Zootaxa 5339 (6): 501–519
https://www.mapress.com/zt/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

https://doi.org/10.11646/zootaxa.5339.6.1
http://zoobank.org/urn:lsid:zoobank.org:pub:C6BD77C1-BEBE-4A24-9C8A-884FAD824490

Four new saproxylic species of *Paranura* Axelson, 1902 (Collembola: Neanuridae: Neanurinae) from Japan

HIRO KASAI[1, 3] & TAKUO SAWAHATA[2]
[1]*Graduate School of Agriculture, Kindai University, 3327-204 Nakamachi, Nara 631-8505, Japan.*
shkhiro1@gmail.com; *https://orcid.org/0000-0002-1917-5527*
[2]*Faculty of Agriculture, Kindai University, Nakamachi 3327-204, Nara, 631-8505, Japan.*
tsawahata@nara.kindai.ac.jp; *https://orcid.org/0000-0002-5946-9896*
[3]*Corresponding author*

Abstract

Four new saproxylic species of the genus *Paranura* from Nagasaki, Nara, and Niigata provinces of Japan are described and illustrated in this paper. *Paranura tsushimaensis* **sp. nov.** is characterized by a dark blue body color, Abd. V four times as long as Abd. VI, 3+3 eyes, three ocular chaetae on the head, four ordinary chaetae De on Th. III, two ordinary chaetae Di on Abd. V, and all dorsal chaetae of Abd. VI in a unique reticulated plate. *P. nakamurai* **sp. nov.** is identified by its yellowish white body color, 2+2 eyes, tubercle Af on the head with two reticulated tubercles, and tubercles Di on Abd. V fused. *P. alpicola* **sp. nov.** is characterized by its yellow body color, 3+3 eyes, presence of complete chaetotaxy in the central area of the head, Th. II–III with two and three ordinary chaetae De respectively, and tubercles Di on Abd. V separate. *P. convallis* **sp. nov.** is identified by its orange body color, 3+3 eyes, head without chaeta O, three mandibular teeth, and Th. II–III with three and four ordinary chaetae De respectively. A key for all species of the genus *Paranura* is provided.

Key words: taxonomy, springtails, dead wood, East Asia, identification key

Introduction

The subfamily Neanurinae has a cosmopolitan distribution with over 800 species described to date (Bellinger *et al.* 1996–2023). The ecological relationship between Neanurinae and dead wood was recently elucidated, fostering the discovery of novel Neanurinae species and genera within such habitats (e.g. Kasai *et al.* 2022; Smolis 2011; Smolis & Deharveng 2015; Smolis & Greenslade 2020; Smolis & Kadej 2014).

The genus *Paranura* Axelson, 1902 comprises 45 species (44 valid and one species inquirenda) that are primarily distributed across Asia and the Americas (Smolis & Deharveng 2015). Species such as *P. reducta* Smolis & Deharveng, 2015, *P. setosa* Smolis & Deharveng, 2015, *P. conjuncta* Smolis & Deharveng, 2015, and *P. mjohjangensis* Deharveng & Weiner, 1984 have been reported to be associated with dead wood (Smolis & Deharveng 2015), indicating a strong relationship between this genus and dead wood. Thus, new *Paranura* species are expected to emerge through surveys that primarily focus on this niche. Although only three species of *Paranura* have been reported in Japan, additional species are expected to be found in surveys of the collembolan fauna that inhabit dead wood.

In the present study, we describe four new *Paranura* species identified through research on collembolan fauna inhabiting fallen branches on the forest floor in broadleaf tree forests located in several geographical areas in Japan.

Material and Methods

Specimens were procured from fallen branches on the forest floor using Berlese-Tullgren funnels. They were subjected to biological photography using digital camera (Olympus, Tough TG-5) prior to preservation in 95%

Accepted by W.M. Weiner: 15 Aug. 2023; published: 4 Sept. 2023

ethanol. Subsequently, the specimens were mounted on slides in Hoyer's solution and examined under a microscope (Olympus, BH-2). All data have been deposited in the Apterygota (Ap) collection of the National Museum of Nature and Science (NMNS; previously named the National Science Museum, Tokyo: NSMT), Tokyo Province, Japan.

Terminology. The terminology and layout of the tables used in this study follow Deharveng (1983), Deharveng & Weiner (1984), Smolis & Deharveng (2006), and Smolis (2008).

Abbreviations. General morphology: Abd.—abdominal segment, Ant.—antennal segment, AOIII—sensory organ of antennal segment III, Cx—coxa, Fe—femur, Scx2—subcoxa 2, T—tibiotarsus, Th.—thoracic segment, Tr—trochanter, VT—ventral tube.

Groups of chaetae: Ag—antegenital, An—microchaetae of anal lobes, ap—apical, ca—centroapical, cm—centromedial, cp—centroposterior, d—dorsal, Fu—furcal, vc—ventrocentral, Ve or ve—ventroexternal, Vea—ventroexternoanterior, Vem—ventroexternomedial, Vep—ventroexternoposterior, Vel—ventroexternolateral, Vec—ventroexternocentral, Vei—ventroexternointernal, Vi or vi—ventrointernal, Vl—ventrolateral.

Tubercles: Af—antenna-frontal, Cl—clypeal, De—dorsoexternal, Di—dorsointernal, Dl—dorsolateral, L—lateral, Oc—ocular, So—subocular.

Types of chaetae: Ml—long macrochaeta, Mc—short macrochaeta, Mcc—very short macrochaeta, me—mesochaeta, mi—microchaeta, ms—s-microchaeta, S or s—chaeta s, bs—s-chaeta on Ant. IV, miA—microchaetae on Ant. IV, iv—ordinary chaetae on ventral Ant. IV, or—organite of Ant. IV, brs—border s-chaeta on Ant. IV, i—ordinary chaeta on Ant. IV, mou—cylindrical s-chaetae on Ant. IV, x—labial papilla x, B4, B5—ordinary chaetae on tibiotarsi.

Taxonomy

Family Neanuridae Börner, 1901

Subfamily Neanurinae Börner, 1901, *sensu* Cassagnau, 1989

Tribus Paleonurini Cassagnau, 1989

Genus *Paranura* Axelson, 1902

Paranura tsushimaensis Kasai sp. nov.

[Japanese name: Rurihoso-ibonashi-tobimushi]
Figs 1–11, Tables 1–2

Type material. Holotype: male, Japan, Kyushu, Nagasaki Prefecture, Tsushima-shi, Tsushima Island, Kamitsushima-cho (alt. 33 m, 34°35'52"N 129°25'10"E), evergreen forest, rotten fallen branch, 27-XI-2022, Kahito Nakamura & Hiro Kasai leg. (NMNS, NSMT-Ap 671). Paratypes: 2 females (NMNS, NSMT-Ap 672–673), 2 males (NMNS, NSMT-Ap 674–675), and juvenile (NMNS, NSMT-Ap 676); same data as the holotype.

Etymology. The new species is named after the type locality, Tsushima Island.

Diagnosis. 3+3 black eyes on head. Dark blue body color. Body elongated and flattened. Some tubercles present on dorsal side of body, underlined by reticulations. Abd. V four times as long as Abd. VI. Ant. II with 12 chaetae. Chaetae O, A, E, and three ocular chaetae present on head. Lateral area on head with 6 chaetae Dl and 10 chaetae (L+So). Th. II–III with 3 and 4 ordinary chaetae De respectively. Tubercles Di on Abd. V not developed, with 2+2 chaetae Di. Abd. V with 9 ordinary chaetae De+Dl+L. Furcal remnant with 5–7 mesochaetae and no microchaetae. Tibiotarsi with chaeta M.

Description. Body length (without antennae) 1.58–1.83 mm in adults. Color of the body dark blue (Fig. 1). 3+3 black eyes, two anterior and one posterior. Body elongated and flattened (Fig. 4).

Chaetal morphology. Five types of dorsal ordinary chaetae. Long macrochaetae (Ml) relatively long, thickened, sheathed, apically acuminated; some lateral chaetae longer and strongly acuminate at the apex (Fig. 10). Short macrochaetae (Mc) morphologically similar to Ml, but much shorter. Very short macrochaetae (Mcc) relatively thick and weakly acuminated (Fig. 9). Mesochaetae (me) and microchaetae (mi) similar to ventral chaetae: thin, smooth, and pointed. S–chaetae of tergites thin and smooth.

TABLE 1. Cephalic chaetotaxy of *Paranura tsushimaensis* **sp. nov.**

a) Cephalic chaetotaxy—dorsal side.

Group of chaetae	Number of chaetae	Types of chaetae	Names of chaetae
Cl	4	Mc	F
		me	G
Af	11	Ml	B
		Mc or Mcc	A
		me	D, E, C, O
Oc	3	Mc or Mcc	Ocm
		me	Ocp
		mi	Oca
Di	2	Mcc	Di1
		mi	Di2
De	2	Ml	De1
		mi	De2
Dl	6	Ml	Dl5
		Mc	Dl1
		Mcc or me	Dl3, Dl4
		mi	Dl2, Dl6
(L+So)	10	Ml	L1, So1
		Mc	L4
		Mcc or me	L2, L3, So2, So6
		me	So3, So4, So5

b) Chaetotaxy of antennae.

Segment, Group	Number of chaetae	Segment, Group	Number of chaetae adult
I	7	IV	or, 8 S, i, 12 mou, 6 brs, 2 iv
II	12		
III	5 sensilla AOIII		
ve	5	ap	8 bs, 5 miA
vc	4	ca	2 bs, 3 miA
vi	4	cm	3 bs, 1 miA
d	5	cp	8 miA, 1 brs

Antennal morphology and chaetotaxy. Antenna 4-segmented. Ratio of antennal segments I: II: III + IV = 1:1:1.5. Dorso-central area on Ant. III–IV weakly granulated. S-chaetae of Ant. IV relatively long and thick, S1 and S2 slightly thinner than others (Fig. 2). Apical bulb distinct and trilobed. Chaetotaxy of antennae shown in Table 1b and Figs 2–3.

Mouthparts. Buccal cone relatively long and rounded at apex. Labrum chaetotaxy 0/2,2 (Fig. 5). Labium with 4 basal, 3 distal, and 4 lateral chaetae, papillae x absent (Fig. 6). Mandible with 3 teeth. Maxilla styliform.

Cephalic tubercles and chaetotaxy. Tubercle Cl weakly developed (Fig. 4). Chaetotaxy of the central area complete (Fig. 4). Lateral area with 6 chaetae Dl and 10 chaetae (L+So). Dorsal chaetotaxy of the head shown in Table 1a and Fig. 4. Group Vi with 6+6 chaetae. Groups Vea, Vem, and Vep with 4, 3, and 4 chaetae respectively.

Body tubercles and chaetotaxy. Tubercle Dl on Abd. IV, tubercle De+Dl+L on Abd. V, and a unique tubercle on Abd. Vl developed and reticulated (Figs 4, 11). Tubercles Di on Abd. V not developed, with 2+2 chaetae Di. Abd. V very long, four times as long as the last segment of the body (Figs 4, 11). Dorsal chaetotaxy shown in Table 2 and Figs 4,

11. Furcal remnant with 5–7 mesochaetae and no microchaetae. Genital plate with 28–30 and 12–30 chaetae in females and males respectively. An with 2 mi, rarely one side absent. Ventral chaetotaxy shown in Table 2 and Fig. 7.

Legs. Tibiotarsi I, II, and III with 19, 19, and 18 chaetae respectively, chaeta M present. Unguis without inner tooth (Fig. 8). Chaetae B4 and B5 long. Chaetotaxy of the legs shown in Table 2 and Fig. 8.

FIGURE 1. Live specimen of *Paranura tsushimaensis* **sp. nov.**

Remarks. *Paranura tsushimaensis* **sp. nov.** is the third species with a bluish body color, a very long abdominal segment V, and reticulations in the dorsal area. *P. tsushimaensis* **sp. nov.** is the most similar to *P. reticulata* Smolis & Deharveng, 2015, having a head with 3 ocular chaetae, the lateral area of the head with 16 chaetae, and 4 ordinary chaetae De on Th. III. However, this new species is clearly distinguishable from *P. reticulata* by the absence of prelabral chaetae (in *P. reticulata* 4), 2+2 ordinary chaetae Di on Abd. V (in *P. reticulata* 3+3), 9 ordinary chaetae De+Dl+L on Abd. V (in *P. reticulata* 6–7), and microchaetae absent on the furcal remnant (in *P. reticulata* present). This new species is also similar to *P. s-uenoi* Yosii, 1955. However, the new species differs with 3 ocular chaetae on the head (in *P. s-uenoi* 2), 2 ordinary chaetae De on Th. I (in *P. s-uenoi* 3), and 4 ordinary chaetae De on Th. III (in *P. s-uenoi* 3).

TABLE 2. Postcephalic chaetotaxy of *Paranura tsushimaensis* **sp. nov.**

		Terga					Legs		
	Di	De	Dl	L	Scx2	Cx	Tr	Fe	T
Th. I	1	2	1		0	3	6	13	19
Th. II	3	3+s	3+s+ms	3	2	7	6	12	19
Th. III	3	4+s	3+s	3	2	8	6	11	18
							Sterna		
Abd. I	2	3+s	2	3	VT: 4				
Abd. II	2	3+s	2	3	Ve: 5–7				
Abd. III	2	3+s	2	4–5	Ve: 5–7		Fu: 5–7 me		
Abd. IV	2	2+s	3	10–11	Vel: 5	Vec: 2	Vei: 2	Vl: 4	
Abd. V	2	9+s			Ag: 3	Vl: 2			
Abd. VI	(7+7)				Ve: 14 me+2 mi		An: 2 mi (rarely 1)		

FIGURES 2–11. *Paranura tsushimaensis* **sp. nov.**: 2, dorsal chaetotaxy of Ant. III–IV; 3, ventral chaetotaxy of Ant. III–IV; 4, habitus and dorsal chaetotaxy (holotype); 5, labrum; 6, labium; 7, ventral chaetotaxy of Abd. II–VI; 8, chaetotaxy of tibiotarsus III and unguis; 9, chaeta Di1 of Abd. V; 10, long macrochaeta on Abd. IV; 11, dorsal chaetotaxy and tubercles of Abd. V–VI. ×—missing chaetae.

***Paranura nakamurai* Kasai sp. nov.**
[Japanese name: Himeshiro-ibonashi-tobimushi]
Figs 12–23, Tables 3–4

Type material. Holotype: female, Japan, Honsyu, Niigata Prefecture, Sado-shi, Sado Island, Kanaishimbo (alt. 341 m, 38°04'28"N 138°21'07"E), deciduous broadleaf forest, rotten fallen branch, 18-IX-2022, Kahito Nakamura & Hiro Kasai leg. (NMNS, NSMT-Ap 677). Paratypes: 3 females (NMNS, NSMT-Ap 678–680), same data as holotype; 2 females (NMNS, NSMT-Ap 681–682), Japan, Honsyu, Niigata Prefecture, Niigata-shi, Mount Kakuda (alt. 163 m, 37°45'46"N 138°49'11"E), deciduous broadleaf forest, rotten fallen branch, 12-XI-2022, Takehiro Ogata & Hiro Kasai leg.

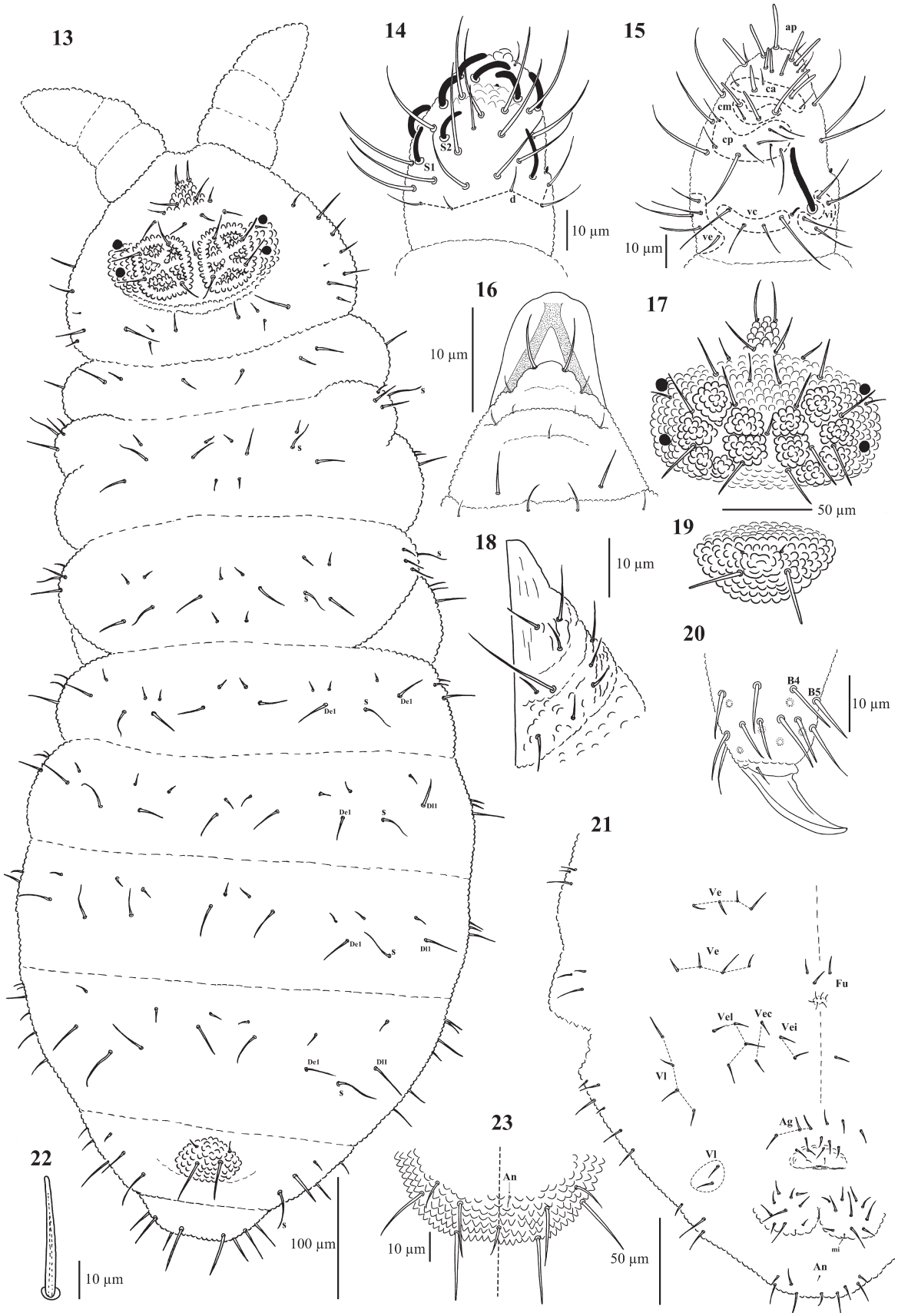
Etymology. This new species is named after Mr. Kahito Nakamura, the collector of the type series.

Diagnosis. 2+2 black eyes on head. Yellowish white body color. Tubercles Cl and Af on the head developed and reticulations present. Ant. II with 11 chaetae. Chaetae O, A, E, and three ocular chaetae present on head. Lateral area on head with 6 chaetae L and 10 chaetae (L+So). Th. II–III with 2 and 3 ordinary chaetae De respectively. Abd. IV with 2 ordinary chaetae Dl. Tubercles Di on Abd. V developed and fused, with 2+2 chaetae Di. Abdomen without clavate chaetae. Furcal remnant with 3–4 mesochaetae and 5–6 microchaetae. Tibiotarsi without chaeta M.

Description. Body length (without antennae) 0.77–1.61 mm in adults. Color of the body yellowish white (Fig. 12A). 2+2 black eyes (Fig. 12B).

Chaetal morphology. Four types of dorsal ordinary chaetae. Long macrochaetae (Ml) short, weakly thickened, and apically acuminated (Fig. 22); some lateral chaetae longer and strongly acuminated apex. Short macrochaetae (Mc) morphologically similar to Ml, but much shorter. Mesochaetae (me) and microchaetae (mi) similar to ventral chaetae: thin, smooth, and pointed. S–chaetae of tergites thin and smooth.

FIGURE 12. *Paranura nakamurai* **sp. nov.**: A, live specimens; B, lateral views of specimen in ethanol.



FIGURES 13–23. *Paranura nakamurai* **sp. nov.**: 13, habitus and dorsal chaetotaxy; 14, dorsal chaetotaxy of Ant. III–IV; 15, ventral chaetotaxy of Ant. III–IV; 16, labrum; 17, dorsal chaetotaxy and tubercles of central area on head; 18, labium; 19, fused tubercles Di of Abd. V; 20, chaetotaxy of tibiotarsus III and unguis; 21, ventral chaetotaxy of Abd. II–VI; 22, chaeta Di1 of Abd. V; 23, ventral chaetotaxy of Abd. VI.

Antennal morphology and chaetotaxy. Antenna 4-segmented. Ratio of antennal segments I: II: III + IV = 1:1:1.6–1.8. Dorso-central area on Ant. III–IV weakly granulated. S-chaetae of Ant. IV short and thick, S1 and S2 slightly thinner than others (Fig. 14). Apical bulb distinct and trilobed. Chaetotaxy of antennae shown in Table 3b and Figs 14–15.

Mouthparts. Buccal cone relatively long and rounded at apex. Labrum chaetotaxy 4/2,5,4 (Fig. 16). Labium with 4 basal, 3 distal, and 3 lateral chaetae, papillae x absent (Fig. 18). Mandible with 3 teeth. Maxilla styliform.

Cephalic tubercles and chaetotaxy. Tubercles Cl and Af developed (Figs 13, 17). Tubercle Af divided into two large parts along the midline, reticulations present. Chaetotaxy of the central area complete, all macrochaeta lengths subequal (Figs 13, 17). Lateral area with 6 chaetae Dl and 10 chaetae (L+So). Dorsal chaetotaxy of the head shown in Table 3a and Figs 13, 17. Group Vi with 6+6 chaetae. Groups Vea, Vem, and Vep with 4, 3, and 3 chaetae respectively.

Body tubercles and chaetotaxy. Tubercles Di on Abd. V developed and fused along the midline (Figs 13, 19), around the tubercle Di weakly raised. On Abd. I–IV, chaetae De far from each other, sensory chaeta halfway between De1 and Dl1 (Fig. 13). Abd. VI with tubercles fused into a single, one ventral chaeta located along the midline (Fig. 23). Dorsal chaetotaxy shown in Table 4 and Fig. 13. Furcal remnant with 3–4 mesochaetae and 5–6 microchaetae. Genital plate with 5–12 chaetae in females. Ventral chaetotaxy shown in Table 4 and Fig. 21.

TABLE 3.Cephalic chaetotaxy of *Paranura nakamurai* **sp. nov.**

a) Cephalic chaetotaxy—dorsal side.

Tubercle	Number of chaetae	Types of chaetae	Names of chaetae
Cl	4	Ml	F, G
Af	11	Ml	A, B, E
		Mc	D, C, O
Oc	3	Ml	Ocm, Ocp
		Mc	Oca
Di	2	Mc	Di1
		me or mi	Di2
De	2	Ml	De1
		me or mi	De2
Dl	6	Ml	Dl1, Dl5
		Mc	Dl3, Dl4
		me or mi	Dl2, Dl6
(L+So)	10	Ml	L1, L4, So1
		Mc	L2, L3, So2
		me	So3, So4, So5, So6

b) Chaetotaxy of antennae.

Segment, Group	Number of chaetae	Segment, Group	Number of chaetae adult
I	7	IV	or, 8 S, i, 12 mou, 6 brs, 2 iv
II	11		
III	5 sensilla AOIII		
ve	5	ap	8 bs, 5 miA
vc	4	ca	2 bs, 3 miA
vi	4	cm	3 bs, 1 miA
d	5	cp	8 miA, 1 brs

Legs. Trochanter with 5 chaetae. Tibiotarsi I, II, and III with 18, 18, and 17 chaetae respectively, and chaeta M absent. Unguis without inner tooth (Fig. 20). Chaetae B4 and B5 short. Chaetotaxy of the legs shown in Table 4 and Fig. 20.

Remarks. *Paranura nakamurai* **sp. nov.** is most similar to *P. bisetosa* Deharveng, 1989, having 2+2 eyes, a head with chaeta O and 3 ocular chaetae, and 2 ordinary chaetae De on Th. II. However, *P. nakamurai* **sp. nov.** differs from *P. bisetosa* in the development of the tubercle Af on the head (in *P. bisetosa* not developed), tubercles Di on Abd. V fused (in *P. bisetosa* separate), Abd. IV with 2 ordinary chaetae De (1 in *P. bisetosa*), chaeta M on the tibiotarsus absent (in *P. bisetosa* present), and microchaetae present on the furcal remnant (in *P. bisetosa* absent). *P. nakamurai* **sp. nov.** is also similar to *P. kedrovayensis* Smolis & Deharveng, 2015 but they clearly differ in the reticulations on head (in *P. nakamurai* **sp. nov.** present, in *P. kedrovayensis* absent), labral formula (4/2,5,4 in *P. nakamurai* **sp. nov.** vs. 4/2,4,4 in *P. kedrovayensis*), number of ordinary chaetae De on Th. II and III (2 and 3in *P. nakamurai* **sp. nov**. vs. 3 and 4 in *P. kedrovayensis*), tubercles Di on Abd. V (in *P. nakamurai* **sp. nov.** developed, in *P. kedrovayensis* not developed), and microchaetae on the furcal remnant (in *P. nakamurai* **sp. nov.** present, in *P. kedrovayensis* absent).

TABLE 4. Postcephalic chaetotaxy of *Paranura nakamurai* **sp. nov.**

		Terga					Legs		
	Di	De	Dl	L	Scx2	Cx	Tr	Fe	T
Th. I	1	2	1		0	3	5	11–12	18
Th. II	3	2+s	3+s+ms	3	2	7	5	11	18
Th. III	3	3+s	3+s	3	2	8	5	10	17
							Sterna		
Abd. I	2	3+s	2	3	VT: 4				
Abd. II	2	3+s	2	3	Ve: 4				
Abd. III	2	3+s	2	3	Ve: 4	Fu: 3–4 me, 5–6 mi			
Abd. IV	2	2+s	2	6	Vel: 4	Vec: 2	Vei: 2	Vl: 4–5	
Abd. V	(2+2)	5+s			Ag: 3	Vl: 2–3			
Abd. VI	(6+1+6)				Ve: 10 me+1 mi		An: 1 mi		

***Paranura alpicola* Kasai sp. nov.**
[Japanese name: Takane-ibonashi-tobimushi]
Figs 24–34, Tables 5–6

Type material. Holotype: female, Japan, Honshu, Nara Prefecture, Yoshino-gun, Totsukawa-mura, Mount Syakagatake (alt. 1,416 m, 34°05'46"N 135°52'45"E), beech forest, rotten fallen branch, 20-IX-2021, Hiro Kasai leg. (NMNS, NSMT-Ap 683). Paratypes: 2 females (NMNS, NSMT-Ap 684–685) and male (NMNS, NSMT-Ap 686), same data as holotype; 2 females (NMNS, NSMT-Ap 687–688), same locality and habitat as holotype, 13-IX-2020, Hiro Kasai leg.

Etymology. The name of the new species refers to alpine region habitat.

Diagnosis. 3+3 black eyes on head. Yellow body color while alive and white in alcohol. Body very thick and plump. Some tubercles poorly developed on the dorsal side and reticulations absent. Ant. II with 11 chaetae. Chaetae O, A, E, and three ocular chaetae present on head. Lateral area on head with 6 chaetae Dl and 9 chaetae (L+So). Th. II–III with 2 and 3 ordinary chaetae De respectively. Abd. IV with 2 ordinary chaetae Dl. Tubercles Di on Abd. V developed and separate, each with 3 chaetae Di. Abdomen without clavate chaetae. Furcal remnant with 4 mesochaetae and no microchaetae. Tibiotarsi with chaeta M.

Description. Body length (without antennae) 1.29–2.21 mm in adults. The body yellow while alive (Fig. 24) and white in alcohol. 3+3 black eyes, two anterior and one posterior. Body very thick and plump.

Chaetal morphology. Five types of dorsal ordinary chaetae. Long macrochaetae (Ml) relatively long and thick, feebly or not serrated, and apically acuminated (Fig. 32); some lateral chaetae longer and strongly acuminate apex.

Short macrochaetae (Mc) and very short macrochaetae (Mcc) morphologically similar to Ml, but much shorter. Mesochaetae (me) and microchaetae (mi) similar to ventral chaetae: thin, smooth, and pointed. S–chaetae of tergites thin and smooth.

Antennal morphology and chaetotaxy. Antenna 4-segmented. Ratio of antennal segments as I: II: III + IV = 1:1.1–1.3:1.8–2.3. Dorso-central area on Ant. III–IV granulated (Fig. 26). S-chaetae of Ant. IV short and thick, S1 and S2 slightly thinner than others (Fig. 26). Apical bulb distinct and trilobed. Chaetotaxy of antennae shown in Table 5b and Figs 26−27.

Mouthparts. Buccal cone relatively long and rounded at apex. Labrum chaetotaxy 0/2,2 (Fig. 29). Labium with 4 basal, 3 distal, and 3 lateral chaetae, papillae x absent (Fig. 28). Mandible with 3 teeth. Maxilla styliform.

TABLE 5. Cephalic chaetotaxy of *Paranura alpicola* **sp. nov.**

a) Cephalic chaetotaxy—dorsal side.

Tubercle	Number of chaetae	Types of chaetae	Names of chaetae
Cl	4	Ml	F
		me	G
Af	11	Ml	B
		Mc	A
		Mcc or me	D, E, C, O
Oc	3	Ml	Ocm
		Mc	Ocp
		mi	Oca
Di	2	Mc	Di1
		mi	Di2
De	2	Ml	De1
		mi	De2
Dl	6	Ml	Dl5
		Mc	Dl1
		Mcc or me	Dl3, Dl4
		mi	Dl2, Dl6
(L+So)	9	Ml	L1, So1
		Mc	L4
		Mcc or me	L2, L3
		me	So3, So4, So5, So6

b) Chaetotaxy of antennae.

Segment, Group	Number of chaetae	Segment, Group	Number of chaetae adult
I	7	IV	or, 8 S, i, 12 mou, 6 brs, 2 iv
II	11		
III	5 sensilla AOIII		
ve	5	ap	8 bs, 5 miA
vc	4	ca	2 bs, 3 miA
vi	4	cm	3 bs, 1 miA
d	5	cp	8 miA, 1 brs

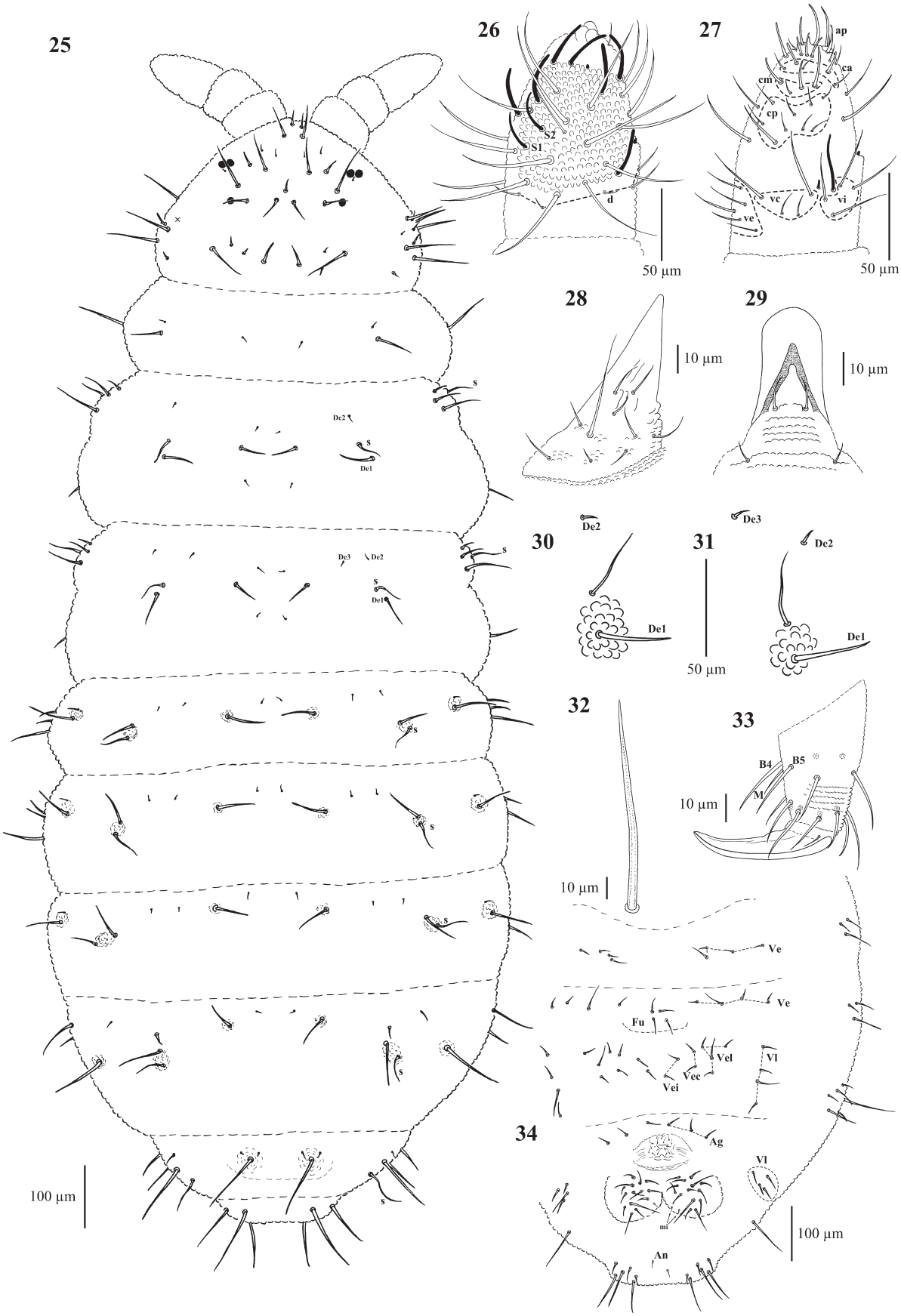
FIGURE 24. Live specimen of *Paranura alpicola* **sp. nov.**

TABLE 6. Postcephalic chaetotaxy of *Paranura alpicola* **sp. nov.**

		Terga					Legs		
	Di	De	Dl	L	Scx2	Cx	Tr	Fe	T
Th. I	1	2	1		0	3	6	13	19
Th. II	3	2+s	3+s+ms	3	2	7	6	12	19
Th. III	3	3+s	3+s	3	2	8	6	11	18
							Sterna		
Abd. I	2	3+s	2	3	VT: 4				
Abd. II	2	3+s	2	3	Ve: 4				
Abd. III	2	3+s	2	3–4	Ve: 4	Fu: 4 me			
Abd. IV	2	2+s	2	6	Vel: 4	Vec: 2	Vei: 2	Vl: 4	
Abd. V	3	4+s			Ag: 3	Vl: 3–4			
Abd. VI	7				Ve: 14 me+2 mi		An: 2–3 mi (rarely absent)		

Cephalic tubercles and chaetotaxy. Tubercles and reticulations not developed. Chaetotaxy of the central area complete (Fig. 25). Lateral area with 6 chaetae Dl and 9 chaetae (L+So) (L1–4, So1, So3–6). Dorsal chaetotaxy of the head shown in Table 5a and Fig. 25. Group Vi with 6+6 chaetae. Groups Vea, Vem, and Vep with 4, 2–3 and 4 chaetae respectively.

Body tubercles and chaetotaxy. Some tubercles poorly developed, reticulations absent (Fig. 25). Tubercles Di on Abd. V developed and separate, around the tubercles Di weakly raised (Fig. 25). Th. II–III with 2 (Ml+mi) and 3 (Ml+2mi) ordinary chaetae De respectively, microchaeta De2 situated far from long macrochaeta De1 (Figs 30, 31). Abd. VI weakly bilobed. Dorsal chaetotaxy shown in Table 6 and Fig. 25. Furcal remnant with 4 mesochaetae and no microchaetae. Genital plate with 13–23 and 26 chaetae in females and males respectively. An with 2–3 mi (1 anterior and 2 posterior), rarely absent. Ventral chaetotaxy shown in Table 6 and Fig. 34.



FIGURES 25–34. *Paranura alpicola* **sp. nov.**: 25, habitus and dorsal chaetotaxy (holotype); 26, dorsal chaetotaxy of Ant. III–IV; 27, ventral chaetotaxy of Ant. III–IV; 28, labium; 29, labrum; 30, chaetae De of Th. II; 31, chaetae De of Th. III; 32, chaeta Di1 of Abd. V; 33, chaetotaxy of tibiotarsus III and unguis; 34, ventral chaetotaxy of Abd. II–VI. ×—missing chaetae.

Legs. Tibiotarsi I, II, and III with 19, 19, and 18 chaetae respectively, chaeta M present. Unguis without inner tooth (Fig. 33). Chaetae B4 and B5 relatively long. Chaetotaxy of the legs shown in Table 6 and Fig. 33.

Remarks. *Paranura alpicola* **sp. nov.** is most similar to *P. chiangdaoensis* Deharveng, 1989 from Thailand, having 3+3 eyes, with chaetae O, E, and 3 ocular chaetae present on head. However, this new species is clearly distinguishable by its 2,2 labral chaetae (2,4 in *P. chiangdaoensis*), 6 chaetae Dl on the head (4–5 in *P. chiangdaoensis*), tubercles Di on Abd. V separate (in *P. chiangdaoensis* fused), and 7 chaetae on Abd. Vl (6 in *P. chiangdaoensis*). This new species is also similar to *P. colorata* Mills, 1934 *sensu* Simón Benito & Palacios-Vargas (2008). However, they differ in presence of chaeta E on the head (absent in *P. colorata*), 2 ordinary chaetae De on Th. II (3 in *P. colorata*), and 2 ordinary chaetae Dl on Abd. IV (4 in *P. colorata*).

Paranura convallis Kasai sp. nov.

[Japanese name: Murou-ibonashi-tobimushi]
Figs 35–47, Tables 7–8

Type material. Holotype: female, Japan, Honshu, Nara Prefecture, Uda-shi, Murou (alt. 348 m, 34°32'25"N 136°02'12"E), deciduous broadleaf forest, rotten fallen branch, 18-VII-2020, Hiro Kasai leg. (NMNS, NSMT-Ap 689). Paratypes: female (NMNS, NSMT-Ap 690) and juvenile (NMNS, NSMT-Ap 691), same data as holotype; male (NMNS, NSMT-Ap 692), same locality and habitat as holotype, 21-VI-2021, Hiro Kasai leg; juvenile (NMNS, NSMT-Ap 693), same locality and habitat as holotype, 21-VII-2021, Hiro Kasai leg; female (NMNS, NSMT-Ap 694), same locality and habitat as holotype, 16-X-2022, Hiro Kasai leg.

Etymology. The new species name refers to the mountain valley habitat.

FIGURE 35. Live specimen of *Paranura convallis* **sp. nov.**

TABLE 7. Cephalic chaetotaxy of *Paranura convallis* **sp. nov.**

a) Cephalic chaetotaxy—dorsal side.

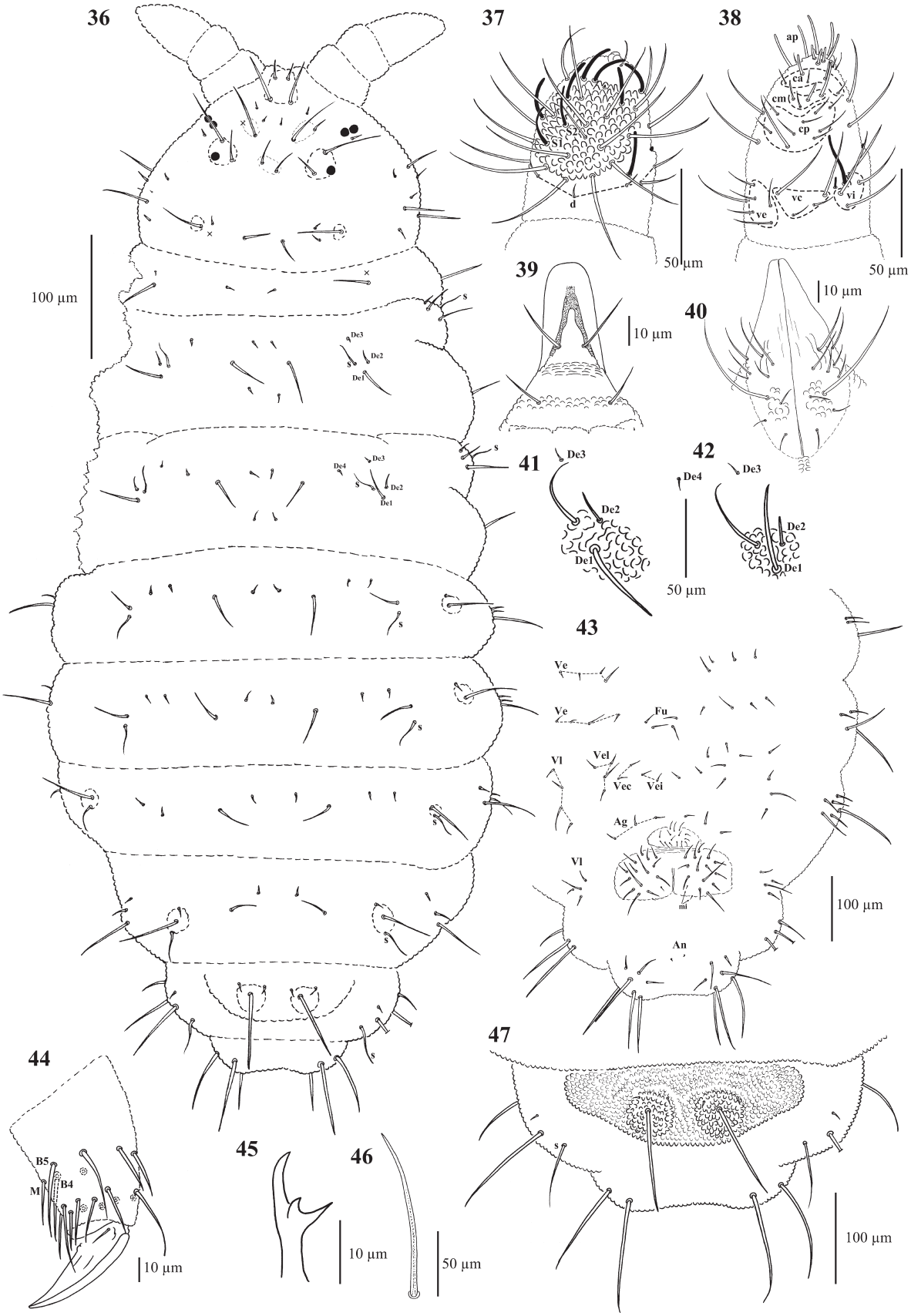
Tubercle	Number of chaetae	Types of chaetae	Names of chaetae
Cl	4	Ml	F
		me	G
Af	10	Ml	B
		Mc	A
		Mcc	E
		me	D, C
Oc	3	Ml	Ocm
		Mc	Ocp
		mi	Oca
Di	2	Mc	Di1
		mi	Di2
De	2	Ml	De1
		mi	De2
Dl	6	Ml	Dl1, Dl5
		Mcc or me	Dl3, Dl4
		mi	Dl2, Dl6
(L+So)	9	Ml	L1, So1
		Mc	L4
		Mcc or me	L2, L3
		me	So3, So4, So5, So6

b) Chaetotaxy of antennae.

Segment, Group	Number of chaetae	Segment, Group	Number of chaetae adult
I	7	IV	or, 8 S, i, 12 mou, 6 brs, 2 iv
II	11		
III	5 sensilla AOIII		
ve	5	ap	8 bs, 5 miA
vc	4	ca	2 bs, 3 miA
vi	4	cm	3 bs, 1 miA
d	5	cp	8 miA, 1 brs

Diagnosis. 3+3 black eyes on head. Orange body color while alive and white in alcohol. Body relatively thick and plump. Some tubercles poorly developed on the dorsal side and reticulations absent. Ant. II with 11 chaetae. Chaetae A, E, and three ocular chaetae present on head, chaeta O absent. Lateral area on head with 6 chaetae Dl and 9 chaetae (L+So). Th. II–III with 3 and 4 ordinary chaetae De respectively. Abd. IV with 3 ordinary chaetae Dl. Tubercles Di on Abd. V developed and separate, each with 3 chaetae Di. Abdomen without clavate chaetae. Furcal remnant with 3–4 mesochaetae and no microchaetae. Tibiotarsi with chaeta M.

Description. Body length (without antennae) 1.51–2.25 mm in adults. The body orange while alive (Fig. 35), white in alcohol. 3+3 black eyes, two anterior and one posterior. Body relatively thick and plump.



FIGURES 36–47. *Paranura convallis* **sp. nov.**: 36, habitus and dorsal chaetotaxy (holotype); 37, dorsal chaetotaxy of Ant. III–IV; 38, ventral chaetotaxy of Ant. III–IV; 39, labrum; 40, labium; 41, chaetae De of Th. II; 42, chaetae De of Th. III; 43, ventral chaetotaxy of Abd. II–VI; 44, chaetotaxy of tibiotarsus III and unguis; 45, mandible; 46, chaeta Di1 of Abd. V; 47, dorsal chaetotaxy and tubercles of Abd. V–VI. ×—missing chaetae.

Chaetal morphology. Five types of dorsal ordinary chaetae. Long macrochaetae (Ml) relatively long and thick, feebly serrated, and apically acuminated (Fig. 46); some lateral chaetae longer and strongly acuminate apex. Short macrochaetae (Mc) and very short macrochaetae (Mcc) morphologically similar to Ml, but much shorter. Mesochaetae (me) and microchaetae (mi) similar to ventral chaetae: thin, smooth, and pointed. S–chaetae of tergites thin and smooth.

Antennal morphology and chaetotaxy. Antenna 4-segmented. Ratio of antennal segments as I: II: III + IV = 1:1:1.8–1.9. Dorso-central area on Ant. III–IV strongly granulated (Fig. 37). S-chaetae of Ant. IV short and thick, S1 and S2 slightly thinner than others (Fig. 37). Apical bulb distinct and trilobed. Chaetotaxy of the antennae shown in Table 7b and Figs 37–38.

Mouthparts. Buccal cone relatively long and rounded at apex. Labrum chaetotaxy 4/2,2 (Fig. 39), prelabral chaetae very tiny. Labium with 4 basal, 3 distal, and 3 lateral chaetae, papillae x absent (Fig. 40). Mandible with 3 teeth (Fig. 45). Maxilla styliform.

Cephalic tubercles and chaetotaxy. Some tubercles poorly developed, reticulations absent (Figs 36, 47). Chaeta O absent. Lateral area with 6 chaetae Dl and 9 chaetae (L+So) (L1–4, So1, So3–6). Dorsal chaetotaxy of the head shown in Table 7a and Fig. 36. Group Vi with 6+6 chaetae. Groups Vea, Vem, and Vep with 4, 3–4 and 3–4 chaetae respectively.

Body tubercles and chaetotaxy. Some tubercles poorly developed, reticulations absent (Figs 36, 47). Tubercles Di on Abd. V developed and separate, around the tubercles Di raised (Fig. 47). Th. II–III with 3 (Ml+Mcc+mi) and 4 (Ml+Mcc+2mi) ordinary chaetae on tubercles De respectively, very short macrochaeta De2 situated close to long macrochaeta De1 (Figs 41, 42), and microchaeta De3 outside the tubercles. Abd. VI weakly bilobed. Dorsal chaetotaxy shown in Table 8 and Figs 36, 47. Furcal remnant with 3–4 mesochaetae and no microchaetae. Genital plate with 14–24 chaetae in females. An with 2 mi, rarely both or one side absent. Ventral chaetotaxy shown in Table 8 and Fig. 43.

Legs. Tibiotarsi I, II, and III with 19, 19, and 18 chaetae respectively, chaeta M present. Unguis without inner tooth (Fig. 44). Chaetae B4 and B5 relatively long. Chaetotaxy of the legs shown in Table 8 and Fig. 44.

Remarks. The new species is most similar to *P. tridentata* Lee & Kim, 1984 and *P. rosea* Lee & Kim, 1984, having 3+3 eyes, tubercle Oc on the head with 3 ocular chaetae, a head without chaeta O, and Abd. V–Vl without clear clavate chaetae. However, the new species can be distinguished by orange body color (in *P. tridentata* light yellow, in *P. rosea* red), inner tooth on the claw absent (in *P. tridentata* absent, in *P. rosea* present), 3 teeth on the mandible (in *P. tridentata* 3, in *P. rosea* 8), 3 ordinary chaetae De on Th. II (2 in *P. tridentate*, 4 in *P. rosea*), 4 ordinary chaetae De on Th. III (in *P. tridentata* 2, in *P. rosea* 4), 2 ordinary chaetae Di on Abd. I–IV (in *P. tridentata* 2, in *P. rosea* 3), and 3 ordinary chaetae Di on Abd. V (in *P. tridentata* 2, in *P. rosea* 3).

TABLE 8. Postcephalic chaetotaxy of *Paranura convallis* **sp. nov.**

		Terga					Legs		
	Di	De	Dl	L	Scx2	Cx	Tr	Fe	T
th. I	1	2	1		0	3	6	13	19
th. II	3	3+s	3+s+ms	3	2	7	6	12	19
th. III	3	4+s	3+s	3	2	8	6	11	18
							Sterna		
abd. I	2	3+s	2	3	VT: 4				
abd. II	2	3+s	2	3	Ve: 4				
abd. III	2	3+s	2	3	Ve: 4	Fu: 3–4 me			
abd. IV	2	2+s	3	5–6	Vel: 4	Vec: 2	Vei: 2	Vl: 4	
abd. V	3	4+s			Ag: 3	Vl: 3–4			
abd. VI	7				Ve: 14 me+2mi		An: 2 mi (rarely 1 or 0)		

Key to *Paranura* updated from Smolis & Deharveng (2015)

1 Head with 2+2 eyes . . . 2
- Head with 3+3 eyes . . . 24
2 Tubercle Oc on head with 2 chaetae . . . 3
- Tubercle Oc on head with 3 chaetae . . . 12
3 Thorax II–III with 2 chaetae Di . . . 4
-. Thorax II–III with 3 chaetae Di . . . 6
4 Head without chaetae A . . . *P. squamosa* Cassagnau, 1991
- Head with chaetae A . . . 5
5 Thorax II–III with 2 chaetae L . . . *P. timorensis* Yoshii & Suhardjono, 1992
- Thorax II–III with 3 chaetae L . . . *P. nudifera* Yoshii & Suhardjono, 1992
6 Head with chaetae A and C 7
- Head without chaetae A and C . . . 11
7 Thorax II–III with 3 and 4 ordinary chaetae De respectively, grey or blue pigment present on body . . . .. *P. impedita* Palacios-Vargas & Deharveng, 1987
- Thorax II–III with 2 ordinary chaetae De, no grey or blue pigment present on body . . . 8
8 Thorax II–III with 2 ordinary chaetae Dl . . . 9
- Thorax II–III with 3 ordinary chaetae Dl . . . 10
9 Abd. I–III with 1 ordinary chaeta De . . . *P. meo* Deharveng, 1989
- Abd. I–III with 2 ordinary chaetae De . . . *P. godavarica* Cassagnau, 1991
10 Head with chaeta O, abdomen IV with chaetae De shifted towards chaetae Dl . . . *P. tapatia* Palacios-Vargas & Peñaranda-Parada, 2005
- Head without chaeta O, abdomen IV with chaetae De not shifted . . . *P. colombiana* Palacios-Vargas & Peńaranda-Parada, 2005
11 Thorax II–III with 1 ordinary chaeta De . . . *P. johorensis* (Yosii, 1976)
- Thorax II–III with 2 and 2–3 ordinary chaetae De respectively . . . *P. garoensis* Cassagnau, 1991
12 Head with chaeta O . . . 13
- Head without chaeta O . . . 21
13 Abdomen V with 2+2 chaetae Di . . . 14
- Abdomen V with 3+3 chaetae Di . . . 18
14 Thorax II with 2 ordinary chaetae De . . . 15
- Thorax II with 3 ordinary chaetae De. . . . 16
15 Tubercle Af on head without reticulations area, abdomen V with tubercles Di separate . . . *P. bisetosa* Deharveng, 1989
- Tubercle Af on head with reticulations area, abdomen V with tubercles Di fused . . . *P. nakamurai* **sp. nov.**
16 Thorax III with 3 ordinary chaetae De . . . *P. quadrilobata* Hammer, 1953 *sensu* Fjellberg 1985
- Thorax III with 4 ordinary chaetae De . . . 17
17 Abdomen IV with 1 ordinary chaeta De, trochanters with 6 chaetae .. . . . *P. microchaetosa* Smolis & Deharveng, 2015
- Abdomen IV with 2 ordinary chaetae De, trochanters with 5 chaetae . . . *P. kedrovayensis* Smolis & Deharveng, 2015
18 Thorax II–III with 2 and 3 ordinary chaetae De respectively . . . *P. dalgeri* Deharveng, 1989
- Thorax II–III with 3 and 4 ordinary chaetae De respectively . . . 19
19 Tibiotarsi without chaeta M . . . *P. tibiotarsalis* Deharveng, 1989
- Tibiotarsi with chaeta M . . . 20
20 Abdomen V with tubercles Di separate, abdomen II without chaetae Ve, furcal remnant without microchaetae . . . *P. modesta* Deharveng, 1989
- Abdomen V with tubercles Di fused, abdomen II with chaetae Ve, furcal remnant with microchaetae . . . *P. cassagnaui* Smolis & Deharveng, 2015
21 Thorax III with 3 ordinary chaetae De . . . 22
- Thorax III with 2 ordinary chaetae De . . . 23
22 Abdomen V with 2+2 chaetae Di . . . *P. tamul* Cassagnau, 1988
- Abdomen V with 3+3 chaetae Di . . . *P. coenobita* Cassagnau, 1991
23 Thorax II–III with 2 ordinary chaetae Dl . . . *P. globulifer* Deharveng, 1989
- Thorax II–III with 3 ordinary chaetae Dl . . . *P. leclerci* Deharveng, 1989
24 Abdomen V at least twice longer than VI . . . 25
- Abdomen V slightly longer than VI . . . 27
25 Thorax III with 3 ordinary chaetae De, tubercle Oc on head with 2 chaetae . . . *P. s-uenoi* Yosii, 1955
- Thorax III with 4 ordinary chaetae De, tubercle Oc on head with 3 chaetae . . . 26
26 Abdomen V with 3+3 ordinary chaetae Di, furcal remnant with microchaetae. . . . *P. reticulata* Smolis & Deharveng, 2015
- Abdomen V with 2+2 ordinary chaetae Di, furcal remnant without microchaetae . . . *P. tsushimaensis* **sp. nov.**
27 Abdomen V–VI with clear clavate chaetae . . . 28
- Abdomen V–VI without clear clavate chaetae . . . 29
28 Tibiotarsi I, II and III with 12, 12 and 11 chaetae respectively . . . *P. clavisetis* (Axelson, 1902)
- Tibiotarsi I, II and III with 19, 19 and 18 chaetae respectively . . . *P. sitchensis* Fjellberg, 1985
29 Tubercle Oc on head with 2 chaetae . . . 30

- Tubercle Oc on head with 3 chaetae 34
30 Thorax I with 1 chaeta De 31
- Thorax I with 2 chaetae De 32
31 Abdomen I–IV with 2 ordinary chaetae De . . . . . *P. sarukhani* Palacios-Vargas & Deharveng, 1987
- Abdomen I–IV with 1 ordinary chaeta De . . . . . *P. jorgei* Palacios-Vargas & Deharveng, 1987
32 Thorax II with 2 ordinary chaetae De . . . . . *P. longisensillata* Palacios-Vargas & Deharveng, 1987
- Thorax II with 3 ordinary chaetae De 33
33 Thorax III with 3 ordinary chaetae De . . . . . *P. magdalenae* Simón Benito & Palacios-Vargas, 2008
- Thorax III with 4 ordinary chaetae De . . . . . *P. rooensis* Simón Benito & Palacios-Vargas, 2008
34 Head with chaeta O 35
- Head without chaeta O 47
35 Tibiotarsi I, II and III with 12, 12 and 11 chaetae respectively . . . . . *P. sexpunctata* (Axelson, 1902)
- Tibiotarsi I–III with higher number of chaetae 36
36 Thorax III with 2 or 3 ordinary chaetae De 37
- Thorax III with 4 ordinary chaetae De 40
37 Thorax II with 3 ordinary chaetae De, head without chaeta E . . . . . *P. colorata* Mills, 1934 *sensu* Simón Benito & Palacios-Vargas 2008
- Thorax II with 2 ordinary chaetae De, head with chaeta E 38
38 Thorax III with 2 ordinary chaetae De, abdomen V with tubercles Di fused . . . . . *P. chiangdaoensis* Deharveng, 1989
- Thorax III with 3 ordinary chaetae De, abdomen V with tubercles Di separate . . . . . *P. alpicola* **sp. nov.**
40 Abdomen V with 3+3 chaetae Di 41
- Abdomen V with 2+2 chaetae Di 43
41 Tubercle (L+So) on head with 9 chaetae . . . . . *P. ieti* (Yosii, 1966)
- Tubercle (L+So) on head with 10 chaetae 42
42 Abdomen V with tubercles Di separate, trochanters with 5 chaetae, furcal remnant with microchaetae, no grey or blue pigment present on body . . . . . *P. najtae* Deharveng & Weiner, 1984
- Abdomen V with tubercles Di fused, trochanters with 6 chaetae, furcal remnant without microchaetae, grey or blue pigment present on body . . . . . *P. conjuncta* Smolis & Deharveng, 2015
43 Head with additional chaetae in central area . . . . . *P. setosa* Smolis & Deharveng, 2015
- Head without additional chaetae in central area 44
44 Trochanters with 5 chaetae, abdomen II without chaetae Ve1, no grey or blue pigment present on body . . . . . *P. koryoi* Deharveng & Weiner, 1984
- Trochanters with 6 chaetae, abdomen II with chaetae Ve1, grey or blue pigment present on body 45
45 Labium with 11+11 chaetae, formula of labral chaetotaxy: 4/5, 4; furcal remnant without microchaetae . . . . . *P. mjohjangensis* Deharveng & Weiner, 1984
- Labium with 10+10 chaetae, formula of labral chaetotaxy other, furcal remnant with microchaetae 46
46 Abdomen IV with 1 ordinary chaeta De, distal part of labrum with 4 chaetae . . . . . *P. oregonensis* Smolis & Deharveng, 2015
- Abdomen IV with 2 ordinary chaetae De, distal part of labrum with 2 chaetae . . . . . *P. reducta* Smolis & Deharveng, 2015
47 Claw with inner tooth, mandible with 8 teeth . . . . . *P. rosea* Lee & Kim, 1984
- Claw without inner tooth, mandible with 3 teeth 48
48 Thorax II with 2 ordinary chaetae De, abdomen V with 2+2 chaetae Di . . . . . *P. tridentata* Lee & Kim, 1984
- Thorax II with 3 ordinary chaetae De, abdomen V with 3+3 chaetae Di . . . . . *P. convallis* **sp. nov.**

Acknowledgments

We would like to thank our collecting partners, Kahito Nakamura and Takehiro Ogata. We are also grateful to Dr. Adrian Smolis, Dr. Louis Deharveng, and Dr. Wanda Maria Weiner for their helpful comments and corrections to the manuscript. We would like to thank Editage (www.editage.com) for English language editing.

References

Axelson, W.M. (1902) Diagnosen neuer Collembolen aus Finland und angrenzenden Teilen des nordwestlichen Russlands. *Meddelanden af Societatis pro Fauna et Flora Fennica*, 28, 101–111.

Bellinger, P., Christiansen, K. & Janssens, F. (1996–2023) Checklist of the Collembola of the World. Available from: http://www.collembola.org (accessed 27 March 2023)

Börner, C. (1901) Über ein neues Achorutidengenus Willemia, sowie 4 weitere neue Collembolenformen derselben Familie. *Zoologisher Anzeiger*, 24 (648), 422–433.

Cassagnau, P. (1988) Les Collemboles Neanurinae des Massifs du sud de L'Inde et de Ceylan. *Travaux du Laboratoire d'Ecobiologie des Arthropodes Edaphiques, Toulouse*, 5 (4), 21–51.

Cassagnau, P. (1989) Les Collemboles Neanurinae; elements pour une synthèse phylogénétique et biogéographique. In: Dallai, R. (Ed.), *3rd International Seminar on Apterygota, Siena*, 1989, pp. 171–182.
Cassagnau, P. (1991) Les collemboles Neanurinae de l'Himalaya II. Paranurini et Paleonurini paucituberculés. *Travaux du Laboratoire d'Ecobiologie des Arthropodes Edaphiques, Toulouse*, 6, 1–20.
Deharveng, L. (1983) Morphologie évolutive des Collemboles Neanurinae en particulier de la lignée Neanurinae. *Travaux du Laboratoire d'Ecobiologie des Arthropodes Edaphiques, Toulouse*, 4 (2), 1–63.
Deharveng, L. (1989) The genus Paranura Axelson, 1902 in Thailand (Collembola Neanurinae). *Tropical Zoology*, 2, 103–121. https://doi.org/10.1080/03946975.1989.10539432
Deharveng, L. & Weiner, W.M. (1984) Collembola de Corée du Nord. III. Morulinae et Neanurinae. *Travaux du Laboratoire d'Ecobiologie des Arthropodes Edaphiques, Toulouse*, 4, 1–61.
Fjellberg, A. (1985) Arctic Collembola I. Alaskan Collembola of the families Poduridae, Hypogastruridae, Odontelidae, Brachystomelidae and Neanuridae. *Entomologica Scandinavica*, Supplement 21, 1–126.
Hammer, M. (1953) Investigations on the microfauna of Northern Canada. Part II. Collembola. *Acta Arctica*, 6, 1–108.
Kasai, H., Hayasaka, D. & Sawahata, T. (2022) First report of the genera *Paralobella* and *Blasconura* (Collembola: Neanuridae: Neanurinae) from Japan with the description of three new species. *Zootaxa*, 5168 (3), 332–349. https://doi.org/10.11646/zootaxa.5168.3.5
Lee, B.-H. & Kim, J.-T. (1984) Eight new species of Korean Psuedachorutinae (Neanuridae, Collembola). *Korean Journal of Entomology*, 14, 13–23.
Mills, H.B. (1934) *A Monograph of the Collembola of Iowa*. Collegiate Press, Inc., Ames, Iowa, p.1–143. https://doi.org/10.31274/isudp.1934.47
Palacios-Vargas, J.G. & Deharveng, L. (1987) Quatre nouvelles espéces mexicaines de Neanurinae (Collembola). *Bulletin de la Société d'Histoire Naturelle de Toulouse*, 123, 105–111.
Palacios-Vargas, J.G. & Peñaranda-Parada, M.R. (2005) Two new species of *Paranura* (Collembola: Neanuridae) from Colombia and Mexico. *Journal of the Kansas leg. (NMNS, NSMT-Ap 671) Paratypes Entomological Society*, 78, 308–314. https://doi.org/10.2317/0404.01.1
Simón Benito, J.C. & Palacios-Vargas, J.G. (2008) Two new species of *Paranura* (Collembola: Neanuridae) from Southeastern Mexico. *Annals of the Entomological Society of America*, 101 (4), 683–688. https://doi.org/10.1093/aesa/101.4.683
Smolis, A. (2008) Redescription of four Polish *Endonura* Cassagnau, 1979 (Collembola, Neanuridae, Neanurinae), with a nomenclature of the ventral chaetae of antennae. *Zootaxa*, 1858 (1), 9–36. https://doi.org/10.11646/zootaxa.1858.1.2
Smolis, A. (2011) *Xylanura oregonensis*, a new genus and species of saproxylic springtail (Collembola: Neanuridae: Neanurinae) from North America, with a key to genera of the tribe Neanurini. *Pan-Pacific Entomologist*, 87, 15–26. https://doi.org/10.3956/2010-06.1
Smolis, A. & Deharveng, L. (2006) *Vitronura mascula*, a new species of Neanurinae (Collembola: Neanuridae) from northern Vietnam, with a key to the species of the genus. *Revue suisse de Zoologie*, 113, 263–268. https://doi.org/10.5962/bhl.part.80349
Smolis, A. & Deharveng, L. (2015) Diversity of *Paranura* Axelson, 1902 (Collembola: Neanuridae: Neanurinae) in Pacific Region of Russia and United States. *Zootaxa*, 4033 (2), 203–236. https://doi.org/10.11646/zootaxa.4033.2.2
Smolis, A. & Greenslade, P. (2020) New Lobellini (Collembola: Neanuridae) from Queensland contribute to understanding distribution and ecology of Australian fauna. *Austral Entomology*, 59, 253–264. https://doi.org/10.1111/aen.12460
Smolis, A. & Kadej, M. (2014) A new saproxylic Paleonurini (Collembola, Neanuridae) species from North America with the first record of *Galanura agnieskae* Smolis, 2000 from the continent. *Florida Entomologists*, 97 (4), 1386–1394. https://doi.org/10.1653/024.097.0413
Yoshii, R. & Suhardjono, Y.R. (1992) Notes on the collembolan fauna of Indonesia and its vicinities. 3. Collembola of the Timor Island. *Acta Zoologica Asiae Orientalis*, 2, 75–96.
Yosii, R. (1955) Meeresinsekten der Tokara Inseln VI. Collembolen nebst beschreibungen terrestrisher Formen. *Publications of the Seto Marine Biological Laboratory*, IV (2–3), 221–243. https://doi.org/10.5134/174510
Yosii, R. (1966) Collembola of Himalaya. *Journal of the College of Arts and Sciences, Chiba University, Natural Sciences Series*, 4 (4), 461–531.
Yosii, R. (1976) On some Neanurid Collembola of Southeast Asia. *Nature and Life in South East Asia*, 7, 257–299.