

Five new species of Collembola (Isotomidae) from Jharkhand, India

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Abstract

A total of five new species of Collembola belonging to two genera under two subfamilies of family Isotomidae have been described from the state of Jharkhand, India. An identification key to the Indian species and their distribution are also provided.

Keywords: Collembola, Isotomidae, New species, Jharkhand, India

Introduction

The present study of collembolan fauna is based on collection made during 2012-2015, from different districts of Jharkhand, India, as a part of the “Annual Action Plan” of Apterygota section of Zoological Survey of India.

Collembola, commonly called “spring-tails”, are small, entognathous, wingless hexapods possessing a spring-like forked jumping organ, the furcula, underneath the fourth abdominal segment. They are minute in size (less than 6 mm in length); antennae primarily with 4 segments. The presence of antennae and absence of cerci distinguish them from the other entognathous hexapods. The collembolans have very diverse distribution occurring in all Zoo-geographical regions of the world inhabiting a wide range of ecological niche and climate.

The first record of Collembola was known from Ghatsila area of Jharkhand by the published work of Mandal & Hazra (2004). Thereafter, the present project was undertaken for extensive study of Collembola fauna of Jharkhand as per Annual Plan of Research Work of Apterygota section for the year 2012-2015. Mandal (2014a, b, c, 2015), Mandal and Hazra (2013), Mandal & Suman (2014) published Collembola from different sanctuaries of Jharkhand. Mandal, Suman & Bhattacharya (2016) published four new species of collembola from different districts of Jharkhand.

The species belonging to the family Isotomidae, identified of the collembolan found are included into the genera, *Proisotoma* and *Isotomurus*. A total of 5 species of Collembola belonging to 2 genera under 2 sub families of family Isotomidae have been described as new to science from the state of Jharkhand, 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.

Materials and Methods

The Sampling Area

Jharkhand is a state in eastern India, shares its border with the states of Bihar to the north, Uttar Pradesh and Chhattisgarh to the west, Orissa to the south, and West Bengal to the east. It is situated between 23.3500° N Latitude and 85.3300° E Longitude. The state is very rich in biodiversity and is the part of the Chhotanagpur plateau, province of the peninsula biogeographic zone. The present study of collembolan fauna is based on collection made during 2012-2015, from different districts of Jharkhand, India.

Specimens were mounted under a coverslip in Hoyer's solution, and were studied under a Leica Digital

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Module (DM 2500) microscope. Photographs were taken under a Leica Digital Module R (DMR) microscope using mounted 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, ZSI = Zoological Survey of India, (Kolkata).

Family Isotomidae Borner, 1913

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

Subfamily Anurophorinae Borner, 1913

Genus *Proisotoma* Borner, 1901

1901. *Proisotoma* Börner, *Abh. Nat. Wiss. Ver. Bremen* 17: 1-40

Type species: *Isotoma minuta* Tullberg, 1871

Borner (1901) erected the genus *Proisotoma*, based on these characters: Furcula present. Mucro with 2 or more teeth. Fourth and fifth abdominal segments at least separated by a nonsetaceous band. Post antennal organ present. Ventral manubrial setae 6 or fewer. Hind femur without spur. Mucro distinctly separated from dens. At least 5+5 eyes present.

So far, a total of 77 species in this genus are known from the world (Bellinger *et al*, 2016). From India, three species of *Proisotoma* are known (Mandal, 2010). *Proisotoma himalayana* Baijal, 1958 and *Proisotoma senetijohani* Baijal and Chandra, 1970 is found to be endemic to India. A checklist of Indian species, of *Proisotoma* as reference to their distribution in India and the World is provided.

1. *Proisotoma himalayana* Baijal, 1958. It was recorded from Himachal Pradesh, Jammu and Kashmir of India.
2. *Proisotoma senetijohani* Baijal and Chandra, 1970. It was recorded from Uttar Pradesh of India.
3. *Proisotoma minuta* (Tullberg, 1871). It was recorded from Maharashtra, Kerala of India. Elsewhere: COSMOPOLITAN

Proisotoma pakurensis n. sp. This new species is described here from Littipara, Tussar plantation site, Pakur district, Jharkhand of India.

Key to the Indian species of *Proisotoma*

1. Unguis and mucro very long.....
.....*Proisotoma himalayana* Baijal, 1958
- Unguis and mucro not very long.....2
2. Unguis without tooth3
- Unguis with one inner tooth and retinaculum with 3 setae.....*Proisotoma pakurensis* n. sp
3. Retinaculum with 1 setae and 4 + 4 teeth.....
.....*Proisotoma minuta* (Tullberg, 1871)
- Retinaculum with more than 1 setae and 4+4 teeth
.....*Proisotoma senetijohani* Baijal & Chandra, 1970

1. *Proisotoma pakurensis* n. sp.

(Plate 1, Figures 1-21, Table 1)

Material examined: HOLOTYPE: female on slide, India: Jharkhand: Littipara, Tussar plantation garden, Pakur district, 27. viii. 2013, Lat & Long, N 24° 42' 35.3" E 87° 36' 51.8", collected by G. P. Mandal, Registration No. 1980/H14/ZSI. PARATYPE: 01 ex on slide, India: Jharkhand: Littipara, Tussar plantation site, Pakur district, 27. viii. 2013, Lat and Long, N 24° 42' 35.3" E 87° 36' 51.8", collected by G. P. Mandal, Registration No. 1981/H14/ZSI; 01 ex on slide, India: Jharkhand: Littipara, Tussar plantation site, Pakur district, 27. viii. 2013, Lat & Long, N 24° 42' 35.3" E 87° 36' 51.8", collected by G. P. Mandal, Registration No. 1982/H14/ZSI; 03 exs in ethyl alcohol, India: Jharkhand: Littipara, Tussar plantation site, Pakur district, 27. viii. 2013, Lat & Long, N 24° 42' 35.3" E 87° 36' 51.8", collected by G. P. Mandal, Registration No. 1983/H14/ZSI.

Description: Body length up to 0.98 mm (excluding appendages).

Colour Pattern: Back ground colour yellow to grey, violet pigment present from head to Abd. VI on anterior side, the violet pigment form light transverse band through thorax to abdomen. Head slightly deep pigmented, eye patch deep blue-black, one light bluish dot like structure present in between two eyes. Posterior margin of the body grey in colour. Ant. I and II greyish but Ant.III and Ant.

IV with light violet pigment anteriorly. Legs are yellowish in colour. Furcula white to grey in colour (Figure 1).

Head: Eyes 8+8, more or less equal (Figure 2). P.A.O present, kidney shaped, elongate, unconstricted, 2 smooth setae present near the base (Figure 3). P.A.O is 1.3 times as long as the diameter of largest eye. Antennal segment ratio in length as I: II: III: IV= 1: 1.7:1.5:2.7. Fourth antennal segment without apical bulb and distinct blunt setae (Figure 4). Third antennal segment with two small pegs like structure present (Figure 5). Maxillary outer lobe with 4 sublobal hairs. Labrum without papillae (Figure 6).

Thorax and Legs: Ratio of segments of Thorax II: III= 1:0.8. Unguis stout, with one inner tooth at basal half, no outer teeth and lateral tooth. Unguiculus short, broad, without teeth (Figure 7). Tenent hair long, thin and acuminate (Figure 8). Ventral tube with 6+6 distal lateral smooth setae (Figure 9). Trochanteral organ with 3+1+3 setae (Figure 10).

Abdomen: Ratio of segments of Abdomen I: II: III: IV: V: VI= 1: 1.04: 1.18: 1.53: 0.8: 0.3. Retinaculum with 4+4 teeth and 3 setae (Figure 11). Manubrium: dens: mucro = 4.48:5.08:1. Manubrium with six anterior setae and posterior side without setae but laterally with 28-30 small, smooth setae (Figures 12 and 13). Dens stout, broad and without distinct crenulations, anterior side with 14 short,

smooth setae, posterior side 12 setae, laterally with 48 setae in 16 rows, each row having 3 setae (Figures 14 and 15). Mucro short, stout with 2 teeth and without lamellae (Figure 16). Fourth abdominal segment 1.29 times as long as third. Fifth and sixth abdominal segments separated by a non-setaceous band.

Body Chaetotaxy: Body clothed with normal smooth setae throughout head, thorax and abdomen. Cephalic portion clothed with normal setae without macro chaetae (Figure 17). Th. II – Abd. V also clothed with normal setae (Figures 18 & 19). Only 1+1 macrochaetae present on sixth abdominal segment (Figure 20). Ant. I with 3 and Ant.II with 2 basal microsensilla present (Figure 21). Ant.III with two peg like structures and Ant.IV with acuminate setae present.

Ecology: Found under leaf-litter of moist deciduous forest, particularly Tussar plantation garden of Littipara of Pakur district of Jharkhand.

Etymology: The new species is named after the type locality, Pakur district, Jharkhand, India.

Discussion: The new species from, Littipara Tussar plantation garden of Pakur district of Jharkhand, India can easily distinguished from other known species of *Proisotoma* by manubrial and dental chaetotaxy, number of setae on retinaculum and claw structure. It is close to

Table 1. The differences between *Proisotoma nigromaculosa* Folsom, 1932 and *Proisotoma pakurensis* n. sp.

Characters	<i>Proisotoma nigromaculosa</i> Folsom, 1932	<i>Proisotoma pakurensis</i> n. sp.
Colouration	White to grey; darker specimens with intersegmental membranes, venter and appendages pale.	Yellow to grey; violet pigment ranging from head to Abd.VI anteriorly, form light transverse band.
Post Antennal Organ (P.A.O)	PAO broadly oval and weakly constricted medially, 2.5–3.7 times as long as diameter of largest eyes.	PAO kidney shaped, elongate, and without constriction, 1.3 times as long as diameter of largest eyes.
Unguis and Unguiculus	Unguis with clear inner tooth but no outer teeth and lateral tooth. Unguiculus simple.	Unguis stout, with one inner tooth at basal half, no outer teeth and lateral tooth. Unguiculus short, broad, without teeth.
Tenent hair	Tenent hair varying from acuminate to clearly clavate.	Tenent hair long, thin and acuminate.
Ventral tube	Ventral tube with 4+4 distal lateral setae.	Ventral tube with 6+6 distal lateral setae.
Trochanteral organ	Trochanteral organ unknown.	Trochanteral organ with 3+1+3 setae.
Retinaculum with setae	Retinaculum with 4+4 teeth and 1 seta.	Retinaculum with 4+4 teeth and 3 setae.
Manubrial setae	Manubrium with 3+3 distal ventral setae.	Manubrium with six anterior setae and without posterior setae but laterally with 28-30 small, smooth setae.

Dental setae	Dens dorsally crenulated, with 8-11 dorsal setae and 19-24 ventral setae.	Dens stout, broad and without distinct crenulations, anterior side with 14 short, smooth setae, posterior side 12 setae, laterally with 48 setae in 16 rows.
Mucro	Mucro bidentate, short, without lamellae.	Mucro bidentate, strong, broad and without lamellae.
Macrochaetae on Abd. VI	Macrochaetae absent on sixth abdominal segment.	1+1 macrochaetae present on sixth abdominal segment.
Body length	1.2 mm	0.98 mm

Proisotoma nigromaculosa Folsom, 1932 in having similar type of claw structures, mouth parts and bidentate mucro but strongly differs from *Proisotoma nigromaculosa* in the characteristics given in Table 1.

Subfamily **Isotominae** Schaffer, 1896

Genus **Isotomurus** Börner, 1903

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

Type species: *Podura palustris* Muller, 1776

The genus *Isotomurus* erected by Börner (1903) includes characters: Furcula present. Post antennal organ present. Mucro with 2 or more teeth. Fourth and fifth abdominal segments at least separated by nonsetaceous band. Ventral manubrial setae 14 or more. Some abdominal setae multilaterally ciliate.

So far, about 70 species of the genus *Isotomurus* known from the world (Bellinger *et al*, 2016).

A checklist of Indian species, of *Isotomurus* as reference to their distribution in India and the World is provided.

1. *Isotomurus balteatus* (Reuter, 1876). It was recorded from Maharashtra, Kerala, West Bengal, Sikkim and Arunachal Pradesh of India. Elsewhere: COSMOPOLITAN
2. *Isotomurus ciliatus* Stach, 1947. It was recorded from West Bengal, Odisha, Uttar Pradesh of India; Elsewhere: POLAND.
3. *Isotomurus palustris* (Muller, 1776). It was recorded from West Bengal, Uttar Pradesh of India; Elsewhere: NORTH AMERICA.
4. ***Isotomurus jharkhandensis* n. sp.** This new species is described here from Ramgarh, Ranchi, East Singhum and Dhanbad districts of Jharkhand of India.
5. ***Isotomurus dhanbadensis* n. sp.** This new species is described here from Dhanbad district of Jharkhand of India.
6. ***Isotomurus indicus* n. sp.** This new species is described here from Ramgarh and Jamtara districts of Jharkhand of India.
7. ***Isotomurus sahebganjensis* n. sp.** This new species is described here from Sahebganj district of Jharkhand of India.

Key to the Indian species of *Isotomurus*

1. Body with distinct pigment absent, except eye region and antennae.....2
- Body with distinct pigment present.....3
2. Claw with two distinct inner teeth.....
.....*Isotomurus sahebganjensis* n. sp.
- Claw without inner teeth, only one outer tooth....
.....*Isotomurus indicus* n. sp.
3. With median longitudinal band.....
.....*Isotomurus palustris* (Muller, 1776)
- Without median longitudinal band.....4
4. With distinct transverse band.....
..... *Isotomurus balteatus* (Reuter, 1876)
- Without distinct transverse band.....5
5. Body with yellowish green, ventrally and laterally darker verdigris-green.....*Isotomurus ciliatus* Stach, 1947
- Body without yellowish green.....6
6. Claw with two inner teeth, Th. II — Abd. IV with lateral blue-black belt present.....
.....*Isotomurus dhanbadensis* n. sp.
- Claw with two lateral teeth, Th. II— Abd. I pigmented near the border, Abd. II-Abd. IV pigmented and forming a flake like structure.....*Isotomurus jharkhandensis* n.sp

2. *Isotomurus dhanbadensis* n. sp.

(Plate 2, Figures 1-20, Table 2)

Material examined: HOLOTYPE: on slide, India: Jharkhand: Amaghata Forest, Dhanbad, Dhanbad district, 07. ix. 2013, Lat and Long. N 23°49'43.4" and E 86°30'13.3", collected by G. P. Mandal, Registration No. 1992 /H14/ZSI. PARATYPE: 1 ex on slide, India: Jharkhand: Amaghata Forest, Dhanbad, Dhanbad district, 07. ix. 2013, Lat and Long, N 23°49'43.4" and E 86°30'13.3", collected by G. P. Mandal, Registration No. 1993 /H14/ZSI; 09 exs in ethyl alcohol, India: Jharkhand: Amaghata Forest, Dhanbad, Dhanbad district, 07. ix. 2013, Lat and Long, N 23°49'43.4" and E 86°30'13.3" collected by G. P. Mandal, Registration No. 1994/H14/ZSI.

Description: Body length up to 2.7 mm (excluding appendages).

Colour Pattern: Background colour grey to white. Eyes dark blue-black, a line of pigment present between anterior side of two ocelli, median side a long, broad black dot present & remarkably 3+3 ocelli like structure present between the dot, posterior side of head with enlarged pigment patches. Antennae I laterally pigmented with blue-black in one side, Ant.II, III pigmented laterally with deep blue pigment on both sides, Ant. IV totally pigmented. Precoxae, coxae deeply pigmented, rest of the legs unpigmented. Thorax II- Abd. IV with lateral blue black belts present. Dorsally without pigment except Abd. V and VI with narrow stripe present transversely. Furcula unpigmented (Figure 1).

Head: Eyes 8+8, more or less same. 3+3 ocelli- like structure in median of head. (Figure 2). P.A.O oval, egg shaped, two large smooth setae present between the PAO. P.A.O is equal to nearest eye (Figure 3). Antennal segment ratio in length as I: II: III: IV = 1: 1.8: 1.9: 2.1. Fourth antennal segment without apical bulb, a big pin seta but many curved setae & blunt setae present (Figure 4). Third antennal segment with two peg like structure present and many curved setae along with blunt setae (Figure 5). Ant. I with six basal sensilla present (Figure 6). Labrum with 5-7 + 5-7 basomedian setae.

Thorax and Legs: Ratio of segments of Thorax II: III = 1: 0.8. Thoracic setae small, median and large, smooth and ciliate (Figure 7). Tibio-tarsus setae all smooth, no large macrochaetae on tibio-tarsus. Unguis stout and strong, with two inner teeth, no outer and lateral tooth, unguis 2.8 times longer than unguiculus (Figure 8). Unguiculus short, without teeth (Figure 9). Tenent hair thin and

acuminate. Ventral tube with 4+4 latero-distal (Figure 10). Trochanteral organ with 11-12 long setae (Figure 11). **Abdomen:** Ratio of segments of Abdomen I : II : III : IV : V : VI: 1: 1.5 : 1.8 : 1.4 : 0.8 : 0.6. Retinaculum with 4 teeth and more than 6 setae in each. Manubrium: dens: mucro 1 : 1.9 : 0.05. Manubrium with large no of anterior and posterior setae (Figure 12). Manubrium with short, broad several smooth setae (Figure 13). 2/3rd of the dens straight and not crenulated (Figure 14). Dens with numerous lateral setae and few posterior setae (Figure 15). Dens longer than manubrium & crenulate. Mucro with 4 teeth but without seta (Figure 16).

Body Chaetotaxy: Body clothed with small to medium and large smooth and ciliate setae on head, thorax & abdomen. Long ciliate macrochaetae present on abdomen III (Figure 17). Long unilaterally ciliate macro-chaetae present on Abd.V (Figure 18). Cephalic portion with smooth setae. Abd. VI with 4+4 large macrochaetae present (Figure 19). Abdomen V with 7+7 sensilla, two medial ones elongated (Figure 20).

Ecology: Found under thick bed of leaf litter of Amaghata Forest, Dhanbad district, Jharkhand, India.

Etymology: The new species is named after the type locality, Dhanbad, Jharkhand, India.

Remarks: This species has remarkable 3+3 ocelli like structure on median of the head along black long, broad dot present. This species belongs to *Palustris* group having trichobothria 3, 3, 1. Abd. V with 7+7 sensillum, two medial ones elongated, retinaculum with more than 6 setae. Inner tooth on the claw, seta and lamella on the mucro variable.

Table 2. The differences between *Isotomurus viridipalustris* Kos, 1938 and *Isotomurus dhanbadensis* n. sp.

Characters	<i>Isotomurus viridipalustris</i> Kos, 1938	<i>Isotomurus dhanbadensis</i> n. sp.
Colour pattern	Pigmentation diffuse, no distinct spots and bands.	Body with pigment. Thorax II- Abd. IV with lateral blue black belts present.
Ocelli- like structure in median of head	absent	3+3 ocelli- like structure in median of head.
Unguis and Unguiculus	Unguis with two inner tooth in distal half and lateral teeth.	Unguis with two inner tooth but no lateral teeth.
Ventral tube	Ventral tube with 5 + 5 latero-distal setae.	Ventral tube with 4+4 latero- distal setae.
Tibiotarsus with macrochaete	Tibiotarsus with macrochaetae.	Tibiotarsus without macrochaetae.
Trochanteral organ	Trochanteral organ unknown.	Trochanteral organ with 11-12 long setae.

Retinaculum with setae	Retinaculum with 6 setae.	Retinaculum with more than 6 setae.
Manubrium with setae	Manubrium with few anterior setae	Manubrium with large no. of anterior setae
Dens with setae	Dens crenulated with few lateral setae	2/3rd of the dens straight and rest portion crenulated, with large no. of lateral setae.
Body length	3.0 mm	2.7 mm

Discussion: The new species from Dhanbad district of Jharkhand, India can easily distinguished from other known species of *Isotomurus* by colour pattern, 3+3 ocelli-like structure in median of head, claw structure, setae on ventral tube and retinaculum. It is close to *Isotomurus viridipalustris* Kos, 1938, in having claw with two inner tooth in distal half and mucro without seta but strongly differ from *Isotomurus viridipalustris* in colour pattern and other characteristics given below in the Table 2.

3. *Isotomurus indicus* n. sp.

(Plate 3, Figures 1-20, Table 3)

Material examined: HOLOTYPE: on slide, India: Jharkhand: 7 km from Rajrappa, Kuju range, Ramgarh forest, Ramgarh district, 26. xii. 2014, Lat & Long. N 22°38'58.0" and E 86°30'5.2", collected by G. P. Mandal, Registration No. 1995/H14/ZSI. PARATYPE: 01 ex on slide, India: Jharkhand: 7km from Rajrappa, Kuju range, Ramgarh forest, Ramgarh district, 26. xii. 2014, Lat & Long. N 22°38'58.0" and E 86°30'5.2", collected by G. P. Mandal, Registration No. 1996/H14/ZSI; Other materials: 07 exs in ethyl alcohol, India: Jharkhand: Amlachatar, Jamtara district, 05. ix. 2013, collected by G. P. Mandal, Registration No. 1997 /H14/ZSI; 01 exs on slide, India: Jharkhand: Amlachatar, Jamtara district, 05. ix. 2013, collected by G. P. Mandal, Registration No. 1998 /H14/ZSI; 01 exs on slide, India: Jharkhand: Amlachatar, Jamtara district, 05. ix. 2013, Lat. and Long. N 23°58'6.1" and E 86°50'31" collected by G. P. Mandal, Registration No. 1999 /H14/ZSI;

Description: Body length up to 1.82 mm (excluding appendages).

Colour Pattern: Background colour white. Body without distinct pigment or patches. Body without dorso-median line or flakes. Eyes dark blue-black, one anterior & one median black spot present between eyes. Ant - I, II, III & IV pigmented with blue basally. Abd. II- Abd. IV with 3+3, 3+3, 1+1 hollow dot marking the base of bothritrichia. Furcula and legs unpigmented Abd. IV with bluish spot in proximal & median. Greenish dot present Th, II- Abd. VI ventrally (Figure 1).

Head: Eyes 8+8, more or less equal (Figure 2). P.A.O slender type, unconstricted, 3 long setae near the base. P.A.O is more or less equal of the largest omma (Figure 3). Head: Antennae ratio as 2.13. Antennal segment ratio in length as I: II: III: IV = 1: 1.8: 2.17: 2.3. Ant. I with basal sensilla shown in (Figure 4). Third antennal segment with blunt seta and sensilla shown in (Figure 5). Fourth antennal segment without apical bulb, but big pin setae (Figure 6). Maxillary outer lobe with 4 sublobal hairs (Figure 7).

Thorax and Legs: Ratio of segments of Thorax II: III = 1: 1.08. Thoracic setae smooth and ciliate. Three large macrochaetae present on each tibia tarsus of all legs (Figure 8). Unguis strong, long with one outer large tooth in the proximal, and one lateral tooth but no inner tooth. Unguiculus short, broad, without teeth (Figure 9). Unguis 2.6 times longer than unguiculus. Tenent hair thin, acuminate, 1.5 times less than unguis (Figure 10). Ventral tube with 4+4 anterior setae (Figure 11). Trochanteral organ with 20 setae (Figure 12).

Abdomen: Ratio of segments of Abdomen I : II : III : IV : V : VI = 1: 1.2 : 1.6 : 1.4 : 0.7 : 0.6. Retinaculaum with 4 teeth and 6 setae in each (Figure 13). Manubrium: dens : mucro 1 : 1.6 : 0.08. Manubrium with large no of lateral setae (Figure 14). Den with numerous lateral setae (Figure 15). Dens longer than manubrium and crenulate. Mucro quadridentate, lamella present on base of mucro but without seta (Figure 16).

Body Chaetotaxy: Body clothed with normal ciliate smooth setae on head, thorax and abdomen. Abd. VI with long ciliate setae present (Figures 17, 18 & 19). Abd. V with 7+7 sensilla shown in (Figure 20).

Ecology: Found under moist nullah cover by leaf litter of Kuju range, Ramgarh forest, Ramgarh district and moist nullah of Amlachatar of Jamtara district, Jharkhand, India.

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

Table 3. The differences between *Isotomurus jharkhandensis* n. sp. and *Isotomurus indicus* n. sp.

Characters	<i>Isotomurus jharkhandensis</i> n. sp.	<i>Isotomurus indicus</i> n. sp.
Colour pattern	Body with distinct pigment patches and Th.II- Abd. I pigmented near the border, dark dorso-median line present from Th.II- Abd. IV. Abd. II-IV forming a flake like structure, Abd.V – VI pigmented laterally.	Body white, no distinct pigment patches except antennae and eyes. 3,3,1 hollow dot/spot present on Abd.II-IV.
P.A.O	P.A.O. is 1.5 times as long as the largest omma and no setae near the base.	P.A.O. is more or less equal to the largest omma and 3 long setae near the base.
Unguis & Unguiculus	Unguis with one outer tooth but no lateral & inner tooth. Unguiculus without tooth.	Unguis with one outer & one lateral tooth and without inner tooth. Unguiculus without tooth.
Ventral tube	Ventral tube with 18+18 anterior setae.	Ventral tube with 4+4 anterior setae.
Tibiotarsus with macrochaete	Tibiotarsus with one ciliate macrochaetae.	Tibiotarsus with three ciliate macrochaetae.
Trochanteral organ	Trochanteral organ with 16-17 setae.	Trochanteral organ with 20 setae.
Retinaculum with setae	Retinaculum with 8-10 setae.	Retinaculum with 6 setae.
Body length	1.93 mm	1.82 mm

Remarks: This species also belongs to *Palustris* group having trichobothria 3, 3, 1. Abd. V with 7+7 sensillum, retinaculum with 6+ 6 setae.

Discussion: The new species from Ramgarh and Jamtara districts of Jharkhand, India can easily distinguished from other known species of *Isotomurus* by pigment pattern, claw structure, setae on ventral tube and retinaculum, and macrochaetae on tibia-tarsus. It is close to *Isotomurus jharkhandensis* n. sp., in having similar type of outer teeth on unguis but strongly differ in colour pattern and other characteristics given below in the Table 3.

4. *Isotomurus jharkhandensis* n. sp.

(Plate 4, Figures 1-20, Table 4)

Material examined: HOLOTYPE: female on slide, India: Jharkhand: 7km from Rajrappa, Kuju range, Ramgarh forest, Ramgarh district, 26. xii. 2014, Lat and Long. N 22°38'58.0" and E 86°30'5.2", collected by G. P. Mandal, Registration No. 1984/H14/ZSI. PARATYPE: 01 ex on slide, India: Jharkhand: 7km from Rajrappa, Kuju range, Ramgarh forest, Ramgarh district, 26. xii. 2014, Lat and Long. N 22°38'58.0" and E 86°30'5.2", collected by G. P. Mandal, Registration No. 1985 /H14/ZSI; PARATYPE: 11 exs in ethyl alcohol, India: Jharkhand: 7km from Rajrappa, Kuju range, Ramgarh forest, Ramgarh district, 26. xii. 2014, Lat and Long. N 22°38'58.0" and E 86°30'5.2", collected by G. P. Mandal, Registration No. 1986 /H14/ZSI; 01 ex on slide, India: Jharkhand: 7km from Rajrappa, Kuju range, Ramgarh forest, Ramgarh district, 26. xii. 2014, Lat and Long. N 22°38'58.0" and E 86°30'5.2", collected by G. P. Mandal, Registration No. 1987 /H14/ZSI; 01 ex on slide, India: Jharkhand: Damodar River bed

near Ramgarh, Ramgarh district, 23. xii. 2014, collected by G. P. Mandal, Registration No. 1988/H14/ZSI; 01 ex on slide, India: Jharkhand: Birsa Mrig Bihar, Ranchi district, 20. xii. 2014, collected by G. P. Mandal, Registration No. 1989/H14/ZSI; 01 ex on slide, India: Jharkhand: Asanpani, Ghatsila, East Singbhum district, 28. vi. 2014, Lat and Long N 22°45'18.8" and E 86°26'56.8" collected by G. P. Mandal, Registration No. 1990/H14/ZSI; 01 ex on slide, India: Jharkhand: Amaghata Forest, Dhanbad district, 07. ix. 2013, Lat & Long. N 23°49'43.4" and E 86°30'13.3", collected by G. P. Mandal, Registration No. 1991/H14/ZSI.

Description: Body length up to 1.93 mm (excluding appendages).

Colour Pattern: Background colour yellowish white. Eyes dark blue-black, one anterior & one median black spot present between eyes. Base of antennae and posterior side of head pigmented with violettish blue. Ant - I, II laterally pigmented, Ant - III and IV darker. Pre coxae and coxae lightly pigmented, tibiotarsi laterally pigmented, ventral tube without pigment. Th. II to Abd. I. pigmented near the border. Abd. II to Abd. IV pigmented with violettish blue transversely, form a distinct flecks like structure. Abd.V –VI pigment laterally. Body with dark dorso median line on Th. II – Abd. III, much broader near the border of segments. Abd. II – Abd. IV with 3+3, 3+3, 1+1 hollow spots marking the base of bothritrichia. Furcula unpigmented (Figures 1 and 2).

Head: Eyes 8+8, more or less equal (Figure 3). P.A.O elongate, slender type, unstricted, no setae near the

base. P.A.O is 1.15 times as long as the diameter of largest eye. Antennal segment ratio in length as I: II: III: IV = 1: 1.7: 1.8: 2. Third antennal segment with blunt seta and curved setae along with smooth setae (Figure 4). Fourth antennal segment without apical bulb, but pin setae, many curved setae present (Figure 5). Labrum with 4 longitudinal ridges, maxillary outer lobe with 4 sub-lobal hairs (Figure 6).

Thorax and Legs: Ratio of segments of Thorax II: III = 1: 0.9. Body setae smooth and ciliate. Large multilaterally ciliate macrochaetae present in the abdomen. One large macrochaetae present on each tibia tarsus of all legs (Figure 7). Unguis strong, with one outer teeth, no inner and lateral tooth. Unguiculus short, broad, without teeth (Figure 8). Tenent hair thin, acuminate, 1.5 times less than unguis (Figure 9). Ventral tube with 12 – 15 laterodistal, 18 anterior and 24 posterior setae (Figures 10, 11 & 12). Trochanteral organ with 16-17 setae (Figure 13).

Abdomen: Ratio of segments of Abdomen I : II : III : IV : V : VI: 1: 1.6 : 2 : 1.3 : 0.9 : 0.8. Retinaculum with 4 teeth and 8-10 setae in each (Figure 14). Manubrium: dens : mucro 1 : 2 : 0.06. Manubrium with large no of lateral setae (Figure 15). Den with numerous posterior setae (Figure 16). Dens longer than manubrium and crenulate. Mucro quadridentate, without seta (Figure 17). Lamella on proximal tooth present.

Body Chaetotaxy: Body clothed with normal setae on head, thorax and abdomen (Figure 18). Multilaterally long ciliate macrochaetae present on abdomen (Figure 19). Cephalic portion without macrochaetae (Figure 20). Ant III and IV with curved setae and blunt setae present. Ant. IV with pin seta.

Ecology: Found under thick bed of mosses of semi dried Damodar river bed of Ramgarh district, Jharkhand, India

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

Remarks: This species belongs to *Palustris* group having trichobothria 3, 3, 1. Abd. V with 7+7 sensillum, retinaculum with more than 6 setae. Inner tooth on the claw, seta and lamella on the mucro variable. Colour variation found & few specimens are also found in lighter forms.

Discussion: The new species from Ramgarh, Ranchi and East Singhbhum districts of Jharkhand, India can easily distinguished from other known species of *Isotomurus* by colour pattern, claw structure, setae on ventral tube and retinaculum, and macrochaetae on tibia-tarsus. It is close to *Isotomurus punctiferus* Yosii, 1963, in having similar type with dark dorsomedian line on Th II – Abd III, P.A.O and claw with one outer tooth but strongly differ from *Isotomurus punctiferous* in the characteristics given below in the Table 4.

Table 4. The differences between *Isotomurus punctiferus* Yosii, 1963 and *Isotomurus jharkhandensis* n. sp.

Characters	<i>Isotomurus punctiferus</i> Yosii, 1963	<i>Isotomurus jharkhandensis</i> n. sp.
Colour pattern	Greyish white. One black fronto-median spot. Antennae, ventral tube and tibio tarsus darker, all segments with narrow bands on the anterior edge, lateral parts also darker.	Yellowish white. Two black spots, one in between base of two antennae and other one fronto-median side. Abd. II – Abd. IV pigmented and forming a flake like structure. Th. II – Abd. I pigmented near the border, Abd. V – VI pigmented laterally. Ventral tube unpigmented.
Unguis and Unguiculus	Unguis with two lateral teeth & one outer tooth & without inner tooth. Unguiculus with inner tooth.	Unguis without lateral tooth & one outer tooth & without inner tooth. Unguiculus without tooth.
Ventral tube	Ventral tube with 9 – 18 + 9 – 18 laterodistal, about 20+20 anterior and 30 posterior setae	Ventral tube with 12 – 15 latero distal, about 18 anterior and 24 posterior setae.
Tibiotarsus with macrochaete	Tibiotarsus without macrochaetae.	Tibiotarsus with one ciliate macrochaetae.
Trochanteral organ	Trochanteral organ unknown.	Trochanteral organ with 16-17 setae.
Retinaculum with setae	Retinaculum with 10 – 20 setae.	Retinaculum with 8-10 setae.
Mucro	Mucro with seta.	Mucro without seta.
Body length	2.6 mm	1.93 mm

5. *Isotomurus sahebganjensis* n. sp.

(Plate 5, Figures 1-19, Table 5)

Material examined: HOLOTYPE: on slide, India: Jharkhand: Dhobijharna under hill stream, Sahebganj district, 22. viii. 2013, Lat and Long. N 25°13' and E 87°38', collected by G. P. Mandal, Registration No. 2000/H14/ZSI. PARATYPE: 05 exs in ethyl alcohol, India: Jharkhand: Dhobijharna under hill stream, Sahebganj district, 22. viii. 2013, Lat and Long. N 25°13' and E 87°38', collected by G. P. Mandal, Registration No. 2001/H14/ZSI. 01 on slide, India: Jharkhand: Dhobijharna under hill stream, Sahebganj district, 22. viii. 2013, Lat & Long. N 25°13' and E 87°38', collected by G. P. Mandal, Registration No. 2002/H14/ZSI.

Description: Body length up to 1.4 mm (excluding appendages).

Colour Pattern: Background colour white. Body devoid of any pigment or patches. Legs, ventral tube and furcular devoid of pigment. Eyes dark blue-black, two black dot present between eyes and median of head. A bluish line present in the posterior side of head. Ant. I, II, III pigmented laterally and Ant. IV pigmented distally (Figure 1).

Head: Eyes 8+8, more or less equal P.A.O rounded or more or less oval, unstricted, no setae near the base. P.A.O is 1.3 times less than the diameter of nearest omma (Figure 2). Head : Antennae ratio in length as 1.56. Antennal segment ratio in length as I: II: III: IV = 1: 2: 2.1: 2.8. Ant. I with basal sensilla shown in (Figure 3). Ant. III with sensilla shown in (Figure 4). Fourth antennal segment without apical bulb, but pin setae present (Figure 5). Maxillary outer lobe with 5 sublobal hairs (Figure 6).

Thorax and Legs: Ratio of segments of Thorax II: III = 1: 1.14. Thoracic setae smooth & ciliate. Tibio-tarsus with one large macrochaetae present in all legs (Figure 7). Unguis strong, long with two inner teeth, no outer & lateral tooth. Unguis 2.9 times longer than unguiculus. Unguiculus short, no teeth (Figure 8). Tenent hair thin, acuminate and more or less half of unguis (Figure 9). Ventral tube with 6+6 anterior setae (Figure 10). Trochanteral organ with 16 long setae (Figure 11).

Abdomen: Ratio of segments of Abdomen I: II: III: IV: V: VI: 1: 1.1: 1.6: 1.5: 0.7: 0.6. Retinaculum with 4 teeth & 6 setae in each (Figure 12). Manubrium: mucrodens as 1: 2.2. Manubrium with large no. of anterior and posterior setae (Figure 12). Manubrium with large no. of long ciliate setae posteriorly (Figure 13). Dens longer than manubrium and crenulated. Laterally 14-20 ciliate setae arranged in a row on dens (Figure 14). Mucro with 4 teeth but without seta (Figure 15).

Body Chaetotaxy: Body clothed with small to medium and large smooth and ciliate setae on head, thorax and abdomen. Cephalic setae, small to large, ciliate (Figure 16). Thoracic setae small, ciliate and large smooth macrochaetae also present (Figure 17). Abdominal long unilaterally macrochaetae and multilateral macrochaetae present (Figures 18 and 19).

Ecology: Found under hill stream near Dhobijharna of Sahebganj district, Jharkhand, India.

Etymology: The new species is named after the type locality, Sahebganj, Jharkhand, India.

Remarks: This species belongs to *Palustris* group having trichobothria 3, 3, 1. Abd. V with 7+7 sensillum, two

Table 5. The differences between *Isotomurus dhanbadensis* n. sp. and *Isotomurus sahebganjensis* n. sp.

Characters	<i>Isotomurus dhanbadensis</i> n. sp.	<i>Isotomurus sahebganjensis</i> n. sp.
Colour pattern	Body with distinct colour pattern. Thorax II- Abd. IV with lateral blue black belt present.	Body devoid of any pigment or patches.
Unguis and Unguiculus	Unguis with two inner teeth. Unguiculus without tooth.	Unguis with two inner teeth. Unguiculus without tooth.
Ventral tube	Ventral tube with 4+4 latero- distal setae.	Ventral tube with 6+6 anterior setae.
Tibiotarsus with macrochaete	Tibiotarsus without macrochaetae.	Tibiotarsus with one large macrochaetae.
Trochanteral organ	Trochanteral organ with 11-12 setae.	Trochanteral organ with 16 setae.
Retinaculum with setae	Retinaculum with more than 6 setae.	Retinaculum with 6 setae.
Manubrium with setae	Manubrium with large no. of anterior setae	Manubrium with large no. of posterior setae

Dens with setae	2/3rd of the dens straight and rest portion crenulated.	Dens totally crenulated and a distinct row of 14-20 setae present laterally.
Body length	2.7 mm	1.4 mm

medial ones elongated, retinaculum with 6+ 6 setae. This species is nearer to *Isotomurus dhanbadensis* n. sp. In having two inner teeth on claw but strongly differ in colour pattern of *Isotomurus dhanbadensis* n. sp.

Discussion: The new species from Sahebganj district of Jharkhand, India can easily distinguished from other known species of *Isotomurus* by claw structure, devoid of pigment, setae on ventral tube and retinaculum and macrochaetae on tibia tarsus. It is close to *Isotomurus dhanbadensis* n. sp, in having claw with two inner teeth but strongly differ from *Isotomurus dhanbadensis* n. sp in colour pattern and other characteristics given below in the Table. 5.

Summary

A total of 5 species of Collembola belonging to 2 genera under 2 sub families of family Isotomidae have been described as new to science from the state of Jharkhand, 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.

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 the Agro-ecosystem some of them are minor pests in agriculture.

Acknowledgements

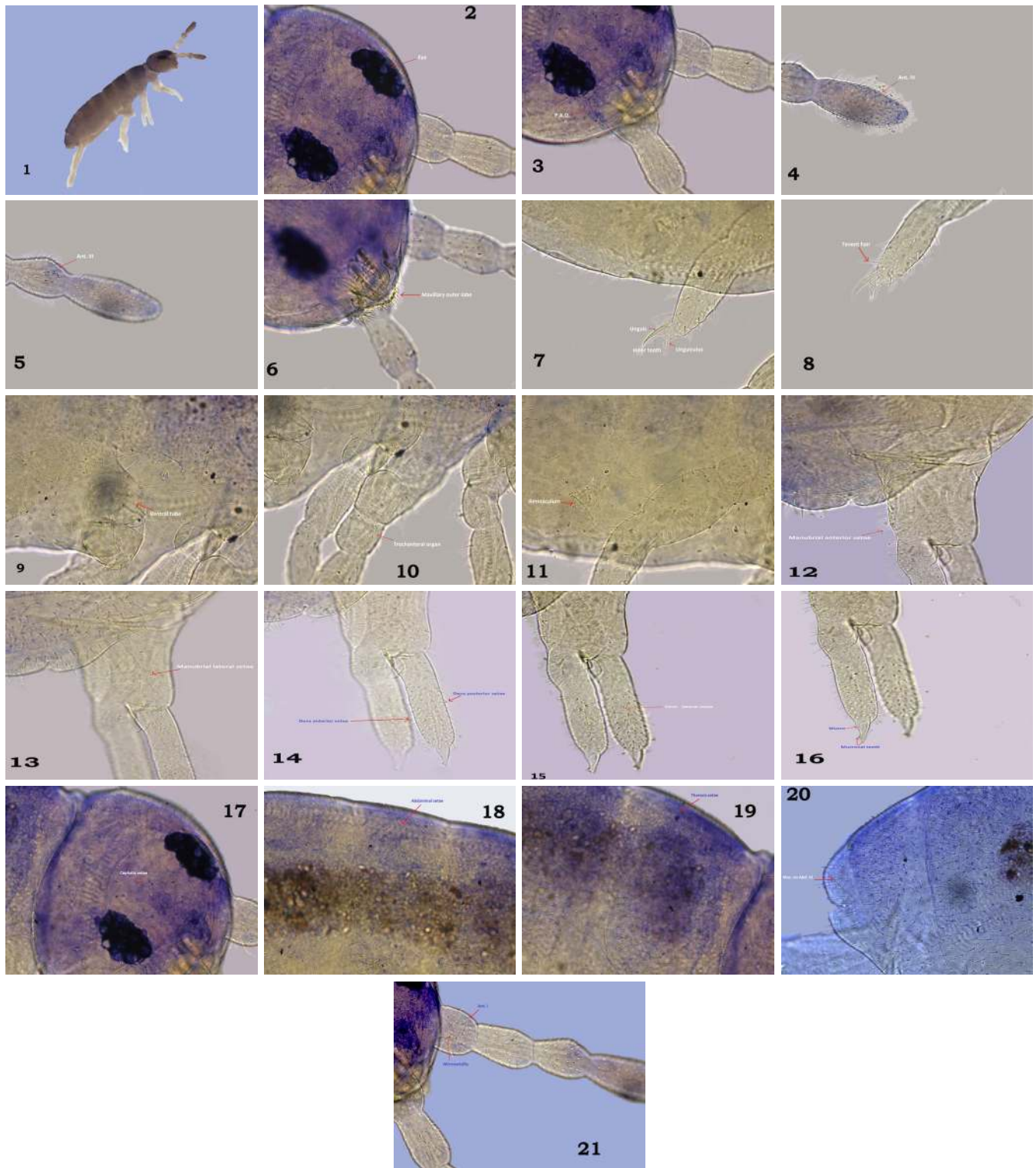
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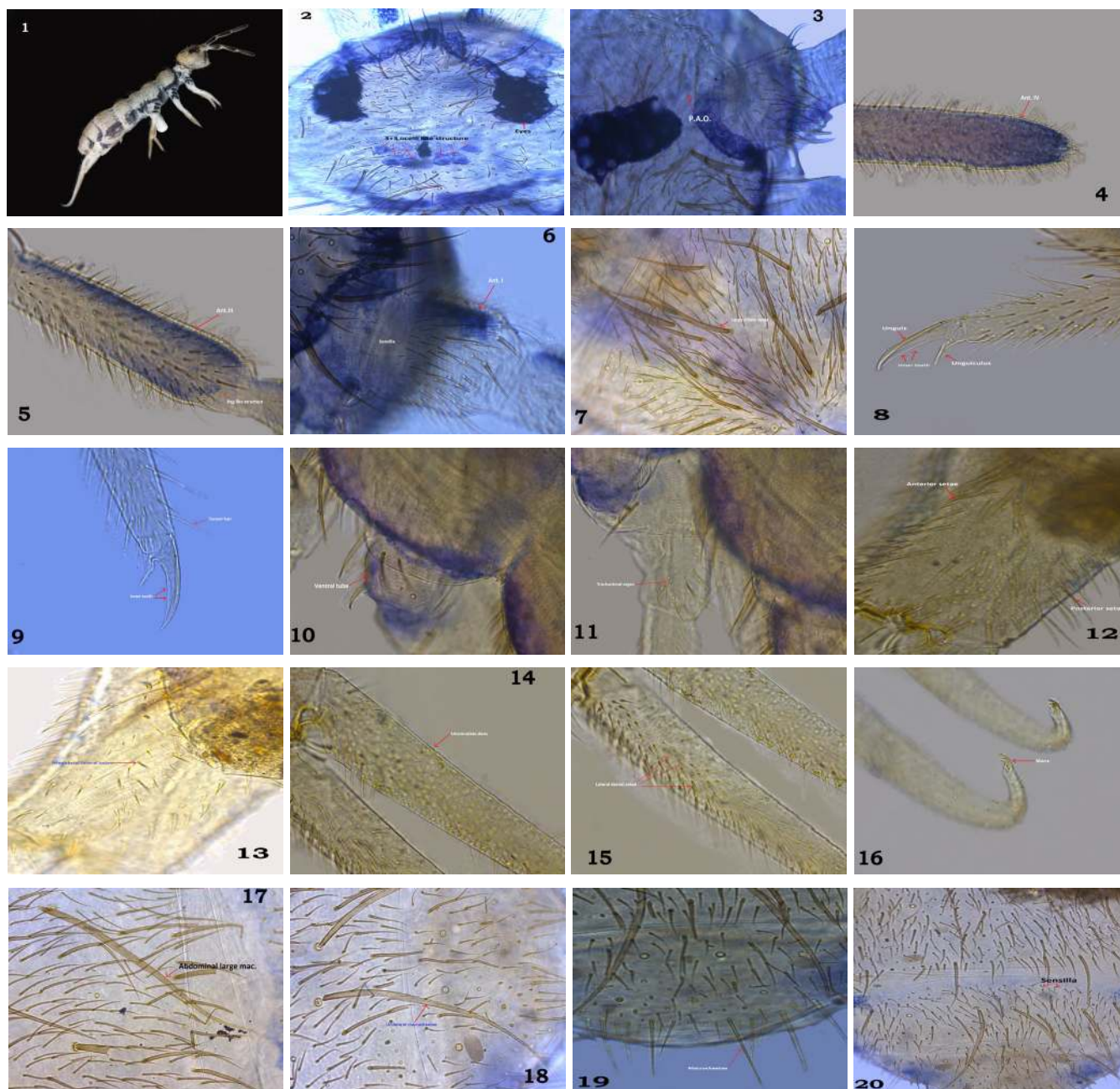
PLATE 1



1. Figures 1-21. *Proisotoma pakurensis* n. sp.

Proisotoma pakurensis n.sp. (lateral view); 2. Eyes; 3. P.A.O; 4. Ant.IV; 5. Ant.III; 6. Mouthparts; 7. Unguis & unguiculus ; 8. Tenent hair; 9. Ventral tube; 10. Trochanteral organ; 11. Retinaculum; 12. Manubrial anterior setae; 13. Manubrial lateral setae; 14. Dental anterior & posterior setae; 15. Dental lateral setae; 16. Mucro; 17. Cephalic setae; 18. Abdominal setae; 19. Thoracic setae; 20. Macrochaetae on Abd.VI; 21. Microsensilla on Ant. I & II.

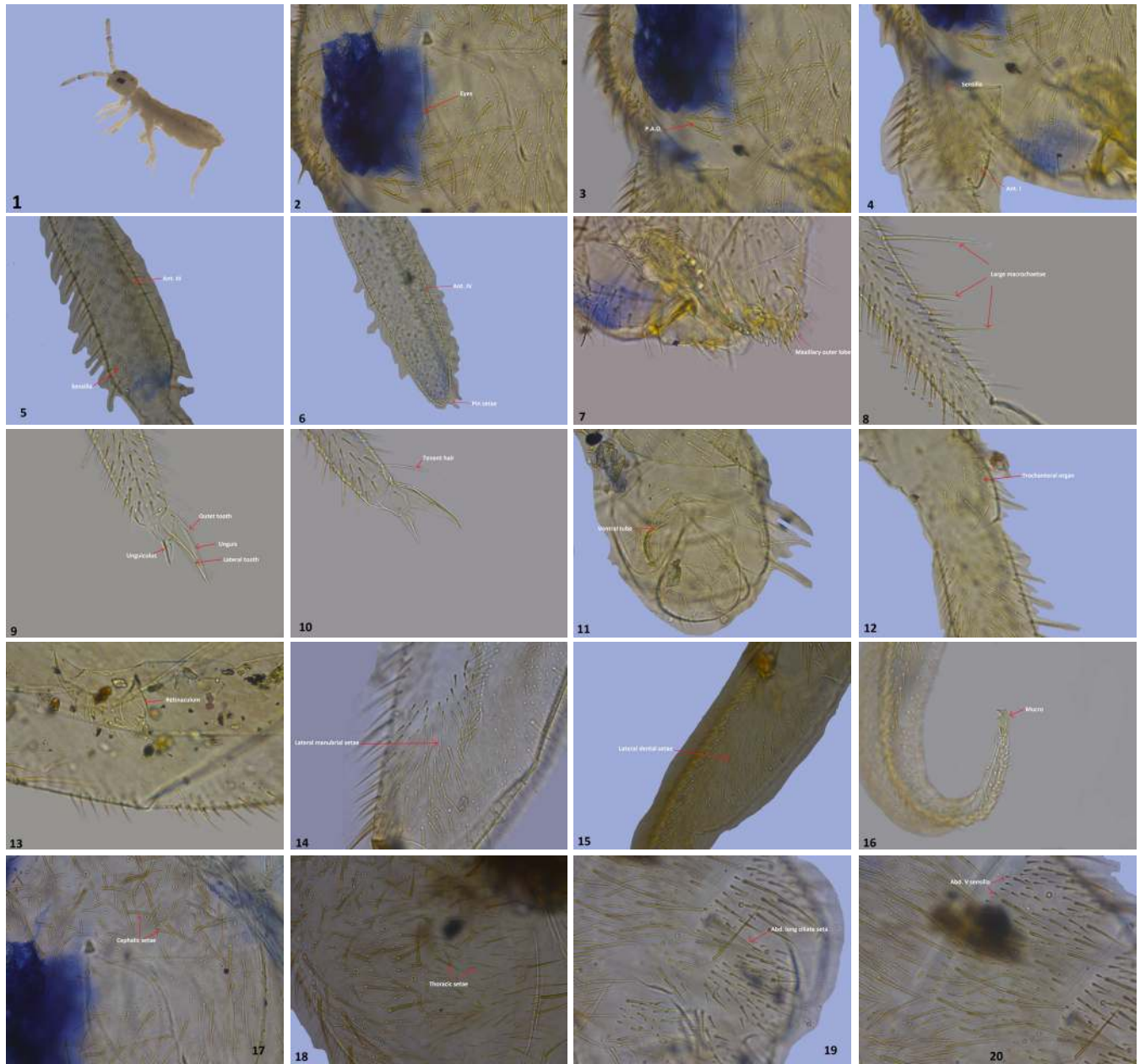
PLATE 2



2. Figures 1-20. *Isotomurus dhanbadensis* n. sp.

Isotomurus dhanbadensis n. sp. (lateral view); 2. Eyes & ocelli; 3. P.A.O; 4. Ant.IV; 5. Ant.III; 6. Ant.I; 7. Thorax II setae ; 8. Unguis & Unguiculus 9. Tenent hair; 10. Ventral tube; 11. Trochanteral organ; 12. Manubrial anterior & posterior setae; 13. Manubrial lateral setae; 14. Uncrenulate dens; 15. Dental lateral setae; 16. Mucro; 17. Large macrochaetae on Abd.III; 18. Abd.V with unilateral macrochaetae; 19. Macrochaetae on Abd.VI; 20. Abd V sensilla.

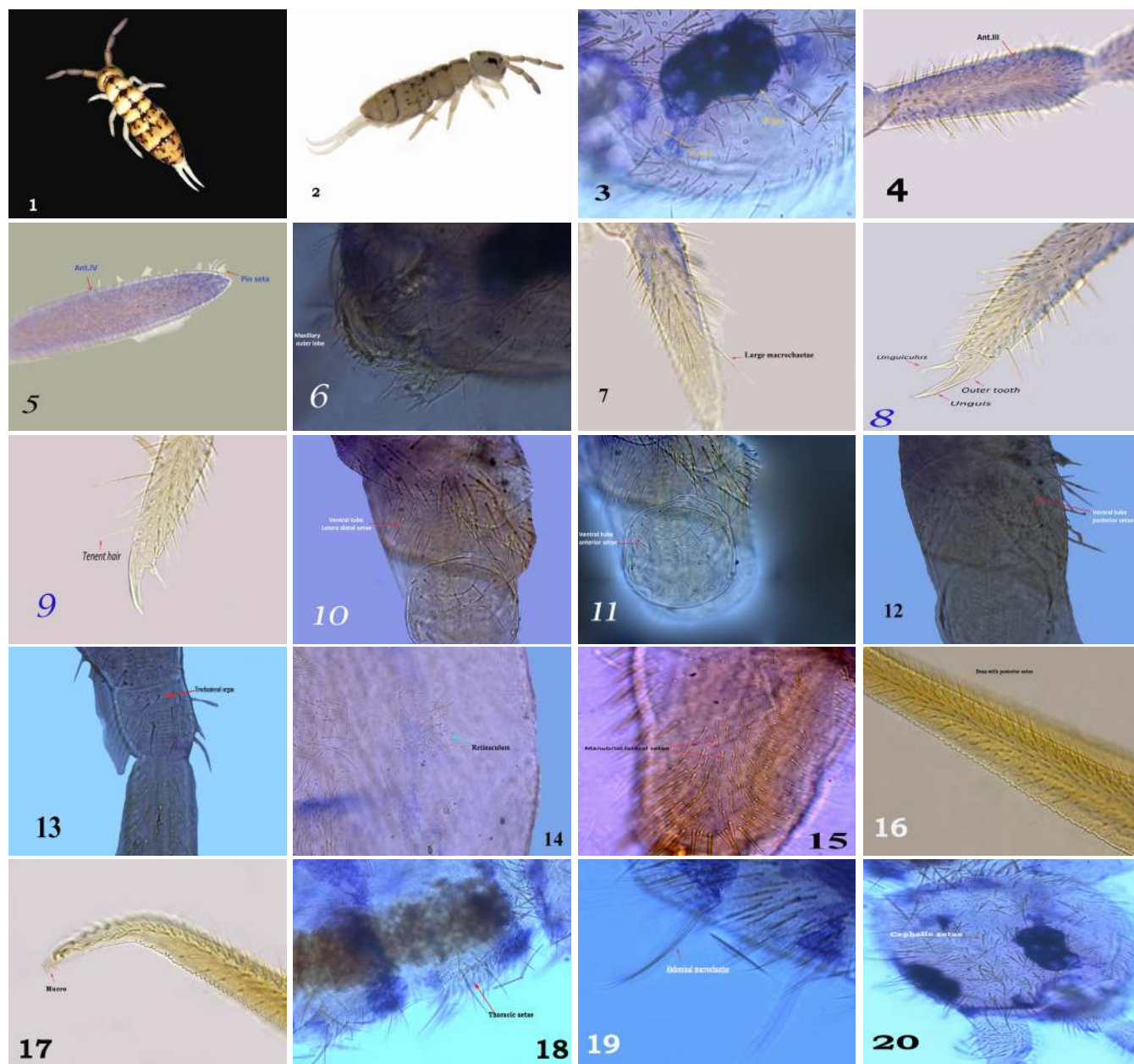
PLATE 3



3. Figures 1-20. *Isotomurus indicus* n. sp.

Isotomurus indicus n. sp. (lateral view); 2. Eyes; 3. P.A.O; 4. Ant.I; 5. Ant.III; 6. Ant. IV; 7. Mouthparts; 8. Macrochaetae on tibia tarsus; 9. Unguis & unguiculus; 10. Tenent hair; 11. Ventral tube anterior view; 12. Trochanteral organ; 13. Retinaculum; 14. Manubrial setae (lateral view); 15. Dental setae (lateral view); 16. Mucro; 17. Cephalic setae; 18. Thoracic setae; 19. Abdominal macrochaetae; 20. Sensilla on Abd. V.

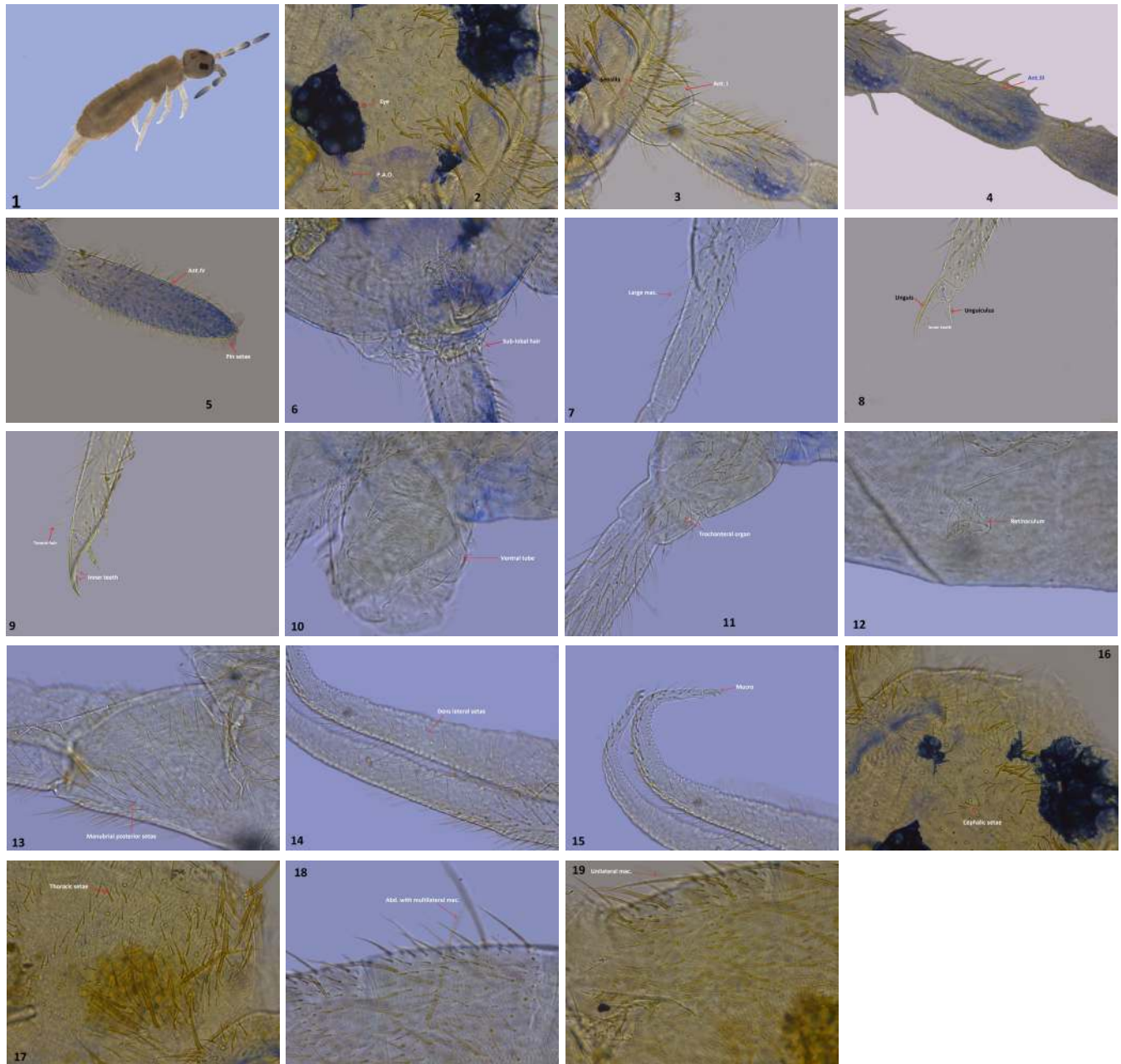
PLATE 4



4. Figures 1-20. *Isotomurus jharkhandensis* n. sp.

Isotomurus jharkhandensis n. sp. (dorsal view); 2. *Isotomurus jharkhandensis* n.sp. (lateral view); 3. Eyes &.P.A.O.; 4. Ant. III; 5. Ant.IV; 6. Mouth parts; 7. Macrochaetae on tibia tarsus; 8. Unguis & unguiculus; 9. Tenent hair; 10. Ventral tube laterodistal view; 11. Ventral tube anterior view; 12. Ventral tube posterior view; 13. Trochanteral organ; 14. Retinaculum; 15. Manubrial setae(lateral view); 16. Dental setae (posterior view); 17. Mucro; 18. Thoracic setae; 19. Abdominal macrochaetae; 20. Cephalic setae;

PLATE 5



5. Figures 1-19. *Isotomurus sahebganjensis* n. sp.

Isotomurus sahebganjensis n. sp. (lateral view); 2. Eyes & P.A.O; 3. Ant.I; 4. Ant.III; 5. Ant.IV; 6. Mouthparts; 7. Macrochaetae on tibia tarsus; 8. Unguis & unguiculus; 9. Tenent hair; 10. Ventral tube anterior view; 11. Trochanteral organ; 12. Retinaculum; 13. Manubrial setae (posterior view); 14. Dental setae (lateral view); 15. Mucro; 16. Cephalic setae; 17. Thoracic setae; 18. Abdominal multilateral macrochaetae; 19. Abdominal unilateral macrochaetae.