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Discovery of a New Species of the *Aackia* Yosii, 1966 from Sikkim, India (Collembola: Isotomidae)

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ABSTRACT

This study describes a new species, *Aackia sikkimensis* sp. nov., from the Eastern Himalayan Hotspot region in Sikkim, India. With this discovery, the genus *Aackia* Yosii, 1966, now comprises two species, both of which are found in the Himalayas. Both species are characterized by a dorsally swollen distal dens and a large distal chaeta on the dens. This new species differs from *A. karakoramensis* Yosii, 1966 by the absence of an inner tooth on the unguis and unguiculus, absence of chaetae on lateral flap of Ventral Tube, fewer chaetae on the retinaculum, and a rounded Post Antennal Organ. The two species have been found in the Himalayas. The two sites where they were located show a significant altitude difference of 4500 meters, with a distance of 1420 kilometers between them.

Keywords: *Aackia sikkimensis* sp. n., Himalayan Isotomid, new species, unusual dens, labral distal teeth.

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INTRODUCTION

Collembola are minute, wingless micro-arthropods typically abundant in soil and leaf litter habitats, based on food resources such as fungus (Hopkins, 1997). This minute creature can use locomotory organ, furcula as jumping apparatus to evade threats and can be effortlessly transported by the wind, allowing them to cover a wide array of habitats, from deserts to Antarctic regions, and towering mountains and hidden caves (Freeman, 1952; Gressitt, Leech, & O'Brien, 1960; Hopkins, 1997). Currently, approx. 9600 Collembola species are recorded globally (Bellinger, Christiansen, & Janssens, 1996-2024), and India has only 381 species, which is only approx. 3.97% of the global total (Mandal, Bhattacharya, & Suman, 2024a; Mandal et al., 2024b).

Isotomidae are mostly found in soil as a secondary consumers (Chahartaghi, Langel, Scheu, & Ruess, 2005). Isotomid Collembola are characterized by falcate or bidentate mucro, fused or separated distal abdominal segments, and the absence of a trochanteral organ (Soto-Adames, 2008). Currently, 1611 species of Isotomidae are distributed worldwide (GBIF Secretariat, 2023). India is home to only 45 Isotomid species (Mandal et al., 2024a). In 1966, Yosii described a new genus and species, *Aackia karakoramensis*, from Siachen Glacier at an altitude of 5000 m, which is one of the highest mountainous Collembola habitats (Rapoport, 1969). This small (1.3 mm) species (*A. karakoramensis* Yosii, 1966*)* is dark blackish in appearance despite being found at such a high altitude (Rapoport, 1969). This Isotomid genus defers from others by possessing four rounded teeth on the labrum and an unusual swelling on the distal dorsal dens (Yosii, 1966). Currently, this genus is recorded to have only one species worldwide (Bellinger et al., 1996-2024). This study describes a new *Aackia* Yosii, 1966 species from Sikkim, a Himalayan state of India and part of the Eastern Himalayan Hotspot. The new species, *Aackia sikkimensis* sp. n., shares all generic characters with the previously described species and also shows distinctive features on the claw, post antennal organ (PAO), mucro, retinaculum and ventral tube structure.

MATERIALS AND METHODS

The specimens were collected directly using a mouth-operated aspirator and indirectly by collecting topsoil or leaf litter, from which specimens were isolated using a Tullgren funnel and preserved in 70% ethyl alcohol. Sorting and photographs were performed under a Leica M205A stereomicroscope with an attached DMC6200 camera. Specimens were mounted on slides using Marc André II solution (Walter & Krantz, 2009) and dried on a hot plate for 24-48 hours. To study chaetotaxy, specimens were treated with Nesbitt's fluid (Krantz, 1978) for depigmentation before mounting. General identification up to the genus level was done following the key of Bellinger et al. (1996-2024), and photographs were taken under a Leica DM2500 microscope with an attached Leica DFC 295 camera. The labral chaetotaxy follows Cipola, Morais, & Bellini (2014), labial chaetotaxy follows Potapov (2001) & Cipola et al (2014), labial palp and maxilla chaetotaxy follows Potapov (2001) & Potapov, Huang, Gulgenova, & Luan (2020). Drawings of chaetotaxy and morphological characteristics were made using CorelDraw Suite 2021 version 23.1.0.389.

Institutions of depository of materials. All specimens are deposited in the NZC of ZSI.

Abbreviations used. a.s.l.-above sea level; **Ant.**-antennae/ antennal segment/s; **Th.**-thorax/ thoracic segment/s; **Abd.**-Abdomen/ abdominal segment/s; **PAO**-Post antennal organ; **VT**-Ventral tube. Institutional abbreviation: **NZC**-National Zoological Collection; **ZSI**-Zoological Survey of India

RESULT

Taxonomy

Class: COLLEMBOLA Lubbock, 1870

Order: ENTOMOBRYOMORPHA Börner, 1913

Family: ISOTOMIDAE Schäffer, 1896

Subfamily: ISOTOMINAE Schäffer, 1896

Genus *Aackia* Yosii, 1966

Diagnosis: Labral distal margin is provided with 2+2 small teeth connected by a transverse ledge. Swollen dorso-distal dens. Tenent hair apically pointed.

***Aackia sikkimensis* Mazumdar, Roy & Mandal sp. n. (Figs. 1-4)**

Type material: Holotype: on slide, in the moist leaf litter and moss, lower Ghurpsey hill stream, Namchi, Sikkim, India, 27°10'32.4''N, 88°23'10.8''E, altitude 571 m. a.s.l., 10.ix.2022, coll. by Dr. G. P. Mandal and party, NZC reg. no. 3722/H14. Paratype: 3 on slide, 1 in alcohol, lower Ghurpsey hill stream, Namchi, Sikkim, India, 27°10'32.4''N, 88°23'10.8''E, altitude 571 m. a.s.l., 10.ix.2022, Dr. G. P. Mandal leg. and party, NZC reg. no. 3723/H14.

Diagnosis: Rounded PAO. Absence of unguiculus inner teeth. Corpus of retinaculum with two chaetae. Tridentate mucro. Lateral VT flap without chaetae.

Description

Body length (holotype) 0.72 to 0.97 mm (head to Abd.-VI).

Colour. Background colour pale white. Blue pigments diffuse all over the body (Fig. 1). Ant. blue pigmented. The blue pigmentation fades significantly in the legs from the coxa to the claw. Sparse pigmentation can be seen on the posterior and lateral sides of the VT. Manubrium with very few blue pigmentations.

Head. Ratio of Ant. I : II : III : IV = 1 : 2.18 : 2.28 : 3.95. Ant. IV with a low subapical cone, all chaetae are same sized. Normal and simple chaetae on Ant. I to III. PAO present, ratio between PAO and nearest ocelli is 1.12 : 1 and ratio of distance (between PAO & nearest ocelli) and difference of diameter (between PAO & nearest ocelli) is 1.83 : 1, rounded (or quite lens-shaped) forming a wall-like structure in border (thick bordering) (Fig. 2A). Eye 8+8, dark pigmented. Eyepatch prominent overhead (Fig.

2A). Labral Formula 4/5,5,4; distal ones with heavy sockets; all chaetae are smooth (Fig. 2B). Mandibles with molar plate as shown in Isotomids (Fig. 2C). The labial palp with five main papillae (A-E) and a lateral process (Figs. 2D-E). Papilla C without guard chaetae. Maxillary outer lobe with simple maxillary palp and sublobal hair (Fig. 2F). Labial triangle with smooth sub-equal chaetae, formula : A1-2, M1-2, E (Fig. 2G). Cephalic chaetotaxy as in Fig. 2H.

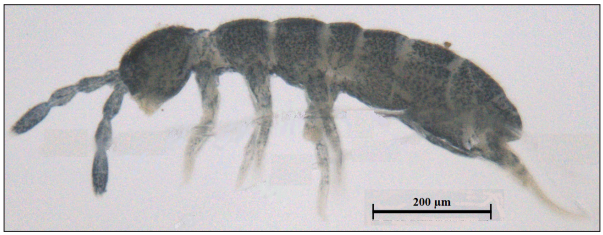

Figure 1. *Aackia sikkimensis* sp. n. habitus (paratype) (dorso-lateral).

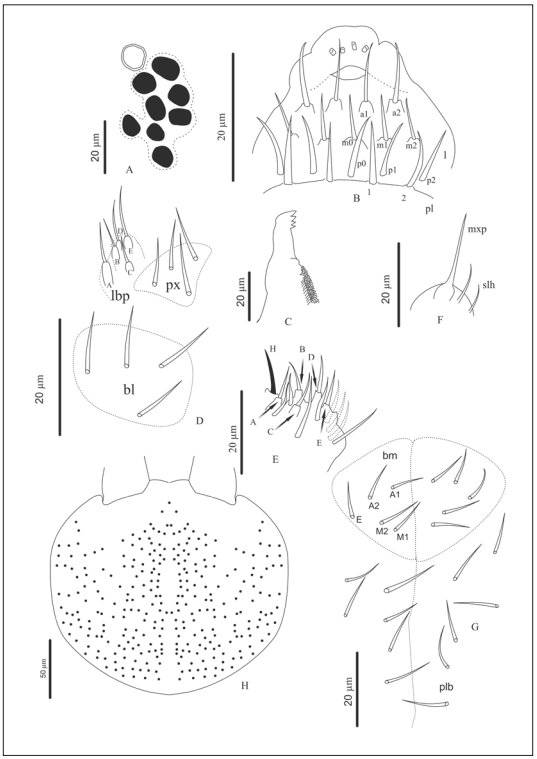

Figure 2. *Aackia sikkimensis* sp. n. A) PAO & Eyes, B) prelabral & labrum chaetae with 2+2 small teeth connected by a transverse ledge on distal margin, C) left mandible, D) labial palp (lbp: labial palp, px: proximal chaetae, bl: basolateral chaetae), E) labial palp (right side), F) maxillary outer lobe (mxp: maxillary palp, slh: sublobal hair), G) labial triangle (bm: basomedial chaetae, plb: post labial chaetae), H) cephalic chaetotaxy.

Body. Integument is smooth. Body chaetae are all small, simple and smooth. Ratio of Th. II : III = 1.06 : 1. Legs with apically pointed tenent hair (Fig. 3A). Strong unguis with a dorsolateral tooth and no inner tooth (Fig. 3A). Unguiculus truncated without inner tooth (Fig. 3A). Ratio of Abd. I : II : III : IV : V : VI = 1.92 : 2.39 : 3.28 : 3.17 : 1.31 : 1. VT anteriorly 3+3 chaetae (Fig. 3B), posteriorly 4 chaetae (Fig. 3C), lateral flap without chaetae. Retinaculum 4+4 toothed, corpus with 2 chaetae (Fig. 3D). Ratio of manubrium : dens : mucro = 9.28 : 23.06 : 1. Manubrium ventrally with 2+2 large chaetae distally (Fig. 3E) and other chaetae relatively small, approx. 30 chaetae; dorsally with equal sized approx. 50 chaetae (Fig. 3F). Dens slightly tapering distally; numerous ventral chaetae becoming slightly longer near distal end; dorsal side of dens cranulate, similar with this genus (Fig. 3G). Few chaetae present on the distal side of dens; near the distal end of dens, the integument is remarkably swollen, with a large apical chaeta near mucro (Fig. 3G). Mucro slightly curving and tridentate; subapical tooth slightly smaller than apical tooth; third tooth very small (or equal sized) and attach laterally (Fig. 3H); from the subapical tooth to the base, there is a longitudinal ledge on inner side of the mucro (not show in Figure). Mucro without chaetae (Fig. 3H). Body chaetotaxy as in Fig 4; sensilla present in Th. II to Abd. VI as 0,0/5,4,3,5,5,5,3 and micro-sensilla as 0,0/0,1,0,0,0,0.

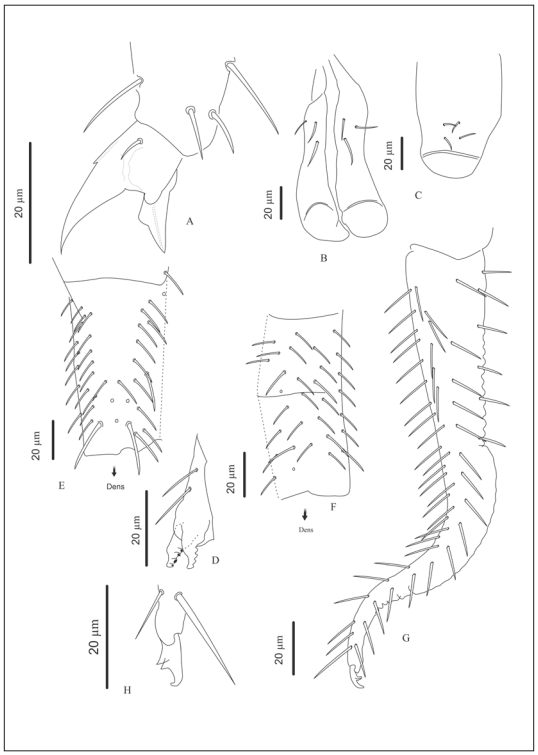

Figure 3. *Aackia sikkimensis* sp. n. A) claw, B) VT (anterior), C) VT (posterior), D) retinaculum, E) manubrium (ventral half), F) manubrium (dorsal half), G) dens, H) mucro.

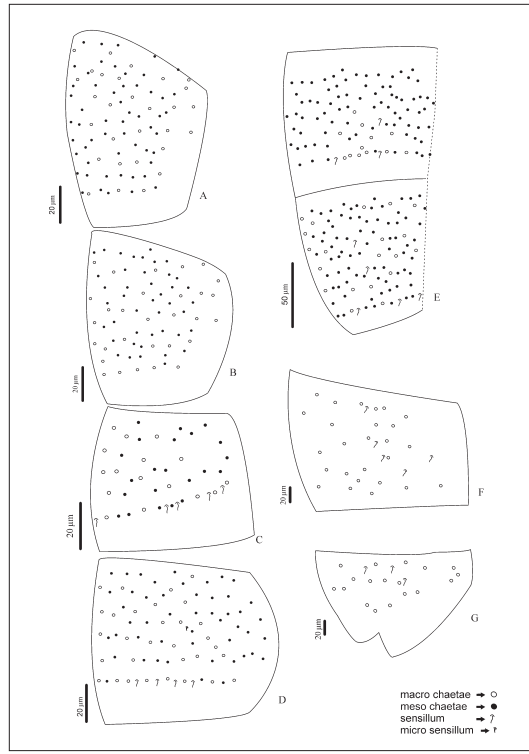

Figure 4. *Aackia sikkimensis* sp. n. A) Th.-II chaetotaxy, B) Th.-III chaetotaxy, C) Abd.-I chaetotaxy, D) Abd.-II chaetotaxy, E) Abd.-III & IV chaetotaxy, F) Abd.-V chaetotaxy, G) Abd.-VI chaetotaxy.

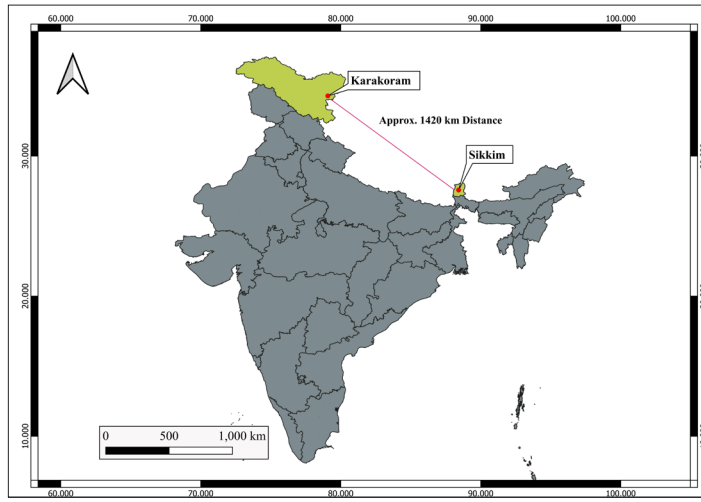

Figure 5. Map showing distance between type locality of *A. karakoramensis* Yosii, 1966 (in Siachen Glacier, Karakoram, India) and type locality of *A. sikkimensis* sp. n. (in Namchi, Sikkim, India).

Etymology

The species name is after the collection state.

DISCUSSION

In this study, we described a new species of *Aackia* Yosii, 1966 from Sikkim, India,. This new species reveals distinct morphological differences from *A. karakoramensis* Yosii, 1966 such as unguis without inner tooth (present in *A. karakoramensis*), truncated unguiculus without an inner tooth (acuminate and with tooth in *A. karakoramensis*), VT lateral flap without chaetae (15 in *A. karakoramensis*), corpus of retinaculum with 2 chaetae (9 in *A. karakoramensis*), tridentate mucro with different sized apical and subapical teeth, and a rounded PAO diameter almost similar to the nearest eye (elongate, elliptical, length is almost twice the diameter of an eye in *A. karakoramensis*). At the same time, *A. sikkimensis* sp. n. shares some characteristics with *A. karakoramensis* Yosii, 1966 which can be marked as typical characters for this genus, *Aackia* Yosii, 1966, such as four rounded teeth on labral transverse ledge, dorsal swelling of distal dens, dens devoid of granules, presence of apically pointed tenent hair and tridentate mucro. We studied four specimens, one specimen (holotype) was found with swollen dorso-distal dens and all specimens had a four-toothed transverse labral ledge and a large apical chaeta on dens near the tridentate mucro. The new species, *A. sikkimensis* sp. n., is found from Himalayan region (Sikkim) but at a lower altitude compared to *A. karakoramensis* Yosii, 1966, which was found on Siachen Glacier (5000 m. alt.), Karakoram. The distance is approximately 1420 km between two type localities (Fig.5) . Altitude plays an important role in body pigmentation due to temperature gradients (Rapoport, 1969). The new species is quite less dark (blue pigmented) compared to the dark black pigmentation of *A. karakoramensis* Yosii, 1966. These two different localities, one on the west side of India (Karakoram) and another on the east side of India (Sikkim) suggest that there is a significant scope to discover many Collembola and Isotomid species with different morphological appearances and habitats at various elevations. Before this study, this genus had only one species, which created some difficulties in establishing the new species in this genus due to the isolation of generic character based on *A. karakoramensis* Yosii, 1966.

Future research should focus on conducting more surveys across different habitats, both latitudinally and attitudinally, to better understand the distribution patterns and ecological aspects of Isotomid Collembola. This study significantly contributes to the taxonomy of *Aackia* Yosii, 1966, by identifying new species and providing a comprehensive analysis of their distinguishing characteristics. It also emphasizes the importance of continued taxonomic efforts in biodiversity-rich regions.

AUTHORS' CONTRIBUTION

All authors confirm their contributions as follows: S. Mazumdar-identification, manuscript review; K. K. Roy-identification, preparation of the original manuscript; G. P. Mandal-project supervision, collection, identification, manuscript review.

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