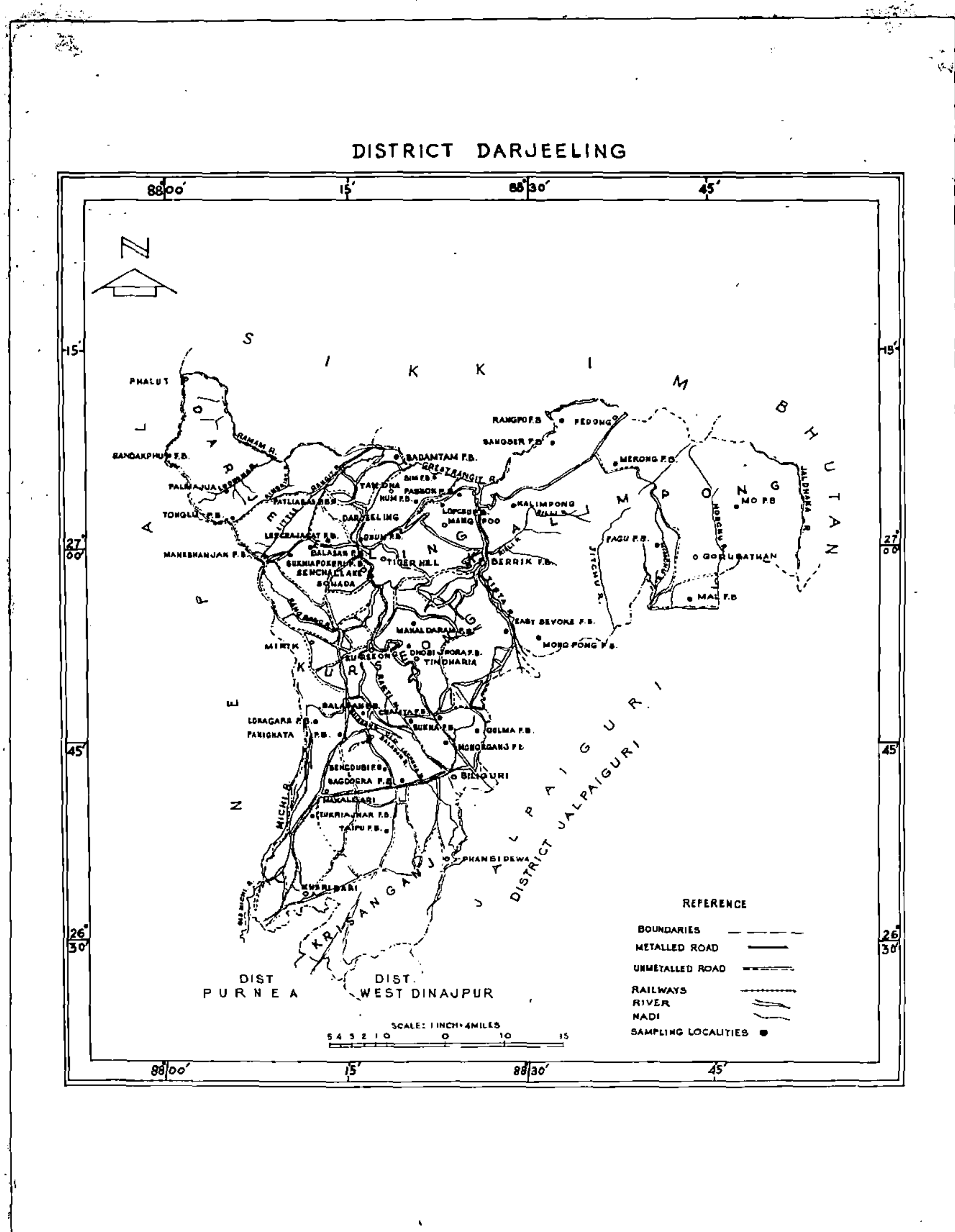
Lobong (1759 m.) and spurs before they descend to the Rangit river. The northern slopes of the tract are drained by the Rammam, the Great Rangit and the Little Rangit, all tributaries of the Tista river, while on the southern slopes the important rivers are the Mahanadi and the Balason. The western boundary of this district follows the southward ridge continuous as the boundary right up to the plains from the Phalut region, thence the boundary of Nepal up to the south-western corner of the district. Besides these the tract is intersected by numerous rapid hill torrents forming deep valleys, the sides of which are usually steep and often precipitous. Many streams again break the terrain forming tributaries to the main current. The forests, thus, form watershed of numerous streams and rivers either in part or in whole.

The district of Darjeeling is divided into 4 civil subdivisions viz., Darjeeling, Kalimpong, Kurseong and Siliguri. The entire area of forests of this district is mainly divided into 3 divisions i.e., Darjeeling forest division, Kalimpong forest division and Kurseong forest division. These divisions are again subdivided into ranges and many blocks. The total area of the Reserved forests of Darjeeling Forest Division is 294 Sq. Km. The Darjeeling civil subdivision covers approximately 864 Sq. Km. of land area and the reserve forests, therefore, comprise nearly 1/3rd of the subdivision. The Darjeeling Forest Division is bounded by the Tista river and forest of



MAP OF THE DISTRICT OF DARJEELING SHOWING FOREST AREAS AND TEA ESTATES

Kalimpong Division to the east, the state of Sikkim to the north, the state of Nepal to the West and forests of Kurseong Division and Tea Gardens to the south. The entire forest area of this division is subdivided into 7 territorial ranges, viz., Tista valley, Takdah, Senchal, Ghum-Simana, Tonglu, Singalila and Darjeeling Ranges and contains 77 blocks under these ranges. The area of Kalimpong civil subdivision is 1079 Sq. Km. of which 589 Sq. Km. are under reserved forests. The forest areas of Kalimpong Forest Division lie entirely within Kalimpong civil subdivision of Darjeeling civil district. The Kalimpong Forest Division is bounded on the north by Sikkim and Bhutan, on the east by Jaldhaka river, on the south by the Jalpaiguri district and on the west by the Tista river. The entire forest area of this division is split into 8 territorial ranges, viz., Kalimpong, Chel, Neora, Pankasari, Jaldhaka, East Jaldhaka, plantation and Lulagaon Ranges and contains 56 blocks under these ranges. Similarly, the Kurseong Forest Division is bounded on the east by the river Tista and on the west by the river Mechi. On the south lies the forest of Baikunthapur Forest Division as well as cultivation and Tea Estates of the Siliguri plains. The Darjeeling civil subdivision forms the northern boundary. The forests of Kurseong Forest Division are mostly situated within the civil subdivision of Kurseong and Siliguri. The whole area of the Reserved forests of Kurseong Forest Division is 287 Sq. Km. which is divided into 5 ranges, viz., Kurseong, Sevoke, Sukna, Bagdogra and Pankhabari and contains 81 blocks



MAP OF THE FOREST AREAS IN THE DISTRICT OF DARJEELING SHOWING SAMPLING LOCALITIES

under these ranges besides unclassed state Forests consisting of 12.33 Sq. Km. spread over 4 ranges containing 16 blocks.

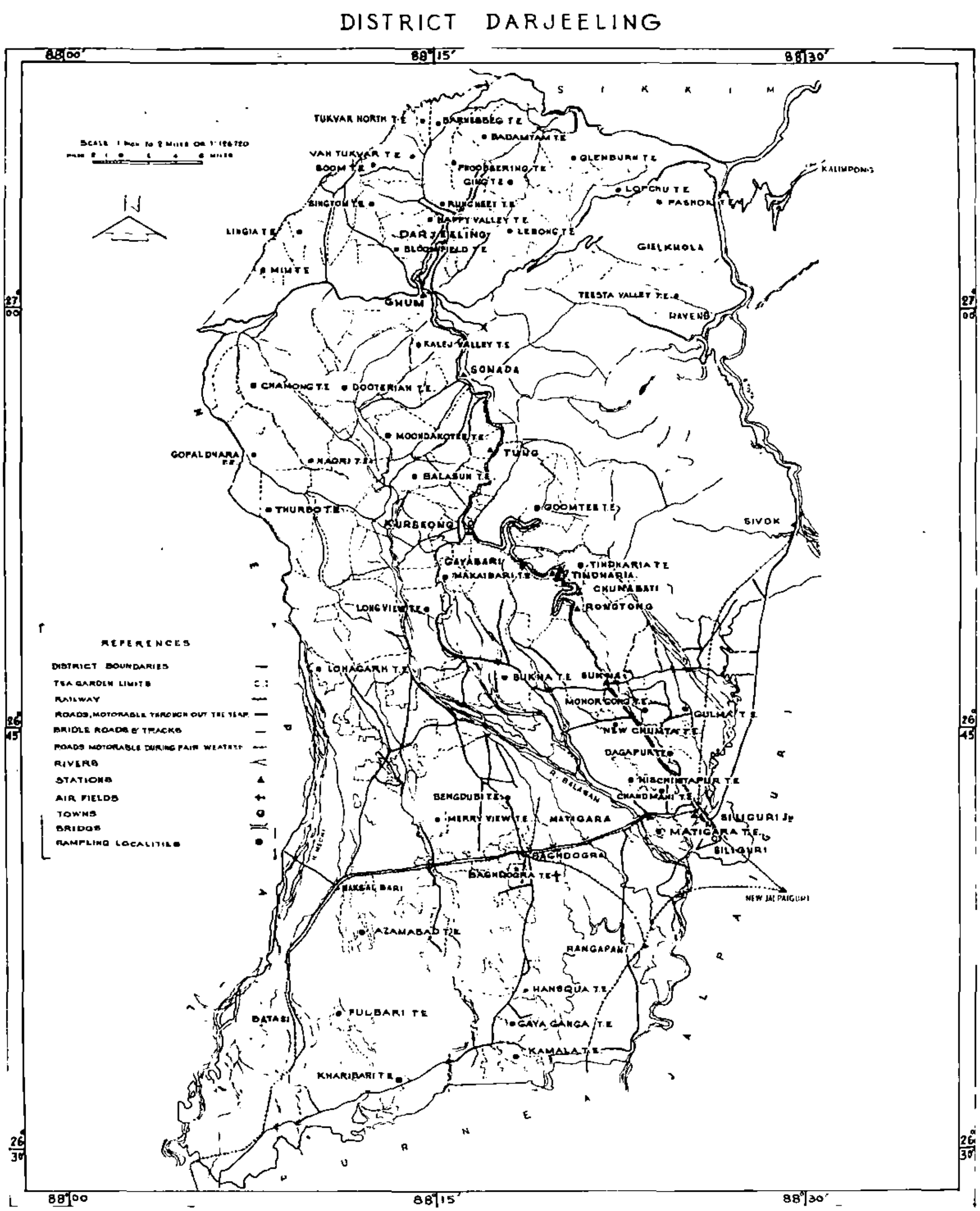
Of the 142 Tea Estates of Darjeeling district 53 are situated in Darjeeling, 6 in Kalimpong, 35 in Kurseong and 48 in Siliguri civil subdivisions.

Geological account :

The district of Darjeeling geologically consists of unaltered sedimentary rocks, confined to the hills on the south and different grades of metamorphic rocks over the rest of the area. The outcrops of the various rocks form a series of bands more or less parallel to the general line of the Himalayas and dipping one beneath the other into the hills of the district. During Tertiary period the great range was elevated on the site of an ancient sea that had accumulated sediments of different geological ages. The present relief of high peaks and deep valleys has been curved by wind, water and snow, three principal agents of denundation. The rock formations found in the district of Darjeeling belong to the Darjeeling Gneiss and Daling series of the Archaeans. The minerals of the district include coal, graphite, iron, copper ores, lime etc.

Pedological account :

3 main types of soil, viz., red, white and black are usually found in the hills of the Darjeeling district. The



MAP OF THE TEA ESTATES IN THE DISTRICT OF DARJEELING SHOWING SAMPLING LOCALITIES

black type is the richest, the white is the poorest and the red type of soil is intermediate in position. But the terai region, the foot hill of the district, is composed of soil which is alluvial in nature, a light sandy loam being the most common. The soil is characterised usually by low clay percentage and high acidity although pH of soil in the different parts of the district varies.

The soil in the Tista and Rangit valleys has been formed by the decomposition of the Daling rocks. The resulting soil is sandy loam with higher portion of sand. In the hills, it is formed by the decomposition of Gneiss rocks and is remarkably suited to the growth of numerous species of trees and other plants found in the forests. Even the greater portion of the hill area lies on Darjeeling Gneiss which most commonly gives rise to a stiff reddish loam but may also produce almost pure sandy or stiff red clay. Generally soils throughout the tract are deficient in lime. Red and yellow podzolic soils have developed on the gneisses and schists on the higher slopes of Darjeeling Himalayas and humus podzols in the valley bottom and other depressions. There is generally leaf mould in the forest floors where the sun rarely penetrates. The floors of the tea fields are also covered with tea litter.

<u>Meteorological account</u> :

The topography and the direction of the prevailing winds solely control the climate of a particular region. However, the main elements of climate are temperature, rainfall, relative humidity, wind etc, which have also been considered in certain cases.

Due to low and high altitudes in different parts of the district the climate varies remarkly in respective places from time to time. But mainly the climate is temperate in the hills, tropical in the terai region while sub-tropical in the tista valley. The winter in Darjeeling extends from December to March and is extremely cold. The summer spreads from April to mid July, the hottest time of the year, though it is delightfully cool. The temperature is least during the rainy season which appears from June to September. The temperature below the freezing point are experienced every year and snow falls occur occasionally in Darjeeling.

Darjeeling is called as one of the dampest hill stations in India because it receives very high rainfall, the sunshine is in deficit and thick mist prevails over the tract throughout greater part of the year and therefore the relative humidity is very high.

The wind is generally rather unsteady at Darjeeling. During the premonsoon months the southern wind current brings moisture from the Bay of Bengal and collides with cool northern and eastern currents and storms take place in the plain down below.

The physiology of the flora and fauna of a particular region depends on the atmospheric pressure which is one of the main factors. The dominant factor, for the zonal vegetation of this district, is the varying altitude.

The average monthly temperature, rainfall and relative humidity in the district of Darjeeling during the collection period is computed below (vide Table 1 and 2).

TABLE - 1

Average monthly Temperature, Rainfall and Humidity in the district of Darjeeling for the year 1977

Months	Mean Max. Temp.(°c)	Mean Min. Temp.(°c)	Mean Total Rainfall(mm)	Mean Relative Humidity (%)
January	11.97	3.23	5.00	82.18
February	6.10	-1.15	Nil	55.01
March	18.60	11.03	18.00	69.78
April	18.51	9.22	124.60	87.48
May	18.40	11.28	12.95	88.35
June	20.18	13.87	14.28	91.98
July	19.82	14.43	23.63	89.29
August	20.72	15.47	19.28	93.09
September	20.79	14.52	20.85	91.16
October	18.27	10.87	25.05	87.90
November	15.88	8.09	9.11	86.43
December	13.04	4.43	Nil	88.19

TABLE - 2

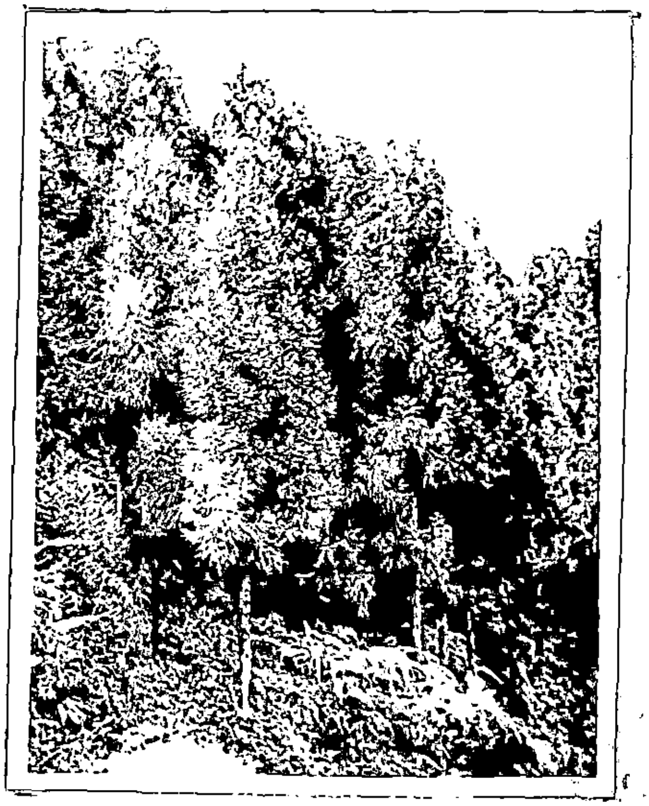
Average monthly Temperature, Rainfall and Humidity in the district of Darjeeling for the year 1978

Months	Mean Max. Temp. (°c)	Mean Min. Temp. (°c)	Mean Total Rainfall (mm)	Mean Relative Humidity (%)
January	9.68	1.99	9.65	85.32
February	12.02	4.14	4.06	80.23
March	16.63	7.67	12.08	64.78
April	19.54	11.13	10.63	74.60
May	19.70	12.91	12.76	86.63
June	20.12	13.95	22.13	91.68
July	20.07	13.53	17.47	94.33
August	22.25	13.80	21.89	86.56
September	20.23	13.03	16.19	92.81
October	21.34	15.21	27.23	73.72
November	16.23	7.45	5.12	83.53
December	15.34	5.84	4.40	66.75

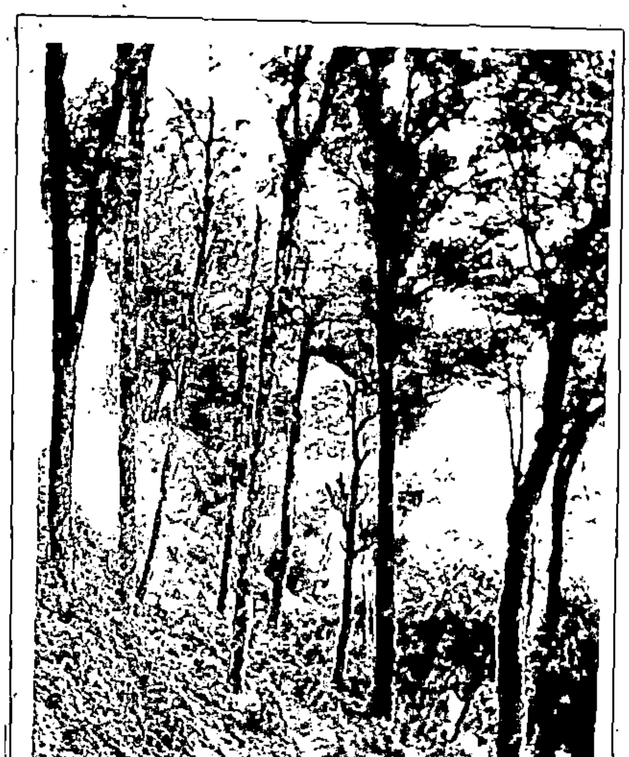
Vegetation :

A number of physiographic, climatic, edaphic and biotic factors are responsible for the richness and variety of the vegetation of this district. The character of the vegetation is being greatly influenced by the configuration of the mountains and hills of the district and the impact of strong moisture laden monsoon winds from south upon them. It is estimated that the plant communities in the district consist of about 4,000 species of flowering plants under 160 families. There are also 300 ferns, including their allies, chiefly *Selaginella*, *Lycopodium*, *Equisetum* spp. etc. In addition, there are many other non-flowering plants-Liverworts, Mosses, Algae, Fungi and Lichens. Of 180 spp. of thallose and foliose, Liverworts reported from India, about 140 spp. are recorded from this area of which 72% are endemic. 75 spp. of the hard fungi which attack timber trees have been recorded from this district.

The forests can be classified into 2 broad groups - (a) Plain forests and (b) Hill forests. In the plains and lower foot hills (up to 900 metre altitude) of the district, there are 4 major types of forest zones that can be accounted as - (i) Riverian forest-dominated by *Acacia catechu*, *Dalbergia sissoo*, *Albizzia* spp. etc., (ii) Sal forests - represented predominantly by *Shorea robusta*, mixed with *Schima wallichii*, *Terminalia belerica*, *Stereospermum chelonoides* etc., (iii) Dry mixed forests-dominated by *Tetrameles nudiflora*,



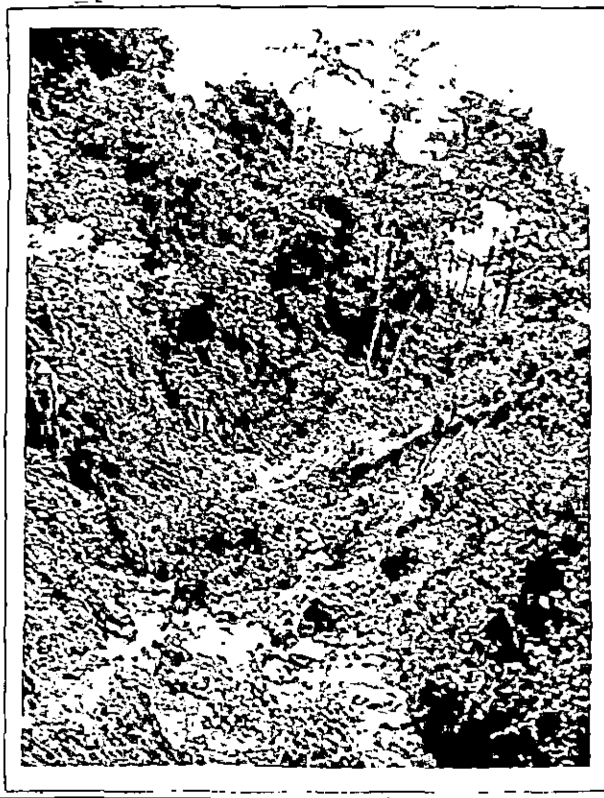
Collection site around the trunk of Cryptomeria japonica in Palmajua (Alt. 2300 m. approx.) under Tonglu forest range, Darjeeling forest Division, Darjeeling.



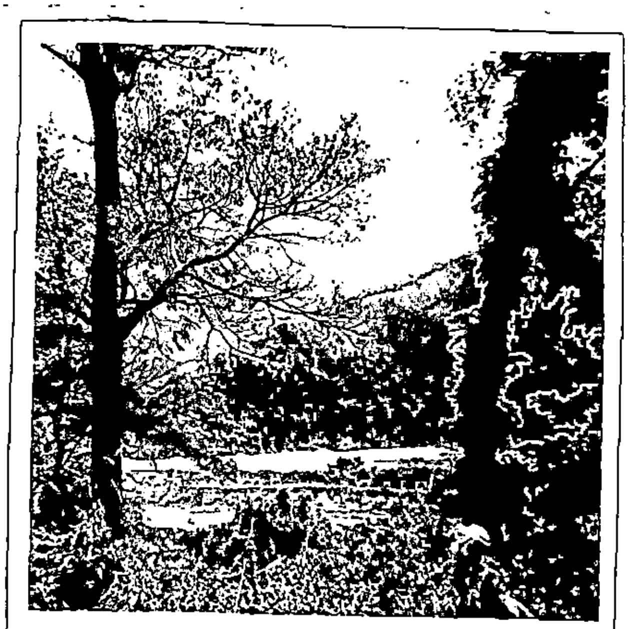
Collection locality on the hilly slope showing mixed broad leaves forest dominated by Quercus lamellosa, Magnolia campbelli etc. in Lepchajagat forest block (Alt. 2000 m. approx.) under Ghum-Simana forest range, Darjeeling forest Division, Darjeeling.

Machilus gammieana, Sterculia villosa, Erythrina indica, Garuga pinnata etc. and (iv) Wet mixed forests-dominated by Terminalia myriocarpa, Amoora rohituka, Michelia champaka, Eugenia spp., Dillenia pentagyna etc. The middle hill forests (from 900 to 1800 metre altitude) are well represented by Schima wallichii, Engelhardtia spicata, Castanopsis tribuloides, Castanopsis indica, Betula cylindrostachys etc. The upper hill forests (from 1800 to 2700 metre altitude) are predominated by Quercus lamellosa, Q. pachyphylla, Q. liniata, Castanopsis indica, Machilus edulis, Bucklandia populnea, Prunus nepalensis, Podocarpus nerifolia, Acer campbellii, Cryptomeria japonica etc. In addition, in the upper zones of the Singalila range, Rhododendron-conifer forest, Oak-Hemlock forest and Alpine forest is quite often noticeable. The conifer are represented by Tsuga brunoniana, Taxus baccata, Abies densa, Cryptomeria japonica etc. Various species of Rhododendrons are present but the most important ones are R. arboreum, R. companulatum, R. barbatum, R. cinnabasinum, R. hodgsonii, R. grande, R. falconeri, R. campanulatum is often found in pure crop in patches above 3450 metre or mixed with conifers. The alpine forest association is illustrated by shrubs like Barberis aristata, Rosa sericea, Gaultheria grifithiana, Crotoneater spp. etc. with several annual herbs.

Natural regeneration is in deficit generally. In the valley forests some regeneration of Duabanga sonneratioides, Anthocephalus indica etc. are noticed, while at the upper



Locality surveyed amongst Quercus liniata, Cestrum aurantianum, Eupatorium glandulosum, Glychenia glauca, Polygonum chinensis, Thumbergia alata etc. in Sonada forest block (Alt. 2100 m. approx.) under Senchal forest range, Darjeeling forest Div., Darjeeling.



Site of sampling by the side of Tista river amongst Albizzia and Tetrameles vegetation in Berrik forest block (Alt. 250 m. approx.) under Sevoke forest range, Kurseong forest Division, Darjeeling.

hill slopes, regenerations of Betula alnoides, Prunus nepalensis, Acer campbellii, Quercus spp., Tsuga brunoniana, Abies dense etc. are observed.

Associated fauna :

The soil fauna associated with the soil oribatid mites in the district of Darjeeling are as follows :

Collembola (Entomobryidae, Isotomidae, Hypogastruridae, Onychiuridae, Sminthuridae and Neelidae), Prostigmata and Mesostigmata mites, Protura, Symphyla, Pauropoda, soil nematodes, enchytraeids, thrips, scolopendra, aphids, pseudoscorpion, Isopoda, Coleoptera, Coleopteran larvae, Diptera, Dipteran larvae, Hymenoptera and different larval and nymphal stages of Insecta. The Collembolan fauna are sometimes predominated over oribatid fauna.

D. Habit and Habitat :

Oribatid mites are primarily fungivorous, algivorous or saprophagous. While examining the gut contents of some oribatid mites Forsslund (1939) and Schuster (1956) observed the fungal mycelia. Oribatids feed mainly on moss, lichen, decaying leaf, humus, fungal spores and nematode eggs. Riha (1951) noticed that some species feed on decaying wood. Murphy (1954) has shown that a number of Ptyctima-mites feed on raw-humus and also observed them to feed on litter, wood and decaying stems.

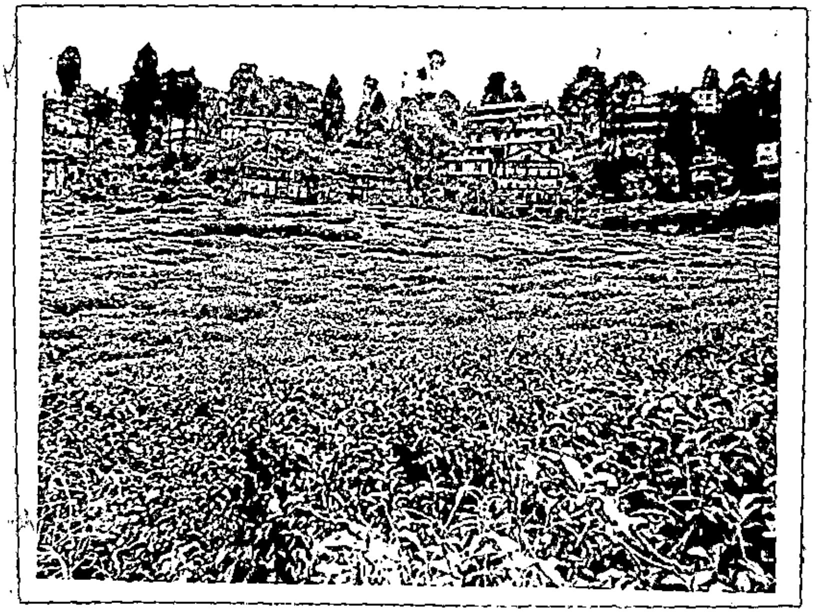
Sampling locality showing tea (Thea sinensis) plantation in Thurbo Tea Estate (Alt. 1700 m. approx.), Darjeeling.

Collection site under a tea plant (Thea sinensis) in Phoob Sering Tea Estate (Alt. 1350 m. approx.), Darjeeling.

The oribatid mites occur in almost all ecological niches, especially where vegetative materials decay with sufficient moisture and are penetrated by fungal mycelia. Majority of these mites are terrestrial in habitat. A few species are slightly hydrophilic and some inhabit the sea (Willman, 1931b). The soil oribatid mites occur in soil litter, compost heaps, humus, decaying logs, moss, lichens growing over tree stumps, twigs and leaves, higher plants (Aoki, 1971), nest of birds (Aoki, 1966; Yeroshenko and Kharchenko, 1970), caves (Moritz et al., 1971), lava caves (Yamamoto and Aoki, 1971), the nest of small mammals (Bulanova-Zachvatkina et al., 1974), pasture soil, coniferous taiga forest, artic tundra (Bregetova, 1965) and even the subantarctic zones (Wallwork, 1973).

The soil oribatid mites are the most abundant soil micro-arthropods and they may be found in a great diversity of habitats ranging from tropical rain forests (Williams,1941) to deserts (Trägårdh, 1905), temperate zone to artic tundra (Hammer, 1944, 1952), intertidal zone (Aoki, 1974a) to high altitude in the mountains (Franz, 1943, 1944).

Van der Drift (1951) estimated that soil mites constitute about 80 per cent of the soil fauna. Bregetova (1965) opined that soil oribatid mites comprise 40 to 70 per cent of the fauna in coniferous taiga. This view has been substantiated in India by Chakrabarti and Raychaudhuri (1965), Choudhuri and Roy (1970, 1971), Singh and Mukherji (1971)



Collection locality beneath the tea (Thea sinensis) plantation in Happy Valley Tea Estate (Alt. 1990 m. approx.), Darjeeling.

Collection site showing tea (Thea sinensis) plantation in Gopaldhara Tea Estate (Alt. 1500 m. approx.), Darjeeling along with natural mixed forest dominated by Alnus nepalensis, Quercus lamellosa, Machilus sp. etc.

and Bhattacharya (1974).

C. General biology :

The works on the biology of oribatid mites are scanty, of which the works of Jacot (1930c), Pérez-Iñigo (1969), van der Hammen (1972a) are worth mentioning. Oribatei are mainly monoecious and reproduce parthenogenetically though majority of acarina are dioecious. The discovery of less than a digital number of males amongst more than fifty thousand discovered species throws little light on the matter.

Three nymphal stages, viz., protonymph, deutonymph and tritonymph are found in the life cycle of oribatid mites. These 3 nymphal stages can be primarily separated from one another on the number of genital suckers present. The protonymph has one, deutonymph two and tritonymph three pairs of genital suckers. The tritonymphal stages are usually similar to the adults, but some nymphs differ markedly from the adults.

D. Economic importance :

Although once considered to be harmless moss-mites, the oribatids are now regarded as an economically important group of soil micro-arthropods and several governments through their various agencies viz., army, navy, agriculture, public health, veterinary, research institute and universities have accelerated the study of the oribatid mites. In recent years, attention has been paid to this group by Acarologists throughout the globe as many species of oribatid mites act as intermediate hosts of certain anoplocephaline cestodes and are responsible for the transmission of various helminth diseases of cattle and other domesticated animals (Stunkard, 1937,1940,1941; Kates and Runkel, 1948; Potemkina, 1941,1944a,1944b; Soldatova, 1945; Wallwork and Rodriguez, 1961 and Usova and Yaroshenko, 1971). Oribatid mites belonging to the families Carabodidae, Liacaridae, Pelopidae, Galumnidae, Oribatulidae, Notaspididae and Haplozetidae have been reported as vectors of various tapeworms. Anantaraman (1951) described a new species of oribatid mites, Scheloribates madrasensis from Madras, India, which was known to act as intermediate host of Moniezia, the large tapeworm of domestic ruminants.

It is claimed by Oribatidologists that the oribatei may be instrumental in decomposing organic material in or on the soil and promote soil fertility. Sellnick (1928) believed that they contribute considerably to the fertility of the forest soil. Spencer (1951) remarked that the role played by these mites in the comminution of decaying leaf tissue is of a higher order. Murphy (1955) opined that their role in promoting soil fertility can not be neglected.

Jacot (1930a) pointed out that the bodies, bristles, legs and mouth parts of many species of oribatid mites are infested with spores of fungus and they transmit fungal infection to plants while moving from one plant to another.

Sengbusch (1954) observed that the oribatid mites can cause minute injuries to the plants with their mouth parts and so it is possible that the disease germs are directly inoculated into the plants. Rockett and Woodring (1966b) suggested that the saprophytic oribatid mites comprise an important natural group regulating soil nematode populations.

Therefore, in view of their importance and significance in Soil Zoology, agriculture, veterinary and parasitology, the study of the taxonomy of this group of mites should be accelerated.

E. Material and Method :

Soil samples were collected by the writer from different areas of forests and tea estates in the district of Darjeeling in search of oribatid mites since 1977 (vide maps). Extraction of soil oribatids from the different soil samples was made using both Berlese funnel modified by Tullgren (1918) and Tullgren apparatus modified by Haarløv (1947). The kind of dry behavioural extraction apparatus used is a large galvanised tin funnel, bearing on its upper opening a fine gauged (1.5-2.5 mm.) wire mesh. 5 cm. thin layer of soil samples were placed on this mesh, and the funnel was fixed on a stand. An electric bulb (40 W.) was used on the upper surface of soil samples for heating and desiccating the same from above. A glass vial containing a small quantity of 75-85% alcohol was placed under the lower opening of funnel and 5% glycerol was occasionally added to the alcohol to prevent evaporation of the alcohol too soon. As a result of the dry funnel extraction method, the extracted oribatid specimens were then transferred into an equal amount of 80% alcohol and lactic acid in a small vial for desclerotization as advised by Balogh (1965, 1972). When the mites became transparent, almost vitreous a certain amount of concentrated lactic acid was used as a mounting medium for microscopic studies following Grandjean (1949) and Balogh (1965, 1972). Some other known permanent mounting media e.g., canada balsam, polyvenyl alcohol, Hoyer's mounting medium etc. were tried but the results were not satisfactory. Finally, Balogh's (1965, 1972) temporary mounting method was preferred.

After microscopical examinations the specimens were kept in the Derham's tube (2.5x0.7 cm) containing 80% alcohol and plugged with absorbent cotton with tissue paper for final preservation and they were put into large tube (5x1.2 cm) with labels giving details of the species i.e., habitat, locality, date of collection, name of collector, name of the species etc. Further, alcohol was added and the tube was plugged with either cork or cotton wool and finally, the plugged tube was preserved in glass jars in 80% alcohol.

Measurements were taken with the aid of ocular and stage micrometers. Camera-lucida drawings were made for every specimen (both new and known species) and that of new species are provided as photo-copies in this dissertation.

The collections, after final examination with proper label, are kept in the laboratory of the Department of Zoology, Presidency College, Calcutta.

F. Morphology and Terminology :

The body of an oribatid mite consists of two parts, the propodosoma or prosoma, the dorsal covering of which is termed as prodorsum, situated anteriorly and posteriorly situated opisthosoma or hysterosoma comprising the abdominal region, the dorsal covering of which is called notogaster. The prodorsum and notogaster are demarcated by the dorsosejugal suture in most of the oribatei.

Propodosoma : The propodosoma is articulated to the hysterosoma movably (Perlohmannoidea) or immovably (Nothroidea). In phthiracaroidea and Euphthiracaroidea the propodosoma termed as aspis (Figs. 3,5) can be folded like the blade of a penknife to the hysterosoma. In most cases the prodorsum is smooth, but it may be ornamented variably viz., puncate (Fig.5), foveolate (Fig.31), granulate (Figs.11,13,15), reticulate (Fig.35) or with protruding areae porosae (Fig.7). Anterior extremity of prodorsum is called rostrum which sometimes bears teeth (Fig.33, Ceratoppia, Ceratozetes). Rostrum may be pointed (Xiphobelba), very acute (Rhynchoribates), tubiform (Nasobates), rounded (Figs.18,20,22,24,28), mucronate (Fig.31), truncate (Truncopes), dentate (Rhynchoppia) or incised (Suctobolba). From the base of the prodorsum and towards the rostrum, there usually remains on either side flat, lath-shaped or expanded structure called lamellae (in most Poronoticae), or rib-like, narrow costula (in most Pycnonoticae). The development, shape and position of lamellae is variable viz., weakly sigmoid (Kodiakella), ribbon-shaped (Fig. 35, Oribatula), linear (Lucoppia, Phauloppia), narrow (Limnozetes), wide (Joelia), very wide, covering entire prodorsum (Cuspitegula), intricate form (Leobodes, Nippobodes), meeting at one point only (Cepheus, Sadocepheus), meeting along a longer common line (Eremaeozetes, Topalia), wholly fused along median line with a 'V' -shaped incision medially (Umbellozetes), straight, convergent (Ceratoppia, Pyroppia), situated medially (Figs.18,20,22, 24,26,28), situated marginally (Fig. 37, Microtegeus). Sometimes the lamellae are connected apically by narrow transverse ridge (Fig.35) called translamella. Translamella may be linear (Melanozetes, Unguizetes, Baloghobates), wide (Opsiorlstes), long (Porozetes), ribbon-shaped (Fig.35, Trichoppia, Calyptozetes) The apical part of the lamellae is called cuspis. Cuspis may be long (Opsioristes, Macquarioppia), short (Hypozetes), rounded (Hypozetes), with external apex (Ferolocella), with two points (Oribatella, Fenestrobates), outwardly pointed (Lamellobates, Microzetes), outwardly obtuse (Brazilozetes), arcuately incised (Fuscozetes, Cosmozetes), with short teeth (Undulozetes), with pointed teeth (Schizozetes), obliquely truncate (Rugozetes), arcuately truncate (Parahypozetes), or projecting beyond rostrum (Eupterotegaeus, Cuspitegula). Costulae may be parallel (Megeremaeus), divergent (Kodiakella), long (Anderemaeus), short (Veloppia), 1 pair usually, 2 pairs (Cristeremaeus), wide (Cosmogneta), introrsely arcuate (Operculoppia), lyriform (Lyroppia), trapeziform (Quadroppia).

A small cup-like structure situated generally near the base of prodorsum laterally, called bothridium or pseudostigma (Figs. 7,9,15,28,35,39) is one of the main characters of oribatid mites. Bothridium is absent (Malaconothrus, Trimalaconothrus, Zeanothrus, Fossonothrus, Mucronothrus, Trypochthoniellus, Hygroribates), extremely small (Ameronothrus) or may be reduced (Hydrozetes). Sometimes the opening of bothridium is covered by a lid (Operculoppia). Bothridial scale (Figs.3,5) may be present occasionally (Euphthiracaroidea).

Sensillus, another main character of this mites, arises from bothridium. Sensillus is absent (Malaconothrus, Trimalaconothrus, Mucronothrus, Fossonothrus, Zeanothrus, Hygroribates, Trhypochthoniellus), extremely small (Ameronothrus, Hydrozetes). There are different types of sensilla in this group. It may be (Figs. 3,5,37,39) unbranched (Hanhermannia, Masthermannia, Cyrthermannia) or with 3 (Trizetes) or with many branches (Gitella, Multioppia, Brachioppia) at it's distal half. Sensillus may be setiform (Leobodes, Ceratoppia, Amazoppia, Rhaphidosus, Magnobates, *Ceratorchestes*, *Eremobodes*, *Setenoribates*, *Simkinia*, *Urubambates*, *Conchogneta*), rod-shaped (Fig.9), fusiform (*Oppiella*, *Oxyoppia*, *Liacarus*, *Licnocepheus*, *Solenoppia*, *Pedrocortesia*, *Chavinia*), flagelliform (Figs.13,15, *Eremulus*, *Metabelba*, *Novonothrus*, *Aleurodamaeus*), filiform (Fig. 11, *Palaeacarus*, *Pseudonothrus*), pectinated (Fig.7, *Trichthonius*, *Ramognota*, *Ctenobelba*, *Enantioppia*, *Tripiloppia*, *Synoppia*, *Brachioppiella*, *Ramusella*, *Sternoppia*, *Cryptoppia*, *Porrhoppia*, *Ramuloppia*, *Epimerella*, *Ctenogalumna*, *Lohmannoidea*). The head of the sensillus may be spoon-shaped (Fig.18), club-shaped (Figs. 37,39), clavate (Fig.35), licheniform (*Licnodamaeus*, *Licneremaeus*), capitate (*Amerioppia*, *Eremella*, *Aeroppia*, *Belloppia*, *Heteroppia*, *Austrognota*, *Procorynetes*), bacilliform (*Suctoribates*), lanceolate (*Lanceoppia*, *Minunthozetes*), globular (*Globoppia*, *Ommatocepheus*). Sensillus may be proclinate (*Microzetes*, *Papuazetes*, *Rugozetes*, *Schalleria*), reclinate (*Oxyzetes*, *Mysterozetes*, *Stylozetes*, *Miracarus*, *Nellacarus*), exclinate (*Austrozetes*) or fully covered (*Cryptobothria*).

Eyes are absent in case of oribatid mites but presence of 3 eyes has been reported in *Heterochthonius gibbus* Berlese, 1910 (vide Grandjean, 1928a).

Generally prodorsum bears 5 pairs of setae viz., rostral (*ro*), lamellar (*la*), interlamellar (*int*), anterior exobothridial (*exa*) and posterior exobothridial setae (*exp*). The latter two setae (*exa* and *exp*) may sometimes be reduced or absent.

The rostral setae is absent (Amnemochthonius). It may arise from below (Saxicolestes) or above (Litholestes) the rostrum and may be simple (Figs. 15,39, Malaconothrus, Trimalaconothrus, Xenolohmannia, Archegozocepheus) or bifurcate (Zetorchestes, Hardybodes, Nothrolohmannia). The rostral setae may be foliate (Fig. 7), slightly elbowed (Fig. 31), strongly elbowed (Fig. 33), buldge in the middle (Fig. 13), glabrous (Fig. 31) or barbed (Figs. 18,28,35).

Lamellar setae is absent (Poroliodes, Liodes) or reduced (Angullozetes). It may be foliate (Fig. 7, Lohmannia), bifid with flagelliform tips (Masthermannia), stout (Fig. 13) or thin (Fig. 31). It may be placed on rostrum close to the rostral setae (Figs. 18,20,22,24) or on prodorsum far backward from rostral setae (Figs. 3,5,31,35) or adjacent to dorsosejugal suture (Cuneoppia). Lamellar setae are generally located in the vicinity of lamellar apex or on lamellar cusps (Figs. 35,37). It may be situated on a prominent knob-like lamellar apophyses (Figs. 11,15), glabrous (Figs. 11,31), barbed (Figs. 18,20, 22,24,26,28,35,37), proximally barbed (Fig. 15), distally barbed (Figs, 1,3,5). It may originate marginally (Pedrocortesia), dorsally (Pedrocortesella) or near interlamellar setae (Rhinosuctobelba).

Interlamellar setae are generally situated on interbothridial region in between the lamellar bases. It may be located near dorsosejugal suture (Amazoppia, Ocesobates), on dorsosejugal suture (Fig. 39, Jugoribates). It is absent (Amerioppia, Hypovertex, Phalacrozetes, Orthozetes, Dinozetes, Porrhotegaeus, Pterozetes, Cantharozetes, Cuspitegula) or may be reduced (Rhabdozetes, Metrioppia). It may be fusiform (Sacculobates), papilliform (Papillonotus), spatulate (Fig. 39), long, glabrous (Fig. 31), long, barbed (Figs. 11,26,28,35), plumose (Plumobates, Cosmobates), willow-leaf-shaped (Papillocepheus), apically bifurcate (Parapelops), short (Sadocepheus), long (Cepheus), longer than lamellae (Megallozetes, Jugatala), longer than prodorsum (Stenoxenillus), setiform (Peloptulus, Magnobates, Clavazetes), erect (Figs. 3, 5, Notophthiracarus). It may originate near each other (Eremulus) or on lamellae proper (Leobodes, Hippobodes, Microzetes, Fuscozetes, Rugozetes).

Anterior and posterior exobothridial or exopseudostigmatic setae originate from anterior and posterior side of the bothridium respectively. Both may be present (Fig. 7), absent (Figs. 9,22,24,37,39), or only the anterior one may be present (Figs. 11,13,15,18,20,26,28,31,35).

The prodorsum is usually separated from the notogaster by a suture, sutura dorsosejugalis or dorsosejugal suture (Figs. 7,9,11,13,15,18,20,22,24,31,33,37,39). It is absent (Tectocepheus, Litholestes, Strenzkea, Belorchestes, Cavernocepheus, Paraphauloppia, Sellnickia, Grandjeania, Allozetes, Acanthozetes, Brachyoripoda, Oxyamerus, Beckiella, Dampfiella, Pteremerus, Nesmerus, Amerus, Andesamerus) or interrupted medially (Fig. 35, Nasobates, Eporibatula, Unguizetes, Rhopalozetes, Brachyoripoda, Terrazetes, Podoribates, Constrictobates, Dynatozetes, Tentaculozetes, Trichogalumna). It may be straight (Eremulus, Pyroppia, Oribatodes, Nemacepheus, Megeremaeus, Pseuderemulus, Reteremulus, Oribella, Cristeremaeus, Ctenobelba, Proteremaeus, Nesoribatula, Siculobata, Domatorina, Protoripoda) arcuate (Kodiakella, Fosseremus, Damaeolus, Granuloppia, Operculoppia, Homoppia, Octoppia, Laminoppia, Ramuloppia, Mancoribates), cuneate anteriorad (Cuneoppia, Podacarus, Epimerella, Kaszabobates, Licneremaeus), convex anteriorad (Bornebuschia, Tegeocranellus), concave anteriorad (Glanderemaeus, Bulleremaeus), usually with a single arch (Figs. 9,13,31,37) or with 3 arches (Rostrozetes).

The propodosoma bears gnathosoma or capitulum, epimeral or coxisternal plates and legs in the ventral side. Gnathosoma is composed of cheliceras, pedipalpi, hypostomal and epistomal structure. Generally chelicerae is simple but may be peloptoid (Eupelops, Peloptulus, Cuneoppia, Metrioppia, Xiphobelba, Beckiella), or attenuating (Suctobelbidae). Epimeral region consists of 4 (I-IV) epimeral or coxisternal plates. Epimeral setae may be simple (in most cases) or may be bi-and triradiate (Eremulus), or penta-and hexaradiate (Fig. 12). The number of setae on epimeres I-IV is represented by a formula, called the epimeral setal formula, which in most cases is 3-1-3-3 (denoting number of setae in epimeres I-IV). Generally 4 epimeral plates are attached to each other but in case of _Paulianacarus_ (Fig. 8), _Malaconothrus_ and _Haplacarus_ in between I, II, and III, IV epimeral plates there is a gap. The epimeral plates are bordered by chitinous thickenings, the apodemata which are usually 5 in number viz., apo_1, apo_2, apo_{sj}, apo_3 and apo_4 (Fig. 10).

Legs may be monodactylous (_Malaconothrus_, _Platynothrus_, _Dolicheremaeus_, _Megalotocepheus_, _Pseudotocepheus_, _Tectocepheus_, _Zetorchestes_, _Microtegeus_, _Leobodes_, _Lamellobates_, _Basilobelba_, _Hymenobelba_, _Eremulus_, _Eremobelba_, _Rostrozetes_) or tridactylous (_Ceratoppia_, _Ameronothrus_, _Zygoribatula_, _Eupelops_, _Peloribates_, _Chaunoproctus_) but rarely bidactylous (_Passalozetes_, _Arthronlophora_, _Phyllochthonius_). Legs I-III monodactylous and leg IV tridactylous (_Heterobelba_, _Heterogalumna_). Leg I monodactylous and leg II-IV tridactylous (_Heterozetes_, _Cultrobates_). Legs I-III monodactylous, leg IV bidactylous (_Onychobates_). Legs I-II monodactylous, legs III-IV tridactylous (_Hamobates_). Legs I monodactylous and others without claw (_Strenzkea_). Legs consist of 6 segments, viz., coxa, trochanter, femur, genu, tibia and tarsus, arranged uniformly. In primitive oribatids it may be cylindrical but the length and shape may vary in case of higher oribatid mites. In Palaeacaroidea, the femur is divided into 2 parts viz., basifemur and telofemur. A typical hollow sensory (most probably chemoreceptor) seta is present in the distal segments of the legs, termed as "Solenidien" by Vitzthum and "Solenidions" by Grandjean.

Hysterosoma : Notogaster may be rounded (Figs. 13,35,39, Bremulus), elongated (Malaconothrus, Nanhermannia, Cyrthermannia, Entomotritia), oval (Figs. 11,18,20,31,37) or sometimes posterior portion broader than anterior (Allonothrus) or posterior border conical in shape (Annectacarus), pentagonal (Archegozetes), hexagonal (Notogalumna), flat (Platyliodes) or hemispheric (Metabelba, Belba, Damaeus). Notogaster may be smooth (Suctobelbilla, Hydrozetes), punctate (Figs. 5,9), foveolate (Fig. 35), pitted (Fig. 37), granulate (Fig. 11), with protruding areae porosae (Fig. 7), reticulate (Annectacarus), tuberculate (Cepheus), with large tubercles (Neocarabodes), with chitinous crests (Apotomocepheus), with sculpture (Scapheremaeus), with semicircular depressions (Fossoremus), with cerotegumental granules (Fig. 11, Ctenobelba, Granuloppia, Granizetes), with 4 longitudinal ridges (Fossonothrus), with 4 transverse crests (Arthrovertex), with scattered light spots (Licneremaeus), with carina at shoulder (Saxicolestes, Litholestes, Strenzkea), with fine parallel or radiating lines (Striatoppia), with areolate or polygonal chitinous structure (Licnocepheus, Eremella), with a hexagonal structure anteriorly (Anoribatella), with 1 median pore (Allogalumna), with a deep hollow anteriorly (Spinozetes, Cavernocepheus, Charassobates), with lenticulus (Fig. 39, Arthrovertex, Scutovertex), with nymphal exuviae

(Figs, 13,15, Xiphobelba, Haplobelba). Notogaster is generally undivided but sometimes it may be divided by one (Gehypochthonius, Sphaerochthonius), two (Trichthonius, Liochthonius, Brachychthonius) or three (Haplochthonius, Pterochthonius, Cosmochthonius) sutures. On its posterior border there may be one (Sellnickia), two (Grandjeania) or four (Cyrthermannia) tubercles. Latero-abdominal glands may be present in parhypochthonioidea, but absent in Hypochthonoidea. Generally 10-16 pairs of notogastral setae are observed in oribatid mites; 3 pairs (Fig. 13), 2-7 pairs (Ceratoppia), 7-10 pairs (Fig.39), 9 pairs (Microtegeus, Leobodes, Hippobodes), 10 pairs (Figs.18, 20,22,24,26,28, Tectocepheus, Hymenobelba, Oppiella, Lamellobates, Oribatella, Scheloribates, Rostrozetes), 11 pairs (Fig. 11, Eremulus, Ceratozetes, Zetorchestes), 14 pairs (Fig. 37, Rhysotritia, Spinoppia, Zygoribatula), 15 pairs (Fig. 9, Neocarabodes), 16 pairs (Nanhermannia, Cyrthermannia, Masthermannia), or even 32-35 pairs (Neotrichozetes). Notogastral seta is absent (Gustavia, Vilhenabates, Parapelops, Phalacrozetes, Baloghobates, Conozetes, Pergalumna, Xenogalumna, Cryptogalumna, Allogalumna, Aerogalumna) or sometimes 50-55 pairs of alveoli present (Multoribula). Notogastral setae may be simple (Fig.31, Nanhermannia), phylliform (Fig. 7, Malacoangelia, Striatoppia, Stachyoppia), fan-shaped (Fig.33), widening like a knife-blade (Fig. 9), fusiform (Ampullobates, Sacculobates), setiform (Oribella, Reticuloppia, Diapterobates), papilliform (Papillonotus), dilated (Phyllocarabodes, Eremella, Sacculoppia), spatulate (Aokiella, Mystroppia), blade-shaped (Pseudoremulus), incrassate (Carabodoides), with vesiculately incrassate apex (Tentaculozetes). Sometimes notogastral setae may be reduced (Angullozetes), very short (Suctobelbila), extraordinarily long (Stelechobates), glabrous (Fig. 31, Heterozetes, Globozetes), barbed (Figs. 9,18,22,24,26,28), long, flagelliform, curved at the distal half (Fig. 11), with long, bifid, flagelliform tips (Masthermannia), or may be much reduced to alveoli (Gymnobates, Ctenogalumna). Usually in higher oribatids there are 4 pairs of areae porosae termed as Aa, A_1, A_2 and A_3 (Phauloppia, Subphauloppia, Zygoribatula, Ceratozetes, Eupelops, Flagellozetes, Cerachipteria), or they may be 2 pairs (Pseudoppia, Scutovertex), 3 pairs (Passalozetes), 5 pairs (Fig. 35, Reticuloppia), 8 pairs (Spinoppia, Neotrichozetes) or even 15-20 pairs (Rykella). These may be absent (Galumnella, Neoscutegaeus). The shape of those areae porosae are generally circular but may also be ribbon-shaped (Capilloppia) or only posterior two areae porosae (A_2 and A_3) are ribbon-shaped (Terrazetes). Sometimes sacculi, slit or dot-like openings on notogaster may be present, these are 4 pairs viz., Sa, S_1, S_2 and S_3 (Fig.37, Rostrozetes, Scheloribates) generally, but may be 5 pairs (Nannerlia), or 6 pairs (Fissurobates), sometimes pores may be reduced to pin-heads termed as pori (Trachygalumna, Pseudachipteria). In higher oribatid mites, 3-5 pairs of slit-like fissures, lyrifissures, viz., ia, im, ih, ips, ip are present on notogaster (Figs, 9,18,20,22,24,26,28,37). Orifice of latero-abdominal gland termed as gla is sometimes present on notogaster (Figs. 18,20,22,24,26,28).

The pteromorpha, a wing-like appendage, originates from antero-lateral margin of notogaster in many oribatids (Scheloribates, Pilobates, Rostrozetes, Galumna, Epactozetes, Galumnella, Galumnopsis), which may be movable (Figs. 37,39, Pelopsulus, Parapelops, Rostrozetes) or immovable (Ceratozetes, Scheloribates, Microzetes), horizontal (Multoribates) or bent downwards laterally (Cosmobates). The anterior margin of the pteromorph may be straight or concave and lateral margin may be parallel with the body or wavy (Scheloribates).

Venter

Ventral plate : The ventral part of the hysterosoma is entirely covered by ventral plate which may be divided either completely or partly by a transverse suture. The suture may be parabolic (Eulohmannia), or semicircular (Cyrthermannia, Masthermannia) or straight (Epilohmannia). The genital plates are located on the anterior half of the ventral plate and the anal plates are situated on posterior half. The genital and anal plates may be connected with each other and occupy entire length of the ventral plate. These may be large, triangular (Nothrus, Platynothrus, Allonothrus, Malaconothrus, Trimalaconothrus) (Macropyline type characteristic of primitive oribatid mites) or may be small and more or less circular in shape placed apart from each other (Figs. 19,21,23,25,27,29,32,34,36,38,40) (Brachypyline type characteristic of higher oribatids).

Genital plate : In most of the cases genital plates may be circular or rounded (Figs. 17,36,38,40) or narrowly triangular (Rhysotritia). These may be divided in primitive oribatids by a transverse suture (Eohypochthonius, Lohmannia, Heptacarus, Perlohmannia, Liodoidea) or may be undivided (Fig. 8, Hypochthonius, Javacarus, Haplacarus, Dendracarus, Mixacarus, Millotacarus, Annectacarus). 4-6 pairs of genital setae are present generally in oribatid mites. These may be 1 pair (Pirnodus), 2 pairs (Constrictobates), 3 pairs (Figs. 27,29, Trichocepheus), 4 pairs (Figs. 19,21,23,25, Leobodes, Zygoribatula, Scheloribates, Neosuctobelba, Tuberemaeus), 5 pairs (Fig. 38, Microtegeus), 6 pairs (Figs. 2,12,17,32,34,36,40, Eremulus Hymenobelba, Lamellobates, Neocarabodes, Zetorchestes, Tectocepheus), 7 pairs (Fig. 14), 8 pairs (Flammeremaeus), 8-9 pairs (Rhysotritia), 9 pairs (Figs. 4,6), 10 pairs (Fig.8), 13 pairs (Fig. 10), or may be sometimes 13-25 pairs (Platynothrus). Generally genital setae are simple but these may be barbed (Fig.14), or biradiated (Eremulus). The aggenital setae are usually found posterior to genital plates (Figs. 19,21,23, 25,27,29,32,34,36,38,40) or on lateral side of the genital plate (Figs. 10,14). These may be 1 pair (Figs. 19,21,23,25, 27,29,32,34,36,38,40), 2 pairs (Fig. 10, Rhysotritia, Platynothrus), 3 pairs (Pilobates, Tripiloppia, Terratritia) or may be absent (Nothrus, Allonothrus, Malaconothrus, Trimalaconothrus, Archegozetes). In most cases these are simple but may be bi-or triradiated (Eremulus).

Anal plate : An unpaired plate without setae is situated infront of anal plates termed as preanal plate (Fig. 8). It may be a small triangle-shaped (Annectacarus, Cryptacarus, Dendracarus) or wide transverse strap-like (Fig.8, Javacarus, Haplacarus, Millotacarus). Anal plates may be fused with lateral adanal plates (Fig., Javacarus, Haplacarus, Cryptacarus) or may be separated from each other (Meristolohmannia, Thamnacarus, Lohmannia, Lepidacarus, Papillacarus, Meristacarus, Mixacarus). Anal setae are usually 2-3 pairs. These may be absent (Javacarus) or 1 pair (Haplacarus), 2 pairs (Figs. 4,6, 8,10,12,14,17,19,21,23,27,29,32,34,36,38,40), 3 pairs (Figs. 2,25, Hoplophorella, Rhysotritia), 4 pairs (Steganacarus). These may be simple in most cases but may be also barbed (Figs. 19, 21,23,25,29). Adanal setae are generally 3 pairs (Figs. 4,6, 10,19,21,23,25,27,29,32,34,38,40). It may be one pair(Gymnobates, Exoripoda), 2 pairs (Microtegeus, Zetorchestes, Lamellobates), 4 pairs (Fig.8), 5 pairs (Torpacarus), or 8-9 pairs (Psammogalumna). An adanal pore termed as iad, is slit-like in appearance, may be parallel (Figs. 12,17,32,34,36,38) or oblique (Figs. 19,21) to the lateral border of anal field or aligned nearly transversely close to the anterior margin of anal opening (Fig.10).

Neotrichy in Oribatid mites : Travé (1979) provided a review of neotrichy in oribatid mites. Ho (op.cit.) elucidated that body regions in the progressive evolutions are, in order of importance : aggenital region, epimeric region, notogaster, genital region, adanal region, anal region and infracapitulum. Neotrichy is a secondary phenomenon. It occurs more frequently in the lower oribatids than in the higher oribatids. Gastronotic neotrichy is more frequent chiefly in Lohmannoidea, Ctenacaroidea and genital neotrichy in Nothroidea. Pygidial neotrichy may be strongly (Thamnacarus, Vepracarus) or weakly (Papillacarus, Annectacarus) developed.

G. Abbreviations used :

Abbreviations of notations are used here following Grandjean (1934a), Knülle (1957), Wallwork (1960,1967a,1967b), Aoki (1965c,1967b), Balogh (1972), and Hammer (1972) as follows : ro = rostral setae, la = lamellar setae, int = interlamellar setae, exa = anterior exobothridial setae, exp = posterior exobothridial setae, ss = sensillus, bo = bothridium, tbd = dorsal bothridial plate, tbv = ventral bothridial plate, sc = bothridial scale, lc = lateral carinae, spa.l = lateral lamelliform expansion, tU = tutorium, rin = interlamellar wrinkles, pd.2-3 = pedotecta - complex II-III, spd = subpedotectum, co.pl = lateral prodorsal condyles, co.pm = median prodorsal condyles, co.nl = lateral notogastral condyles, co.nm = median notogastral condyles, ve = notogastral tubercle, n = thong of buckle attachment, a = arm of buckle attachment, pt = pteromorph; c_1 , c_2 , c_3 , cp, d_1 , d_2 , d_3 , e_1 , e_2 , f_1 , f_2 , h_1 , h_2 , h_3 , ps_1 , ps_2 , ps_3 =

notogastral setae in primitive oribatids, ta, te, ti, ms, r_1, r_2, r_3, p_1, p_2, p_3, s1, s2, s3, s4, l1, l2, l3, c_1, c_2, cp, d_1, d_2, da, dm, la, lm, lp, e_1, e_2, f_1, f_2, h_1, h_2, h_3, ps_1, ps_2, ps_3 = notogastral setae in higher oribatids; RLN = relative length to notogaster; vm = marginal ridge; ia, im, ih, ips, ip = dorsal lyrifissures; Aa, A_1, A_2, A_3 = areae porosae on notogaster; Sa, S_1, S_2, S_3 = sacculi on notogaster; gla = orifice of lateroabdominal gland; an = anal plate; an_1 - an_3 = anal setae; ad = adanal plate; ad_1 - ad_3 = adanal setae; iad = adanal fissure; gon = genital plate; g_1 - g_{18} = genital setae; ag_1-ag_2 = aggenital setae; 1a, 1b, 1c, 2a, 3a, 3b, 3c, 3d, 3e, 4a, 4b, 4c, 4d, 4e, 4f, 4g = epimeral setae on epimeres I, II, III and IV respectively; apo_1, apo_2, apo_{sj}, apo_3, apo_4 = apodemata; c.st = sternal ridge.

H. Systematics :

The systematic position of oribatid mites is still somewhat controversial, although, Vitzthum (1931) proposed it as follows :

Acarina Nitzsch
Order Acarina Nitzsch
Suborder Sarcoptiformes Reuter
Supercohors Oribatei Duges

Redford (1950) and Baker and Wharton (1952) also followed Vitzthum's (1931) classification. But in later years Fujikawa

(1972) considered oribatei as a suborder of the order Acari.

Van der Hammen (1972a) elevated the group to the status of an order, but proposed a new name, Oribatida instead of Oribatei. While doing so Van der Hammen (1972) rejected the names Cryptostigmata, Mesostigmata, Prostigmata, etc., proposed by Evans, sheals and Macfarlane (1961) for classifying mites and divided the mites into two superorders viz., Anactinotrichida and Actinotricha, the former consisting of the orders Opilioacarida, Holothyrida, Gamasida and Ixodida and the latter Actinedida, Oribatida, Acaridida and Tarsonemida.

Basing on the ontogenic stages of Oribatei a new system of classification was introduced by Grandjean (1954a). Woolley (1958a) and van der Hammen (1968,1971,1972a,1972b) attempted the phylogeny of the group. Almost all new taxa are erected on the basis of taxonomic characters of adult specimens as the life history stages of 98% of oribatid mites are still unknown. So in recent years most of the oribatidologists follow Balogh's (1961b,1963a,1965,1972) system of artificial classification which is based on simple, easily recognizable, morphological adult characters.

I. <u>Short historical account</u> :

There are approximetely fifty thousand species of oribatid mites which belong to near about 800 genera, over 140 families and 44 superfamilies so far known from the literature. Taxonomy of the oribatid mites has come to the limelight of scientific study from different parts of the globe through the works of different workers. So prior to work on taxonomy of oribatid mites we should mention the devoted works of Koch (1836-1841,1842), Michael (1880,1884-1888, 1898, 1908), Berlese (1884, 1885, 1888, 1892, 1895, 1896, 1903, 1904, 1905, 1908, 1910, 1913, 1916), Ewing (1908, 1909, 1910, 1913, 1917, 1918), Oudemans (1896, 1900, 1902, 1903, 1906, 1915, 1916, 1917, 1929), Willmann (1918, 1919, 1925, 1928, 1929, 1930, 1931, 1935, 1936, 1938, 1939, 1940, 1941, 1943, 1951, 1953), Jacot (1923, 1924, 1925, 1929, 1930, 1933, 1934, 1936, 1937, 1938, 1939), Sellnick (1919, 1922, 1923, 1925, 1928, 1950, 1955, 1958, 1959, 1960), Grandjean (1928, 1931, 1933, 1934, 1936, 1941, 1942, 1948, 1950, 1954, 1958, 1967, 1971), Balogh (1937, 1943, 1958, 1959, 1960, 1961, 1962, 1963, 1965, 1966, 1968, 1970, 1972), van der Hammen (1952, 1959, 1963, 1968, 1971, 1972), Hammer (1944, 1952, 1953, 1955, 1958, 1961, 1962, 1966, 1967, 1968, 1970, 1971, 1972, 1973, 1975, 1977, 1979), Woolley (1957, 1958, 1961, 1967, 1969), Kunst (1957, 1958, 1959, 1961, 1962, 1971), Aoki (1958, 1959, 1961, 1962, 1963, 1964, 1965, 1966, 1967, 1968, 1969, 1970, 1971, 1973, 1974, 1975, 1976, 1977, 1978, 1980), Wallwork (1960, 1961, 1962, 1963, 1964, 1965, 1966, 1967, 1972, 1973), Märkel (1964), Moritz (1965, 1966, 1968, 1969, 1970, 1971, 1974), Pletzen (1963, 1965), Pérez-Iñigo (1964, 1967, 1968, 1969, 1970, 1971, 1972, 1976, 1977, 1978), Mahunka (1963, 1969, 1973, 1974, 1975, 1976, 1977, 1978, 1979, 1980) Balogh and Mahunka (1965, 1966, 1967, 1968, 1969, 1974, 1975, 1977, 1978, 1979, 1980), Engelbrecht (1972, 1973, 1975) and others.

Investigations on the oribatid fauna of India is meagre till now. Consequently there exists very few literature on Indian oribatid mites. In this respect first contribution was made by Pearce (1906) with description of 8 new species of oribatid mites along with 12 known species from Sikkim Himalaya. Jacot (1933b) correctly identified the 2 species, *Galumna tessellata* and *G. nilgiria*, previously described by Ewing (1910) from topotypic material at Nilgiri Hills in South India. Later, a new species *Scheloribates chauhani* was described by Baker (1945) from Bareilly in Uttar Pradesh. Anantaraman (1951) described *Scheloribates madrasensis* as a vector of *Moniezia* from Madras in South India. 4 new species viz., *Platynothrus numatai*, *Liacarus inermis*, *Locbodes anulatus* and *Unduloribates hebes* and 6 known species were reported by Aoki (1965a) from Nepal Himalayas. Prasad (1965) reported 3 oribatid mites i.e., *Cosmochthonius*, *Oppia* and *Tectocepheus* from Bhagalpur in Bihar. Bhaduri and Raychaudhuri (1967) reported 6 oribatid mites (diagnosed up to generic level) i.e., *Oppia*, *Lamellobates*, *Basilobelba*, *Conoppia*, *Xiphobelba* and *Hoplophorella* for the first time from West Bengal in India. They (1968) described one new subgenus *Paralamellobates* under the genus *Lamellobates* (Later upgraded as a distinct genus by Balogh in 1972), one new species *Allonothrus indicus*, one new subspecies *Archegozetes magna indicus* and simultaneously reported 4 known species from

Calcutta in West Bengal. Singh and Mukherji (1971) recorded 10 genera (without mentioning species), 3 species and 1 subspecies from Varanasi in Uttar Pradesh. Hafeez-Kardar (1972) described one new species Papillacarus indicus from Aligarh in Uttar Pradesh. Chakrabarti and Bhaduri (1972a) reported 11 species (one without specific determination) of oribatid mites from the districts of Nadia and 24-Parganas in West-Bengal. Chakrabarti, Bhaduri and Raychaudhuri (1972, 1973) described one new species Cosmochthonius bengalensis and 2 new subspecies, Malacoangelia remigera indica and Eupelops acromios minor and recorded 9 known species and 3 genera (without mentioning species) for the first time from India. Bhaduri, Chakrabarti and Raychaudhuri (1974) described one new species, Basilobelba indica from Calcutta and suburbs. 2 new species, latilamellaris and translamellaris under the genus Tectocepheus were described by Hafeez-Kardar (1974) from Aligarh in Uttar-Pradesh. Bhattacharya, Bhaduri and Raychaudhuri (1974) reported 3 new species viz., Annectacarus longisetosus, Cryptacarus dendrisetosus and Papillacarus simplirostratus, a new subspecies Haplacarus foliatus bengalensis and 2 known species from Santiniketan in West Bengal. Prasad (1974) published a catalogue of mites of India and there possibly inadvertently he mentioned that only 19 species of oribatid mites were found in India till 1972? Bhaduri, Bhattacharya and Chakrabarti (1975) described 2 new species, abalai and clavisetosus under the genus Chaunoproctus from Calcutta in West Bengal. Deb and Raychaudhuri

(1975) described 2 new species *Galumna crenata* and *G. parascaber* and reported one subspecies from West Bengal in India. Hafeez-Kardar (1975) reported 2 new species *Oribatella alami* and *O. kashmiriensis* from Jammu and Kashmir in India. He (1967a) added 4 new species of *Oppia* viz., *Samadi*, *aligarhiensis*, *sensiclavata* and *alamellata* from Aligarh in Uttar Pradesh. He (1976b) further described 4 new species, *Scheloribates bicuspidatus*, *S. translamellaris*, *S. baloghi* and *S. rufafulvus* from India. Haq (1976) described 6 new species viz., *Annectacarus trivandricus*, *Cyrthermannia bicornuta*, *Allonothrus giganticus*, *Eremobelba nagarcorica*, *Multioppia indica*, and *Dolicheremaeus indicus* and one new subspecies, *Suctobelba semiplumosa indica* from Kerala in South India. Chakrabarti, Bhaduri and Raychaudhuri (1977b) described 2 new species *Cyrthermannia quadricornuata* and *Nanhermannia himalayensis* and reported *Masthermannia mamillaris* from West Bengal in India. Chakrabarti, Bhaduri and Raychaudhuri (1977a) described one new species *Haplacarus intermedius* and simultaneously recorded 14 known species from West Bengal. Chakrabarti, Kundu and Roy Talukdar (1977) reported one new species under the genus *Dolicheremaeus* and recorded 9 known species from Darjeeling in West Bengal. Chakrabarti, Mondal and Kundu (1978) described 2 new species of *Pseudotocepheus* viz., *hammerae* and *gobletus* from West Bengal in India. 2 new species *Eremobelba indica* and *Allonothrus monensis*, 2 known species and one known subspecies were reported by Ghosh and Bhaduri (1978) from Nagaland in India.

Chakrabarti, Kundu and Mondal (1978) described one new genus <u>Sigmonothrus</u> under the family Camisiidae with 3 new species i.e., <u>quadristriatus</u>, <u>bistriatus</u> and <u>ovatus</u> from Darjeeling in West Bengal. Chakrabarti, Chanda and James (1979) recorded 12 known species of oribatid mites from Darjeeling in West-Bengal. Chakrabarti and Roy Talukdar (1979) described one new species <u>Malaconothrus assamensis</u> and recorded 7 known species from the district of Cachar in Assam, India. Haq (1979) described one new species, <u>Xiphobelba ismalia</u> from Kerala in South India. Bhattacharya and Banerjee (1979) reported one new species <u>Pilobatella berlesei</u>,one new subspecies <u>Epilohmannia pallida indica</u> and one known species of <u>Zygoribatula</u> from Birbhum district in West Bengal. While dealing with some ecological works Bhattacharya (1980) recorded 22 known species, 1 known subspecies and 16 known genera (without mentioning species) of oribatid mites from soils of Santiniketan and it's adjacent areas in West Bengal, India. Mishra, Bhaduri and Raychaudhuri (1980) recorded 13 known species, 1 known subspecies and 26 known genera (without mentioning species) of oribatid mites from Orissa in India. Another 2 new species under the genus <u>Dolicheremaeus</u> viz., <u>coronarius</u> and <u>himalayensis</u> were reported from West Bengal, India by Chakrabarti, Bhaduri and Kundu (1981). Chakrabarti and Mondal (1981) described one new species, <u>Eupelops longisetosus</u> and recorded 9 known species and 2 known genera viz. <u>Heterobelba</u> and <u>Metabelba</u> from Darjeeling, West Bengal, India.

Thus the total number of species and subspecies described and reported from India till date stands at 143 and 8 respectively of which 63 species and 6 subspecies have been described as new to science from India. Species and subspecies reported and described from West Bengal in India are 80 and 6 respectively of which 24 species and 5 subspecies have been newly described. Species reported and described from Darjeeling in West Bengal are 29 of which 14 species are recorded for the first time from India and 9 species are new to science.

A total of 50 species including 2 varieties distributed over 41 genera under 31 families have been incorporated in this dissertation from the study of the collected material at Darjeeling. A new subgenus Parapseudotocepheus has been proposed under the genus Pseudotocepheus and 19 species are considered here as new to science. Accounts of two new species have been published (original papers attached hereto).

It may be noted here that out of 31 families 5, of 41 genera 14 and 31 species (excluding 19 new species) 19 are recorded for the first time from Indian territory. Of the 2 varieties recorded, both are reported for the first time from India. Similarly out of 41 genera 30 and of 31 species (excluding 19 new species) 23 are recorded here for the first time from Darjeeling, India.

Running keys for the genera and species have been given wherever necessary. Generic diagnosis have been provided also besides illustrations of new species. The histories of the families and genera have been dealt with briefly. Data concerning distribution of a genus and species have been incorporated. Collection data for the species have been provided. Wherever necessary suitable remarks have been incorporated also under genera and/or species.

In major cases for naming the new taxa diagnostic features and type-localities have been given priority. Although 2 new species have been named after Dr. Antonio Berlese, the father of Acarology, and Dr. Jun-ichi Aoki who is renowned for his contributions to oribatid mites.