

A New Species of Genus *Neelus* Folsom, 1896 (Collembola: Neelidae) from Himalayan Region of Sikkim, India

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ABSTRACT

This paper describes with a new species of the genus *Neelus* Folsom, 1896. The species, named *Neelus sikkimensis* sp. nov. is reported from India for first time. The paper includes a comprehensive comparative table and an identification key for all known species of *Neelus*. Additionally, it provides insights into the distribution and ecological characteristics of species within the genus.

Keywords: *Neelus sikkimensis* sp. nov, identification key, moss, Himalayan region.

INTRODUCTION

Collembola have been found in various localities that are primarily associated with soil and litter. The monograph of the family Neelidae made by Bonet (1947), included a revised diagnosis of the genus *Neelus*, when only the type species *Neelus murinus* Folsom, 1896 was known. In the monograph, the descriptions were primarily based on the specimens found in Mexico and some specimens from other countries like Europe and Zelandothorax from New Zeland (Marin and Palacios-Vargas, 2018). The genus *Neelus*, Folsom, 1896 comes under the family Neelidae was established by Folsom, 1896. The family Neelidae comprises 6 genera and 65 species in the world (Bellinger *et al.* 1996-2024) of which the genus *Neelus*, Folsom, 1896 has 8 valid species and 5 unnamed species (Bellinger *et al.* 1996-2024). The genus *Neelus* may be easily recognized within the family Neelidae by obvious morphological features like the structure of labrum chaetae, Antennae, sensory fields and furcular morphology (Bonet, 1947). The project is part of the Zoological Survey of India's research program, which has been approved by the Indian government for Sikkim and the Northeast states. During a Collembola faunal survey in Sikkim, we collected the *Neelus* sp. This is the first time in Sikkim that we have collected the species. There was no literature available earlier.

The present paper, we described first time a new *Neelus* sp. from the North Sikkim, India. The paper is completed with a diagnostic table for the *Neelus* and identification key to the world species.

MATERIALS AND METHODS

A moss sample were collected from the Turum (Sikkim) hot spring by using a shovel and stored in a plastic bag. It was then processed in a modified Tullgren funnel setup under a 40-watt bulb for 36 hours. After this period, the specimens migrated downward and accumulated in the alcohol collection tube and specimens were preserved in 70% ethyl alcohol. The Neeles specimens were sorted under a Leica M205A stereo microscope and preserved in 70% ethyl alcohol. Photographs were taken using Leica M205A stereo microscope attached to a DMC 6200 camera. Specimens were mounted on slide using Hoyer's solution media under a coverslip and dried for two-three days on slide hotplate. Body length was measured on slides excluding antennae and furcula. Morphological identification and terminology was done based on Bonet, (1947) under Leica DM 2500 microscope attached to a DFC 295 camera. Specimens were deposited at National Zoological Collection, Zoological Survey of India.

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

Abbreviations. **Ant.**-antennal segment; **Abd.**-abdominal segment; **Th.**- Thoracic segment; msmicro sensila; **NZC**-National Zoological Collection ; **ZSI**-Zoological Survey of India.; sgd-guard dorsal sensillum and guard ventral sensillum.

RESULTS

Taxonomic hierarchy

Phylum: ARTHROPODA Latrielle, 1829

Class: COLLEMBOLA Lubbock, 1870

Order: NEELIPLEONA Masssoud. 1971

Family: NEELIDAE Folsom, 1896

Genus: *Neelus*, Folsom, 1896

Type species: *Neelus murinus* Folsom, 1896

Diagnosis: Antennal segments well divided, Ant. IV longer than III, Ant. IV with a big sensillum and a small one. One forked. Ant. III with two central small sensilla and two guard sensilla, one dorsal and bigger ventral, one ventral micro sensilla. Unguis without external teeth with one ventral teeth and two lateral. Tenent hair absent. Ventral tube with two apical chaetae. Retinaculum with 3+3 teeth and without chaetae. Furcula long and strong manubrium with six chaetae. Dens with one chaetae. Both edge of mucro dentate.

Neelus sikkimensis Suman and Mandal sp. n. (Figs1-4)

Type material: Holotype; male on slide, India, Sikkim, North Sikkim. 4km. from Turum Hot Spring, Lat. 27° 23.312' N, Long. 88° 2.043', Alt. 7480 ft, 09.09.2022, Collector G.P. Mandal Reg. no.3664 /H14.

Paratype: 1 male on slide 7 specimens in alcohol, the same data as the holotype. Reg.no.3669/H14;all materials are deposited in NZC, ZSI.

Description

Body. Length 0.3-0.5 mm.

Colour. Mostly whitish, sometimes with pale yellow pigment some small patches over dorsal part of head, thorax, abdomen and legs.

Head. Head length and width as 0.082 mm and 0.070 mm respectively. Labrum with 4,5,5,4 chaetae (Fig.1c). Anterior labral chaetae a1 and a2 thick, smooth and curve. a2 longer than a1 (0.00726 mm and 0.00958 mm respectively). Eyes absent. Ventral side of head with 3+3 smooth postmedian chaetae (Fig.1d). Maxillary palp simple, mandible strong with 5 asymmetrical apical teeth. Anterior labral chaetae a1 curved and medially serrated. a2 smooth apically curved.

Thorax and abdomen. Thorax to last abdominal segment length 0.02413 mm. Dorsal, lateral area of thorax form 6 ordinary chaetae. Abd. with 4+4 simple chaetae. Male genitalia plate with 5+19 micro chaetae arranged in circle (Fig. 2b).

Appendage. Ant. III and Ant. IV can be distinguished separately. Ratio of Ant. I: II: III: IV has 5.79: 8.93: 12.00: 29.58. Ant. 1 with 3 soft dorsal chaetae. Ant II with 6 dorsal chaetae. Ant. III with 6 chaetae, 2 sgd, and 2 micro sensilla. Ant. IV with 6 micro chaetae with 1 sgd (0.0155 mm) with 4 sensilla (0.01317 mm). Chaetae numbers of leg

1-3 (Figs. a-c), coxa with 1+1+1 chaetae; trochanter with 2+2+2 chaetae; femur with 11+11+11 chaetae; tibiotarsus with 13+13+13 chaetae. Unguis narrow elongated, both unguis and unguiculus are unequally long in leg. I, II and III unguis 0.0198 mm, 0.01858 mm and 0.01756 mm, respectively. Unguiculus I, II, III 0.0059, 0.00629 and 0.00754 mm respectively. Unguis furnished with two small lateral teeth. Unguiculus toothed without apical filament. Retinaculum with 3+3 teeth, no chaetae (Fig. 2d). The ventral tube with two small chaetae. Furcula well developed (Fig. 3f). Length of manubrium 0.03854 mm, dens proximal part 0.01551 mm and dens distal part 0.00962 mm and mucro 0.03052 mm. Mucro width 0.00362 mm. Manubrium dorsally 3+3 chaetae, dens in basal part with 4+4 dorsal chaetae and lateral 6+6 chaetae. Mucro with serrated dorsal lamellae and rounded teeth.

Etymology: The new species is named after the type locality, Sikkim in the Eastern Himalayan range of India.

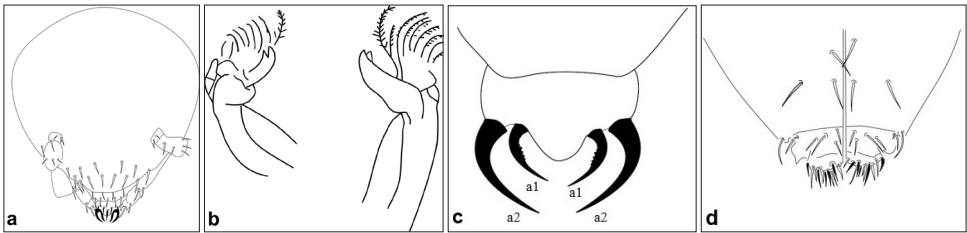


Figure 1. *Neelus sikkimensis* sp. nov. a) Mouth part, b) Maxilla, dorsal & ventral view, c) Labral row enlarged, d) Ventral side of head with labium.

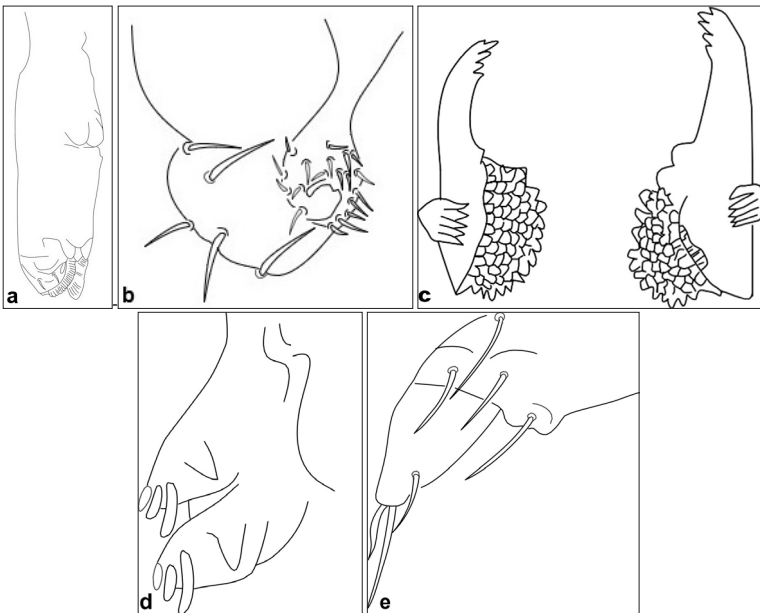


Figure 2. *Neelus sikkimensis* sp. nov. a) Ventral tube, b) Male genital plate, c) Mandibles, d) Retinaculum, e) Maxillary outer lobe.

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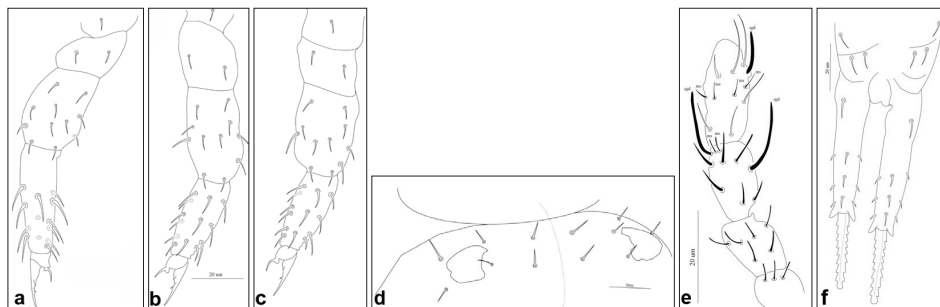


Figure 3. *Neelus sikkimensis* sp. nov. a) Leg I, b) Leg II, c) Leg III, d) Thoracic segment I, e) Antenna dorsal view, f) Furca dorsal view.

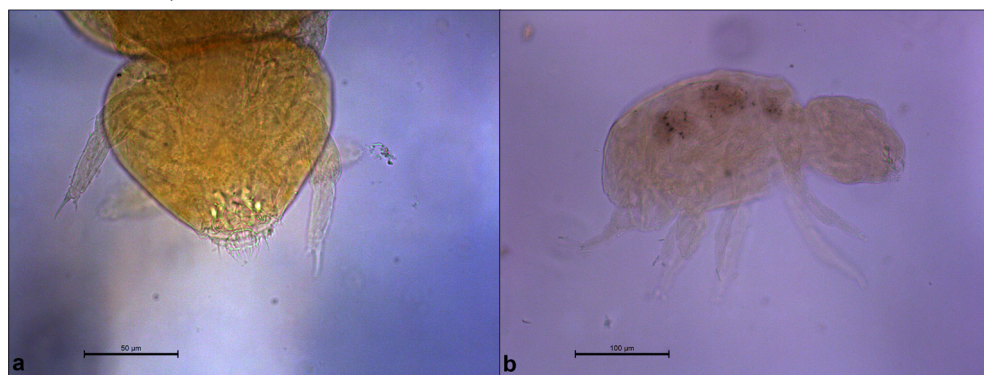


Figure 4. *Neelus sikkimensis* sp. nov. a) Mouth part with labral chaetae, b) Habitus.

DISCUSSION

Neelus sikkimensis sp. nov. is clearly assignable to the genus *Neelus* based on the general morphology of the body, the structure of the antennae, the chaetotaxy of the labrum, and the reduced furcal apparatus. Within the genus, the new species belongs to the group of taxa characterized by a 3+3 chaetae arrangement on the posterior side of the manubrium, a species shared with *N. labralisetosus*, *N. murinus*, and *N. fimbriatus*. The revised identification key to all known species of *Neelus* indicates that *N. sikkimensis* sp. nov. can be readily differs from other neelus species by a unique combination of labral chaetotaxy, chaetal morphology, and ventral cephalic characters.

Among species with a 5-chaeta medial and 4-chaeta anterior formula of the labrum, *N. sikkimensis* sp. nov. is most similar to *N. murinus* and *N. fimbriatus*. However, *N. murinus* possesses smooth anterior chaetae a1 and a2, with a1 bearing only a small basal tooth, whereas *N. sikkimensis* sp. nov. distinctly exhibits a1 medially serrated and a2 smooth but apically curved. Likewise, *N. fimbriatus* differs in having both a1 and a2 coarsely serrate, and additionally shows 1+1 ciliated postmedian chaetae on the ventral side of the head, whereas these chaetae are smooth in the new species. The combination of a1 serration pattern, the unique curvature of a2, and the homogenous

smoothness of the postmedian cephalic chaetae thus provides a clear diagnostic suite distinguishing *N. sikkimensis* sp. nov (Table 1).

The new species also demonstrates notable geographic significance.

Identification key to the World species of *Neelus*

1. Posterior side of manubrium with 4+4 chaetae.....2
 - Posterior side of manubrium with 3+3 chaetae.....6
2. Labral chaeta a1 smooth and apically branched; Ant I with 2 chaetae.....
 - *N. desantisi* Najt, 1971 (Argentina)
 - Labral chaeta a1 serrated or branched; Ant I with 2 or 3 chaetae.....3
3. Posterior abdomen dorsally with numerous tertiary rods; sensory field on thorax without stouter, lanceolate spines.....4
 - Posterior abdomen dorsally without tertiary rods; sensory field on thorax with stouter, lanceolate spines.....5
4. Posterior part of abdomen dorsally only with tertiary rods; a1 serrated...
 -*N. koseli* Kováč & Papáč, 2010 (Slovakia, caves)
 - Posterior part of abdomen dorsally with tertiary rods and ordinary chaetae; a1 forked (medially with strong tooth).....
 - *N. cvitanovici* Papáč, V., Lukić, M. & Kováč, Ľubomír, 2016. (Croatia, caves)
5. Thoracal sensory field with 7 axial lanceolate spines; Ant. I with 2 chaetae.....*N. klisurenensis* Kováč & Papáč, 2010 (Kosovo, caves)
 - Thoracal sensory field with 4 anterior lanceolate spines and 3 axial lanceolate spines; Ant. I with 3 chaetae..... *N. lackovici* Papáč, V., Lukić, M. & Kováč, Ľubomír, 2016 (Croatia, caves)
6. Labrum with 3 medial and 6 anterior chaetae, a1 medially forked and basally without small tooth or serrate.....
 -*N. labralisetosus* Massoud & Vannier, 1967 (Solomon Islands)
 - Labrum with 5 medial and 4 anterior chaetae, a1 medially not forked and basally with small tooth or serrate.....7
7. Anterior labral chaetae a1 and a2 smooth, a1 basally with small tooth; ventral side of head with 3+3 postmedian chaetae..... *N. murinus* Folsom, 1896 (Jamaica)
 - Anterior labral chaetae a1 medially serrated, a2 smooth apically.....8
8. Anterior labral chaetae a1 medially serrated, a2 smooth apically curved; ventral side of head with 3+3 postmedian smooth chaetae.....
 -***N. sikkimensis* sp. nov. (India)**
 - Anterior labral chaetae a1 and a2 roughly serrate; ventral side of head with 3+3 postmedian chaetae of which 1+1 posterior ones ciliated.
 - *N. fimbriatus* Bretfeld & Trinklein, 2000 (Ecuador)

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Table 1. Differential characters of the world species of the genus *Neelus* Folsom, 1896 with new species *Neelus sikkimensis*.

Ant. IV-nr. of S-chaetae	Ant. III-nr. of chaetae	Ant. II-nr. of chaetae (whorl)?	Ant. I-nr. of chaetae	proximal and 2+2 distal)	Posterior Mandibulum-nr. Of chaetae	Apically curved	(p-m-arc) Labral chaetae of arc	Prelabral/labral chaetae nr.	Body length(mm)	Character
12	-	5 (4 in distal whorl)	3	4+4 chaetae	3+3 chaetae (1+1 proximal and 2+2 distal)	a1-apically branched a2-external edge apically serrate	a1-basally branched a2-external edge smooth	4/5, 5, 4	0.7–1.1	<i>N. murinus</i> (Folsom, 1896) sensu Schneider (in press)
9?	-	?	?	4+4 chaetae	3+3 chaetae (1+1 proximal and 2+2 distal)	a1-external edge roughly serrate a2-external edge roughly serrate	a1-medially forked a2-apically finely serrate a3-smooth,	?/?, 3, 6	0.6–0.8	<i>N. labralisotus</i> Massoud & Vannier, 1967
9?	-	5 (4 in distal whorl)?	2?	4+4 chaetae	4+4 chaetae	a1-external edge medially roughly serrate a2-external edge finely serrate		?/?, 5, 4	0.6	<i>N. desantisi</i> Najt, 1971
11	-	?	?	4+4 chaetae	3+3 chaetae (1+1)	a1-medially branched a2-external edge apically finely serrate		?/?, 5, 5, 4	0.5	<i>N. fimbriatus</i> Breffeld & Trinklein, 2000
10	-	6 (5 in distal whorl)	3	3+3 chaetae (2+2 distal and 1+1 proximal)		a1-medially forked		4/5, 5, 4	0.9–1.0	<i>N. kosei</i> Kováč & Papáček, 2010
14	-	5 (4 in distal whorl)	2			and apically serrated a2-external edge medially finely serrate		4/5, 5, 4	0.7–0.9	<i>N. klutrensis</i> Kováč & Papáček, 2010
11	-	6 (5 in distal whorl)	3			a1-medially forked with 2 teeth and apically finely serrated a2-external edge medially finely serrate		4/5, 5, 4	0.7–1.0	<i>N. cvitarovici</i> Papáček, Lukáč and Kováč, 2016
12	-	6 (5 in distal whorl)	2			a1-medially serrated a2-smooth apically curved		4/5, 5, 4	0.9–1.2	<i>N. lackovici</i> Papáček, Lukáč and Kováč, 2016
6 micro chaetae with 1 sgd (15.05 µm) with 4 sensilla (13.17 µm)	6 chaetae, 2 sgd, and 2 micro sensilla	6	3					4/5, 5, 4	0.3–0.5	<i>N. sikkimensis</i> sp. nov.

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AUTHOR CONTRIBUTION

K.K. Suman, Identification, preparation of the original manuscript: G.P. Mandal, Project supervision, identification, manuscript review.

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