

Three new species of Collembola from India

G. P. Mandal*

Zoological Survey of India, M-Block, New Alipore, Kolkata - 700053,
West Bengal, India; gpmandal.zsi@gmail.com

Abstract

Three new species of Collembola belonging to genera: *Calx*, *Folsomia* and *Bourletiella* under three families have been described from the states of Jharkhand, Arunachal Pradesh and Meghalaya, India. An identification key to the Indian species and their distribution are also provided.

Keywords: Bourletiellidae, Collembola, Entomobryidae, India, Isotomidae, New Species

Introduction

The present study of collembolan fauna is based on collection made from three different states of India, Jharkhand, Arunachal Pradesh and Meghalaya, as a part of the “Annual Action Plan” of Zoological Survey of India.

The species belonging to the family Entomobryidae, Isotomidae and Bourletiellidae, identified of the collembolan found are included into the genera, *Calx*, *Folsomia* and *Bourletiella*. A total of 3 species of Collembola belonging to 3 genera under 3 families Entomobryidae, Isotomidae and Bourletiellidae have been described as new to science from India. The detailed descriptions of each species of Collembola with discussion for difference between closely related species, total numbers of species in the world as well as from India, key to the Indian species and their distribution are also provided.

Material and Methods

Specimens were mounted under a cover slip in Hoyer's solution, and were studied under a Leica Digital Module (DM 2500) microscope. Photographs were taken under a Leica Digital Module R (DMR) microscope using amounted Leica DFC 295 digital camera, and were enhanced with Photoshop CS4 (Adobe Inc.). All specimens are deposited in the Apterygota Section, Zoological Survey of India (ZSI), Kolkata.

Abbreviations: Abd = abdominal segment, Ant = antennal segment, Mac = macrochaetae, P.A.O= post antennal organ, Th = thoracic segment, VT= ventral tube, ms-microsensillum, s-sensillum, Mac-macrosetae, c-common setae, p-row-posterior row of tergal setae, px-group of proximal setae, bm-group of basomedial setae, App. an. = Appendices anales, ZSI = Zoological Survey of India, (Kolkata).

Family ENTOMOBRYIDAE Schäffer, 1896

Subfamily ENTOMOBRYINAE Schäffer, 1896

Genus *Calx* Christiansen, 1958

1958. *Calx* Christiansen *Bull. Mus. Comp. Zool. Harv. Univ.*, **118**: 437-545

Type species: *Entomobrya (Drepanura) sabulicola* Mills, 1931

Calx Christiansen, 1958 is a new world scale less Entomobryinae genus with falcate mucro; head with 8+8 eyes; large macrochaetae bases present on anterior margin of thorax; mucronal basal spine absent, claw with four inner teeth (Christiansen, 1958). So far, four species have been described all over the world (Bellinger *et al.*, 2017) and the genus *Calx* is recorded from India for the first time with a description of new species *Calx kailashi* n. sp. A checklist of world species of *Calx* as reference to their distribution in India and the world is provided.

* Author for correspondence

1. *Calx sabulicola* (Mills, 1931). It was recorded from N. North America, S. North America, Pacific North America.
2. *Calx cubensis* (Folsom, 1927). It was recorded from Caribbean mainland, Antillean and S. Florida.
3. *Calx luthuli* Rapoport and Rubio, 1968. It was recorded from Cerro El Pajonal, Antofagasta, Steppe tall, Chile (Andean).
4. *Calx neryi* Soto-Adames, 2002. It was recorded from Antillean and S. Florida
5. *Calx kailashi* n. sp.

A new species, *Calx kailashi* n. sp. is described from Panvasba Nallah, Koderma Wild Life Sanctuary, Koderma district, Jharkhand, India.

Key to the world species of the genus *Calx*

1. Body with dark pigment patches2
 – Body without dark pigment patches4
2. Apical sense organ of Ant.III with two small rods
sabulicola
 – Apical sense organ of Ant.III with more than two small rods...3
3. Internal unguis paired teeth, close to the middle of the claw.....
neryi
 – Internal unguis paired teeth, two third distal of the claw
kailashi n. sp.
 – Unguis without lateral teeth. Tenent hair absent.....
luthuli
 – Unguis with a pair of long, sharp lateral teeth. Tenent hair long and strong.....
cubensis

Calx kailashi sp. nov

(Plate 1, Figures– 1–22, Table 1 and 2)

Type material: Holotype: male on slide, INDIA, Jharkhand, Panvasba Nallah, East side of Koderma Wild Life Sanctuary, district Koderma, Altitude 389 meters, Latitude 24°29'23.2"North and 85°36'41.3" East, date 01.xii.2012, coll. G. P. Mandal (Registration No. 1931 / H14) deposited in the National Zoological Collection, Zoological Survey of India, (Kolkata). Paratypes: 1

example on slide (dissected), same data as Holotype (Registration No. 1932 / H14) and 30 examples in ethyl alcohol, same data as Holotype (Registration No. 1933 / H14) deposited in the National Zoological Collection, Zoological Survey of India, (Kolkata).

Description: Body length up to 1.32 mm (excluding appendages).

Colour-pattern: Back ground colour yellow-orange, dark violet pigment present in fresh specimens (Figure 1) but in preserved specimens pigments are dark blue (Figure 2). Antennae moderately and uniformly dark except base of each segment. Eye patches dark, an irregular patches below eye to mid-dorsal margin of head; prothorax with anterior portion with small patches, meso and metathorax with dark pigmented patches and spots, posterior margin darker than anterior (Figure 3). Ventrally yellowish in colour, fifth and sixth abdominal segments laterally with pigmented patches (Figure 4). Furcula without pigment. Thorax II to Abd. IV laterally dark pigmented, Th.II to Abd.IV forming an irregular median transverse band and patches (Figures 1–3). Legs base yellow and mid-dorsal and lateral edges dark. Abd.V with dark blue band in midline. Abd. VI totally dark blue.

Antennae: The antennae approximately 2.32 times as long as cephalic diagonal; the ratio of antennal segments I: II: III: IV= 1: 1.8: 1.5: 2.5 (Figure 5). Antennal segments sub cylindrical in shape and sub equal in diameter. Apex of Ant. IV with two apical bulb in two different sizes, distinctly not sub apical, and one distinct pin setae, two small smooth setae (Figure 6). Apical sense organ of third segment of four small rod shaped sensillae (Figure 7).

Head: Head more or less oval, 1.19 times as long as broad, outer labral papillae rounded and five smooth ciliate setae present (Figure 8). Labial appendages with clearly differentiated external setae of normal size present (Figure 9). Eyes 8+8, H smaller than G, 2 large multilaterally ciliate setae arise from eye patch (Figure 10). Cephalic macrochaetae and anterior type 5 setae as shown in Figure 11.

Clothing: Normal five types of setae present, type 1 setae very broad, long, sharply expanded basally and apex truncate type, predominant on head, Thorax II, III and Abd. I to III. All tergal macrochaetae truncate. Setae of type 5 acuminate for apical two thirds of length, slightly expanded medially. Coarsely multilaterally ciliate setae present on head, thorax and abdomen. Bothriotrichia present on head, thorax and abdomen (Figure 12).

Thorax and Abdomen: Relative length index of thoracic segments II: III = 1.6: 1. Relative length index abdominal segments I: II: III: IV: V: VI = 1: 1.2: 1.1: 5.6: 1.3: 0.6. Chaetotaxy of Th.II– III and Abd. I– III are shown in Figure 13 and Figure 14. Rami of retinaculum with quadridentate; corpus with one long, broad, inner serrated, truncate seta (Figure 15).

Legs: Trochanteral organ with 12–15 smooth triangular setae (Figure 16). Metatibiotarsi proximally with 5 long multilaterally ciliate setae (Figure 17). Unguis with four inner teeth, inner unguis paired teeth two-third distal of the claw (Figure 18). Unguiculus lanceolate. Unguis and unguiculus without internal ciliation. Tenent hair as long as unguiculus, slender and acuminate.

Furcula and genital plate: Ratio of Manubrium: Dens: Mucro = 1: 1.69:0.02. Furcula with great number of multilaterally ciliate setae present on manubrium and both sides of dens. Manubrium with 38–40 multilaterally ciliate setae present on the dorsal side (Figure 19). Dens deeply crenulated. Mucro very small and short (Figure 20). Male genital plate with 10 papillae, 10 angular setae, 6 pegs and 6 normal setae (Figure 21).

Biology: In Jharkhand, found in dry habitats near Panvasba Nallah where the big rock covered with semi decomposed leaf litters, at an altitude 389 meters of elevation and coordinates between 24°29'23.2"N latitude and longitude 85°36'41.3" E. Soil is micaceous type (containing particles of mica) and sandy in texture. The forest is tropical dry deciduous type and dominated by tall trees like – *Terminalia arjuna*, *Shorea robusta*, *Tectona grandis* and different types of herbs and shrubs like – *Digitaria marginata*, *D. royleana*, *Euphorbia hirta* and *Lantena camera* etc. (Figure 22).

Etymology: The new species is named after Dr. Kailash Chandra, Director of the Zoological Survey of India for his keen interest and encouragement in my study.

Discussion: Among the species of New world scale Entomobryinae with falcate mucro only *Calx neryi* is yellow and orange with Th. 3 and Abd. 3 uniformly black (Soto-Adames, 2002). *Calx luthuli* is prussian blue coloration throughout the body, head, antennae, legs and manubrium (Rapoport and Rubio, 1968). *Calx cubensis* is white, rather scantily marked with blue (Folsom, 1927). *Calx sabulicola* is dark blue to purple pigment & background yellow to dull gray (Christiansen, 1958). The new species *Calx kailashi* n. sp. is also yellow-orange background and dark blue pigment patches throughout the body in preserved specimens, but in fresh specimens dark violet in colour. The dorsal macrochaetotaxy of the trunk of *Calx kailashi* n. sp. is more (26, 27, 14, 14, 12, on Th. 2– Abd. 3) setae and differs markedly from the chaetotaxy of *C. sabulicola* and *C. neryi*. The unguis of *Calx kailashi* n. sp. resembles that of *C. neryi* but differs in the position of the dorsal tooth, which is inserted on the two third distal of the claw. The sensillae of third antennal segment are small rods shaped without blunt, but are short blunt rods in *C. neryi*. The shape of the apical bulb of Ant. 4 is differs from *C. neryi* and *C. sabulicola*. Male genital plate of *Calx kailashi* n.sp. is having 10 papillae, 10 angular setae, 6 pegs and 6 normal smooth setae and differs markedly from *C. neryi* and *C. sabulicola*. The new species could be easily distinguished from all the known species of the genus by the presence of outer labral papillae rounded and five smooth ciliate setae, labial appendages with clearly differentiated external seta, male genital plate, and other characters shown in Table 1.

Remarks: The colour pattern and pigment structure of *Calx kailashi* n. sp. is nearer to *Calx sabulicola* but strongly differs with presence of an external differentiated seta on the labial appendages, labral papillae with five smooth ciliate setae, male genital plate having different types of setae, pegs and papillae, number of dorsal macro chaetae of Th. II– Abd. III is more and unguis and unguiculus without internal ciliations and other characters shown in Table 2. The female is larger than male.

Table 1. Comparison of *Calx kailashi* n. sp. with other members of the genus

Sl. No	Characters	<i>Calx sabulicola</i>	<i>Calx cubensis</i>	<i>Calx luthuli</i>	<i>Calx neryi</i>	<i>Calx kailashi</i> n. sp.
1	Body length	2.5mm	1.4mm	1.4mm	1.1mm	1.32 mm
2	Colouration	Background yellow to dull grey; pigmented dark blue to purple, varied in distribution but generally in irregular bands & patches.	White, rather scanty marked with blue & large specimens have often a yellowish tinge. Head with a little lateral pigment and a pair of spots or a transverse mark in front of the eye. Mesonotum & metanotum bordered laterally with pigments.	Prussian blue colour throughout the body, head, antennae, legs & manubrium. Only dens lack pigmentation.	Background colour yellow-orange, more intense on head anterior to the eyes and up to Ant. II. Th. 3 and Abd. 3 uniformly black.	Back ground colour yellow-orange, pigments are dark blue throughout the body forming irregular band & patches. Antennae dark except each base.
3	Apex of Ant.3 & Ant.4	Apical sense organ of third Ant. segment of two small rods. Antennal apical bulb double, distinctly sub apical.	Unknown	Apical sense organ of third antennal segment are fan or leave-shaped.	Apex of Ant.4 with 3 short truncates sensillae & an unlobed bulb 3 short blunt rods on Ant.3.	Apical sense organ of third antennal segment of four small rod shaped sensillae. Apex of Ant. IV with two apical bulb and one distinct pin setae.
4	Inner unguual teeth	Internal ungula teeth three-fourth of distance from base to apex.	Ungual teeth one fourth from the base.	Internal ungula teeth are very close together and displaced to the distal third of the claw.	Ungual paired teeth, close to the middle of the claws.	Ungual paired teeth, two third distal of the claw.
5	Tenent hair	Tenent hair acuminate.	Tenent hair long, strong & clavate.	Tenent hair absent.	Tenent hair two times larger than ventral smooth setae & acuminate.	Tenent hair as long as unguis, slender & acuminate.
6	Trochanteral organ	Trochanteral organ irregular with a few scattered large setae.	Trochanteral organ absent.	Trochanteral organ absent.	Trochanteral organ with 6-9 smooth triangular setae.	Trochanteral organ distinct, with 12-15 smooth triangular setae.
7	Male genital plate	Fourteen (14) short setae of similar shape, all are acuminate	Unknown	Unknown	Male genital plate with 12 papillae, 10 angular setae, 2 pegs & 4 small smooth seta	Male genital plate with 10 papillae, 10 angular setae, 6 pegs & 6 small smooth setae.
8	Dorsal maul-trial setae	Unknown	Short clavate fringed setae are present.	Unknown	'3' ciliate setae & '2' pseudopores near base of dentes.	38-40 multilaterally ciliate setae present.
9	Mucro	Mucro with tooth heavy & short.	Mucro short and stout strongly rounded ventrally, falcate, with a single stout apical hook.	Mucro falcate, without basal spine.	Mucro falcate, without basal spine.	Mucro falcate, short, without basal spine.

Table 2. Discriminating characters of *Calx sabulicola* and *Calx kailashi* n. sp

Sl.No	Characters	<i>Calx sabulicola</i>	<i>Calx kailashi</i> n. sp.
1	Body length	Up to 2.5mm.	Up to 1.32 mm.
2	Colouration	Background yellow to dull grey; pigment dark blue to purple, varied in distribution but generally in irregular bands & patches. Second & third antennal segments with a single line of small oval pegs.	Back ground colour yellow-orange, pigments are dark blue throughout the body, formed irregular bands & patches. Antennae dark except each base.
3	Outer labral papillae	Labral papillae with outer pair rounded & lacking setae.	Labral papillae with outer pair rounded & '5' smooth ciliate setae.
4	External differentiated setae on labial appendages	Absent	One normal external differentiated setae present.
5	Apex of Ant.IV	Antennal apical bulbs double; distinctly sub apical, without pin setae.	Antenna with two apical bulbs, distinctly not sub apical and one distinct pin setae.
6	Apex of Ant. III	Apical sense organ of third segments of two small rods.	Apical sense organ of third segment of four small rods.
7	Body setae	Setae of Type 1, very broad, sharply expanded basally, slightly so at apex. Setae of type five acuminate for apical two thirds of the length, slightly expanded medially.	Setae of Type 1, broad, robust, sub cylindrical in shape, fine serration present inside the setae. Type five medium to large size, slender multilaterally ciliate, acuminate, present throughout the body.
8	Trochanteral organ	Trochanteral organ irregular with a few scattered large setae.	Trochanteral organ distinct, with 12-15 smooth triangular setae present.
9	Ungual internal teeth	Three-fourth of distance from base to apex.	Two-third of distance from base to apex.
10	Dorsal manubrial setae	Unknown.	38-40 multilaterally ciliate setae present.
11	Male genital plate	Male genital plate with fourteen (14) short setae of similar shape, all are acuminate	Male genital plate with 10 papillae, 10 angular setae, 6 pegs & 6 small smooth setae.
12	Mucronal tooth	Mucro with tooth heavy and short	Mucro with tooth short & small.
13	Lasiotrichia on anterior margin of thorax & head	Single row of lasio-trichia on anterior margin of thorax & head.	Multiple rows of lasio-trichia on anterior margin of thorax & head.
14	Unguis & unguiculus with internal ciliations.	Unguis & unguiculus with internal ciliation.	Unguis & unguiculus without internal ciliation.

Family ISOTOMIDAE Börner, 1913

Subfamily PROISOTOMINAE Stach, 1947

Genus *Folsomia* Willem, 1902

1902. *Folsomia* Willem, *Ann. Soc. Ent. Belg.* **46**: 275-283

Type species: *Folsomia candida* Willem, 1902

Folsomia Willem, 1902 is one of the largest genera in the family Isotomidae. It differs from the other Isotomidae

in the following characters: the last three abdominal segments fused, PAO present, well developed, but rather short furcula, retinaculum with 4+4 teeth and a single large seta, anal spines absent (Ding *et al.*, 2006). So far, about 177 species have been described all over the world (Bellinger *et al.*, 2017) and *F. bajjali* Prabhoo, 1972 is found to be endemic to India. A checklist of Indian species, of *Folsomia* as reference to their distribution in India and the World is provided.

1. *F. fimetaria* (Linnaeus, 1758). It was recorded from Dodabetta, Nilgiris, Tamil Nadu of India and from Arctic and Sub-arctic, Europe, North Eurasia, Sino-Japanese, Himalayan, West and Central Asia, Mediterranean, Macronesian, North America, Caribbean mainland, Antillean and S. Florida.
2. *F. santokhi* (Baijal, 1958). It was recorded from North Slope of Pir Panjal Range Lahaul (upper Chandra Valley), opposite Kulti Nal, 3675m, Himachal Pradesh, India and Himalaya.
3. *F. baijali* Prabhoo, 1971. It was only recorded from Vandiperiyar, Kerala, India.
4. *F. octoculata* Handschin, 1925. It was recorded from Nilgiris, Tamil Nadu of India and Northern Eastern Asia & Hawaii Island, Himalaya, Sino-Japanese and African-Indian desert.
5. *F. arunachalensis* n. sp.

A new species, *Folsomia arunachalensis* n. sp. is described here from Lower Dibang Valley District, 65, Mayudia, Arunachal Pradesh, India.

Key to the Indian species of the genus *Folsomia*

1. Ommatidia absent 2
 - Ommatidia present..... 4
2. Manubrium with fewer than 10 anterior setae 3
 - Manubrium with 17-18 anterior setae *arunachalensis* n. sp.
3. Manubrium with 1+1 anterior setae..... *baijali*
 - Manubrium with 4+4 anterior setae..... *fimetaria*
4. With 6+6 or more ommatidia *santokhi*
 - With 4+4 ommatidia *octoculata*

***Folsomia arunachalensis* sp. nov.**
(Plate 2, Figures– 1–20, Table 3–4)

Type material: Holotype: Female on slide, INDIA, Arunachal Pradesh, Lower Dibang Valley District, 65 Mayudia, Altitude 2481 m., Latitude 28°14.103'N and 95°54.895' E, date 03.xi.2015, coll. Dilip Mondal (Registration No. 1791/H14) deposited in the National Zoological Collection, Zoological Survey of India, (Kolkata). Paratypes: 1 ex on slide, same data as Holotype

(Registration No. 1792/H14) and 50 exs in ethyl alcohol, same data as Holotype (Registration No. 1793/H14) deposited in the National Zoological Collection, Zoological Survey of India, (Kolkata).

Description: Body length up to 0.92 mm.

Colour: Ground colour creamy white, no pigmentation and ocelli (Figure 1).

Head: Ommatidia absent. PAO broad, oval shape, without distinct constriction, with 3 guard setae (Figure 2), PAO 1.3–1.4 times as long as width of Ant. I and 2.2 times more than inner edge of claw III. Maxillary palp bifurcated, maxillary outer lobe with 4 sublobal hairs (Figure 3). Labral setal formula 4, 5, 4. Labium with 4+4 basomedian setae. Ventral side of head with 4+4 setae along linea ventralis (ventral groove). Ant. I, II, III respectively with 1, 1, 0 basal microsensilla (bm) and 2, 3, 3 sensilla (s). Ant. IV with weakly differentiated sensilla with apical lobe (Figures 4, 5, 6, 7).

Body chaetotaxy: Macroseta (Mac) obviously longer than ordinary seta. Sensillum (s) thinner-walled, shorter and more slender than common setae. Microsensillum (ms) thick-walled and shorter than common seta and sensillum (Figures 8, 9, 10). Formula of body macrosetae Th–II, Th–III, Abd–I, II, III, V as 1, 1, 0, 1, 1, 5 per half tergum, longest on last 3 abdominal segment 2.77 times length of mucro. Sensillar and micro-sensillar formula respectively as 4, 3/2, 2, 2, 3, 5 (s) and 1, 1, 0 (ms) (Figures 11, 12, 13). Medial sensilla on all tergites situated within P-row, on Abd. I–III between macrochaeta 1 and 2. Axial setae (common setae along median line on each side) of Th. II–Abd. III: 8–9, 9(10), 8(9), 8. Th. II with 20–22 setae in p-row.

Appendages: Unguis without lateral & inner teeth. Tibiotarsus with many additional setae. Ventral tube with 4+4 latero distal and 4–5 posterior setae (Figure 14). Retinaculum 4+4 teeth and 1 setae (Figure 15). Tenent hairs absent. Anterior side of manubrium with 18 setae, posteriorly with 4 basal setae, of which 3 apical and 1 middle (Figure 16); dens crenulated, anterior side with 22 setae, in two rows, posterior with 4 setae (Figures 17 and 18) and lateral side of

dens with 11 setae (Figure 19). Mucro with 2 teeth (Figure 20), ratio of manubrium: dens:mucro as 5.1:8.5:1.

Etymology: The new species is named after the type locality.

Biology: In Arunachal Pradesh, found under the grasses, covered with dung of animals. The area is hilly and difficult terrain, covered with mixed vegetation of semi evergreen forests.

Discussion: *Folsomia arunachalensis* n. sp. belongs to the *F. fimetaria* group because of abdominal sensilla positioned in the p-row, ventral chaetae on Th.III usually missing and only one pair of macrochaetae present on thoracic segment (Potapov, 2001). The new species could be easily distinguished from all the known species of the genus by the body sensilla being 4, 3/2, 2, 2, 3, 5; setae on anterior side of manubrium being '18' and anterior dental setae in two rows containing '20' and other characters shown in Table 3.

Remarks: All species of the *fimetaria* group are blind, have no chaetae on ventral side of Abd. III and no or only 1+1 lateral sens thickened on Abd. V. The two main characters to discern the *Folsomia* species are ventral setae on the third thoracic segment and number of ventral setae on the distal region of the manubrium. The redescription of *F. fimetaria* by Lucianez and Simon, 2002 also clearly indicate that the absence of ventral setae on the third thoracic segment and manubrium with 4+4 ventral setae. The new species could be easily separated from other species in the *fimetaria* group by its particular body sensilla and chaetotaxy of manubrium and dens. Manubrium with 17 anterior setae arranged in 3+3, 3, 3-5 and posterior side of manubrium with 4 setae. Dens with 22 setae in anterior side arranged in two rows, posterior with 4 setae and laterally with 11 setae. *Folsomia arunachalensis* n. sp. is nearer to *F. fimetaria* (Linnaeus, 1758) having without pigment and omma, maxillary pulp bifurcate, maxillary outer lobe with 4 sublobal hairs but strongly differs with other characters shown in Table 4.

Table 3. Comparison of *Folsomia arunachalensis* n.sp. with other member in *fimetaria* group

Sl No.	Species	Omma	Ventral tube- distal setae	Body sensilla	Manubrium anterior setae
1	<i>arunachalensis</i> n. sp.	0+0	4+4	4, 3/2, 2, 2, 3, 5	17-18
2	<i>asiatica</i> Martynova, 1971	0+0	5+6	4, 3/2, 2, 2, 3	5+5
3	<i>bajjali</i> Prabhoo, 1971	0+0	?	?	1+1
4	<i>bisetosa</i> Gisin, 1953	0+0	5+5	4, 3/2, 2, 2, 3	2+2
5	<i>candida</i> Willem, 1902	0+0	9+9	4, 3/2, 2, 2, 3	16-32
6	<i>cilaita</i> Babenko & Bulavintsev, 1993	0+0	5+5	4, 3/2, 2, 2, 3, 5	3+3
7	<i>cryptophila</i> Potapov & Babenko, 2000	0+0	4+4	4, 3/2, 2, 2, 3, 5	2+2
8	<i>dovernis</i> Fjellberg, 1976	0+0	4+4	4, 3/2, 2, 2, 3, 5	1+1
9	<i>fimetaria</i> (Linnaeus, 1758)	0+0	5+5	4, 3/2, 2, 2, 3	4+4
10	<i>fimetariodes</i> (Axelson, 1903)	0+0	5+5	4, 3/2, 2, 2, 3, 5	7+7
11	<i>mofettophila</i> Schulz & Potapov, 2010	0+0	4+4	4, 3/2, 2, 2, 3, 5	2+2
12	<i>kerni</i> Gisin, 1948	0+0	?	?	4+4
13	<i>lawrencei</i> Rusek, 1984	0+0	3+3	3/2, 2, 2	3+3
14	<i>nivalis</i> (Packard, 1873)	0+0	5+5	4, 3/2, 2, 2, 3, 5	5+5
15	<i>sparsosetosa</i> Potapov & Stebaeva, 1997	0+0	4+4	4, 3/2, 2, 2, 3	11-15
16	<i>stella</i> Grow & Christiansen, 1977	0+0	7+7	4, 2/2, 2, 1, 2	4+3

Table 4. Discriminating characters of *F. fimetaria*, and *F. arunachalensis* n. sp

Characters	<i>F. fimetaria</i> (Linnaeus, 1758)	<i>F. arunachalensis</i> n. sp.
Body length	up to 1.4 mm	up to 0.92 mm
PAO	narrow, as long as width of Ant I or shorter.	broad, oval shape, 1.3–1.4 times as long as width of Ant I.
Ventral setae on the Th.III segment	none	1+1
Basal microsens(bm) and sens(s) of Ant I, II, III	2, 3, 0 (bm) & 2, 1, 5 (s).	1, 1, 0 (bm) & 2, 3, 3 (s).
Ventral tube with setae	5+5 laterodistal setae & 5-6 posterior setae.	4+4 laterodistal setae & 4-5 posterior setae.
Mac chaetotaxy formula	1, 1/3, 3, 3	1, 1, 0, 1, 1, 5
Sensillar formula	4, 3/2, 2, 2, 3	4, 3/2, 2, 2, 3, 5
Manubrium anterior setae	4+4	17-18 setae
Dens on anterior setae	18-24 setae	22 setae, arranged in two rows
Setae on posterior side of dens	5 setae(3+2)	4 setae(3+1)

Family BOURLETIELLIDAE Börner, 1912

Genus *Bourletiella* Banks, 1899

1899. *Bourletiella* Banks, *J.N.Y. Ent. Soc.* 7: 193-197

Type species: *Smynturus hortensis* Fitch, 1863

Bourletiella Banks, 1899 with large abdomen globular, row 5:1 seta. Ant. IV with large sensillum P on 1st whorl behind the tip, with 2 ventral and 12 tip sensilla. Inner setae of Tita not obliquely truncate. Tita I-III with 3, 3, 2 spatulate setae respectively. All empodium pointed, with lamellae, with short and pointed subapical filaments (Bretfeld, 1999). So far, about 31 species have been described all over the world (Bellinger *et al.*, 2017) and *Bourletiella captis* Baijal and Mathur, 1969 is found to be endemic to India. A checklist of Indian species, of *Bourletiella* as reference to their distribution in India and the World is provided.

1. *Bourletiella captis* Baijal and Mathur, 1969. It was recorded from Manali, Himachal Pradesh.
2. *Bourletiella arvalis* (Fitch, 1863). It was recorded from Kashmir, India and Himalaya, Australia, Europe, Sino- Japanese, Canada, U.S.A., New Zealand.
3. *Bourletiella hortensis* (Fitch, 1863). It was recorded from Manali, Himachal Pradesh and widely distributed from various parts of the world such as Europe, Australia, Japan, Canada, U.S.A., Russia and Antarctica.
4. *Bourletiella meghalayensis* n. sp.

A new species, *Bourletiella meghalayensis* n. sp. is described from East Khasi Hills district of Meghalaya, India.

Key to the Indian species of the genus *Bourletiella*

1. Colour entirely yellow with some markings.....2
– Colour blue with or without markings3
2. Colour entirely yellow with both pairs of curved clasping spines on dorsal surface of the anal segment of male pointing posteriorly *arvalis*
– Colour yellow, marked with blue, antennae completely blue; the pair of clasping organ pointing downwards
captis
3. Colour blackish blue, App. an. thin, broad fanlike, apically almost smooth.....*hortensis*
– Colour blue, marked with green and yellow, App. an. narrow, spatula shape, out edge pointed, without serration*Bourletiella meghalayensis* n. sp.

Bourletiella meghalayensis sp. nov.

(Plate 3, Figures – 1– 17, Table 5)

Type material: Holotype: Female on slide, INDIA, Meghalaya, Myllem village, Umiew river, East Khasi Hills district, Altitude 1496 m., Latitude 25°07" & 25°41" N Lat. and 91°21" & 92°09" E Longitude. date 05.iii.2016, coll. E.E.Jhamalar (Registration No. 2048/H14) deposited in the National Zoological Collection, Zoological Survey of India, (Kolkata). Paratypes: Female, 1 ex on slide, same data as

Holotype (Registration No.2049 /H14); Paratypes: Female, 1 ex on slide, same data as Holotype (Registration No. 2050/H14); Paratypes: 3 examples on slide (dissected), same data as Holotype (Registration No. 2051-2053 / H14) and 4 exs in ethyl alcohol, same data as Holotype (Registration No. 2054/H14) deposited in the National Zoological Collection, Zoological Survey of India, (Kolkata).

Description: Body length up to 1.36 mm.

Colour pattern: Main colour blue, marked with green and yellow spot on the thorax and large abdomen. Head dark blue, ocelli dark, lighter form in between two ocelli, Ant. I-IV with blue pigment, base of Ant. I pale, all legs are light blue and furcula blue. Thorax and large abdomen deep blue dorsally with green and yellow marking, a big yellow spot present dorsally on large abdomen (Figure 1).

Head: Length of antennae: head diagonal = 1:5. Head clothed with short, smooth, plain setae. All setae are uniform in size (Figure 2). Mouth parts shown as in Figure 3.

Antennae: Length ratio of antennal segments I: II: III: IV as 1: 1.7: 2.6:5.1. Ant. I with 3 smooth setae medially (Figure 4). Ant. II with 9-12 setae. Ant.III with two sensillum(s) basally and one micro-sensillum(ms) (Figure 5). Ant. IV with 7 sub segments (Figure 6).

Clothing: Head, Antennae, legs, thorax and abdomen clothed with plain, short, smooth setae.

Legs: Unguis with two inner teeth anterior and medially and one outer tooth medially (Figure 7). Unguiculus very thin without teeth (Figure 8). 3 long clavate tenent hair on each foot as long as unguis (Figure 9). Tita II row p: 3 setae (Figure 10). Length of longest setae of Tita III > diameter of Tita (Figure 11).

Furcula and genital plate: Tenaculum with 3 barbs each and without setae (Figure 12). Length ratio of mucro: dens: manubrium as 1: 2.9:1.5. Number of manubrium anterior setae is 5 (Figure 13). Formula of anterior setae of dens 2,1,1,1...1(Figure 14). Mucro with very narrow anterior furrow, basal 2/3 with furrow, mucro with light serration ventrally (Figure 15). Abd.VI dorsally with

Table 5. The differences between *Bourletiella hortensis* (Fitch, 1863) and *Bourletiella meghalayensis* n. sp

Characters	<i>Bourletiella hortensis</i> (Fitch, 1863)	<i>Bourletiella meghalayensis</i> n. sp.
Colour pattern	Main colour blackish blue. Head and large abdomen dorsally more or less pale.	Main colour blue, marked with green and yellow spot on the thorax and large abdomen. Head dark blue, ocelli dark, lighter form in between two ocelli, Ant. I-IV with blue pigment, base of Ant. I lighter, all legs are light blue and furcula blue. Thorax and large abdomen deep blue dorsally with green and yellow marking, a big yellow spot present dorsally on large abdomen
Tita II and Tita III	Tita II row p: 3 setae, length of longest setae of Tita III = diameter of Tita	Tita II row p: 3 setae, length of longest setae of Tita III > diameter of Tita
Unguis and unguiculus	Unguis with one inner tooth and no outer tooth, Unguiculus lanceolate.	Unguis with two inner teeth anterior and medially and one outer tooth medially. Unguiculus very thin without teeth.
Formula of anterior setae of dens	Formula of anterior setae of dens 2+1, 2, 1, 1...1.	Formula of anterior setae of dens 2, 1, 1, 1.....1.
Mucro	Mucro with furrow only in basal 1/3.	Mucro with furrow in basal 2/3.
App. an.	App. an. thin, broad, fanlike, apically almost smooth.	App. an. Narrow, not broad, spatulate, out edge pointed, without serration.
Body length	1.8 mm	1.36 mm

median crest, setae long (Figure 16). Appendices anales (App. an.) narrow, spatulate shape, out edge pointed, without serration (Figure 17). Ratio of App. An: mucro = 1:2.

Etymology: The new species is named after the type locality.

Biology: In Meghalaya, found on the Umiew river bed of East khasi Hill district.

Discussion: The new species from East khasi Hill district of Meghalaya, India can easily distinguished from other known species of *Bourletiella* by colour pattern, claw structure, Tita II row p:3 setae, and Annal appendages. It is close to *Bourletiella hortensis* (Fitch, 1863), in having similar type Tita II row p:3 and Ant. IV with 7 sub segments but strongly differ from *Bourletiella hortensis* in the characteristics given below in the Table 5.

Summary

A total of 3 species of Collembola belonging to 3 genera under 3 families Entomobryidae, Isotomidae and Bourletiellidae have been described as new to science from India. The detailed descriptions of each species of Collembola with discussion for difference between closely related species, total numbers of species in the world as well as from India, key to the Indian species and their distribution are also provided.

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Importance of Collembola

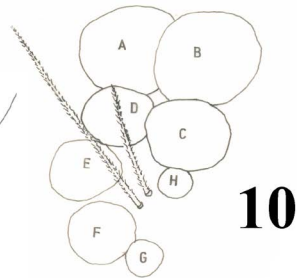
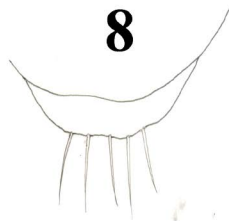
Collembola play a significant role in the breakdown of leaf litter along with certain other micro-arthropods and consequently aiding in the process of humification. Thus, they play a key role in enhancing soil fertility. They are also known to enrich the organic content of the soil in the form of faecal matter. Collembolans are also increasingly getting their due recognition as bio-indicator of soil conditions. These insects exhibit wide range responses to changes in soil factors. It has also been reported (Mitra, 1993) that collembolan can be used as an index of crop production in an Agro-ecosystem; some of them are minor pests in agriculture.

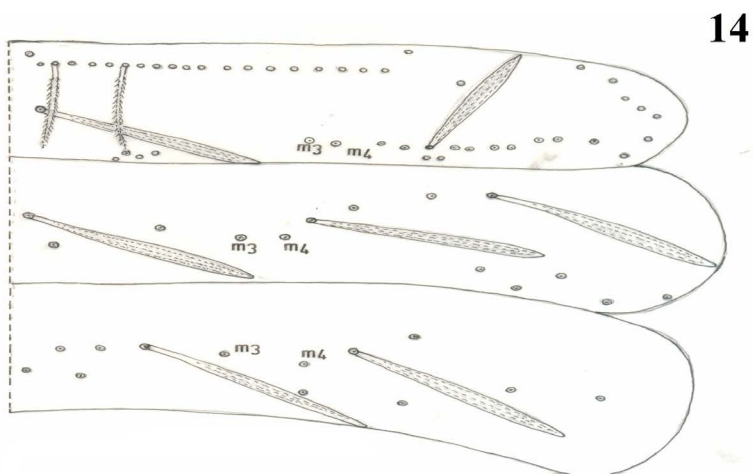
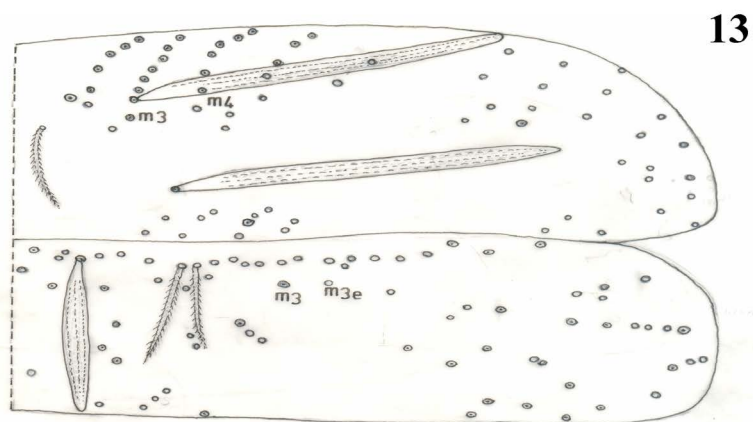
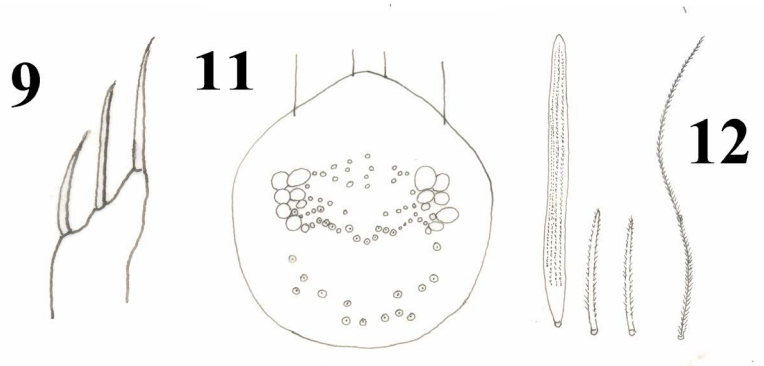
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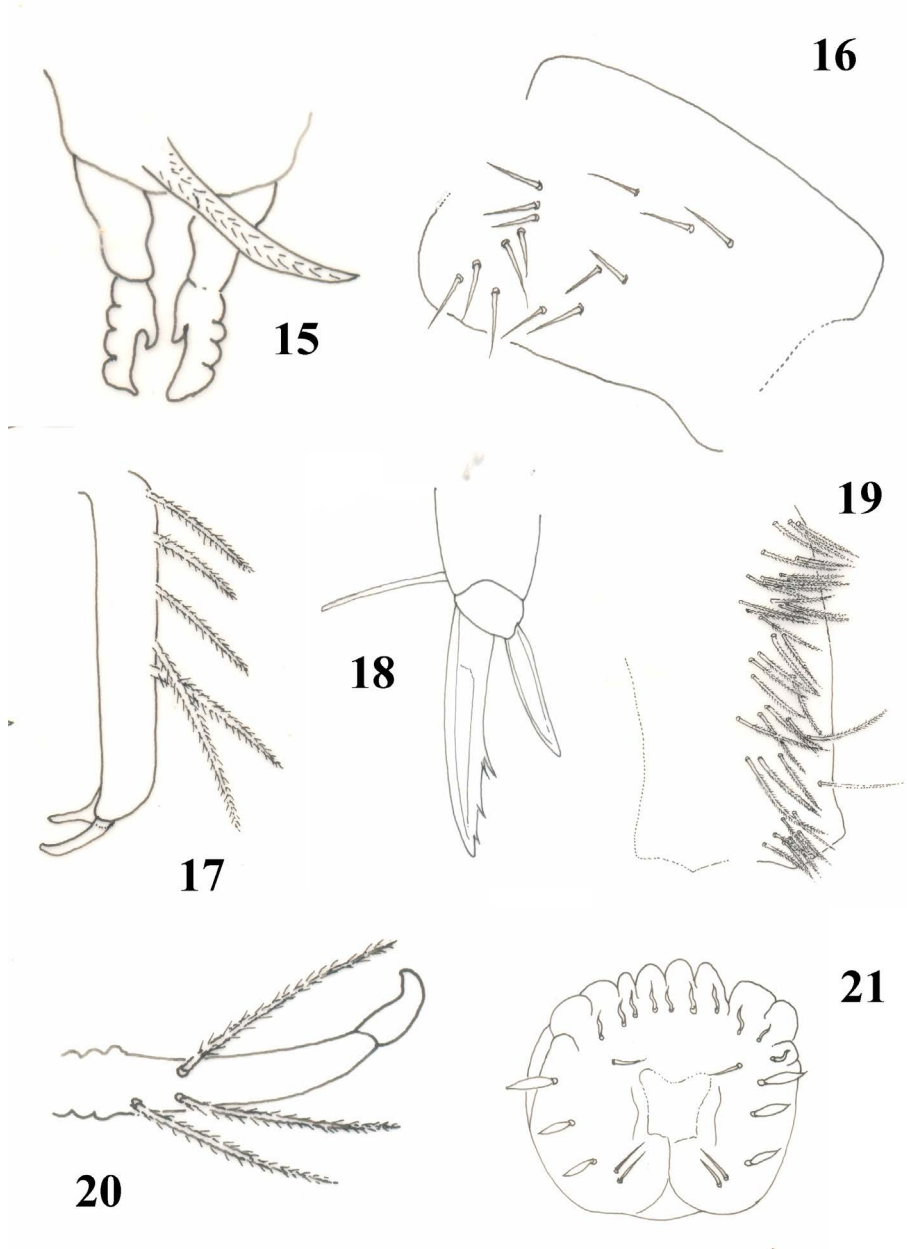
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Plate 1





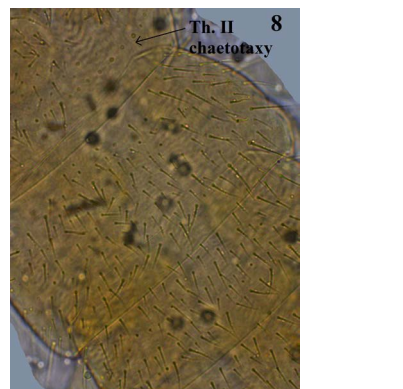
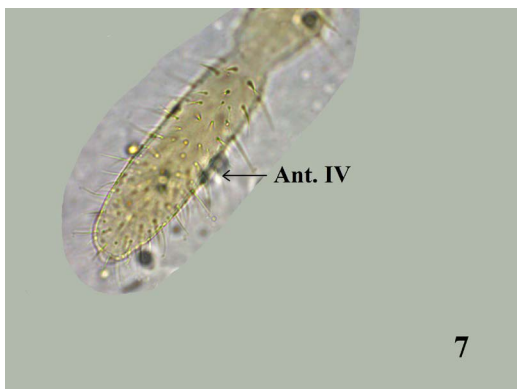
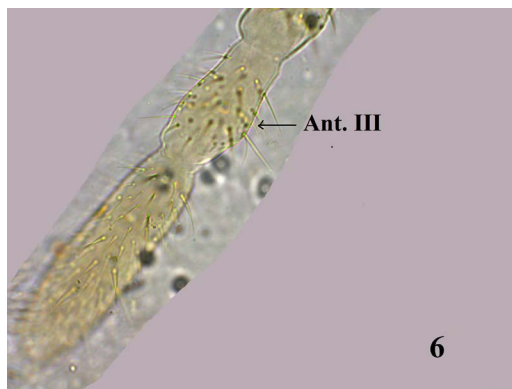
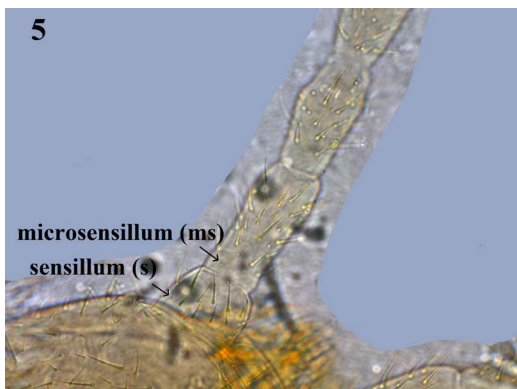
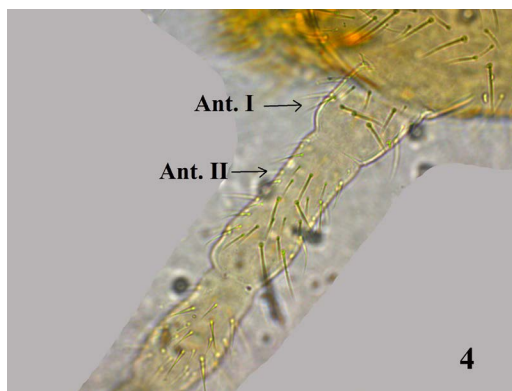
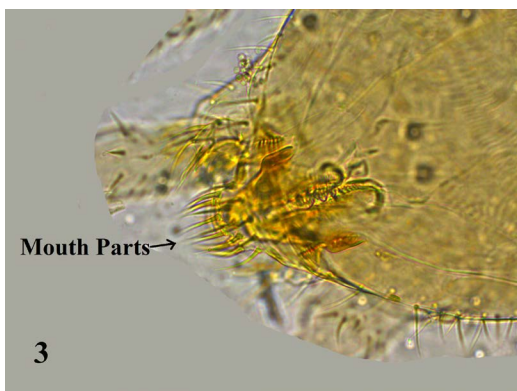
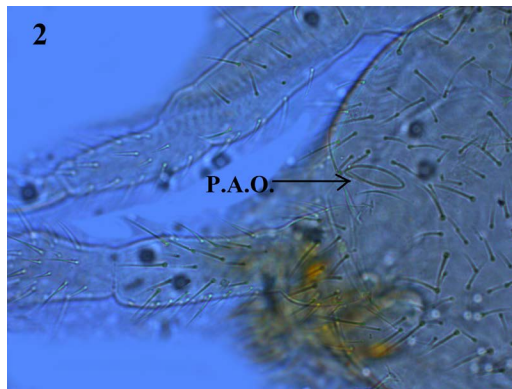
⊙ Macrochaetae (Type I setae)
○ Type v setae

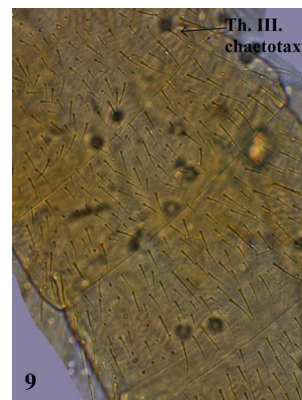
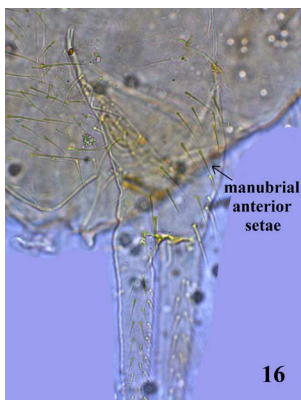
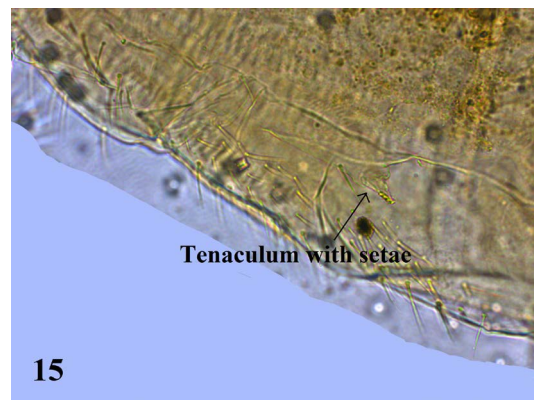
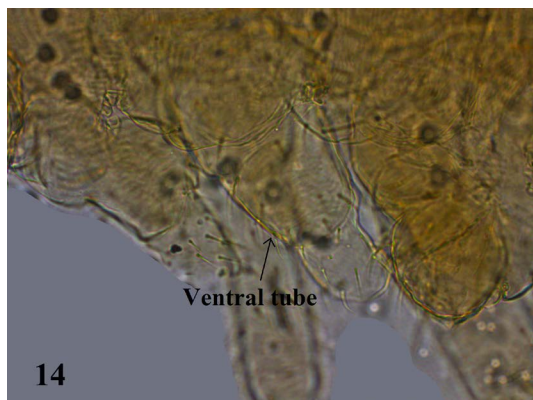
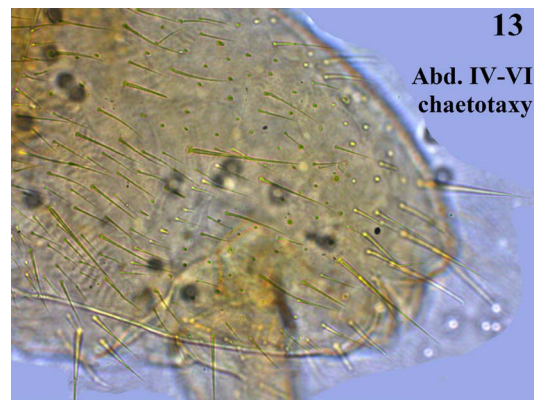
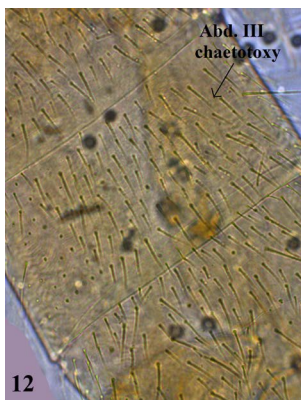
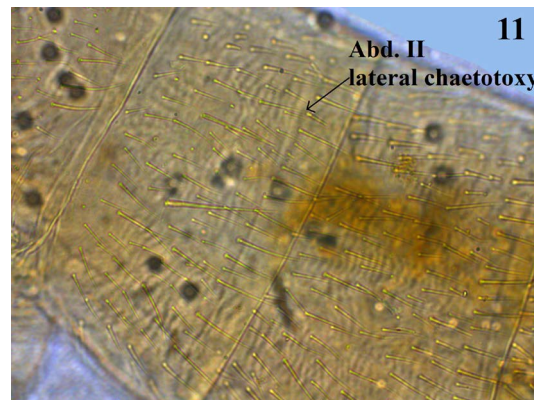
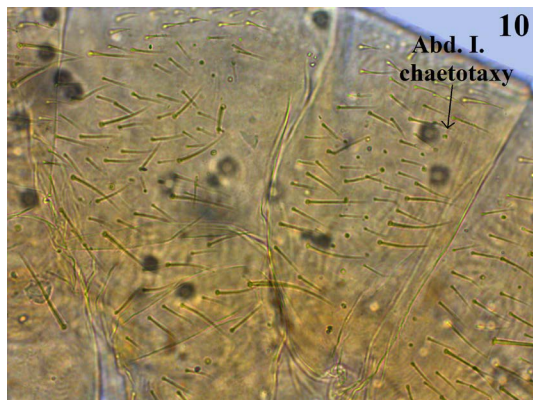


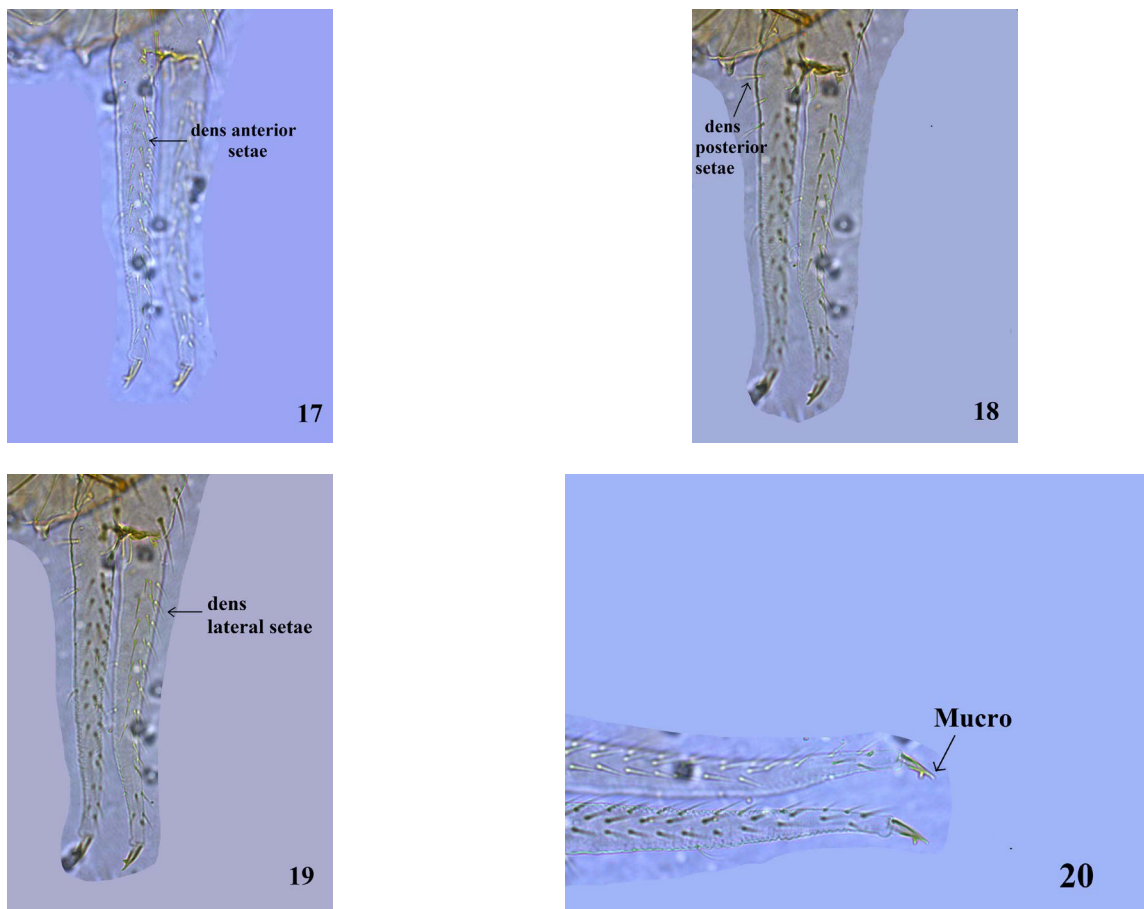


Figures 1-22. *Calx kailashi* sp. nov. 1. *Calx kailashi* sp. nov. habitus (lateral view). 2. *Calx kailashi* sp. nov. habitus (lateral view). 3. *Calx kailashi* sp. nov. habitus (dorso- lateral view). 4. ventral view. 5. Antenna. 6. Apex of Ant. IV. 7. Apex of Ant.III. 8. Outer labral papillae. 9. differentiated external labial setae. 10. Eyes. 11. Dorsal cephalic chaetotaxy 12. Type of setae. 13. Chaetotaxy of Thorax..II- III. 14. Chaetotaxy of Abd.I-III. 15. Retinaculum. 16. Trochantral organ. 17. Tibiotarsal setae. 18. Hind foot complex. 19. Dorsal setae on Manubrium. 20. Mucro. 21. Male genital plate. 22. Type - locality of *Calx kailashi* sp. nov. at Panvasba Nallah, East side of Koderma Wild Life Sanctuary, district Koderma, Jharkhand, India.

Plate 2

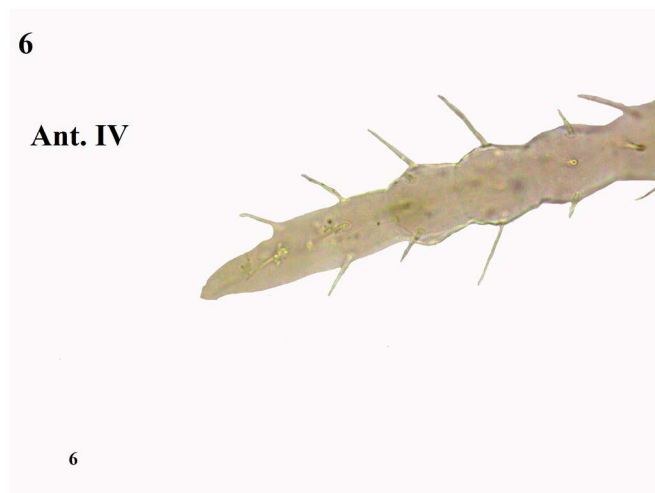
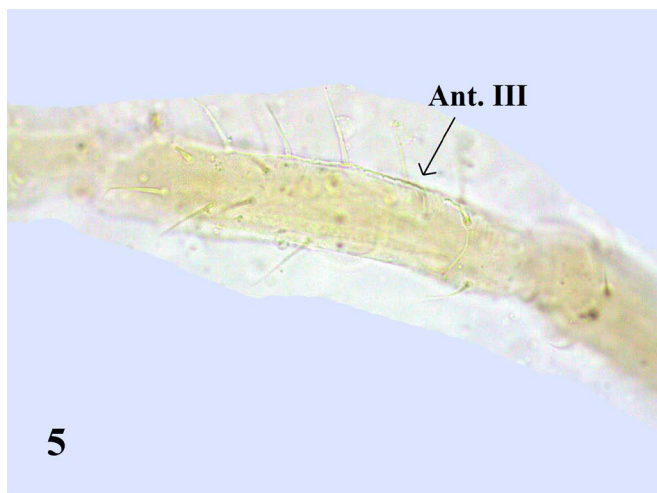
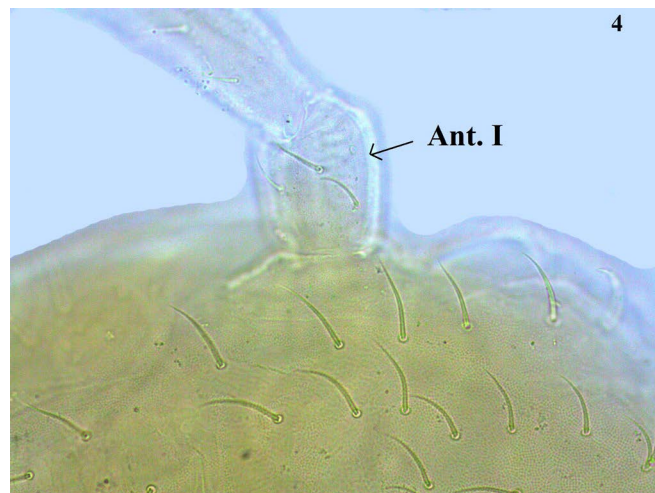
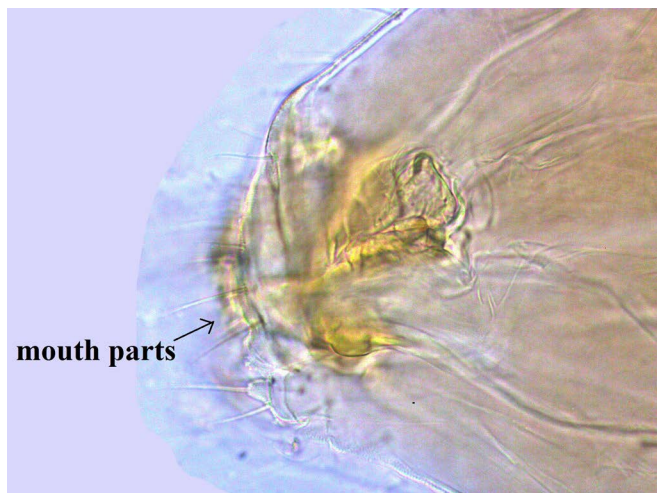
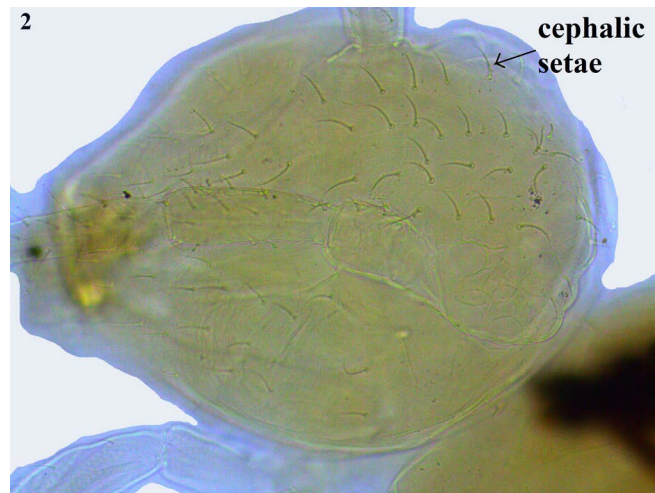


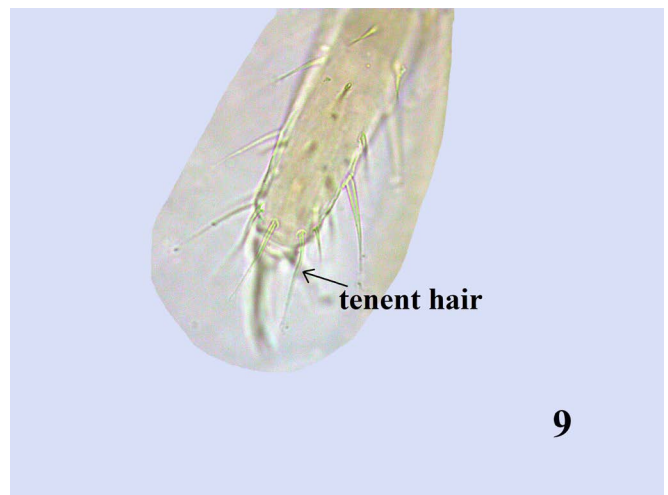
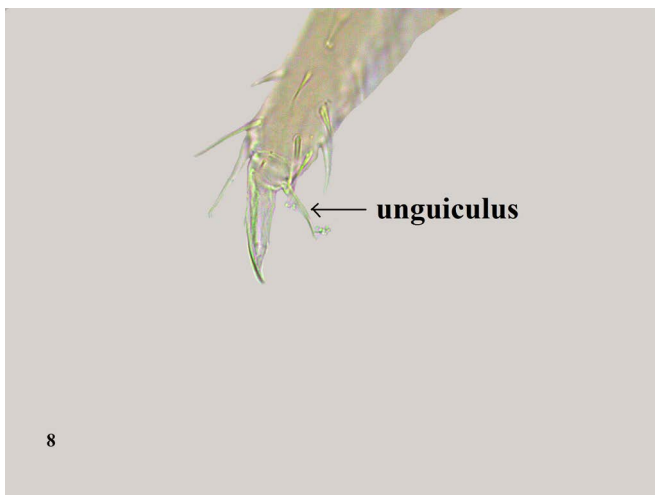
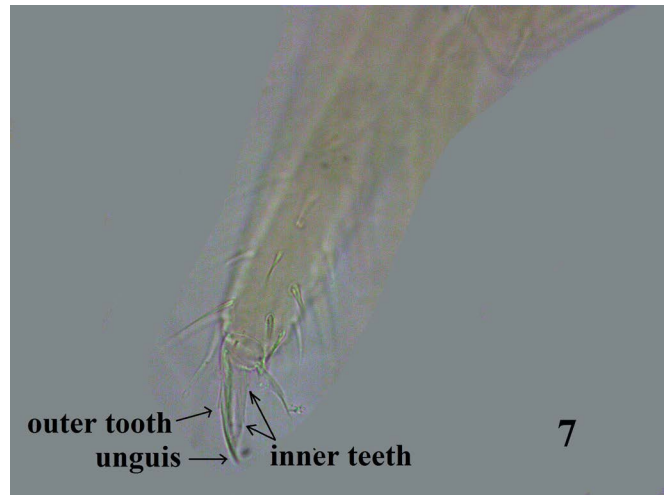
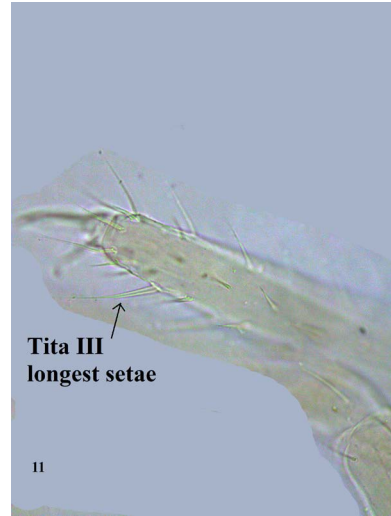
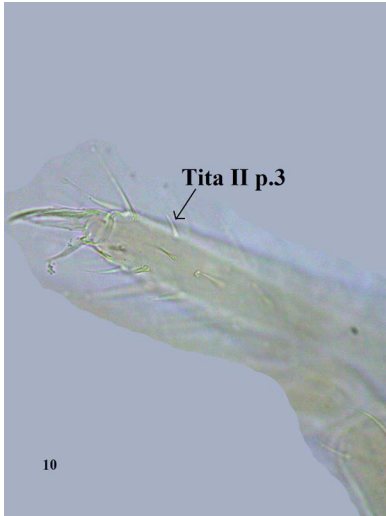


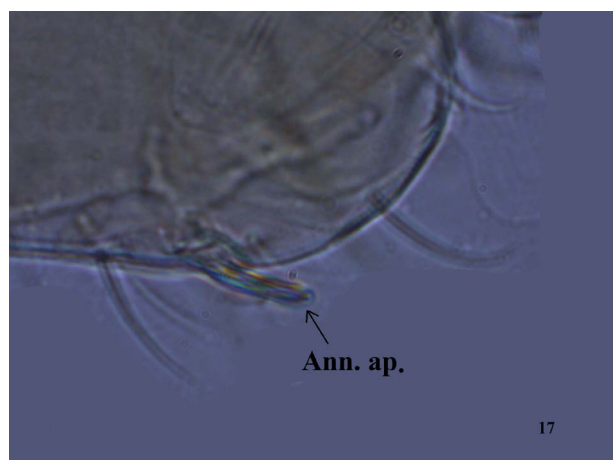
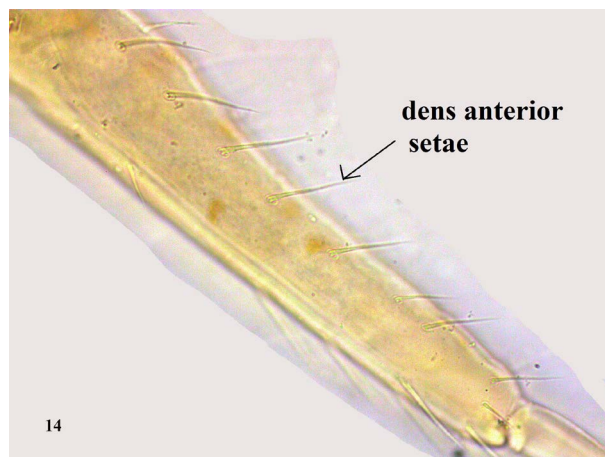
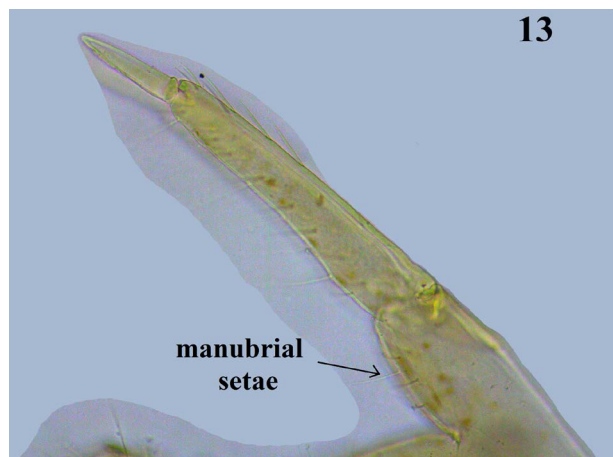


Figures 1-20. *Folsomia arunachalensis* n. sp. 1. *Folsomia arunachalensis* sp. nov. habitus (lateral view). 2. P.A.O. 3. Mouthparts. 4. Ant. I-II. 5. Microsensillum and sensillum. 6. Ant. III. 7. Ant. IV. 8. Th. II Chaetotaxy. 9. Th. III Chaetotaxy. 10. Abd. I Chaetotaxy. 11. Abd. II lateral chaetotaxy. 12. Abd. III Chaetotaxy. 13. Abd. IV-VI Chaetotaxy. 14. Ventral tube. 15. Tenaculum with setae. 16. Manubrial anterior setae. 17. Dens anterior setae. 18. Dens posterior setae. 19. Dens lateral setae. 20. Mucro.

Plate 3







Figures 1-17. *Bourlettiella meghalayensis* n. sp. 1. *Bourlettiella meghalayensis* sp. nov. habitus (lateral view). 2. cephalic setae. 3. Mouthparts. 4. Ant.I. 5. Ant. III. 6. Ant. IV. 7. Unguis. 8. Unguiculus. 9. Tenent hair. 10. Tita II p.3. 11. Tita III longest setae. 12. Tenaculum. 13. Manubrial setae. 14. Anterior setae of dens. 15. Mucro. 16. Abd. VI. 17. Ann. ap.w