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THE PRELIMINARY IDENTIFICATION CHARACTERS OF SOME COLLEMBOLA FROM VARANASI REGION OF UTTAR PRADESH, INDIA

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ABSTRACT
The Collembolans are major part of soil biota. Their collection and identification require expertise hands to know the status of soil biota. Therefore, in present study Collembola fauna of different vegetation in Varanasi district of Uttar Pradesh region was studied from March, 2010 to March, 2012. Collembola specimens belonging to 13 genera under 8 families were collected. The predominant families were Hypogastruridae, Isotomidae, Entomobryidae, Paronellidae, Cyphoderidae, Neelidae, Sminthurididae and Katiannidae. The common identified genera are *Hypogastrura, Folsomia, Folsomides, Isotomurus, Isotoma, Entomobrya, Seira, Salina, Lepidocyrtus, Cyphoderus, Neelus, Sminthurides* and *Sminthurinus*. The preliminary identification characters of these genera are discussed in the paper.

INTRODUCTION

The Collembola (springtails) are the most abundant Apterygote insects in the soil throughout the world, found in vast numbers from the tropics to the poles. They are abundant in the soil and their density can reach 98% proportion of the total density of Arhtropoda collected. There are about 8279 described species of Collembola worldwide (Janssens, 2012). Indian fauna of Collembola represents 299 species in 103 genera under 18 families (Mandal, 2011). They are considered to be useful organisms, whose role is beneficial to the health of soil. Most of the collembolans are only few millimeters long. Springtails are minute insects and most of them have a forked structure on the end of their abdomen, known as furcula with which they jump. This structure functions like a catapult and is normally underneath the body and held in place with a clasp-like structure *i.e.* tenaculum. The majority of springtails feed on fungal hyphae or decaying plant material. They play an important role to control fungal diseases of some plants and they may also influence the growth of mycorrhizae. A number of species are carnivorous and eat nematodes, rotifers and even other collembolan (Cassagnau, 1972).

The studies of various aspects of collembolan diversity in Varanasi district was initiated by several workers (Mukharji and Gupta 1970; Mukharji and Singh, 1970; Singh and Mukharji, 1973; Singh and Pillai, 1981 and Raghuraman *et al.,* 2010). Singh and mukharji (1973) studied the qualitative composition of soil arthropods and described 9 species of Collembolan in Varanasi district. The aim of the present study was to study the diversity of springtails in different habitats *i.e.* cultivated fields and wetlands and to find out their identification characters.

MATERIALS AND METHODS

The study area located in Varanasi district of Uttar Pradesh state which is 80.71m above sea level 25.14′ N and 82.56′ E. The soil sampling was done in cultivated and wetland fields during 2010-2012.

The soil samples were collected at the rate of 2 to 3 samples from each vegetation site thrice in month. Every sampling unit was collected on separate polythene bag and brought to the laboratory and the extraction process was done through modified dynamic Tullgren's funnel. Soil samples were put in separate funnels fitted with mesh in the lower side and was placed in funnels. Collecting vials containing 70% alcohol and few drop of glycerol were fitted to the lower sides of funnels. During extraction, the samples were exposed to less intensity of light to give low heat initially for a period of 12h and later the samples were given more intensity of light and heat for full extraction with the help of illumination timer and light intensity controller. The specimens were sorted and segregated out under zoom stereomicroscope from vials. Subsequently, they were preserved in 70% alcohol with few drops of glycerol. The specimens were mounted on slides in Canada balsam after serial dehydration method. The digital photographs were taken through Lieca MZ16 microscope fitted with Leica DFC 290 camera.

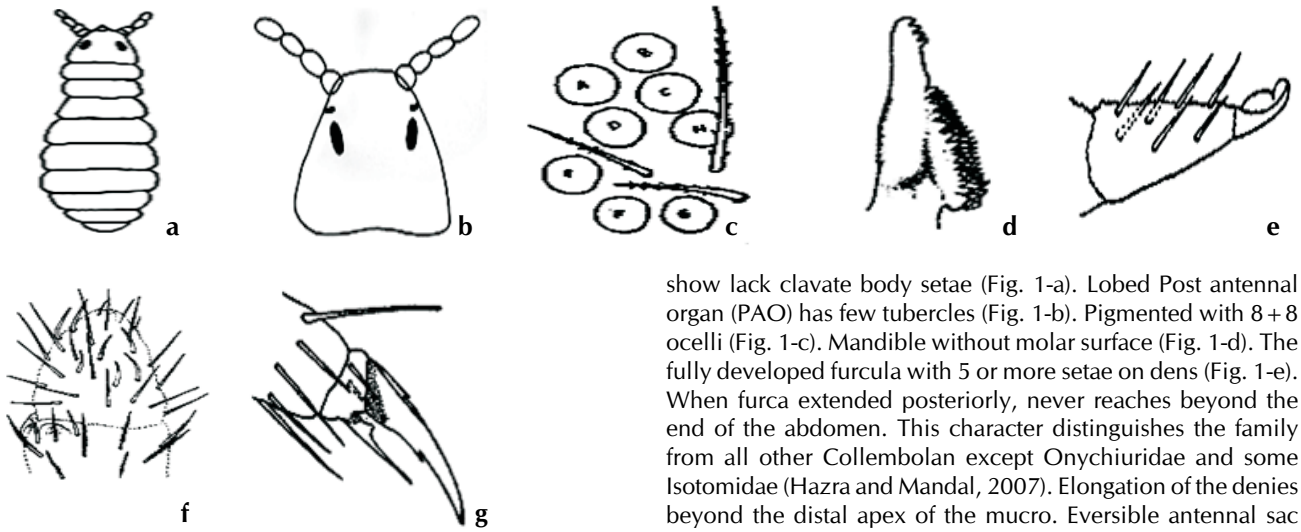


Figure 1: *Hypogastrura* sp,; a. Habitus, b. and c. Eyes and post antennal organ, d. Mandible without molar surface, e. Dens and mucro, f. Antennal segment 3rd and 4th. g.Hind leg with Unguiculus

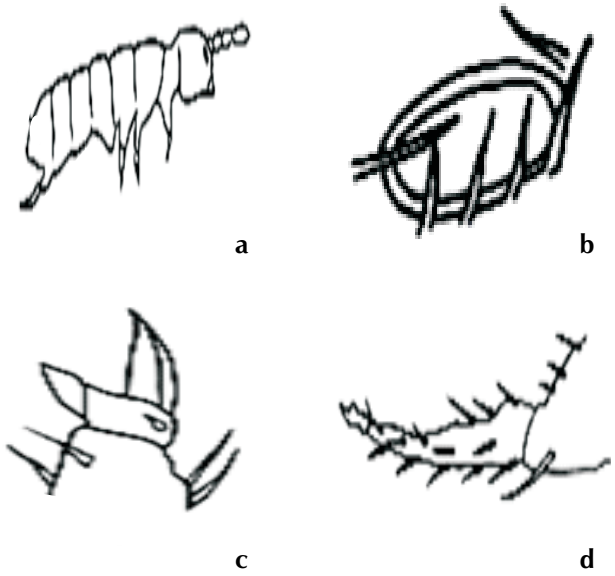


Figure 2: *Folsomia* sp; a. Habitus, b. PAO, c. III leg claw showing unguis and unguiculus, d. Furcula.

RESULTS AND DISCUSSION

In the present study, a total of 659 Collembola specimens were collected. The specimens belonged to 13 genera under 8 families are listed in Table 1

The distribution and identification characters of all collected genus are described below:

***Hypogastrura* sp. (Plate 1- A)**

Hypogastrura Bourlet, 1839 is a large collembolan genus comprising 166 hemiedaphic species (Bellinger *et al*. 2011). The genus is cosmopolitan, but the majority of species live in the temperate zone of the northern hemisphere. The genus *Hypogastrura* sp. has about 166 named species (Janssens, 2012). In India only 8 described species of this genus have been collected (Mandal, 2011). All members of the genus show lack clavate body setae (Fig. 1-a). Lobed Post antennal organ (PAO) has few tubercles (Fig. 1-b). Pigmented with 8 + 8 ocelli (Fig. 1-c). Mandible without molar surface (Fig. 1-d). The fully developed furcula with 5 or more setae on dens (Fig. 1-e). When furca extended posteriorly, never reaches beyond the end of the abdomen. This character distinguishes the family from all other Collembolan except Onychiuridae and some Isotomidae (Hazra and Mandal, 2007). Elongation of the denies beyond the distal apex of the mucro. Eversible antennal sac absent. Small anal spines, usually short and uniform body hairs. No eversible sac between antennal segments 3-4 (Fig. 1-f). Tibiotarsi with 18-19 setae. Unguiculus present in hind leg (Fig. 1-g). They can be readily separated by mouthparts not projecting forward having anal spines present.

***Folsomia* sp. (Plate 1- B)**

Folsomia sp. is the largest genera of the Isotomidae. The genus *Folsomia* sp. has a cosmopolitan distribution, occurring on all continents. The original description of *Folsomia* sp. by Willem (1902) was based on a single specimen floating on a puddle in a cave at Rochefort in Belgium. It currently comprises 163 named species but most species have been described from the Northern Hemisphere (Janssens, 2012). In India, *Folsomia* sp. is the infrequent genus of Collembola, with 4 described species (Mandal, 2011). *Folsomia* sp. shows no anal spines, and an abdomen with the posterior three segments fused (Fig. 2-a). All members of the genus tend to have a reduced number of ocelli. In India few species of *Folsomia* bears upto 8 numbers of ocelli. There is a post-antennal organ behind the base of each antenna (Fig. 2-b). Unguis and unguiculus teethed (Fig. 2-c). *Folsomia* sp. has a well developed furca (Fig. 2-d). The most distinguishing feature that separates *Folsomia* sp. from other members of the genus is the presence of numerous (at least 16) stout setae on the ventral side of the manubrium of the furca (Fig. 2-d).

***Folsomides* sp. (Plate 1- C)**

The genus Folsomides is represented by 62 Species in the world fauna (Janssens, 2012), only one of which is found in India (Mandal, 2011). Some species were thought to be cosmopolitan due to their capacity to cryptobiosis *i.e.* anhydrobiosis (Kovac, 1996). Body much elongated tubelike (Fig. 3-a). All abdominal segments distinctly separated (Fig. 3-a). Abdomen IV shorter than III (Fig. 3-b). Abdomen V, VI elongated, narrow and tapering, flexed ventrally and separated (Fig. 3-b) (Suhardjono and Greenslade, 1994). Furcula short, not reaching to ventral tube but well developed (Fig. 3-c). Manubrium without anterior setae, dens smooth or tuberculate. Mucro absent or with one or two teeth (Fig. 3-d) (Winkler and Korda, 2012), no mucronal setae. Antenna IV without cone. Maxillary palpus bifurcate. Tenet hairs on

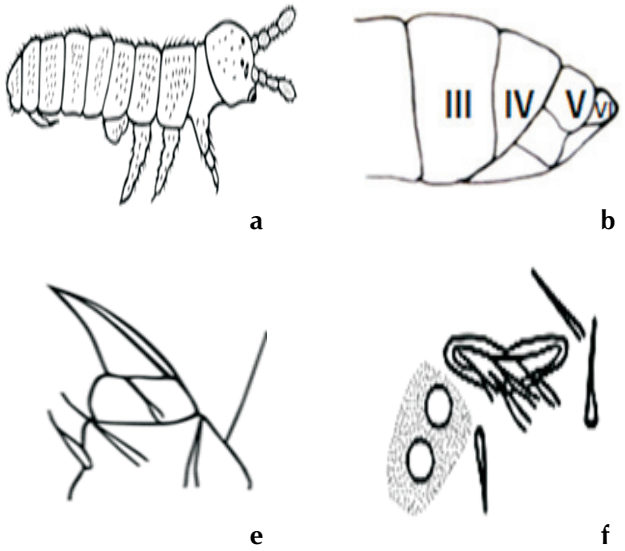


Figure 3: *Folsomides* sp; a. Habitus, b. Abdomen 4 shorter than III, c. Furcula, d. Mucro, e. Hind leg, f. Ocelli

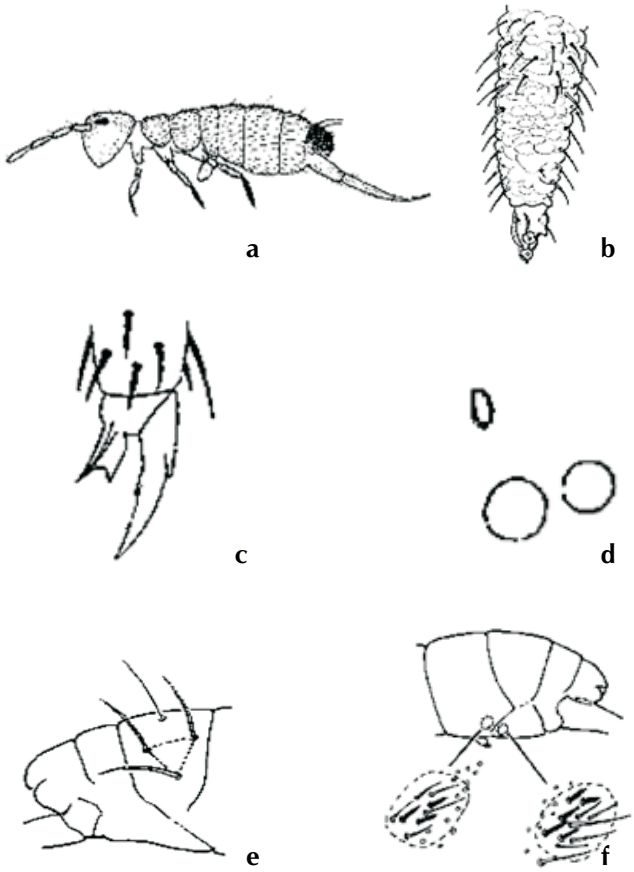


Figure 4: *Isotomurus* sp.; a. Habitus, b. Apical part of crenulated dens and mucro c. Foot: Tibiotarsi with primary setae in the apical whorl and claw with dented Unguis and unguiculus, d. Lateral ocelli and Post Antennal Organ, e. Position of macrochaetae in abdomen, f. Modified seta in male

tibiotarsus are absent (Fig. 3-e). Unguis and unguiculus without teeth (Fig. 3-e). Ventral tube moderately long. Tenaculum tridentate or quadridentate with one long seta on the corpus. The Characters that separate Folsomides from Proisotoma chiefly are: eyes 5, 2, or 1 to each side. Ocellus with posterior setae. Postantennal organ present (Fig. 3-f).

***Isotomurus* sp. (Plate 1- D)**

Isotomurus is a cosmopolitan genus. Most species live in wet habitats (ponds, shores of lakes, stream banks) and can often be scooped in quantities from the surface of waters, in particularly after heavy rain. Under such conditions several species may be collected together. 72 named Isotomurus sp. had been described worldwide (Janssens, 2012). In India there are only 3 species (Mandal, 2011). In the *Isotomurus* sp. abdomen 4 shows demarcation from abdomen 5 (Fig. 4-a). Dens usually crenulated or tuberculated (Fig. 4-b). Tibiotarsi with 8 primary setae in the apical whorl (Fig. 4-c). Unguis and unguiculus are dented (Fig. 4-c). Ocelli 8 + 8 and PAO present at the base of antenna (Fig. 4-d). In the long-haired *Isotomurus* the 3 macrochaetae on each side of abdomen 4 are set in a triangle (Fig. 4-e), while they are all lined up in *Isotoma*. The *Isotomurus* species (apart from *antennalis*) differ from *Isotoma* by presence of long sensorial setae – trichobothria – on abdomen which is easily fall off during preservation procedure. Labrum with many slender setae, 4 prelabrals. Maxillary outer lobe bifurcated, with 4 sublobal hairs. Labium with increased number of setae in the proximal field of the palp (>4) and in the basomedian field (>5). Mandibles normal, strong. Maxilla with strongly serrated lamellae, mostly unmodified.

***Isotoma* sp. (Plate 1- E)**

Total of 80 species are found in the world (Janssens, 2012) out of which 4 in India (Mandal, 2011). In general appearance the Isotoma and Isotomurus are very similar. Mouth cone of Isotoma is less prominent, head more elongate (Fig. 5-a). Profile lines form a narrow angle. No trichobothria in median fields (Fjellberg, 2007). *Isotoma sp.* shows terminal anus (Fig. 5-b). On abdomen 4 the 3 + 3 macrochaetae are set in a straight transverse line (Fig. 5-c). Abodomen 4th shorter than 3rd (Fig. 5-d). Abdominal segments 5–6 separated. Ocelli 8 + 8. PAO small, roundish, shorter than diameter of nearest ocellus (Fig. 5-e). Mucro with 3 teeth, no lateral seta (Fig. 5-f). Mucro without dental spine (Fig. 5-g). Maxillary palp bifurcate, 4 sublobal hairs. Labrum with setae, 4 prelabrals. Apical edge of labrum with 4 folds of variable size. Maxilla with short lamellae, densely covered with denticles. Labium with a full set of papillae and guards, proximal setae 4. Basomedian field with increased number of setae. Sensillary chaetotaxy of thorax 2– abdomen 3 has spine-like sensilla (most easily observed in small

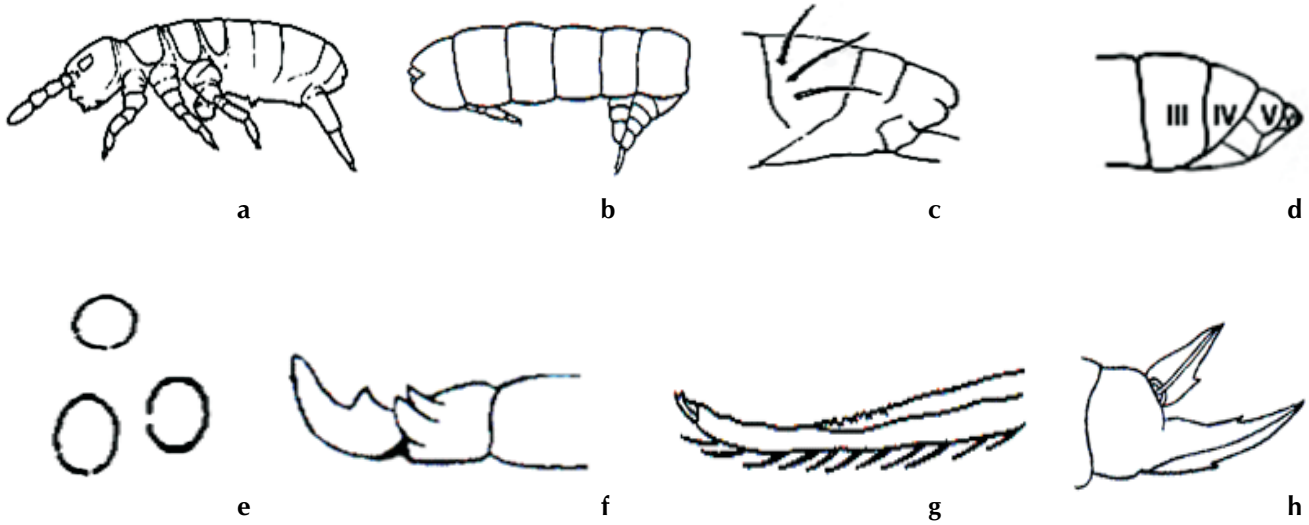


Figure 5: *Isotoma* sp.; a. Habitus, b. Terminal anus, c. Position of macrochaetae in abdomen d. abdomen 4th shorter than 3rd, e. Pao and two nearest ocelli, f. Mucro with 3-4 teeth, g. Murco without dental spines, h. Claw showing teethed Unguis and unguiculus

Table1: List of Collembola

Order	Sub-Order	Section/ Super family	Family	Sub-Family	Genus
Collembola	Arthropleona	Poduroidea	Hypogastruridae	Hypogastrurinae	*Hypogastrura*
		Entomobryoidea	Isotomidae	Proisotominae	*Folsomia*
					Folsomides
				Isotominae	*Isotomurus*
					Isotoma
			Entomobryidae	Entomobryinae	*Entomobrya*
				Seirinae	*Seira*
			Paronellidae	Paronellinae	*Salina*
				Lepidocyrtinae	*Lepidocyrtus*
			Cyphoderidae	Cyphoderinae	*Cyphoderus*
	Symphypleona	-	Neelidae	Neelinae	*Neelus*
			Sminthurididae	Sminthuridinae	*Sminthurides*
			Katiannidae	-	*Sminthurinus*

juveniles). Number of sensilla on abdomen 4-5 usually 6 in small specimens, more in large individuals. Body hairs with glandular basis. Manubrium with thickened spine-like ventroapical setae. No ventral setae on thorax. Ventral tube with numerous setae in aterior, lateral and caudal positions. Long, serrated macrochaetae. Tibiotarsi with 8 primary apical setae, tenent hairs pointed. Unguis and unguiculus teethed (Fig. 5-h).

***Entomobrya* sp. (Plate 1- F)**

Total of 269 named sp. has been described in the world (Janssens, 2012). Only 11 in India have been described (Mandal, 2011). Most of our Entomobrya species have distinct colour patterns which are used for identifying species. They differ from *Willosia*, by absence of scales on the body. Body structure like Fig. 6-a. The body has a ground cover of ciliate setae and long macrochaetae which are set in fixed patterns which often give diagnostic characters on species level. Segmented antenna, 4th seg. not annulate, Ant. 2nd longer than 4th seg. (Fig. 6-b), Antennal tip with an apical bulb which may be either simply rounded, bi- or tri-lobed (Fig.5-c). Furca strong (Fig. 6-d), Dens long (Fig. 6-e), mucro with two teeth and a basal spine (Fig. 6-f). Tibiotarsi with an apically expanded tenent hair. Inner side of tibia 3 with a single smooth seta near apex. Claws with strong teeth and apical seta on tibiotarsus (Fig. 6-g). Head has a full set of eyes (8+8), 2 ocelli usually much smaller than others (Fig. 6-h). Maxillary outer lobe with 3 sublobal hairs and one spine (Fig. 6-i). Labial palps with a full set of papillae. Papilla with 4 guards. Labrum with smooth setae and 4 ciliate prelabral setae. Mandibles strong, maxilla with lamellar complex fused without apparent differentiation (Fig. 6-j).

***Seira* sp. (Plate 1- G)**

Entomobryidae is the largest family of Collembola (Hopkin 1997, Soto-Adames *et al.* 2008, Bellinger *et al.*, 2011). *Seira* Lubbock, 1869 is a predominantly tropical genus of Entomobryidae, with 195 described species worldwide (Janssens, 2012). In India, *Seira* is the most specious genus of Collembola, with 15 described species (Mandal, 2011). Specimens of *Seira* sp. are not very common in Varanasi region practically in all kinds of environment. An abdominal segment IV longer than III (Fig. 7-a). The morphology of species of *Seira* is quite similar to species of other derived genera of Entomobryidae, such as *Entomobrya* Rondani, 1861 and *Lepidocyrtus* Bourlet, 1839. However, species of *Seira* can be distinguished from them by the presence of seven or eight lenses on each eye patch (Fig. 7-b) and yellow or brown round

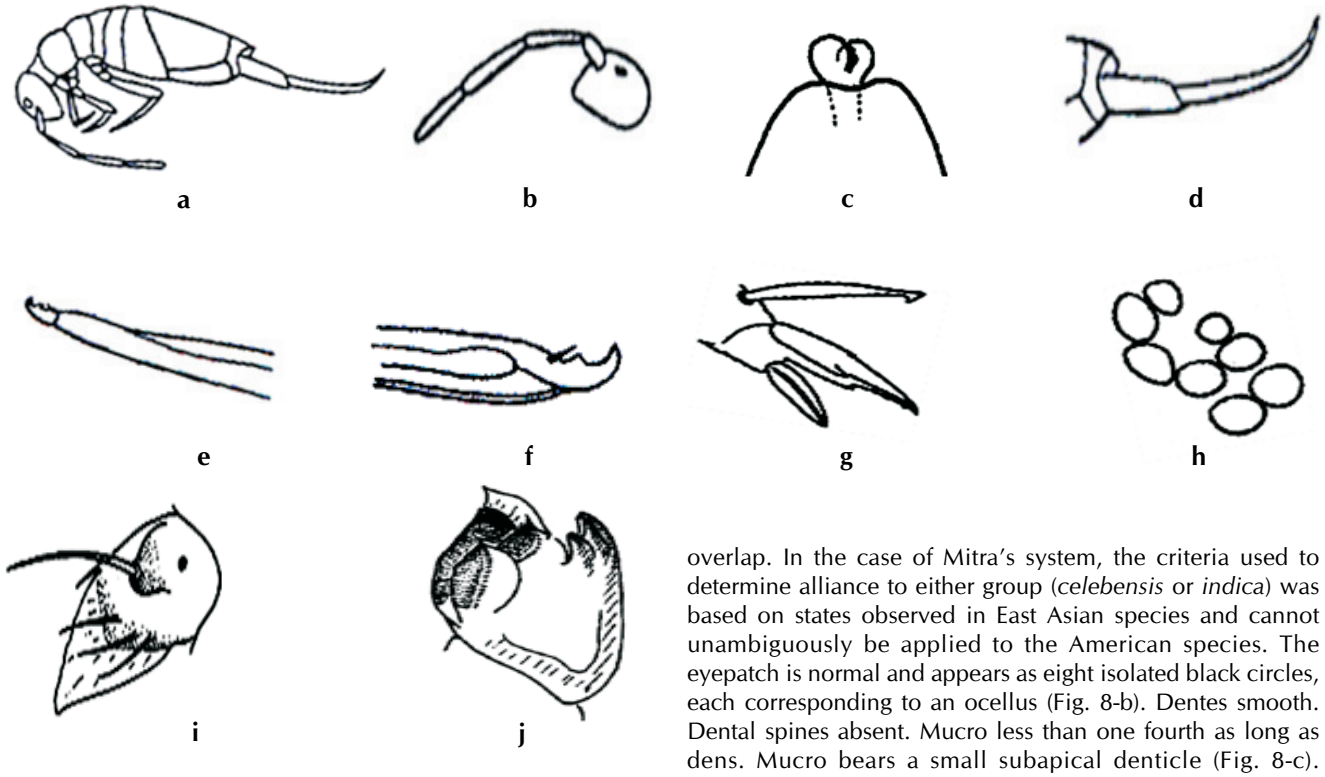


Figure 6: *Entomobrya* sp.; a. Habitus, b. Segmented Antenna, 4th seg. not annulate, Ant. 2nd longer than 4th seg., c. apical papilla on ant., d. furca, e. Dens, f. Mucro with basal spine, g. Claw with apical seta on tibiotarsus, h. , ocelli, i. Maxillary outer lobe, j. maxilla

scales covering the dorsum of the head, body and the first segments of antennae, legs, and furca (Bellinger and Christiansen, 2011; Barra, 2004 a and b). Apical bulb is present on 4th antennal segment (Fig. 7-c). Claws show strong teeth and an apical seta on tibiotarsus (Fig. 7-d). They are also distinguishes itself from other families by the presence of multiciliated setae on body, crenulate dens and a small falcate mucro with one or two well developed teeth (Soto-Adames *et al.,* 2008) (Fig. 7-e). Many species of *Seira* were found in high temperature forested areas or even in open hot semi-arid regions, which points to the natural resistance of the group to the heat and water shortage.

***Salina* Sp. (Plate 1- H)**

Salina is a medium-sized (Bellinger *et al*., 2011) genus of Paronellidae with 17 species distributed principally in India. In the World, the genus is represented by 146 named species (Janssens, 2012). Members of *Salina* show a very homogeneous morphology (Fig. 8-a) that makes separation of species difficult. Traditionally, species have been diagnosed based on colour pattern, mucronal and unguicular shape, number of ungual teeth and dorsal chaetotaxy. *Salina* sp. has longer antennae (Fig. 8-a) and is divided into four groups according to the number of macrosetae on the first and second abdominal segments. Mitra (1993) and Yoshi (1981, 1983) subdivided the genus using chaetotaxy, but each author used a different set of criteria and, as a result, the groups they proposed partially overlap. In the case of Mitra's system, the criteria used to determine alliance to either group (*celebensis* or *indica*) was based on states observed in East Asian species and cannot unambiguously be applied to the American species. The eyepatch is normal and appears as eight isolated black circles, each corresponding to an ocellus (Fig. 8-b). Dentes smooth. Dental spines absent. Mucro less than one fourth as long as dens. Mucro bears a small subapical denticle (Fig. 8-c). Unpaired inner ungual teeth are present. Claw with apical seta on tibiotarsus (Fig. 8 - d).

***Lepidocyrtus* sp. (Plate 1- I)**

Lepidocyrtus is one of the largest genera within the order Collembola. On the global scale listed 260 species (Janssens, 2012). Among them 20 species recorded from India (Mandal, 2011). Taxonomic features of the genus *Lepidocyrtus* have been discussed by several authors (eg. Mari Mutt, 1988; Soto-Adames, 2008; Mateos, 2008; Mateos and Petersen, 2012. Mateos and Petersen (2012) reviewed the conventional and introduced several new diagnostic characters. The distinguishing characters of the genus *Lepidocyrtus* as it is recognized to-day are the four-jointed antennae (Fig. 9-a). The antennae are comparatively short throughout the genus, never being so long as the body. The number of ocelli has been given as characteristic, but this cannot be depended upon. An examination of numerous forms has shown that the number of the ocelli in the eye spot may range from a single ocellus to as many as eight. In the dorsal view of *Lepidocyrtus* the pronotum projects but little (Fig. 9-a). Very long unknobbed hairs are scattered over other parts of the body. Both the long and short hairs are often distinctly fringed. The presence of blunt scales is found all over the body (Fig. 9-b). The abdomen is long and cylindrical, the fourth segment being about three or four times as long as the third. A tenaculum is present and lies in a groove underneath the spring. The dentes are usually serrated, while the mucrones end in the characteristic incurved hook, with a middle tooth nearly as large as the terminal one (Fig. 9-c). Tibiotarsi with a spatulate apical tenent hair. Claws with a pair of lateral teeth and a dorsomedian tooth in basal 1/3. Inner edge has a double tooth in the middle and a single

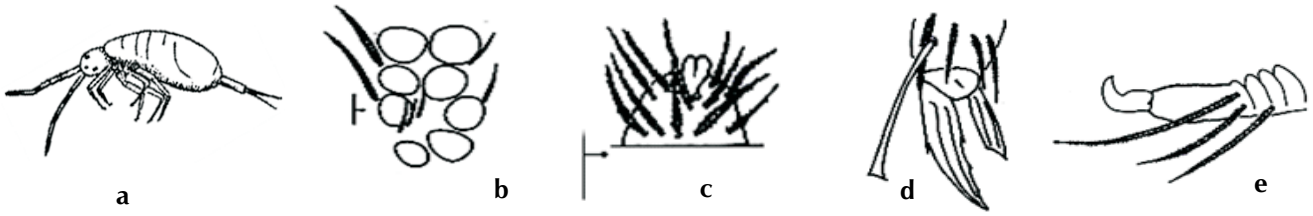


Figure 7: *Seira* sp; a. Habitus, b. Eye patch, c. apical bulb of 4th antennal segment, d. Claws showing strong teeth and an apical seta on tibiotarsus, e. distal part of dens and mucro with developed teeth

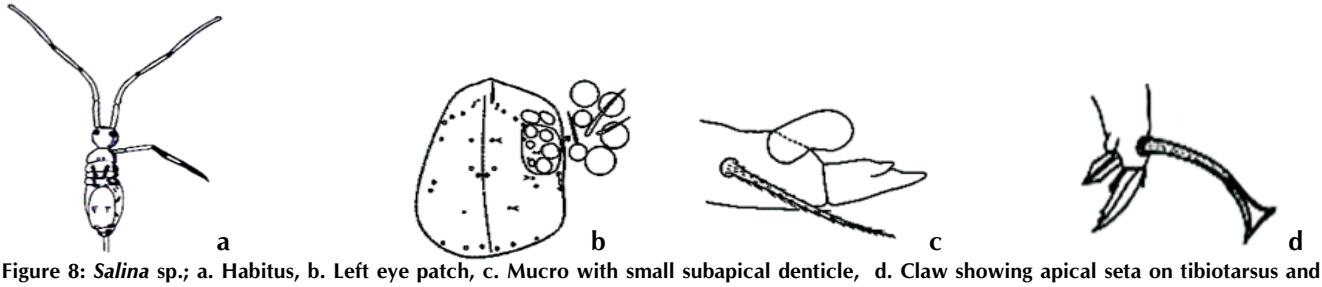


Figure 8: *Salina* sp.; a. Habitus, b. Left eye patch, c. Mucro with small subapical denticle, d. Claw showing apical seta on tibiotarsus and unpaired inner ungual teeth.

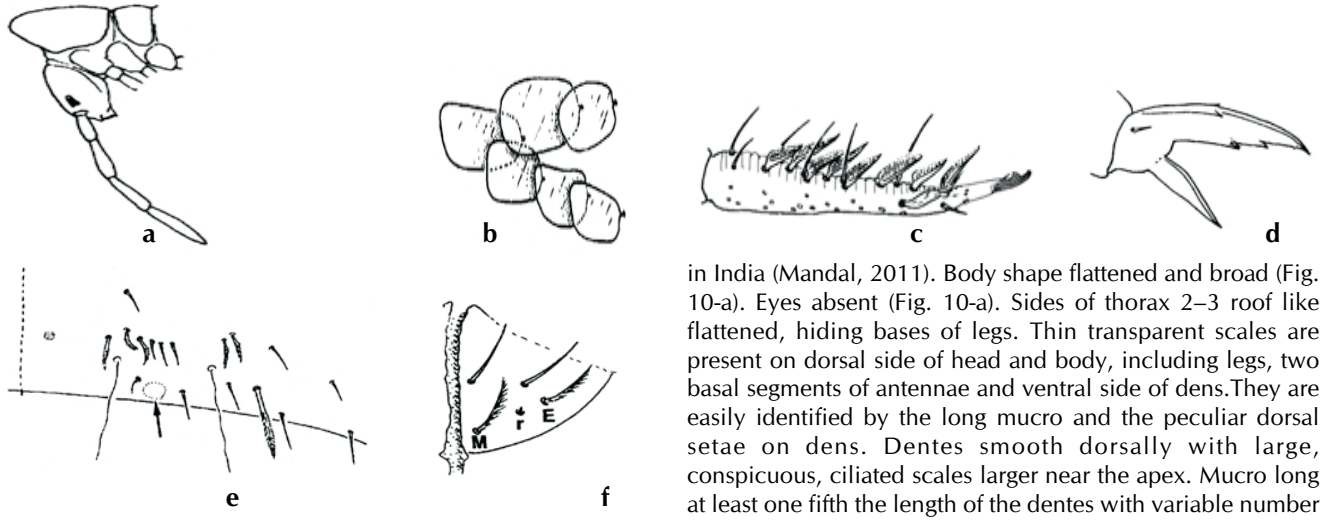


Figure 9: *Lepidocyrtus sp.*; a. Profile of head and thorax, b. blunt scales from dorsal side of abdomen c. Scales on dens and mucro, d. claw showing unguiculus and unguis, e. setal pattern on right side of abdomen 2, absence of macrochaeta (arrow) f. Labial pulp

tooth more distally. Unguiculus of variable shape, ventral edge sometimes serrated (Fig. 9-d). However in some cases, we find but a single tooth on the larger one. Club-shaped hairs may be borne on various parts of the body. Macrochaetae present reduced in number. Trichobothria present on abdomen 2–4 (2-3-2 on each side). The setal arrangement around the trichobothria on abdomen 2–4 offer diagnostic characters (Fig. 9-e). Labrum with many smooth setae and 4 ciliate prelabrals (smooth in *curvicollis*). Labral edge with 4 pointed (hooked) papillae. Labial palps with a normal set of papillae and guards, proximal setae 5 (Fig. 9-f).

***Cyphoderus* sp. (Plate 1- J)**

At the present moment 62 species have been recorded from world fauna (Janssens, 2012), only one of which is described in India (Mandal, 2011). Body shape flattened and broad (Fig. 10-a). Eyes absent (Fig. 10-a). Sides of thorax 2–3 roof like flattened, hiding bases of legs. Thin transparent scales are present on dorsal side of head and body, including legs, two basal segments of antennae and ventral side of dens.They are easily identified by the long mucro and the peculiar dorsal setae on dens. Dentes smooth dorsally with large, conspicuous, ciliated scales larger near the apex. Mucro long at least one fifth the length of the dentes with variable number of teath. Antennae 4-segmented, it is about 2.5 as long as head diagonal. Anennal segment 1 with 7–8 ventral and 3 dorsal (at base) microsensilla. Antennal segments 2–4 with many setaceous short sensilla on dorsal and ventral sides. Antennal organ in 3rd segment inconspicuous, with small apical sensilla and guards (Fig. 10-b). Anennal segments 2–3 with a short, triangular spine-like sensillum in mid-ventral (ventrolateral) position. Antennal segment 4 with a short club shaped subapical organ. PAO absent. Labrum with smooth setae, two setae of the mid-row stronger than others (Fig. 10-c). Trochanteral organ on last leg is V-shaped, with about 10 setae (Fig. 10-d). Ventral tube with 2+2 long anterior setae, 2+2 short distal and 6–7 posterior setae of which three are longer than others (Fig. 10-e). Coxal parts of mid-legs with 2–3 particularly strong macrochaetae (Fig. 10-f). Maxillary palp simple, sublobal hairs absent. Maxilla with 3-toothed capitulum and a fused padshaped lamellary complex which is not easily interpreted (Fig. 10-g). Claws slender, apically expanded, unguis with a long needle-like basal tooth on the

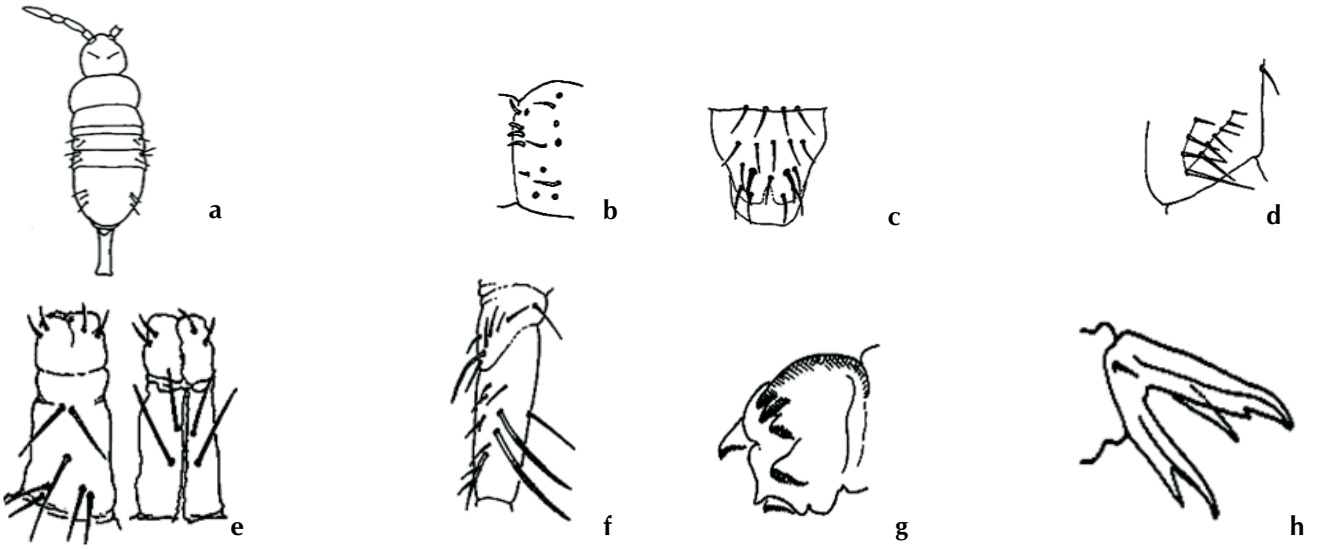


Figure 10: ***Cyphoderus*** **sp.; a. Body shape and distribution of dorsal trichobothria, b. antennal organ (3rd seg) with small sensilla, c. Labrum, d. Trochanteral organ of left hind leg, e. Ventral tube, anterior (left) and posterior (right), f. Setae on outer side of left coxa, g. Maxilla, h. Claw showing unguiculus and unguis**

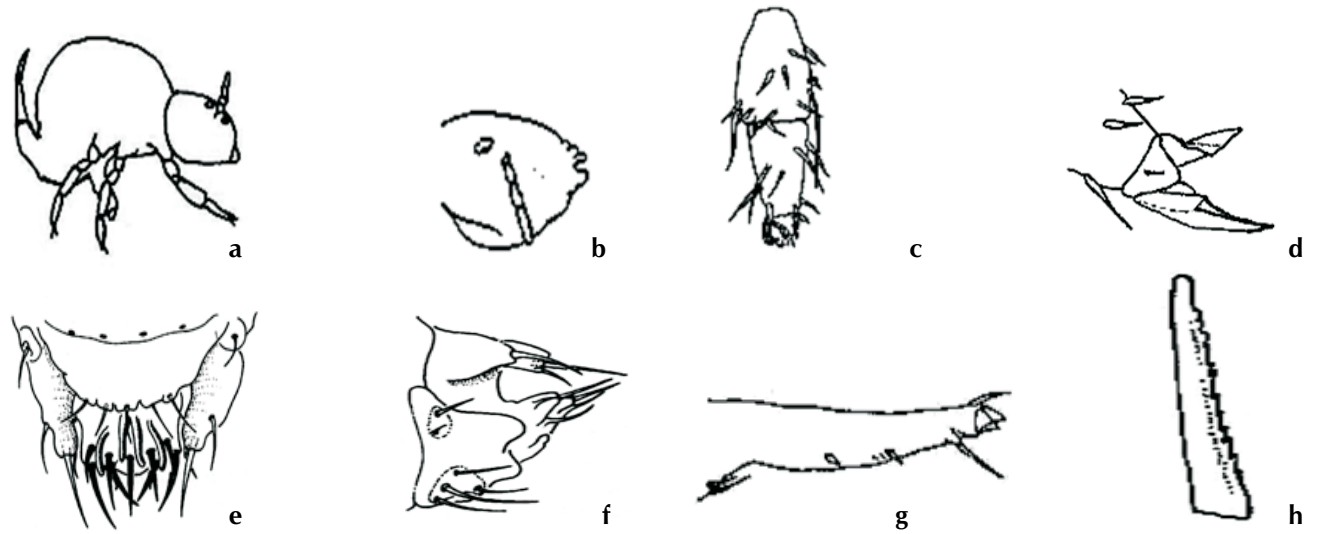


Figure 11: ***Neelus*** **sp.; a. Habitus, b. Antenna, c. Ant. 3rd not longer than 4th, d. claw with unguiculus and unguis, e. Labrum and maxillary palp, f. Labium and maxillary outer lobe, g. Dens, h. Mucro**

back side, inner edge with a small subapical tooth (Fig. 10-h). Unguiculus with a strong, wing-like ventral tooth (Fig. 10-h).

Neelus **sp. (Plate 1- K)**

It is very rare species in the world. Only 6 named species are described (Janssens, 2012) so far, in India only one species is named (Mandal, 2011). *Neelus* sp. was established by Folsom (1896). Body size generally smaller (Fig. 11- a). Body shape globose. Head with sensorial pits in the post antennal organ / ocellar field and in front of the antennal base. Similar sensorial fields are found above the base of legs on thorax 2–3 and on abdomen. Body hairs, apart from the setae surrounding the sensory fields on thorax and abdomen, very short and spine-like. The genus *Neelus* may be easily recognized within the family Neelidae by obvious morphological features, eg. antennae short, antennal segments III and IV apparently separated by suture, segment 4 being not longer than 3rd (Fig. 11-b and c). Ant.1 with 3 dorsal setae, ant.2 with 5. Ant.3 organ with a very long ventrolateral guard sensillum (Fig. 11-c). Claws with a pair of strong lateral teeth and a single strong inner tooth. Unguiculus simple (Fig. 11-d). Sensillary equipment present in 4th antennal segment. Usually with some weak brownish pigment. The 5 setae of the basal row of labrum is thin, apical 5+4 setae enlarged, spine like. Four ridges separate the median 5 setae. The large maxillary palps simple, with one enlarged sublobal hair (Fig. 11- e). Basomedian field of labium with 4 setae, basolateral with two (Fig. 11-f). Ventral side of head with 3 + 3 postmedian setae. Labial palps with 4 proximal setae (Folsom and Champaign, 1901). Dens with two dorsal setae and one dorsal subapical seta (Fig. 11-g). Mucro with serrated dorsal edges and a midventral keel (Fig. 11-h).

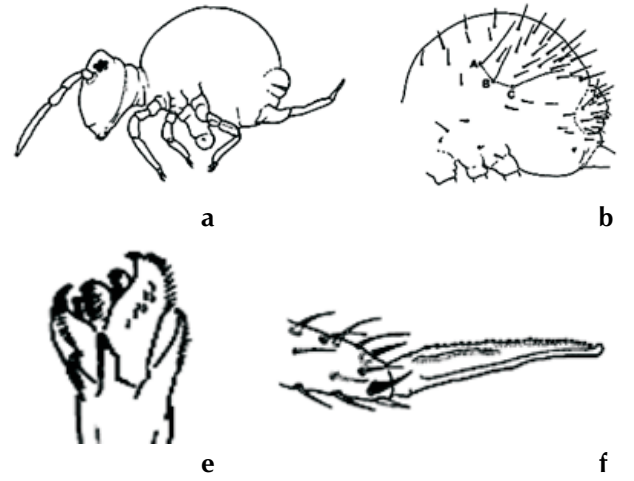


Figure 12: *Sminthurides* sp.; a. Habitus, b. setae of abdomen, with trichobothria, c. male antennal clasping organ with details of ant. 2-3, d. dorsolateral view of Retinaculum, e. Maxilla, f. apical part of dens and mucro without lateral seta

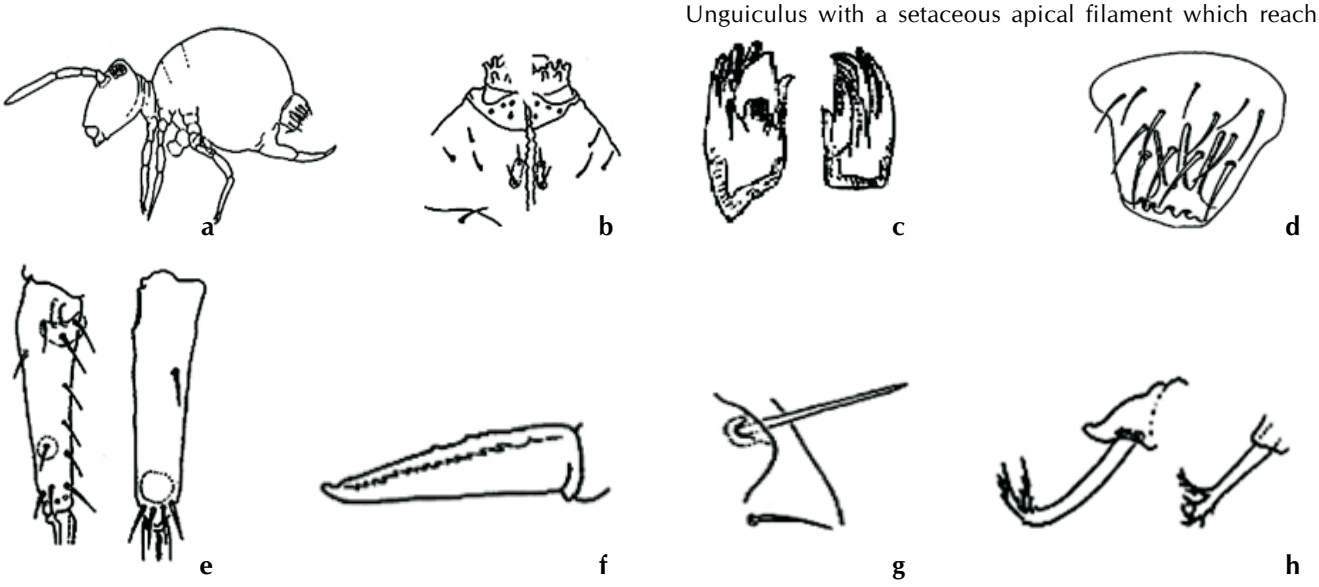


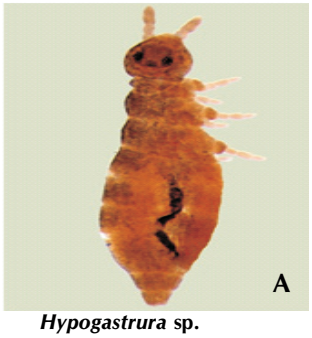
Figure 13: *Sminthurinus* sp.; a. Habitus, b. ventral side of head showing 2 + 2 postlabial setae (encircled), c. maxilla, different views, d. Labrum, e. dens, dorsolateral (left) and ventral (right), f. mucro, g. Spiniform trichobothrium on abdomen 5, h. subanal appendages, different specimens

***Sminthurides* (Plate 1- L)**

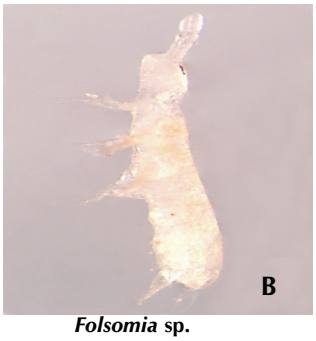
Total 59 named species have been described in world (Janssens, 2012) whereas, 4 in india (Mandal, 2011). Females are larger than males. Head and body with normal setae (Fig. 12-a). The sockets of the 3 trichobothria on each side of the greater abdomen form an ob-tuse angel which opens to the anterior (Fig. 12-b). Males have modified antennal segments 2–3 forming a clasping organ by which they lock up with the female antennae during the courtship. Second antennal segment in males has one trichobothrium on the outer side (Fig. 12-c). Last antennal segment in females often subdivided. Fourth antennal segment with at least 6 subsegments (Hazra and Mandal, 2007). Mandibles large, with strong molar plate. Retinaculum with 3 + 3 teeth and 2–4 setae (Fig. 12-d). Ocelli 6–8, two of them usually much smaller than others. Labial palps complete, with 5 papillae and 16 guards, proximal setae 8. Basomedian field with 4 setae, basolateral with 4–5. Anterior edge of labrum is membranous and undulating, with 4 spines which are curved anteriorly. One or more of the spines may be branched. Maxillary palp simple, sitting on a short blunt papilla. Sublobal hairs 4, with an additional hair on the inner side at base of the palp. Maxilla with 3-toothed capitulum and 6 short lamellae with a sparse cover of denticles/cilia (Fig. 12-e). Dens long (Fig. 12-f) and mucro without lateral seta (Fig. 12-f). Ventral tube with 1 + 1 distal setae. Claws of two first pair of legs long and narrow, with slender unguiculus. Claw on last legs shorter, with broad basal lamella on unguiculus. Unguiculus with a setaceous apical filament which reach beyond tip of unguis.

***Sminthurinus* sp. (Plate 1- M)**

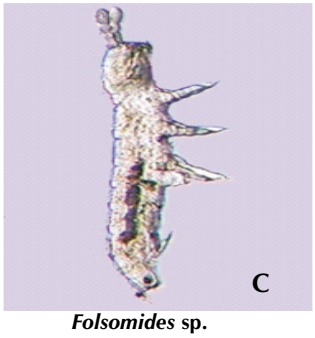
Ninety two named Sminthurinus sp. are described in the world (Janssens, 2012) out of which only one sp. is described in India (Mandal, 2011). According to Richards (1982) spine-like setae on the dorsum of the head is primary in separating Katianna from Sminthurinus. He further points out that *Sminthurinus* shows the median bifid seta found on the anal papilla. Head and body with normal setae (Fig. 13-a). Abdomen with 3 + 3 setaceous trichobothria and abdomen 5 with one trichobothrium. Ventral side of head showing 2 + 2 postlabial setae (encircled), (Fig. 13-b). Maxillary outer lobe with simple palp and one sublobal hair. Mandibles strong, normal. Maxilla with short lamellae (Fig. 13-c). The smooth anterior edge of



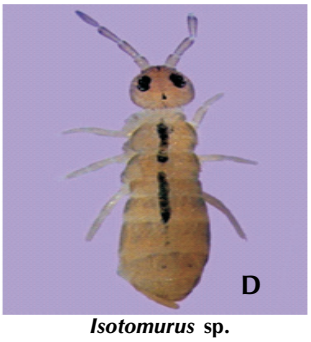
Hypogastrura sp.



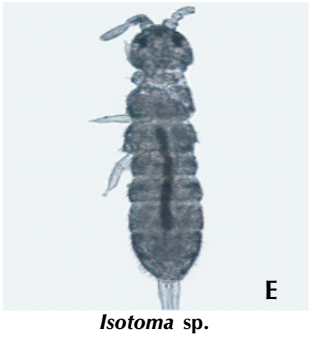
Folsomia sp.



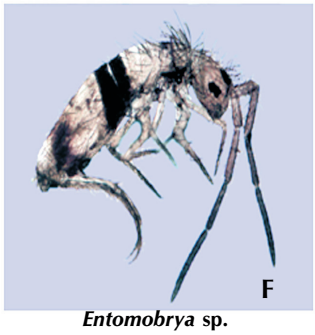
Folsomides sp.



Isotomurus sp.

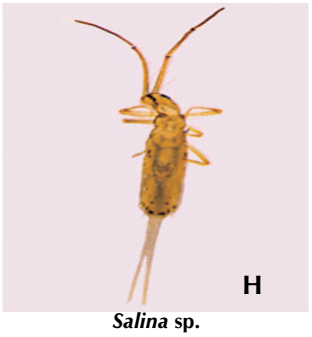


Isotoma sp.



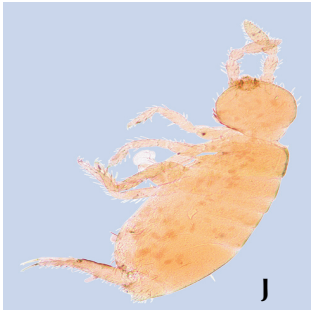
Entomobrya sp.

Seira sp.



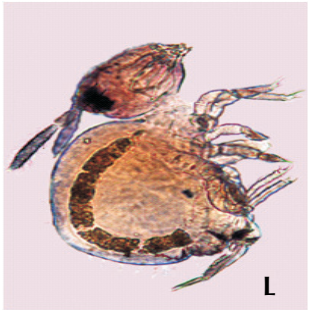
Salina sp.

Lepidocyrtus sp.

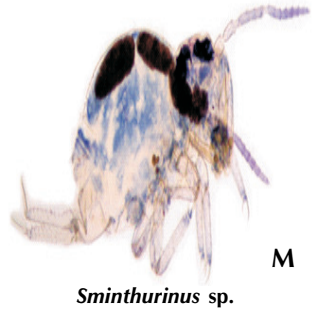


Cyphoderus sp.

Neelus sp.



Sminthurides sp.



Sminthurinus sp.

Plate 1: Microphotographs of collembolans; (A) *Hypogastrura* sp., (B) *Folsomia* sp., (C) *Folsomides* sp., (D) *Isotomurus* sp., (E) *Isotoma* sp., (F) *Entomobrya* sp., (G) *Seira* sp., (H) *Salina* sp., (I) *Lepidocyrtus* sp., (J) *Cyphoderus* sp., (K) *Neelus* sp., (L) *Sminthurides* sp., (M) *Sminthurinus* sp.

labrum with 4 conical papillae followed by three elongate ridges, prelabral setae 6 (Fig. 13-d). Labial palps with all 5 papillae present and variable number of proximal setae and guards. Dens long (Fig. 13-e) and mucro without lateral seta (Fig. 13-f). Spiniform trichobothrium are present on abdomen 5 (Fig. 13-g), Subanal appendages in females curved apically split in several branches (Fig. 13-h). Tibiotarsi with 4–5 clavate apical setae. Claws with serrated lateral bases and usually one pair of subapical lateral teeth, inner edge of unguis with 2–3 teeth. Unguiculus with corner tooth.

CONCLUSIONS

Collembolans are major part of soil biota. Their correct identification will help workers to document data on ecology and distribution of species from different soil types. Therefore, the present work on identification characters of 13 genera are described in paper. The common characters like body structure, head, eye, antenna, PAO, labium, labrum, thorax, abdomen, claw and furca are used for determination for species.

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