



DESCRIPTION OF GENERAL MORPHOLOGICAL FEATURES OF COLLEMBOLA IN UTTAR PRADESH

Harish Chandra	Department of Zoology, Agra College, Agra
H.N. Sharma	Department of Environmental Toxicology, Dr. B.R. Ambedkar University, Agra

ABSTRACT

The collembollan represent an early possible primitive phase in the evolution of insects and , so far as the head is concerned , exhibit to quite distinct groupings. The first group which approximately closely to the hypothetical ancestral form with a prognathous head and an elongated segmented trunk region includes the commonly recognized collembol-arthropleona. In the second group zymphypleona the axis of the head becomes re-oriented so that the head assume a completely hypognathous or obliquely hypognathous position. This accompanied by a tendency for the fusion and telescoping of the trunk segments which advances progressively as evolution of the group proceeds. Therefore, Collembolan occupy unique position among apterygota.

INTRODUCTION

In 1893, Parona was the first man to investigate Collembola from Indian faunal limits, he also described some species from Burma. In 1911 Ritter described some Collembola from Bombay, Java and Sumatra. The most outstanding, well known work in Indian Collembola with remarks on abdominal appendages by Imms which appeared in 1912. He described four genera and 27 species as new and three species belonging to as many genera was already known from Badrinath, Garhwal, Himalaya, Allahabad, Calcutta, lower Burma and Ceylon. Among the new forms described by him, the most remarkable is *Heteromuricus cercifer*. It is unique among Collembola in possessing and elongated portion of V abdominal segment. A new subfamily Heteromuricinae was erected by him for its reception. A new genus Pseudocyphoderus with a single species was described from termite nests from the neighbourhood of Chilka lake. The genera Idiomerus and Dicranocentroides was described as new. He also included a catalogue of oriental Collembola known upto time. In this well illustrated account of Collembola, he also dealt with a few species of the suborder Symphypleona.

In 1917 and 1924 Carpenter studied the Collembola by the Abor expedition from lower Burma and Sijucave, Assam. His accounts of species are however, lacking in many details. His important contribution was the discovery of the genus Cyphoderopsis with a single species, from North East Assam and over half a dozen new species of well known and well distributed genera. His work may be regarded as supplement to the work of Imms. Other contribution in this field are Folsom (1924) described from East India. The next important contribution is the work of Handschin, who in 1929 described large series of Collembola and their abdominal appendages from South India mainly from Nilgiris, Palni hills, Anammalai hills and Ootacamund. He recorded thirteen known species, including well known coasopoliton species from this area and fourteen new species of well known and widely distributed

genera. Few examples were also reported by him from Ceylon. In 1930, Bonet described new species of Collembola from India and a new genus Parasira with a single species. Brown in 1932 described a new species of Proistomeformiida. Denis in 1936 described the Collembola collected by Yale University North India expedition from Kashmir, Ladak and Nilgiri hills. He described five new species from Ladak and two new species from Nilgiri hills and also recorded ten known species from this area. Mukerji in 1932 studied species of Protanura and gave a well illustrated account of its morphology. Denis, Brown and Salmon have materially added to our knowledge. Denis and Brown described some new species of Proisotoma without detailed study of abdominal appendages from India and Nilgiri hills.

In 1955 Baijal described about half a dozen new species of some wellknown genera from India, Himalayas and also prepared a checklist of North West Himalayan Collembola. In 1956 Baijal described three new species from North West Himalayas. Salmon described a few species of unrecorded Collembola from Sikkim, Himalaya and a new species of Pseudoentomobrya from Tehri Garhwal Himalaya. Further in 1957, Goto 1961, Salmon 1958 has described two new species belonging to the subfamily Paronellinae from Kohima, Naga Hills (Assam) and Imphal, Manipur State. Goto in 1961 described a new species of Hypogasturial Collembola that is Brachystomella surendrai from India. Salmon 1970 also reported new species of the unique genus (Pseudoparonellidae Salmon) previously known only from Newzealand and supplemented the description with notes on eight other species, already known from India belonging to the subfamily Paronellinae. Salmon has described the importance of body scales and scales in the classification of genera.

In more recent years the researches of Choudhri in 1958, 1968 described the identity of *Onychiurus granulatus* and *Onychiurus Pseudogranulosus* and he also described a quantitative composition of the Collembolan fauna of some uncultivated fields in Nadia (West Bengal) with a correlation between monthly population and individual soil factor. Thus the main approach of Choudhri was not taxonomy but mainly the ecological aspects of Collembola. In 1970, 1971, 1973 Baijal published few new species of Collembola with description of abdominal appendages from different parts of India.

Prabhoo in 1970, 1971, 1972, 1974 and 1976 studied large number of Collembola from bark, moss and soil from South India. Mitra 1975 described few Paronellinae from India. In 1976 Prabhoo published another important paper on the morphological variations in the local population of the soil Collembola and few new species of Collembola from Southern limits of India. Prabhoo in 1977 gave a new line of thought in the taxonomy of Collembola and published an important paper describing the facultative parthenogenesis in *Cvphoderus Javanus*. Recently Tyagi in 1979 published another paper describing the Collembola infesting human dwellings and two new species of Collembola with consideration of abdominal appendages as taxonomical character collected from sugarcane fields of District Bijnor, Uttar Pradesh, India. Although very large number of papers have appeared on the taxonomy of Collembola, relatively little attention seems to have been paid to the study on other aspects of Collembola. It is with this view point that literature background of the work on taxonomy of Collembola was taken up for research. It is evident from the foregoing review that a fairly large amount of work has been done from other parts of the World. World worker the Collembola as a whole has been totally neglected in India. Although they are extremely common in Indian soil very little is known about them.

MATERIALS AND METHODS

Large number of collembolan have been collected from different parts of Agra and from various localities from Uttar Pradesh in the month of August, September and October. The specimens were mostly procured from under heaps of fallen leaves among mosses, edges of streams and rivers from hilly part of India. Large number of specimens were collected from sugarcane, wheat and rice crop and cultivated fields during monsoon season near about Agra (U.P.). Some specimens were also collected in the vicinity of stagnant water. The specimens were collected with the help of camel hair brush moistened with 90% alcohol. Canada balsam is unsuitable as mounting for collembolan.

For the microscopical study of the structure of the abdominal appendages specimens were first put into dilute KOH and then mounted as a whole on a slide under a binocular microscope and mounted in salmon's - Poly vinyl alcohol-lactophenol medium prepared as follows:

1. Poly vinyl alcohol solution - 10 ml
2. Lactic acid - 10 ml
3. Glycerine - 1 ml

The medium is colorless, oily liquid, slightly viscous. It lacks the phenolic smell and brown color in bulk when exposed to day light. Mounts prepared in this medium kept in over at 40°C for three months did not show any sign of shrinkage or distortion. Specimens can be mounted directly into PL3 from water, alcohol and various preserving and fixing solutions without the necessity of passing through the tedious dehydration procedure. The collembolan collected are sorted out and their locality and habitat labels are put inside the tube. The collembolan are preserved in 70% alcohol plus formaldehyde plus a little amount of glycerine and they are properly identified and their detailed study is made under high power microscope and the different diagrams with the help of the camera lucida have been made.

RESULTS AND DISCUSSION

General Morphological, Features of Collembola (Plate 1A, 1B, 1C, 1D & 1E)

The order Collembola is primitive, simpler, less developed head, thorax and abdomen.

Head: The head of Collembola is pro or hypognathous with distinct labrum, clypeus and irons.

Antennae: The antennae vary in length and the distal segments may be secondary annulated. Plate 1A Fig.1 they are typically four-segmented; the maximum number of six is found in Orchesella. In the Neelidae the antennae may be shorter than the head while in some of the Entomobryidae they are longer than the body.

Sensory organ: Different types of sensory organs are usually present on the last two segments of antennae and are in the form of cones, rods, pits or papillae.

Ocelli: Variable number of ocelli are generally found on head behind the antennae, there are never more than eight on each side and sometimes less number of ocelli are found. In few Collembola they are absent, as in the Onychiuridae, Neelidae and Cynoderinae.

Postantennal organ: Postantennal organ occurs immediately behind the antennae in most Isotomidae and some Entomobryidae but not in the Symphypleona. It assumes a great variety of forms among the different genera, being simple and ring like in *Isotoma* in the form of rosette in *Anurida* while in *Onychiurus* it attains considerable complexity of structure. It is a peculiar sensory organ because it because a special nerve supply and the thinness of its cuticular investment suggests its capability for receiving olfactory stimuli.

Mouth parts: Mouth parts are generally situated deep inside the head and are prominently elongated which allows their freedom of movement when protruded. Plate 10 Fig.5a the mouth cavity is roofed over by the labrum and clypeus. The mandibles are slender organs usually with tooth extremities and apparently provided with only a single articulation with the head capsule. Mandibles are rarely absent as in *Brachystomella*. The maxillae consist of complex apical portion or 'head' which represents a lacinia. In some species of *Collembola palpifer* is present and it carries a vestigial palp end the galea. The cardo and stypes are variable in form. The superlinguae are well developed amellate structure overlying the hypopharynx. The hypopharynx is provided with a pair of elongate brachia, which articulate proximally with the cardines of the maxillae. The labium is very much reduced because neither glossa nor paraglossa separately develop. Labial palpai are totally absent but in *Neanura* and its allies the mouth parts are specialized for sucking aid piercing. The labium and labium together form a conical tube enclosing the rest or: mouth parts and the mandible maxillae are generally modified into stylets.

Thorax: Thorax in collembola generally consists of three similar segments but in the Entomobryidae the prothorax is largely reduced anti its tergum is fused with that of the mesothorax. In the Symphypleona Plate 1B Fig.2 the thorax become intimately fused with the abdomen and its segmentation is not distinct.

Unquis and unguiculus: The legs of Collembola have no true tarsal segments and the tibiae generally end in a pair of claws, an upper and a lower but the latter, a modified empodium rather than a true claw, may be vestigial or wanting. A group of short setae on the trochanter forms the so called trochanteral organ, a structure of some taxonomic importance. Fig.4 claws consists o large elongate unguis with or without teeth or basal groove and small unguiculus with or without lamella and teeth. Tibiotarsus consists of long slender clavate or nonclavate hair but in some genera, like *Neanura*, tenent hair is absent.

Abdomen: The abdomen is made of six segments. In this character Collembola differ from all other insects. In some of the Arthzopleona the IV, V or IV to VI. Segments undergo fusion while in the Symprypleona the first our segments are almost entirely undifferentiated. The Collembola have three abdominal appendages on the abdominal segments. Though medial and unpaired in the adult, apparently they are developed from segmental appendagas that fuse in the course of ontogeny.

Ventral tube: In all Collembola, there is a bilobed structure the ventral tube on the ventral aspect of first four segments which are almost entirely undifferentiated. It is formed by the union of the first pair of embryonic abdominal appendages and consist of a basal column containing a pair of protrusible vesicles in the forte of shallow sac but in some genera they are long and tubular. In most species the ventral

tube and its bilobed terminal vesicles are ordinarily retracted. In some of the Collembola, as in Sminthuridae, each lobe of the vesicle is produce into long eversible tube.

Tenaculum: The tenaculum or clasp is a minute organ situated medially on the concave ventral side of the IIIrd abdominal segment. It consists of a conical base and two laterally divergent distal prongs toothed on their outer margin. The tenaculum serves to hold the furcula in place when the latter is flexed against the ventral side of the body.

Furcula: The furcula is the jumping organ of the Collembola and On account of this these insects get their common name "Springtail". Please 1E Fig. (6-11) furcula consists of large manubrium small dantes and mucro.

Manubrium: The common basal piece of furcula is known as manubrium.

Dentes: The distal arm of manubrium is termed as dens.

Mucro: Each dens carries a variable shaped claw like process or mucro.

The shape and size of the furcula varies much in different species of Collembola and is important in classification of Collembola. In some genera specially Neanura. Protanura the furcula is absent. In some species of Sminthurus that live on the surface of water the furcula specially its mucro has fan like structure. Thus the mucro, dens and manubrium are variable and are the great taxonomic importance in Collenbola.

Chaetotaxy: The chaetotaxy or clothing is of great taxonomic value and may consist of scales, spines, bristles, micro and machrochastae, all of which may or may not be found at the same time in any one species.

Scales: When present, they may be either hyaline or pignentd, plain ribbed or fluted, striated or ciliated and of various shapes varying from round and blunt to oval and pointed.

Setae: Setae is the most common form of clothing occurring in Collembola, certain distinct types of setae in addition to the normal plain setae can be recognized as follows:

(i) Ciliated setae: The shaft of the setae is covered with whorls of fine hairs.

(ii) Serrated setae: The shaft of the setae is serrated or armed with tooth like structures.

(iii) Flexed setae: The shaft of the setae is ciliated and bent over towards its apex, which is more or less flattened and bears longer ciliation than does the shaft.

(iv) Pubescent setae: The shaft of the setae is densely clothed with short, even hairs, it the appearance of Squirrel's tail.

(v) Clavate or Spathulats setae: The apex is swollen into a knob or expanded into spatulate form. The knob is sometimes divided.

Bristles: These are really stout stiff hairs. They may be plain ciliated or divided.

Divided bristles: The apex is subdivided into three to seven; short finger like processes. This type of bristles are usually situated at the apex of mesotergum and are characteristic of Lepidophorelline.

Spines: Spines commonly occur on the dentes but sometimes they also occur on the tibiotarsi or on the body. In certain genera of Symphyleona and genus Rhodonella they are situated on the top of head and in genus Hypogastrura on last abdominal segment known as anal spine. They may be plain, serrated or ciliated and either straight or curved.

Lasiotricnia: Proposed by Salmon (1933) to differentiate the long, thin wavy hairs or bothriotrichia. Bothriotricnia always arise from small cups or mounds on the cuticle whereas lasiotrichia generally arise direct from the cuticle as ordinary setae or hairs.

Trichobothris: Small sensory cups, domes or swellings which occur commonly among the symphyleona. They are situated on the sides of the body, generally giving rise to bothriotrichia or short still sensory bristles.

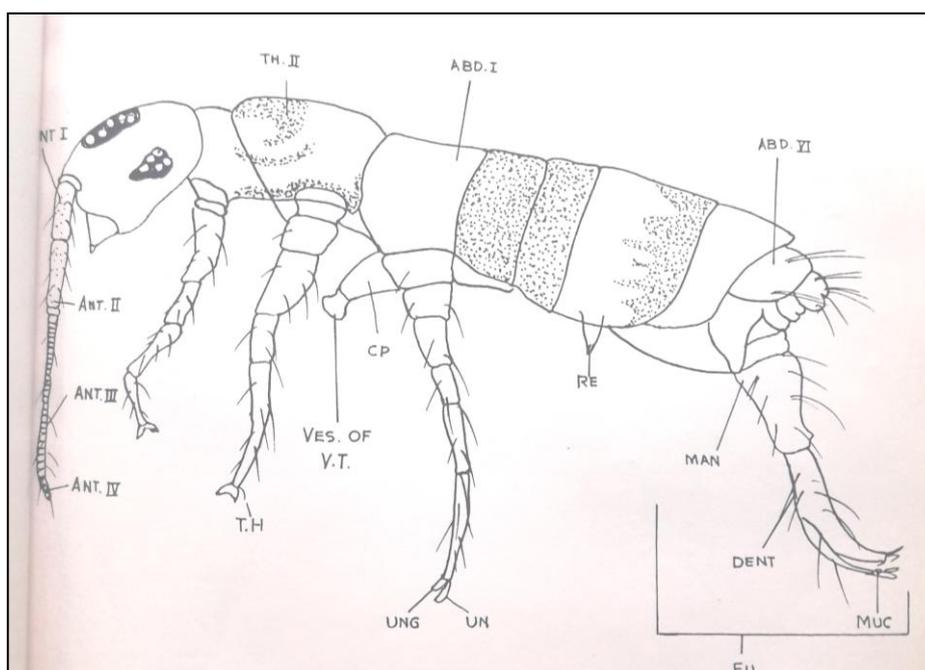


Plate-IA: Arthropleona type of collembolan

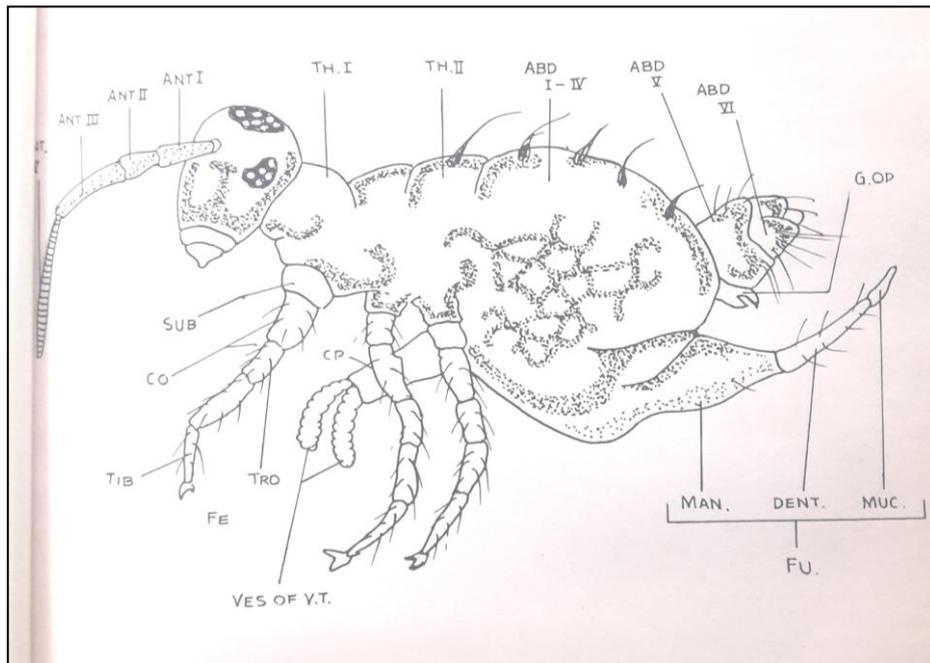


Plate- IB: Symphyleona type of collembolan

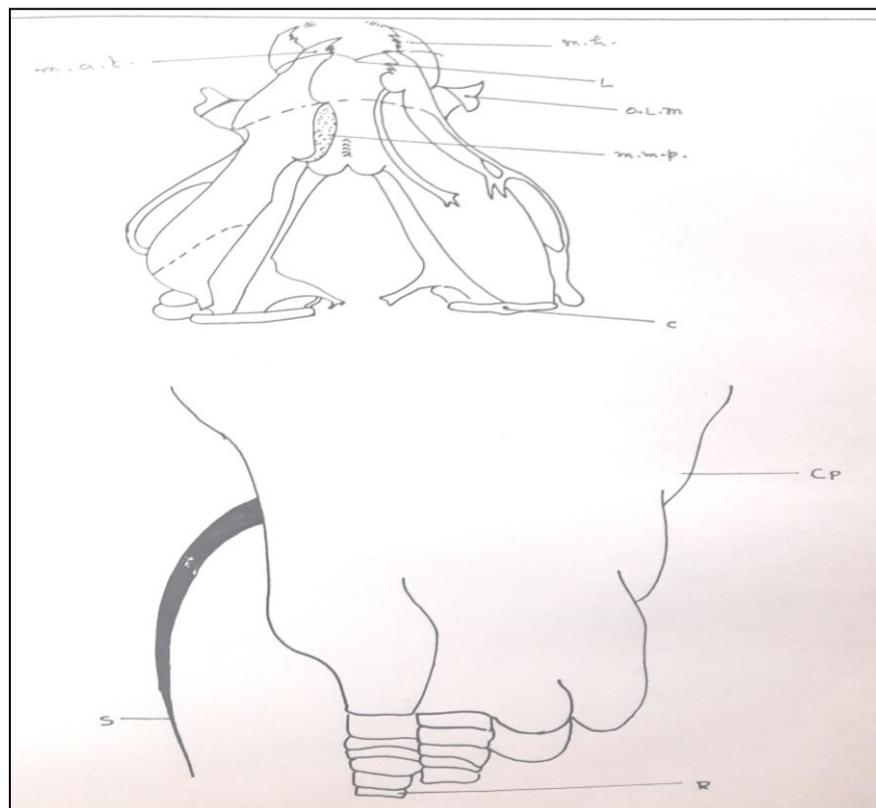


Plate- IC: Ventral tube in collembolan (3: in Sminthuridae; 4: in Hypogastruridae)

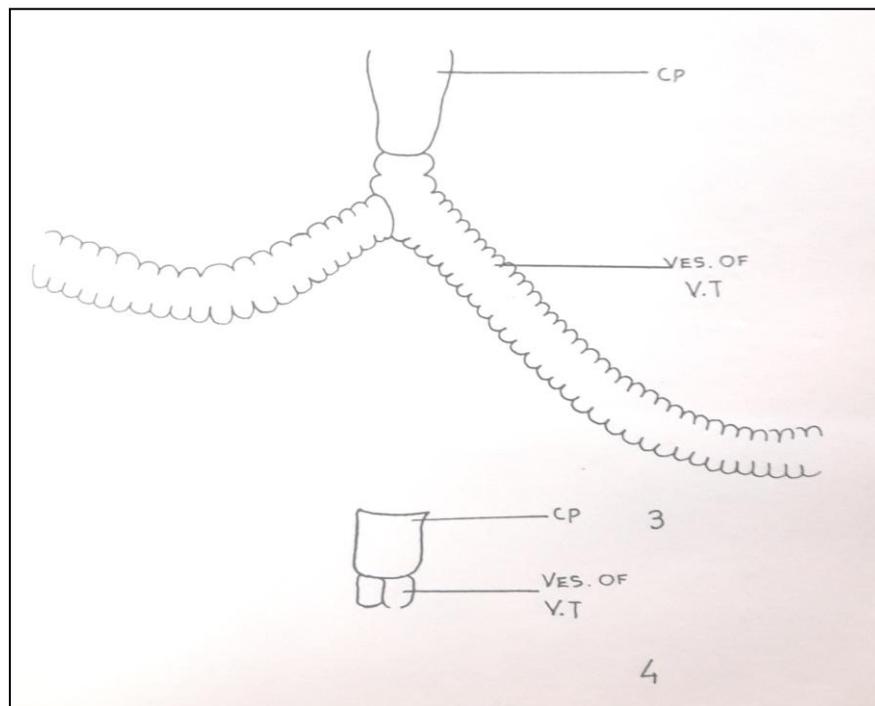


Plate-ID: 5a-Mourth parts in situ of Arthropleona type of collembolan; 5b- Reticulum in collembolan

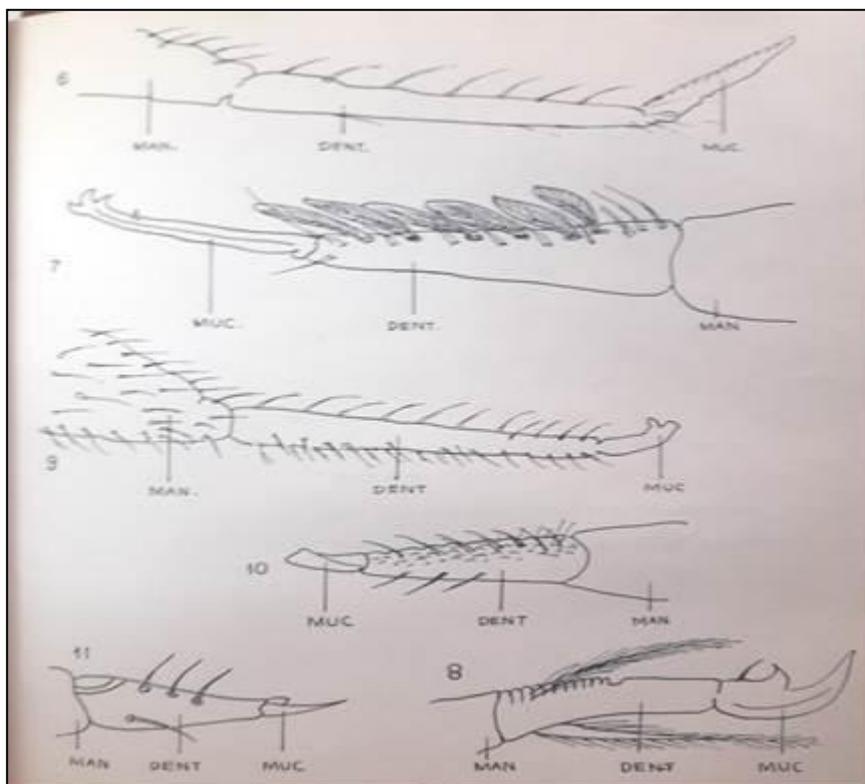


Plate-IE: Furcula in collembolan (6: in family Entomobryidae subfamily Paronellinae; 7: in Entomobryidae genus Cyphodenus; 8: Entomobryidae genus Entomobrya; 9: in Sminthuridae; 10: in Isotomidae; 11: in Hypogastruridae)

Abbreviations:

Ant.- Antenna; Th.- Thorax; Abd.- Abdomen; T.H.- Tenent hair; Ung.- Unguiculus; Un.- Unguis; Re.- Tetinaculum; Fu.- Furcula; Man.- Manubrium; Dent.- Dentes; Muc.- Mucro; V.T.- Ventral tube; Cp.- Corpus; Tibo.- Tibiotarsus; Fe.- Femur; Co.- Coxa, Sub- sub coxa; G.Op.- Genital opening; L.- Labrum; M.a.t.- Mandibular apical teeth; M.h.- Maxilla head; O.l.m.- maxilla outer lobes; m.m.p.- Mollar late; C.- Cardo; R.- Rami; S.- Setae

REFERENCES

1. Parona, C., 1893. Di alcuni Tisanuri et Collembola della Birmania, raccolti da Leonardo Fea. Atti. Soc. Ital., 34: 123-135.
2. Ritter, W., 1911. Neue Thysanuren and Collembolen aus Ceylon and Bombay. Gessammelt Von Dr. Uzel. Wien. Ann. Nat. Hist. Hofmus., 24: 379-398.
3. Imms, A.D., 1912. On some Collembola from India. Burma and Ceylon. with a catalogue of the oriental species of the ordat. Proc. Zool. Soc. London, 1912:80-125.
4. Carpenter, G.H., 1917. Collembola, zoological results of the Abor expedition, 1911-1912. Rec. Indian Mus., Calcutta, 8: 1917; 561-568.
5. Carpenter, G.H., 1924. Collembola of the Siju cavs, Garo Hills, Assam. Rec. Indian Mus., 25: 285-289.
6. Hanschin, E., 1929. Beitrage Zur Collembolen fauna der Sud- Indian. Rev. Suisse Zool. 36: 229-262.
7. Bonet, F., 1942. Notes sinonimical sobre el orden Collembolos. Ciencia (Mexico), 3(2): 56-59.
8. Denis, J.R., 1936. Yale North India Expedition, Report on Collembola. Mem. Conn. Acad. Arts and Sci. 10: 261-282.
9. Mukerji, D., 1932. Description of a new species of Collembola and its Anatomy. Rec. Indian Museum, 34: 47-49.
10. Denis, J.R., 1931. Collemboles des collection C. Schaeffer du zoologisches staats - institute and zoologisches Museum in Hamburg. Mitt. Zool. Mus. Hamburg. 44: 197-242.
11. Brown, J.M., 1923. Two new Collembola found in Britain. Ann. Mag. Nat. Hist. (9), 12: 325-329.
12. Marlo, Esther Z. and Judith N., 1975. Dase species nuev as the Collemboles Symphypleona de la Republica Argentina (Insecta). Physis Secc. Cont. Org. Terr. 33(86): 19-21.
13. Baijal, H.N., 1955. Entomological survey of the Himalayas: Part IV Two new species of Collembola. Agra Univ. J. Res. (Sci) 4 (1): 175-178.
14. Choudhuri, D.K., 1958. Sone new species of Dnychiurus Gervais Collembola: Onychiuridae from Nepal and Uganda. Proc. Roy. Ent. Soc. Lond. (B) 27 (9-10): 147-154.
15. Choudhuri, D.K. and S. Roy., 1968. Quantitative composition of the Collembolen fauna of some uncultivated fields in Madia district (West Bengal) with a corelation between monthly population and individual soil factor Rev. Ecol. Biol. Sol. 4(3): 507-515.
16. Prabhoo, N.R., 1970. Oudemansia Subcoerulea Denisthe first record of a marine Collembola (Insects) from India. "Curr. Sci." No. 21: 490-491.
17. Mitra, S.K., 1975. A new paronellinae genus of Indian springtails (Collembola: Entomobryidae). With the description of three new species. Rev. Ecol. Bio1. Sol., 10(3): 359-377.
18. Prabhoo, N.R., 1976. On Odontella (Clavontella) Mactonychia (Prabhoo). A soil Collembola from Kerala. Entomon., Vol.1. No.2, pp.195-197.
19. Tyagi, N and Baijal, H.N., 1979a. Collembola infesting human dwellings. Sci. Environ., 1(2): 161-165.
20. Baijal, H.N., 1973. On new species of the genus Parrhopalites Bonet and Tullberg (Collembola: Arrhopalitini) from India. Zool. Ans. 189 (1): 94-96.