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## ORIBATID FAUNA (ACARI, ORIBATIDA) FROM THE KUMAYA CAVE OF IHEYA VILLAGE IN CENTRAL RYUKYU ARC, SOUTH JAPAN, WITH A DESCRIPTION OF SEVERAL NEW SPECIES

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**ABSTRACT** — Eleven oribatid species were collected from the Kumaya Cave of Iheya village in Central Ryukyu Arc, South Japan. The cave is a descending horizontal tunnel of a deep-sea abysmal quartziferous deposit formed in the Permian period of the Palaeozoic era and excavated by sea erosion. The floor of the cave was covered with sand, three to four meters deep. Fragments of psephite are found at the end of the cave. Each sample of about 200 cm<sup>3</sup> was collected by hand from the following five marked points of the cave on 17 March 2010: A, Sand and a fragment of psephite; B, Sand and a fragment of psephite; C, Sand, a fragment of psephite, and litter of *Ficus microcarpa*; D, Litter and humus of *F. microcarpa* and *Cassytha filiformis*, and sand; E, Litter and humus of *F. microcarpa* and *C. filiformis*, and sand. All species belonged to Brachypylina: *Oppiella* (*O.*) *nova* from A; *Mabulatrachus kumayaensis* sp. nov., *Protoribates kumayaensis* sp. nov. and *Zygoribatula iheyaensis* sp. nov. from B; *Tectocephus kumayaensis* sp. nov. from C; *Tectocephus iheyaensis* sp. nov., *Oribatula kumayaensis* sp. nov., *Protoribates hirokous* sp. nov. and *Haplozetes makii* sp. nov. from D; *Eupelops kumayaensis* sp. nov. from E; *Neoliodes iheyaensis* sp. nov. from C, D and E.

**KEYWORDS** — Kumaya Cave; new species; Oribatid mite; Ryukyu Arc; South Japan

### INTRODUCTION

In Central Ryukyu Arc of South Japan, faunistical research of soil animals began in the early 1970's (Aoki, 1973; Aoki and Nakatamari, 1974). From Iheya Village, fifty seven oribatid species were already recorded by Aoki (2009). However, the present paper is the first contribution to the knowledge of the oribatid fauna in the Kumaya Cave of Iheya Village. Six species of soil animals in addition to oribatid mites were found. Eleven oribatid species, on which ten were new to Science were

recorded. The objective of the present paper is to provide the description of these ten species. All examined oribatids belong to Brachypylina.

### METHODS

Iheya village is located in the northern Central Ryukyu Arc, South Japan. The Kumaya Cave of Iheya village is located 27°05'N; 128°00'E, about 15–35 m a.s.l. in the North-East of Iheya village. The cave has a depth of 63 m, a height of 10 m and a breadth of 600 m<sup>2</sup> (Arakaki and Ooshiro, in Mo-

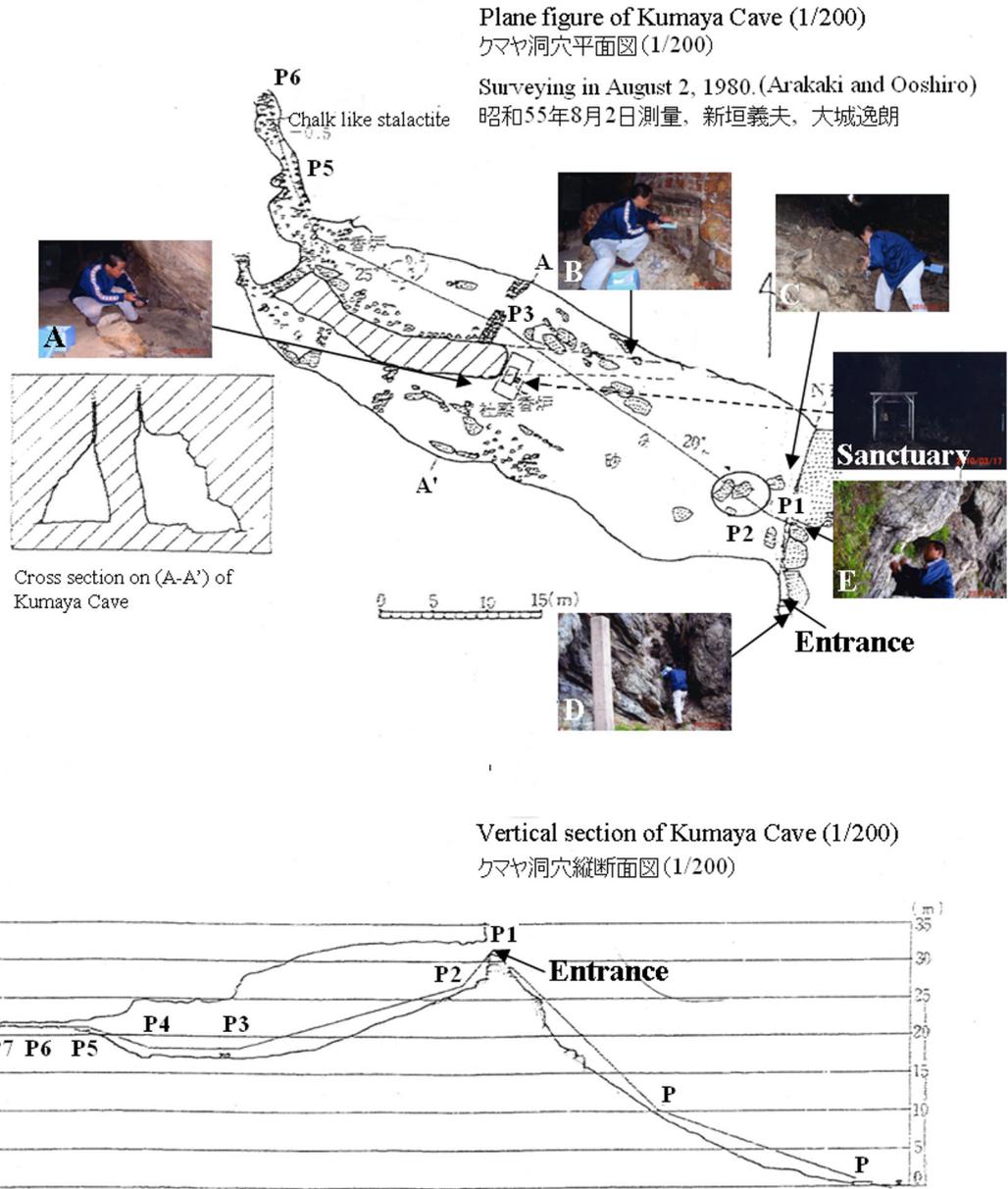


FIGURE 1: The plane figure, a cross section and a vertical section of Kumaya Cave (after Arakaki and Ooshiro, in Moromi, 1981), and sampling plots A-E (photos by Fukumori S.).

romi, 1981) (Fig. 1). The Kumaya Cave is a descending horizontal tunnel of a deep-sea abysmal quartziferous deposit formed in the Permian period of the Palaeozoic era and excavated by erosion of the sea. The floor of the cave was covered with sands washed ashore, three to four meters deep. Fragments of psephite are found at the end of the cave. Each sample of about 200 cm<sup>3</sup> was collected by hand from the following five marked points of the cave on 17 March 2010 by Fukumori S. and Nakamura Y.-N. (Fig. 1): A, a single specimen of oribatid mite was collected from sample consisting of sand and a fragment of psephite; B, three specimens belonging to three oribatid species were collected in sand and fragment of psephite; C, two specimens of two oribatid species and three specimens of collembola were collected in sand, a fragment of psephite, and litter of *Ficus microcarpa* L.f.; D, eight specimens belonging to five oribatid species including one nymph were collected from litter and humus of *F. microcarpa* and *Cassytha filiformis* L., and sand; E, fifty specimens belonging to two oribatid species, one specimen of Mesostigmata, one specimen of millipede and one specimen of dung beetle, *Aphodius* sp. were collected in litter and humus of *F. microcarpa* and *C. filiformis*, and sand. Animals were extracted with a modified Tullgren apparatus. The type series (NSMT-Ac 13582-13602) are deposited in the National Museum of Nature and Science, Tokyo, and topotypes together with sampling materials in Iheya Village Office, Okinawa. The notations of descriptions and figures are mainly based on Balogh and Mahunka (1983), Grandjean (1952) and Hammen (1989) as follows: Aa, Ad, Al, Apo, A1-3: porose areas; *a*, *m*, *h*: anterior, medial and posterior subcapitular setae, respectively; *acm*: anteroculminal seta on pedipalpal tarsus; Bo: bothridium; bo. 1-4, sj; epimeral borders; *c*<sub>1-3</sub>, *da*, *dm*, *dp*. *la*, *lm*, *lp*, *hdown*1-3, *p*<sub>1-3</sub>: notogastral setae; *cha*, *chb*: posterior and anterior setae of chelicerae, respectively; *ft'*: fastigial seta of legs; *g*<sub>1-7</sub>, *ag*, *an*<sub>1-3</sub>, *ad*<sub>1-3</sub>: genital, aggenital, anal and adanal setae, respectively; *gla*: opisthonotal gland; *hy*: dorsophragmatic apophyses; *ia*, *iad*, *ian*, *ih*, *im*, *ip*, *ips*: lyrifissures; *ro*, *le*, *in*, *ex*: rostral, lamellar, interlamellar and exobothridial setae, respectively; *s*: subunguinal seta of legs; *ss*: sensillus; Tg1-2: Trägårdh's

organ;  $\varepsilon$ : famulus on tarsus of leg I;  $\omega_{1-2}$ ,  $\varphi_{1-2}$ ,  $\delta$ : solenidia on tarsi, tibiae and genua of legs, respectively;  $\omega$  on tarsi of pedipalp; *1a-f*, *2a-c*, *3a-c*, *4a-d*: epimeral setae. Number of tarsal claws common to all legs. Setal formula of legs including famulus but excluding solenidia. Solenidiotaxy common to all examined species except for *Eupelops kumayaensis* sp. nov.: I (1-2-2), II (1-1-2), III (1-1-0), IV (0-1-0). Legs of some species could not be studied to not damage the holotypes (and to not break the legs when study). Measurements ( $\mu\text{m}$ ) in the descriptions are according to holotype, except for *Neoliodes iheyaensis* sp. nov. The taxonomical grouping followed the systems proposed by Norton and Behan-Pelletier (2009), Subías (2004) and Weigmann (2006).

## NEOLIODIDAE SELLNICK, 1928

### *Neoliodes iheyaensis* sp. nov.

[Japanese name: Iheya-uzutakadani]  
(Figs. 2-4 and Plate 1)

Diagnosis — Body length (15 exs.) 771 (1098) 1214  $\mu\text{m}$ ; width 643 (742) 893  $\mu\text{m}$ . Integument of prodorsum and legs reticulate: marginal region of prodorsum and notogaster, epimeral region and anal plates costate; central region of notogaster alveolate Sensilli consisting of conspicuously verrucose swollen head and smooth thin stem. Notogaster bearing porose area (Apo) at the center and a pair of conspicuous large hollow laterally considered as opisthonotal gland (gla). Five pairs of notogastral setae, *lp*, *h*<sub>1</sub> and *p*<sub>1-3</sub> at posterior margin. Mentotectum separated medially. Epimeral setal formula: [5,6,7]-3-3-4. Homotridactylous.

Material examined — Holotype (Female) (NSMT-Ac 13582) from point E; 47 paratypes (NSMT-Ac13583-13586): same data as holotype; 1 paratype (Nymph) (NSMT-Ac13587): from point C; 1 paratype (Nymph) (NSMT-Ac13588): from point D.

Etymology — After the name of sampling area, Iheya Village.

Measurements and body appearance — Body length 771 (1098) 1214  $\mu\text{m}$ ; width 643 (742) 893



FIGURE 2: *Neoliodes iheyaensis* sp. nov. A, Prodorsum; B, Notogaster.

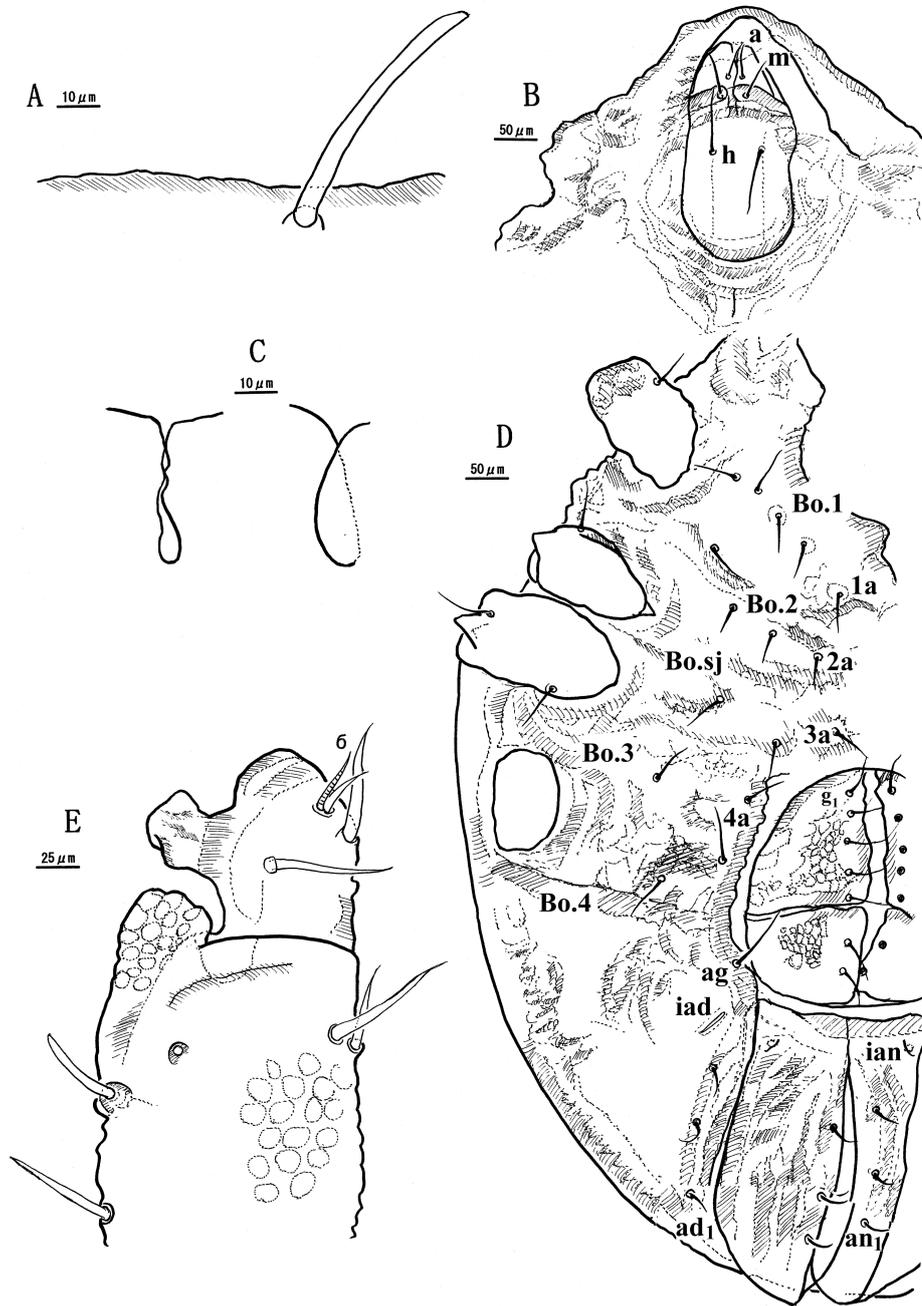


FIGURE 3: *Neoliodes iheyensis* sp. nov. A, Part of femur IV; B, Camerostoma; C, Medial portion of mentotectum; D, Right ventral region; E, Genu and femur of leg I.

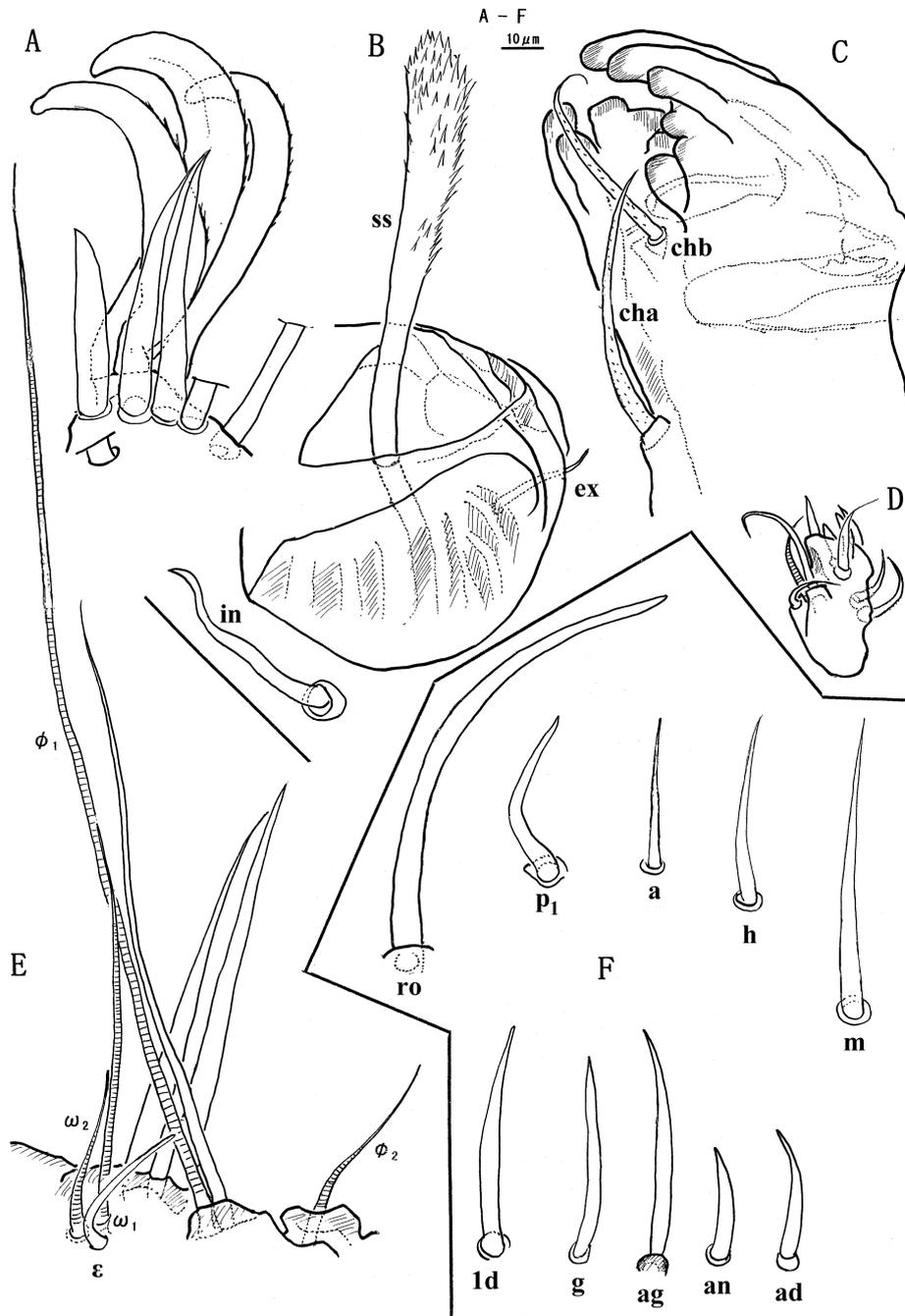


FIGURE 4: *Neoliodes iheyensis* sp. nov. A, Claws of tarsus I; B, Bothridial region; C, Part of chelicera; D, Tarsus of pedipalp; E, Solenidial region on tarsus and tibia of leg I; F, Setae.

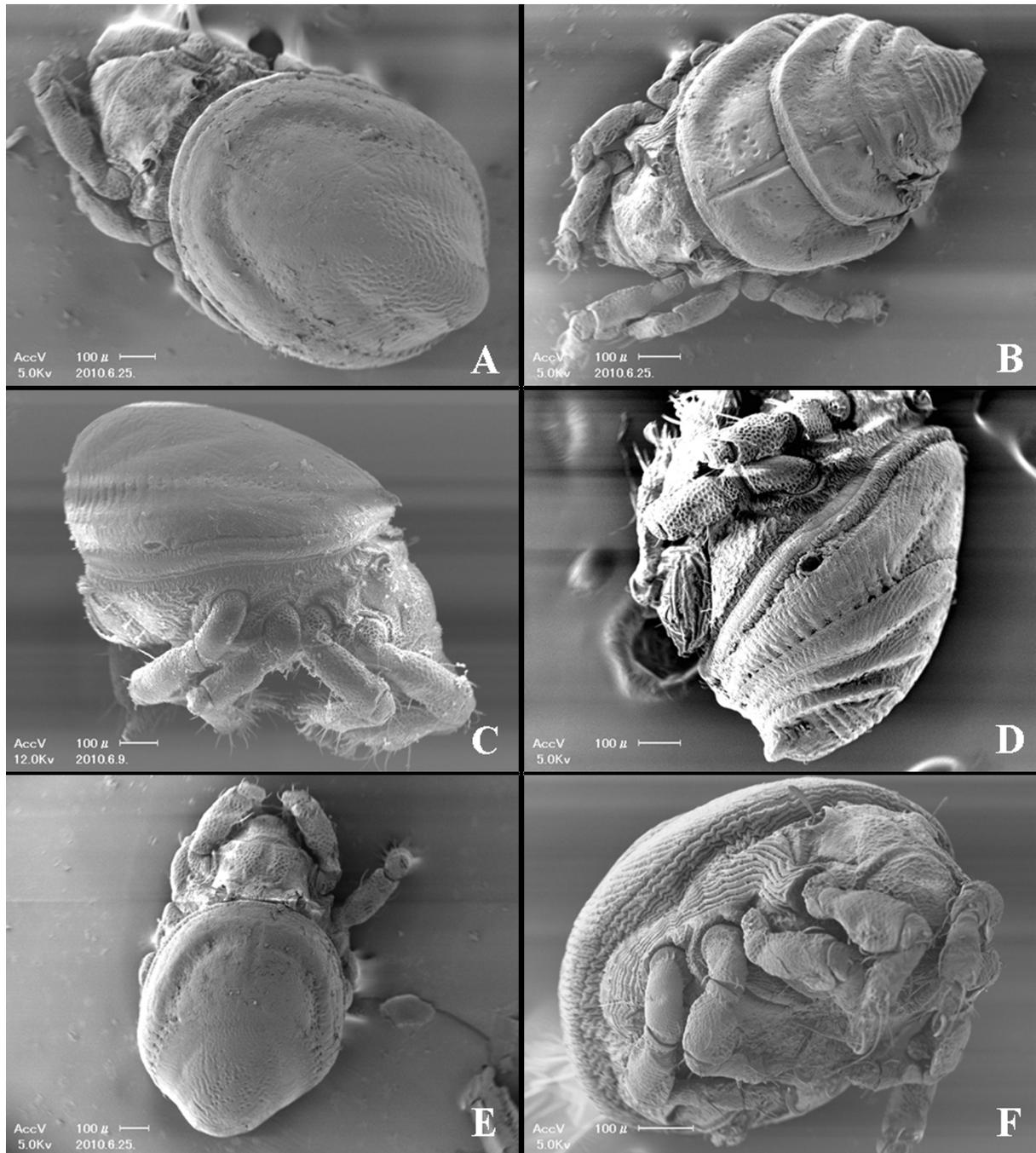


PLATE 1: *Neoliodes iheyaensis* sp. nov. by the scanning electron microscopy (photos by Nakamura Y.-N.). A-D: Adult female; E and F: Tritonymph; A, C and E: Without scalps; B, D and F: With scalps; C and D: Lateral side; F: Ventral side.

$\mu\text{m}$ . Body colour purplish brown. Integument of prodorsum and legs reticulate; marginal region of prodorsum and notogaster, epimeral region and anal plates costate; central region of notogaster alveolate (Plate 1).

Prodorsum — Rostral tip widely rounded bearing roughened setae *ro* (110  $\mu\text{m}$ ) at the lateral margin. Lamellar region protuberant parting right and left (Fig. 2A). Lamellar setae absent. Setae *in* (52  $\mu\text{m}$ ) and *ex* (27  $\mu\text{m}$ ) short, smooth. Bothridia opened dorso-laterally. Sensilli (*ss*) (105  $\mu\text{m}$ ) consisting of conspicuously verrucose swollen head and smooth thin stem (Fig. 4B). Relative lengths and distances:  $ro > ss > in > ex$ ; ( $Bo - Bo$ : 169  $\mu\text{m}$ )  $>$  ( $in - in$ : 150  $\mu\text{m}$ )  $>$  ( $ro - ro$ : 112  $\mu\text{m}$ ).

Notogaster — Oval in shape bearing porose area (Apo) at the center such as found in Galumnidae. A pair of conspicuous large hollow present laterally (Fig. 2B). Hollows elliptical in form, about 69–81  $\mu\text{m}$  in length, directed laterally, considered as opisthotal gland (*gla*), as it is in Hermanniellidae and Plasmobatidae. Five pairs of setae, *lp*, *h*<sub>1</sub> and *p*<sub>1-3</sub> at the posterior margin; setae short, smooth spiniform about 31  $\mu\text{m}$  in length according to depressed specimens (Fig. 4F). Relative distances: ( $p_1 - p_1$ )  $\approx$  ( $p_1 - p_2$ ) (150  $\mu\text{m}$ )  $\approx$   $8x(lp - lp)$  (19  $\mu\text{m}$ ); ( $p_2 - p_3$ ) (58  $\mu\text{m}$ )  $\approx$   $3x(lp - lp)$ ; ( $h_1 - h_1$ )  $\approx$  ( $lp - lp$ ). Lyrifissures *ia* aligned transversely; *im* obliquely anterolateral to hollow; *ip* extending obliquely between setae *p*<sub>1</sub> and *p*<sub>2</sub>.

Ventral region — Genital aperture almost oval in form; anal aperture rectangular. Genital plate divided by transverse suture (Fig. 3D). Genito-anal setal formula: [5+2]-1-3-3; all setae smooth spiniform (Fig. 4F). Genital and anal setae inserted at inner margin of each plate. Setae *ag* inserted at level of insertion of *g*<sub>7</sub>. Adanal setae aligned in adanal. Lyrifissures *ian* and *iad* inverse apoanal, located near anterior margin of anal aperture. Sternal ridge indistinct. Epimeral borders 1-4 and *sj* distinct. Mentotectum separated medially (Fig. 3C). Epimeral setal formula: [5,6,7]-3-3-4; setae smooth spiniform. Pedipalpal setal formula: 0-2-1-3-9[1] (Fig. 4D). Diarthric subcapitulum bearing 3 pairs of setae, *a* (35  $\mu\text{m}$ ), *m* (70  $\mu\text{m}$ ) and *h* (46  $\mu\text{m}$ ); setae smooth spiniform; *m* longest inserted near mid-

ventral line (Fig. 3B). Setae *cha* and *chb* long spiniform bearing minute barbs throughout length (Fig. 4C).

Legs — Homotridactylous; claws minutely barbed dorsally (Fig. 4A). Setal formula: I (1-5-3-7-23), II (1-5-3-6-20), III (2-4-3-5-20), IV (1-2-2-5-18). All genera and femora bearing carina (Fig. 3E). Seta *d* on femur IV smooth bacilliform (Fig. 3A). One solenidion of all tibiae and genera with coupled seta. On tarsus I, famulus  $\varepsilon$  spiniform situated posterior to solenidia  $\omega_2$ ;  $\omega_2$  lateral to  $\omega_1$  (Fig. 4E). Solenidion  $\omega_1$  and  $\omega_2$  setiform. Solenidion  $\varphi_1$  on tibia I originating from apophysis, coupled with seta *d*.

Immature (Plate 1 E-F) — Five tritonymphs: length 921  $\mu\text{m}$ ; width 571  $\mu\text{m}$ . Body surface sulcate.

Remarks — Two species of genus *Neoliodes*, *N. bataviensis* Sellnick, 1925 and *N. zimmermanni* (Sellnick, 1959) have been recorded from Iheya Island (Aoki, 2009). However, descriptions of these latter specimens (Aoki, 2006; 2009) are different from the original descriptions of *N. bataviensis* and *N. zimmermanni* in regards to insertion of rostral setae, form of lamellar-interlamellar region and size of sensilli, and from the new species in insertions of setae *in*, form of lamellar-interlamellar region and notogaster, and absence of conspicuous hollows and porose area (Apo) at the notogastral center. The new species differs from all the species of the genus by having porose area (Apo) at the notogastral center, opisthotal gland as conspicuous hollows laterally on the notogaster, form of lamellar region, notogaster and carina on genu and femur of all legs, and mentotectum separated medially.

## OPPIIDAE GRANDJEAN, 1951

### *Oppiella* (*Oppiella*) *nova* (Oudemans, 1902)

[Japanese name: Namitsubudani]  
(Fig. 5 and Plate 2)

*Eremaeus novus* Oudemans, 1902, Tijdschr. Ent., 46, pp. 6-7, pl. 2, fig. 22.

*Oppia nova*: van der Hammen, 1952, Zool. Verh., No.17, pp. 51-52, fig. 6a.

*Oppiella nova*: Hammer, 1968, Biol. Skr. Dan. Vid. Selsk., 16(2), p. 13; Fujikawa, 1981, Edaphologia, (24), p. 20, figs. 1 and 2; Fujikawa, 1999, Edaphologia, (62), pp. 23–28, figs. 12–19 and 21–28, tables 1 and 4.

*Oppiella (Oppiella) nova*: Subías, 2004, Graellsia, 60, p.128.

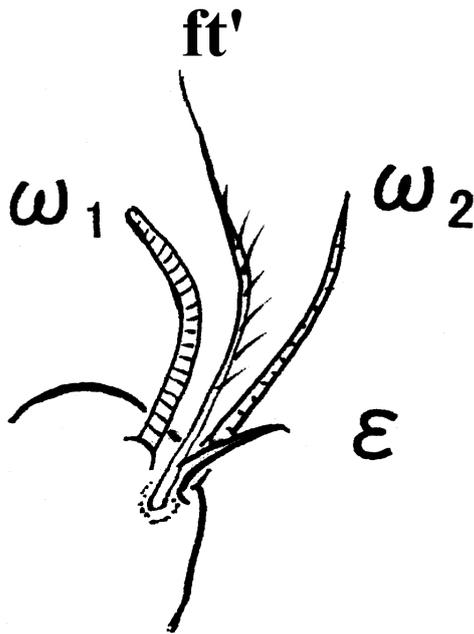


FIGURE 5: *Oppiella (Oppiella) nova* (Oudemans, 1902) Solenidial region of tarsus I.

Diagnosis — Body length 314  $\mu\text{m}$ ; width 150  $\mu\text{m}$ . Parallel lamellar ridges connected with transversal ridge. Medial anterior part of notogaster not extending anterior crista. Setae  $c_2$  glabrous. Epimeral grooves I, II and IV distinct. Setae  $ft'$  on tarsi I long.

Material examined — One female (NSMT-Ac 13589): from point A.

Measurements — Body length 314  $\mu\text{m}$ ; width 150  $\mu\text{m}$ . Body colour light yellow brown.

Supplementary description — Morphological variation in form of lamellar region, anterior part of notogaster, setae  $c_2$  and epimeral region, type A, A, A, and C, respectively (Pl. 2). The nomenclature

used in the Figs. 15 and 16 is the one used by Fujikawa (1999).

Distribution — Cosmopolitan.

Remarks — The examined specimen has longer setae  $ft'$  on tarsi I than that of specimens collected in a nature farm in Hokkaido (Fujikawa, 1981) (Fig. 5). The present species is known as fungivorous, parthenogenetic and cosmopolitan species, with a fossil history of about 8,000 years ago (Karppinen and Koponen, 1973). Only the present species has been found in a deep horizontal drift of gold mine (Fujikawa, private information). Only the present species was collected from the point A where the wall and floor were covered with only sand or fragment of psephite without organic matter. It was observed that a total of 12,803 adults were issued from one female (for twelve years) and that this species was able to crawl in any crevice (Fujikawa, 1999). While *Tectocephus velatus* (Michael, 1880) was not found from crevice the species reared with the same condition with *O. nova*.

#### TECTOCEPHEIDAE GRANDJEAN, 1953[1954]

##### *Tectocephus kumayaensis* sp. nov.

[Japanese name: Kumaya-kuwagatadani]  
(Figs. 6 and 7)

Diagnosis — Body length 264  $\mu\text{m}$ ; width 178  $\mu\text{m}$ . Rostral anterior margin without incision, broadly truncate with two concavities. Setae *in* trigonal pyramidal, roughened. Sensilli with globular head. Bothridia with deep incision, without swelling or projection. Depression and dorsosejugal scissure absent. Humeral region with small triangular projection. Ten pairs of notogastral setae. Genito-anal setal formula: 6-1-2-3. Lyrifissures *iad* located along, near anterior margin of anal aperture. Epimeral setal formula: 3-1-3-3. Trochantera III and IV bearing carina with sharply pointed apex. Monodactyl.

Material examined — Holotype (Female) (NSMT-Ac 13590) from point C.

Etymology — After the name of sampling point, Kumaya Cave.



PLATE 2: *Oppiella (Oppiella) nova* (Oudemans, 1902) (photos by Nakamura Y.)

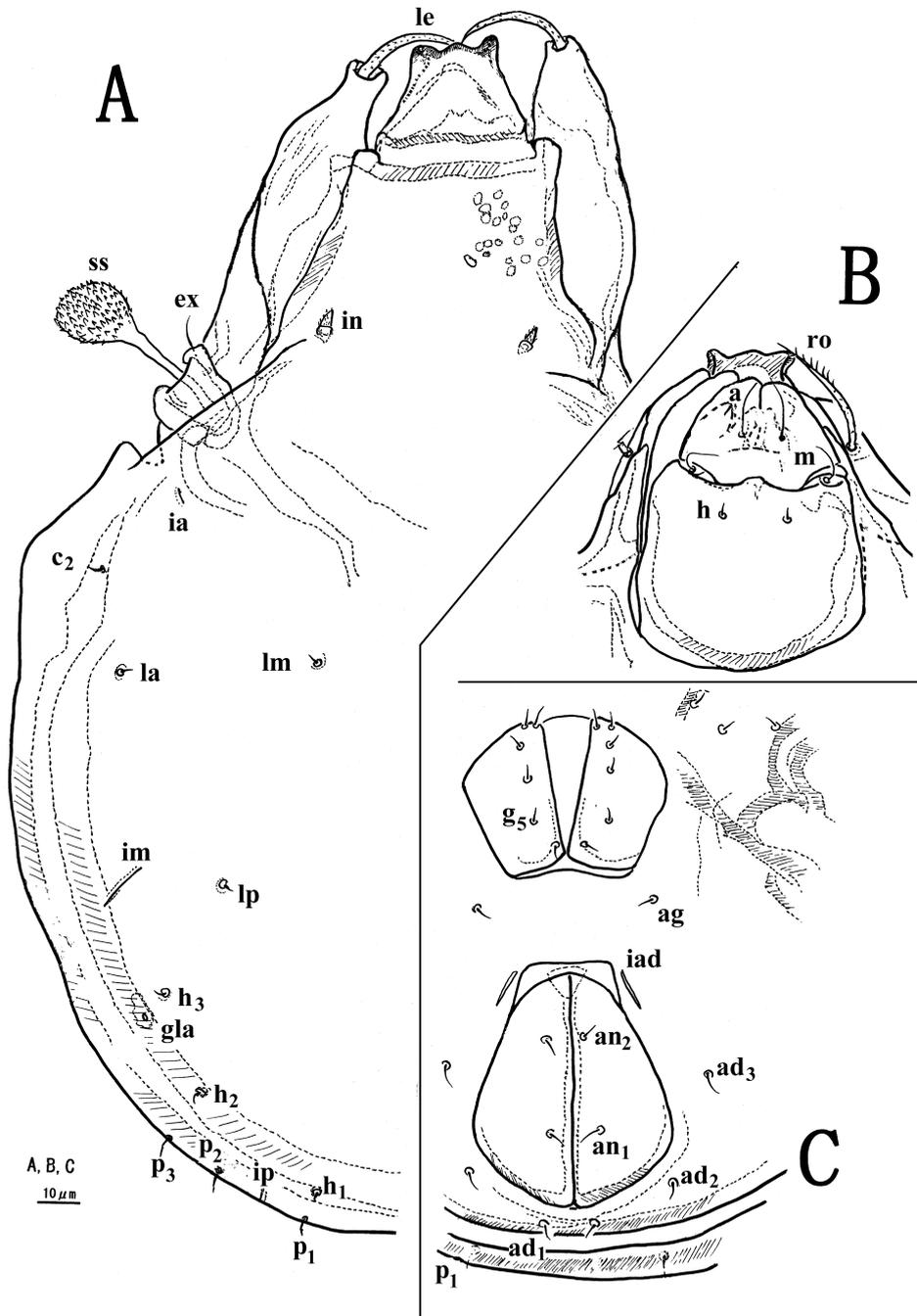


FIGURE 6: *Tectocephus kumayaensis* sp. nov. A, Dorsal view; B, Camerostome; C, Genito-anal region.

Measurements and body appearance — Body length 264  $\mu\text{m}$ ; width 178  $\mu\text{m}$ . Body colour light brown. Whole body surface covered cerotegument; cerotegument irregularly granulate.

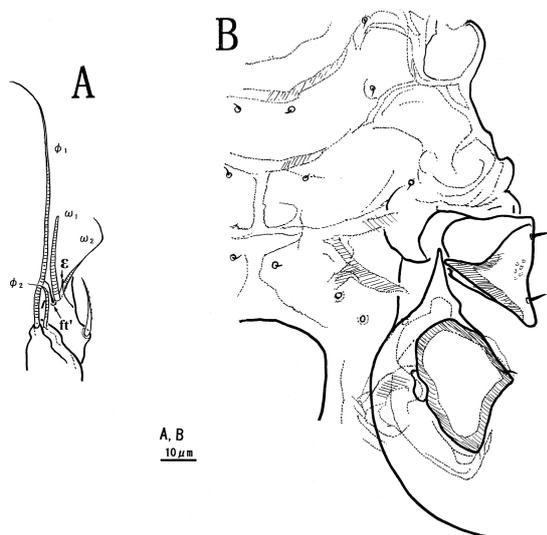


FIGURE 7: *Tectocephus kumayaensis* sp. nov. A, Solenidial region on tarsus and tibia of leg I; B, Left epimeral region.

Prodorsum — Rostral anterior margin without incision, broadly truncate with two concavities (Fig. 6A). Setae *ro* (33  $\mu\text{m}$ ) and *le* (30  $\mu\text{m}$ ) spiniform, extending for a short distance anterior of rostral anterior margin; setae *ro* barbed unilaterally; setae *le* roughened throughout length; *ro* nearly as long as *le*. Lamellar cuspis without dent nor swelling, not extending to level of rostral anterior margin. Rostral and lamellar transverse ridges distinct. Setae *in* (5  $\mu\text{m}$ ) small trigonal pyramidal, roughened throughout length. Sensilli (45  $\mu\text{m}$ ) composed of thin, roughened stem and globular head which bears dark coloured spines. Setae *ex* (8  $\mu\text{m}$ ) smooth, short, longer than setae *in*. Bothridia opened antero-laterally, with deep incision, without swelling or projection.

Notogaster — Depression and dorsosejugal scissure absent. Humeral region with small triangular projection. Ten pairs of notogastral setae short setiform, roughened throughout length. Lyrifissures *ia* aligned perpendicular to notogastral outline, antero-laterally to setae *c*<sub>2</sub>; *im* obliquely, later-

ally to *lp*; *ip* perpendicular to notogastral outline between *p*<sub>1</sub> and *p*<sub>2</sub>. Setae *h*<sub>3</sub> inserted antero-lateral to *gla*.

Ventral region — Genital (36  $\mu\text{m}$ ) and anal (57  $\mu\text{m}$ ) apertures almost pentagonal in form; distance (22  $\mu\text{m}$ ) between them appreciably shorter than half length of anal aperture. Genito-anal setal formula: 6-1-2-3; all setae smooth setiform (Fig. 6C). Setae *g*<sub>1</sub> and *g*<sub>2</sub> inserted nearer anterior margin of plates. Setae *ag* inserted latero-posteriorly to genital aperture. Setae *ad*<sub>1</sub> and *ad*<sub>2</sub> aligned in postanal position, *ad*<sub>3</sub> in adanal. Lyrifissures *iad* located along, near anterior margin of anal aperture. Sternal ridge distinct at epimeres borders 2-4; *bo*. 1,2, *sj* distinct. Epimeral setal formula: 3-1-3-3; setae smooth, minute setiform. Diarthric subcapitulum bearing 3 pairs of setae: *a* (13  $\mu\text{m}$ ), *m* (2  $\mu\text{m}$ ) and *h* (11  $\mu\text{m}$ ); setae thin smooth setiform; relative lengths: *a*  $\approx$  6x *h*; *m*  $\approx$  4x *h* (Fig. 6B).

Legs — Monodactyl; claws with few dens. Legs not studied. Trochantera III and IV bearing carina with sharply pointed apex (Fig. 7B). On tarsus I, famulus  $\epsilon$  trigonal pyramidal situated between solenidia bacilliform  $\omega$ <sub>1</sub> and setiform  $\omega$ <sub>2</sub> (Fig. 7A). Solenidion  $\varphi$ <sub>1</sub> on tibia I originating from apophysis, about three times longer than the length of  $\omega$ <sub>1</sub>.

Remarks — Rostrum with two concavities of the new species is similar in appearance to those of *Tectocephus alatus* Berlese, 1913 and *T. shirakamiensis* Fujikawa, 2001. However, the new species differs from them in form of cuspis, dorsosejugal region, humeral region, and situation or direction of lyrifissures *ia* and *iad*. The new species has a small body size, verrucose globular sensilli and subparallel lyrifissures *iad* to anal aperture as is the case of *T. minor* Berlese, 1903 [1904] *sensu* Bernini (1973) and Japanese specimens collected by Fujikawa. At first she considered these Japanese specimens as *T. cuspidentatus* Knülle, 1954 (Fujikawa, 1988), because (1) she could not find out similar characters like rostrum with two deep incisions between Japanese specimens and Berlese Collection (204/6, 217/27-30 and 82/36-40) in addition slides in the Berlese Collection were hardly examinable for her, and (2) she could find that Japanese specimens beared a striking resemblance in the rostrum shape, sensilli

and lamellar cusps, and situation of lyrifissures *iad* with a specimen of *T. cuspidentatus* in Zoological Museum Copenhagen. Latter the Japanese specimens were identified as *T. minor* (Fujikawa, 2001) according to Nübel-Reidelbach (1994). After that, Mahunk and Mahunka-Papp (1995) and Laumann and al (2007) pointed out that *T. minor* has medially weakly protruding rostral anterior margin, cusps bearing inner and outer dens, globular sensilli, notogaster without depressions, bothridium ventrally expanded, trochanter IV bearing a dorsal spur and lyrifissures *iad* situated subparallel to anal aperture. Fujikawa (1995; 1999) could not observe individual variation in presence or absence of rostral incisions, form of rostral anterior margin, presence or absence of dens of cusps, and situation of *iad* subparallel to anal aperture. Now we consider that the above-mentioned Japanese specimens should be reidentified as *T. cuspidentatus*. *Tectocepheus minor* by Fujita and Fujiyama (2001) should be also included in the species, *T. cuspidentatus*, Fujita and Fujiyama (2001) suggested that, unlike *T. velatus*, *T. cuspidentatus* could migrate in response to seasonal environmental changes. The new species differs from all the species of the genus in having rostral anterior margin with two concavities without incisions, cusps without dens and swelling, trigonal pyramidal interlamellar setae, and form of carina on trochanter III and IV.

***Tectocepheus iheyaensis* sp. nov.**

[Japanese name: Iheya-kuwagatadani]  
(Figs. 8 and 9)

Diagnosis — Body length 307  $\mu\text{m}$ ; width 179  $\mu\text{m}$ . Rostral anterior margin without incision, bearing narrow projection at lateral sides, ending abruptly anteriorly, not extending anterior of rostral anterior margin. Lamellar cuspis with inner swelling, without dens, not extending to level of rostral anterior margin. Depression on notogaster absent. Genito-anal setal formula 6-1-2-3. Monodactyl.

Material examined — Holotype (Female) (NSMT-Ac 13591) from point D.

Etymology — After the name of sampling area, Iheya Village.

Measurements and body appearance — Body length 307  $\mu\text{m}$ ; width 179  $\mu\text{m}$ . Body colour light yellowish brown. Whole body surface covered with cerotegument; cerotegument irregularly granulate.

Prodorsum — Rostral anterior margin broadly rounded without incision, bearing narrow projection at lateral sides, ending abruptly anteriorly, not extending anterior of rostral anterior margin (Fig. 8A). Lamellar cuspis with inner swelling, without dens, not extending to level of rostral anterior margin. Rostral and lamellar transverse ridges distinct. Setae *ro* and *le* spiniform, barbed unilaterally, extending for a short distance anterior of rostral anterior margin. Setae *ro* (41  $\mu\text{m}$ ) nearly as long as *le*. Setae *in* smooth, small bacilliform. Sensilli (38  $\mu\text{m}$ ) composed of thin, smooth stem and globular head which bears dark coloured spines. Setae *ex* (7  $\mu\text{m}$ ) smooth, short, shorter than setae *in* (11  $\mu\text{m}$ ). Bothridia opened dorsally.

Notogaster — Depression on notogaster absent. Dorsosejugal scissure reduced behind setae *in* (Fig. 9A). Ten pairs of notogastral setae short, smooth, setiform. Lyrifissures *ia* aligned obliquely to notogastral outline, antero-laterally to setae *c*<sub>2</sub>; *im* obliquely, laterally to almost mid-distance between *lm* and *lp*; *ih* and *ips* obliquely to, *ip* perpendicular to notogastral outline; *ih* postero-laterally to *im*; *ips* antero-laterally to *h*<sub>3</sub>; *ip* anterior to *p*<sub>2</sub>. Setae *h*<sub>3</sub> inserted postero-lateral to *gla*. Posterior margin of notogaster with broadly truncate elevation bearing setae *h*<sub>2</sub> at corners.

Ventral region — Genital (42  $\mu\text{m}$ ) and anal (76  $\mu\text{m}$ ) apertures almost pentagonal in form; distance (24  $\mu\text{m}$ ) between them appreciably one-third as long as length of anal aperture (Fig. 9B). Genito-anal setal formula 6-1-2-3; all setae smooth setiform. Setae *g*<sub>1</sub> and *g*<sub>2</sub> inserted nearer anterior margin of plates; setae *g*<sub>1</sub> (14  $\mu\text{m}$ ) about more than twice as long as the rest setae (6  $\mu\text{m}$ ). Setae *ag* (6  $\mu\text{m}$ ) inserted latero-posteriorly to genital aperture. Setae *ad*<sub>1</sub> and *ad*<sub>2</sub> aligned in postanal position; *ad*<sub>3</sub> in adanal. Lyrifissures *iad* located transversely near anterior margin of anal aperture. Sternal ridge indistinct. Epimeral borders *bo*. 1, 2, *sj* distinct. Epimeral setal formula 3-1-3-3; setae smooth, setiform. Diarthric subcapitulum bearing 3 pairs of setae: *a*, *m* and *h*; setae *a*

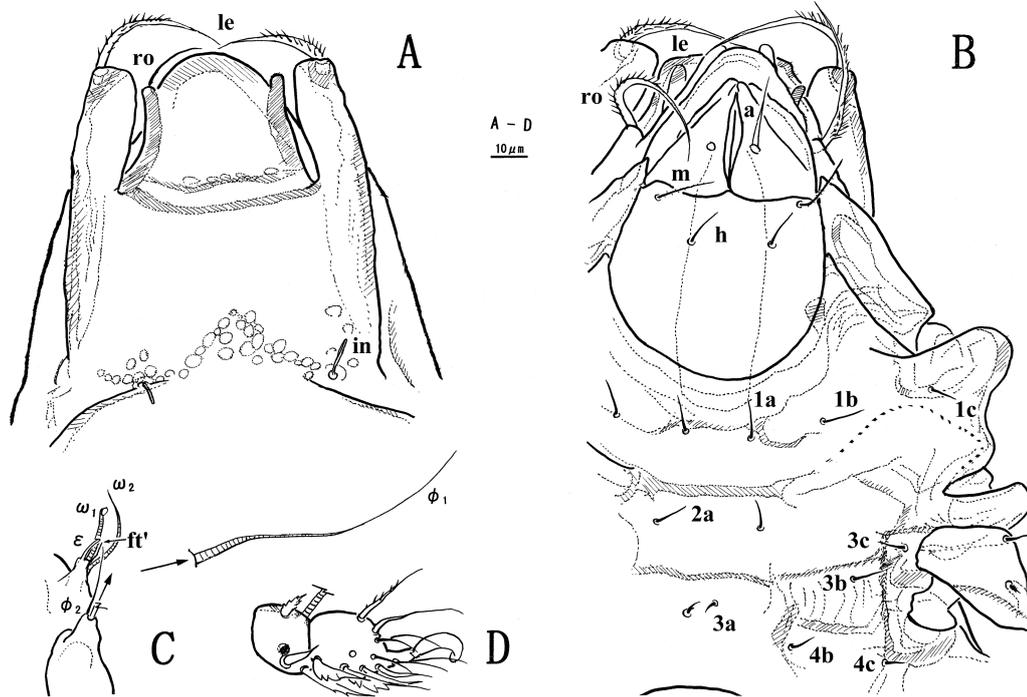


FIGURE 8: *Tectocephus iheyaensis* sp. nov. A, Prodorsal region; B, Camerostome and epimeral region; C, Solenidial region on tarsus and tibia of leg I; D, Tarsus and tibia of leg II.

and *h* thin smooth; *a* spiniform; *m* and *h* setiform; *m* sparsely barbed; relative lengths:  $a \approx m$  (19  $\mu\text{m}$ )  $\approx 2 \times h$  (10  $\mu\text{m}$ ) (Fig. 8B).

Legs — Monodactyl. Setal formula: I (1-5-3-5-17), II (1-4-2-4-14), III (2-3-1-3-12), IV (1-2-2-3-12). On tarsus I, famulus  $\varepsilon$  bacilliform situated beside solenidion  $\omega_1$  originating from apophysis; solenidion  $\omega_1$  bacilliform and  $\omega_2$  setiform;  $\omega_2$  situated anterior to  $\omega_1$  (Fig. 8C). Solenidia  $\varphi_1$  and  $\varphi_2$  on tibia I originating from apophysis;  $\varphi_1$  (79  $\mu\text{m}$ ) about four times longer than the length of  $\omega_1$  (18  $\mu\text{m}$ );  $\varphi_2$  situated anterior to  $\varphi_1$ . Trochanter III bearing well developed carina, long and protruding. Carina of trochanter IV rounded. Tarsi II, tibiae I and II bearing thick setae different from other setae (Fig. 8D).

Remarks — The new species is similar in rostrum, cuspis, sensillus, setae on tarsi II, tibiae I and II, and carina of trochanter IV, and direction of lyrifissures *iad* to *Tectocephus velatus* (Michael, 1880) and *T. velatus sarekensis* Trägårdh, 1910 (Fujikawa, 1988; Laumann *et al.*, 2007; Weigmann, 2002). How-

ever, the new species differs from all the species of the genus in the characteristics of the rostrum with lateral projection, small smooth bacilliform interlamellar setae, notogaster with truncate elevation posteriorly without depression, genital setae  $g_1$  longer than the remains and tochanter III bearing developed carina.

PHENOPELOPIDAE PETRUNKEVITCH,  
1955

*Eupelops kumayaensis* sp. nov.

[Japanese name: Kumaya-enmadani]  
(Figs. 10 and 11)

Diagnosis — Body length 607  $\mu\text{m}$ ; width 486  $\mu\text{m}$ . Tutorium with sharply pointed apex, without dens. Anterior notogastral tectum broadly concave. Ten pairs of notogastral setae bacilliform, spinose. Four pairs of round porose areas. Genito-anal setal formula: 6-1-2-[2, 1]. Chelicerae bearing two

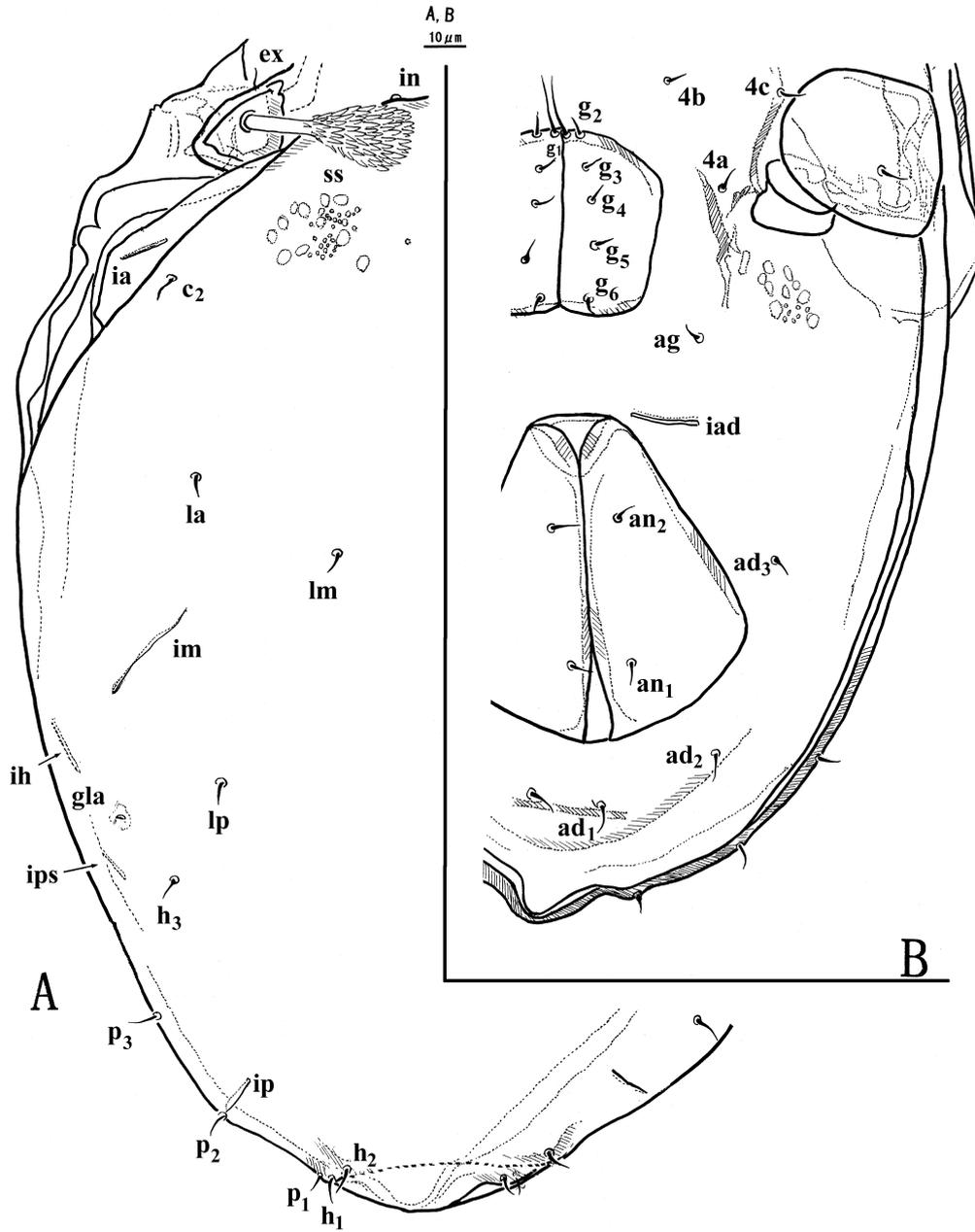


FIGURE 9: *Tectocepheus iheyaensis* sp. nov. A, Notogaster; B, Genito-anal region.

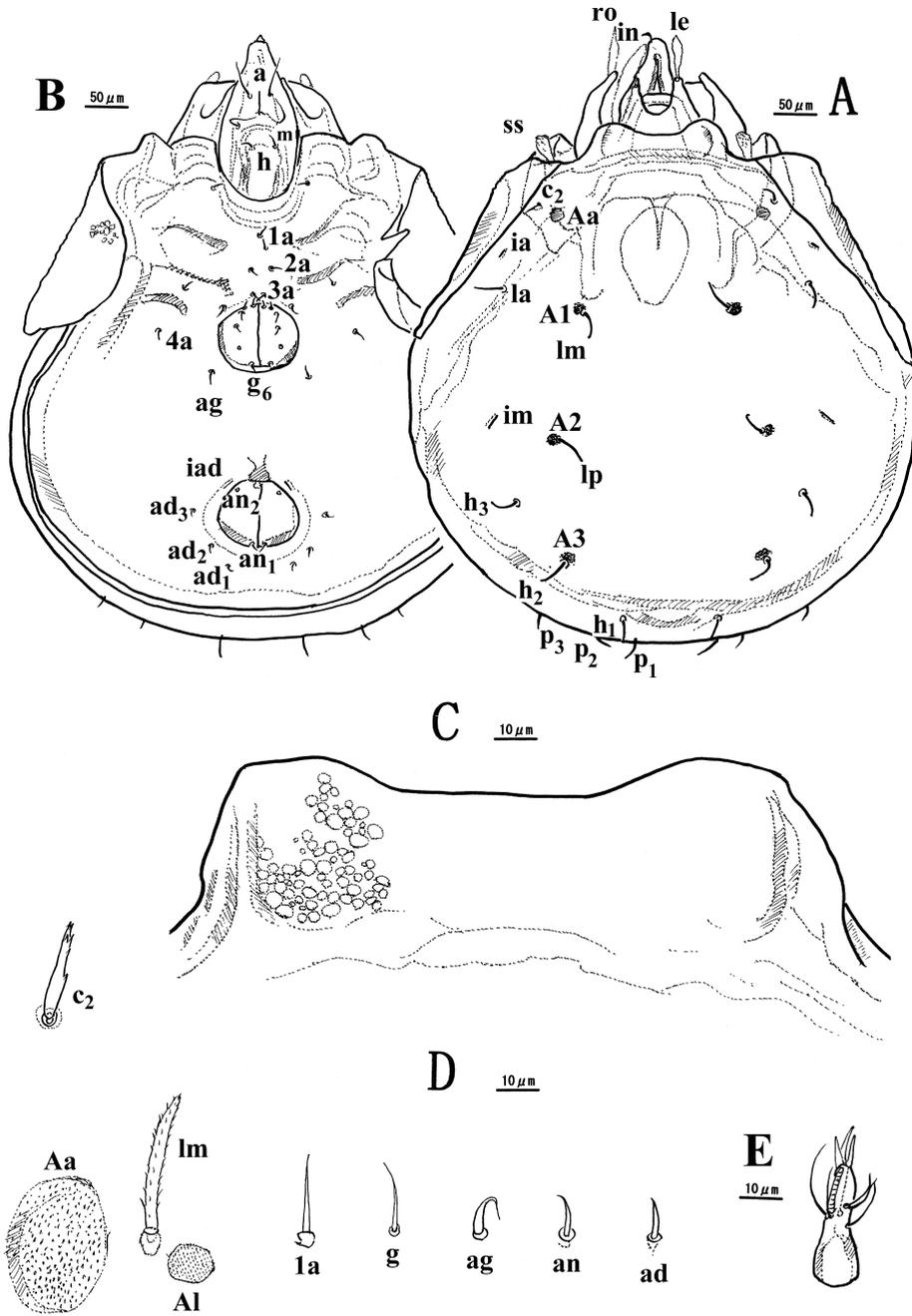


FIGURE 10: *Eupelops kumayaensis* sp. nov. A, Dorsal view; B, Ventral view; C, Anterior tectum of notogaster of a depressed specimen; D, Areae porosae and setae; E, Tarsus of pedipalp.

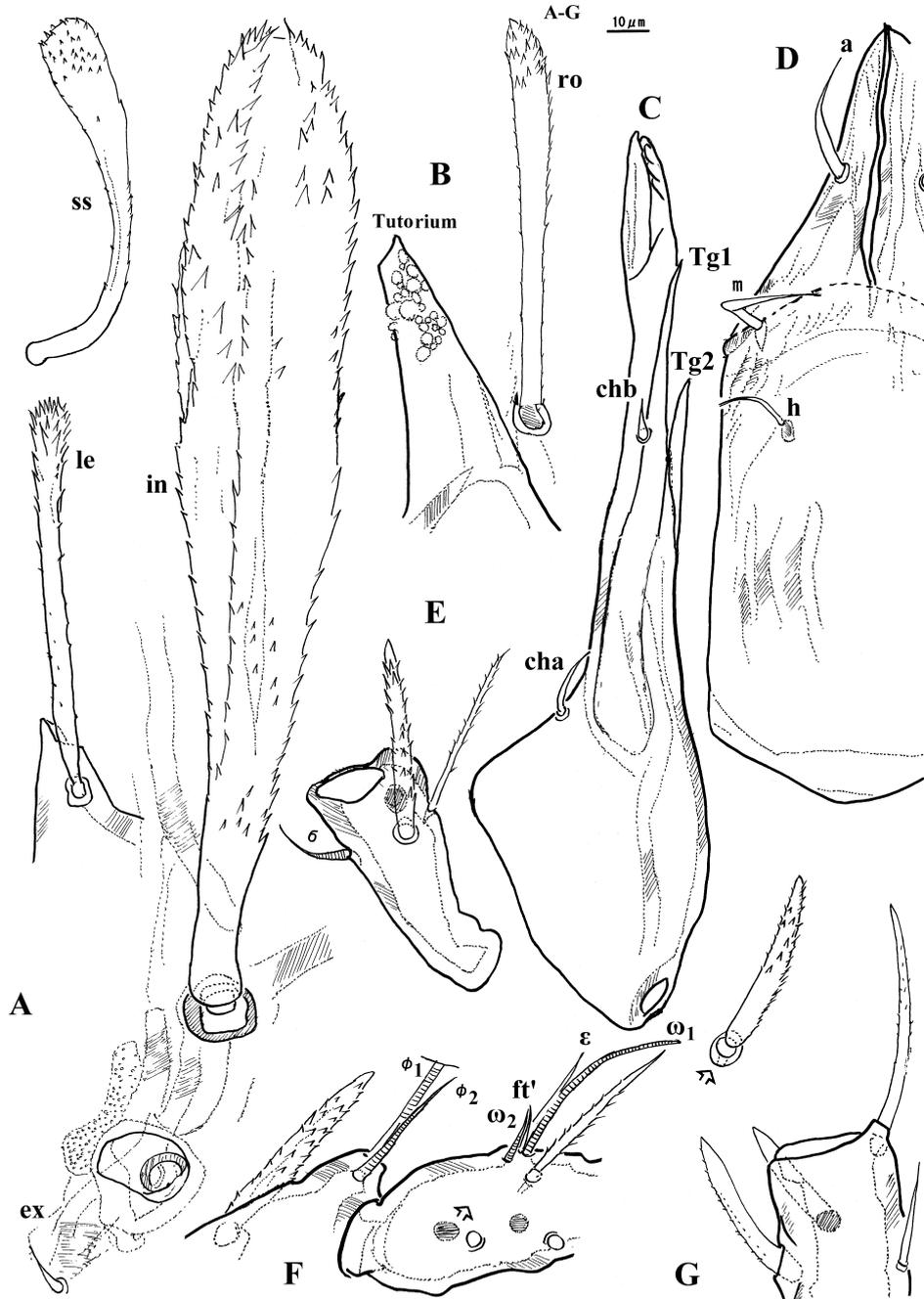


FIGURE 11: *Eupelops kumayaensis* sp. nov. A, Left bothridial region and right sensillus; B, Tip of tutorium and rostral seta; C, Chelicera; D, Gnathosoma; E, Genu I; F, Solenidial region on tarsus and tibia of leg I; G, Tibia IV.

Trägårdh's organs; Tg1 longer than Tg2. Heterotridactylous.

Material examined — Holotype (Female) (NSMT-Ac 13592) from point E; 1 paratype (NSMT-Ac 13593): same data as holotype.

Etymology — After the name of sampling point, Kumaya Cave.

Measurements and body appearance — Body length 607  $\mu\text{m}$ ; width 486  $\mu\text{m}$ . Body colour dark brown. Whole integument except for hypostoma bearing dark granules; hypostome laterally-costate.

Prodorsum — Rostrum protruding with rounded tip (Fig. 10A). Setae *ro* weakly expanded distally, spiculate throughout length, inserted on lateral margins at base of free tip of tutorium, extending for short distance anterior of rostral margin. Tutorium with sharply pointed apex, without dens (Fig. 11B). Tips of lamellar cuspis reaching two third-distance along prodorsum, anterodorsally arising lamellar setae. Space between cuspis forming parabola-shape. Setae *le* bacilliform, spiculate throughout length, reaching anterior margin of rostrum. Setae *in* large phylliform, spiculate throughout length, reaching anterior margin of rostrum (Fig. 11A). Bothridia opening antero-laterally. Sensilli (*ss*) bowing, expanded distally without narrower apex, spiculate throughout length. Setae *ex* short, smooth spiniform. Relative lengths of prodorsal setae *in* (230  $\mu\text{m}$ )  $\approx$  2.5x [*ro*  $\approx$  *le*  $\approx$  *ss* (92  $\mu\text{m}$ )  $\approx$  8x *ex* (11.5  $\mu\text{m}$ )].

Notogaster — Anterior notogastral tectum broadly concave, projecting further anteriorly than anterior margin of movable pteromorphs, covering basal part of prodorsum (Figs. 10A and C). Large oval lenticulus visible. Ten pairs of notogastral setae bacilliform, spinose throughout length, variable in length; shortest *c*<sub>2</sub> (Fig. 10D). Four pairs of round porose areas; Aa located postero-laterally to setae *c*<sub>2</sub>; A1, A2, A3 contiguous to *lm*, *lp*, *h*<sub>2</sub>, respectively. Setae *h*<sub>3</sub> laterally inserted mid-distance between A2 and A3. Lyrifissures *ia* located anterior to *la*; *im* aligned obliquely antero-laterally to A2. Relative distances between notogastral setae in central part of notogaster: (*c*<sub>2</sub> - *c*<sub>2</sub>) (262  $\mu\text{m}$ )  $>$  (*lp* - *lp*) (235  $\mu\text{m}$ )  $\approx$  (*h*<sub>2</sub> - *h*<sub>2</sub>)  $>$  (*lm* - *lm*) (162  $\mu\text{m}$ )  $>$  (*h*<sub>1</sub> - *h*<sub>1</sub>) (108  $\mu\text{m}$ ).

Ventral region — Genital and anal apertures roughly circular in shape, almost equal (77  $\mu\text{m}$ ) in length; distance (130  $\mu\text{m}$ ) between them 1.7x as long as length of each aperture (Fig. 10B). Genito-anal setal formula: 6-1-2-[2, 1]; all setae short, smooth setiform (Fig. 10D); anal setae variable in number. Setae *g*<sub>1</sub> and *g*<sub>2</sub> inserted at anterior margins of plates; *g*<sub>6</sub> at posterior margins. Setae *ag* inserted latero-posteriorly to genital aperture. Setae *an*<sub>1</sub> and *an*<sub>2</sub> inserted near anterior and posterior margin of plates, respectively. Setae *ad*<sub>1</sub> and *ad*<sub>2</sub> aligned in postanal position; *ad*<sub>3</sub> in adanal. Lyrifissures *iad* located antero-laterally to anterior margin of anal aperture, along outline of aperture. Sternal ridge indistinct. Epimeral borders *bo*. 1-3, *sj* distinct. Epimeral setal formula: 3-1-3-3; setae short, smooth setiform. Relative lengths: *la* (18  $\mu\text{m}$ )  $>$  *g* (17  $\mu\text{m}$ )  $>$  *ag* (15  $\mu\text{m}$ )  $>$  *an* (12  $\mu\text{m}$ )  $>$  *ad* (10  $\mu\text{m}$ ). Pedipalpal setal formula: 0-2-1-3-9[1]; solenidion on tarsus short, not extending in front of tarsal anterior margin (Fig. 10E). Suctorial subcapitulum bearing 3 pairs of setae: *a* (32  $\mu\text{m}$ ), *m* (32  $\mu\text{m}$ ) and *h* (17  $\mu\text{m}$ ); all setae smooth; *a*, *m* spiniform; *h* setiform (Fig. 11D). Chelicerae bearing two Trägårdh's organs; Tg1 longer than Tg2 (Fig. 11C). Setae *cha*, *chb* smooth spiniform; *cha* long, *chb* short.

Legs — Heterotridactylous; claws dentate dorsally. Setal formula: I (1-5-3-4-19), II (1-5-3-4-16), III (2-3-1-3-15), IV (1-2-2-4-12). All segment except for femur IV and all trochantera bearing thick, spiculate lateral setae (Fig. 11E). Carina on every segment indistinct. Solenidiotaxy: I (1-2-2), II (1-1-2), III (1-1-0), IV (0-0-0). Solenidion absent on tibiae IV (Fig. 11G). On tarsus I, famulus  $\varepsilon$  long setiform, situated posterior to solenidia  $\omega$ <sub>1</sub>;  $\omega$ <sub>2</sub> posteriolaterally to  $\omega$ <sub>1</sub>;  $\omega$ <sub>1</sub> bacilliform and  $\omega$ <sub>2</sub> setiform; seta *ft'* contiguous and posterior to  $\omega$ <sub>1</sub> between  $\omega$ <sub>1</sub> and  $\omega$ <sub>2</sub> (Fig. 11F). Solenidion  $\varphi$ <sub>1</sub> on tibia I originating from apophysis;  $\varphi$ <sub>2</sub> lateral to  $\varphi$ <sub>1</sub>.

Remarks — As far as the authors know, the new species has concave anterior tectum of the notogaster as it is also observed in *Eupelops bilobus* (Sellnick, 1928) (Sellnick, 1929) and *E. incompletes* Mahunka, 1978. However, the new species is distinguished from these latter species by form and length of prodorsal setae, insertion of notogastral setae *h*<sub>3</sub>, and chelicera with two Trägårdh's organs.

*E. acromios* (Hermann, 1804) (Grandjean, 1936) and *E. kumaensis* Fujikawa, 2009 have two Trägårdh's organs, however they differ from the new species in form of notogastral anterior tectum and notogastral setae, and situation of Aa.

ZETOMOTRICHIDAE GRANDJEAN,  
1954[1955]

*Mabulatrachus kumayaensis* sp. nov.

[Japanese name: Kumaya-nokomedani]  
(Figs. 12, 13 and 14)

Diagnosis — Body length 414  $\mu\text{m}$ ; width 229  $\mu\text{m}$ . Numerous notogastral micropores. Rostrum dentate at anterior margin; seven dens small, rounded. Humeral saccule (*hu*) large. Piriform organ (*py*) conspicuous. Ten pairs of notogastral setae. Notogaster with marginal line between anterior of setae *la*. Epimeral setal formula 3-1-3-3. Trochanter IV bearing seta. Heterotridactylous.

Material examined — Holotype (Female) (NSMT-Ac 13594) from point B.

Etymology — After the name of sampling point, Kumaya Cave.

Measurements and body appearance — Body length 414  $\mu\text{m}$ ; width 229  $\mu\text{m}$ . Body colour light brown. Whole integument smooth, with numerous notogastral micropores.

Prodorsum — Rostrum dentate at anterior margin; seven dens small, rounded (Fig. 12A). A pair of longitudinal ridges convergent, running from bothridia to anterior of setae *le*. Setae *ro* (48  $\mu\text{m}$ ), *le* (89  $\mu\text{m}$ ) and *in* (59  $\mu\text{m}$ ) spiniform, ciliate throughout length, originating from small apophyses. Bothridia opened antero-laterally. Sensilli (*ss*) (64  $\mu\text{m}$ ) setiform, ciliate throughout length; relative lengths *ss*  $\approx$  1.3x *ro*. Setae *ex* (15  $\mu\text{m}$ ) thin, short, smooth, setiform.

Notogaster — Medially interrupted dorsosejugal scissure directed forwards, ending at level of mid-distance between setae *le* and *in*. Humeral region developed, bearing barbed spiniform setae *c*<sub>2</sub> (36  $\mu\text{m}$ ). Humeral saccule (*hu*) large. Piriform organ (*py*) conspicuous (Fig. 12B). Other nine pairs of

notogastral setae except for *c*<sub>2</sub>, thin, smooth, short setiform (8  $\mu\text{m}$ ). Lyrifissures *ia* (16  $\mu\text{m}$ ) and *im* (18  $\mu\text{m}$ ) remarkable long, aligned almost perpendicular to notogastral outline; *ih* and *ip* transversely aligned; *ips* obliquely aligned to notogastral outline. Notogaster with marginal line between anterior of setae *la* (Fig. 12C). Notogaster separated medially and overlapping at posterior border (Fig. 14).

Ventral region — Genital aperture (41  $\mu\text{m}$ ) almost square in form; anal aperture (69  $\mu\text{m}$ ) rectangular; distance (99  $\mu\text{m}$ ) between them about 2.4x and 1.4x as long as lengths of genital and anal apertures, respectively. Genito-anal setal formula 4-1-1-2; all setae smooth, setiform; genital setae (15  $\mu\text{m}$ ) about 4x longer than anal (3  $\mu\text{m}$ ) and adanal (3  $\mu\text{m}$ ) setae, and about 2.5x longer than aggenital setae (6  $\mu\text{m}$ ). Setae *an*<sub>1</sub> and *ad*<sub>3</sub> absent. Genital setae (*g*<sub>1</sub>) inserted at anterior margins of plates; the others inserted at the mid-ventral line. Setae *ag* inserted almost at level of posterior margin of genital aperture. Setae *ad*<sub>1</sub> aligned in postanal position, *ad*<sub>2</sub> in adanal. Lyrifissures *iad* located postero-laterally to anterior margin of anal aperture. Sternal ridge and epimeral borders indistinct. Epimeral setal formula 3-1-3-3; setae roughened setiform. Diarthric subcapitulum bearing 3 pairs of setae: *a* (25  $\mu\text{m}$ ), *m* (35  $\mu\text{m}$ ) and *h* (35  $\mu\text{m}$ ); setae barbed; *a* and *m* setiform; *h* spiniform. Custodium sharp, long, extending anteriorly of setae *1c* (Fig. 13A).

Legs — Heterotridactylous; median claw inflexed, shorter than lateral ones. Setal formula: I (1-5-2-4-16), II (1-5-2-4-14), III (2-3-1-3-11), IV (1-2-2-3-10). On tarsus I, famulus  $\varepsilon$  minute bacilliform, situated lateral to seta *ft'* (Fig. 13B). Solenidion  $\omega$ <sub>1</sub> bacilliform, inserted posterior to famulus. Solenidion  $\omega$ <sub>1</sub> setiform, situated anterior to *ft'*. Solenidion  $\varphi$ <sub>1</sub> on tibia I originating from apophysis;  $\varphi$ <sub>2</sub> situated lateral to the base of apophysis of  $\varphi$ <sub>1</sub>.

Remarks — The new species is distinguished from all the species of the genus *Mabulatrachus*, especially from *M. baloghi* (Mahunka, 1993) by the absence of two large incisions between medial and lateral teeth, from *M. dentatus* Coetzee, 1993 by the absence of a long epimeral setae *la*, from *M. litoralis* Aoki and Hirauchi, 2000 by the presence of rostral dens, conspicuous piriform organ, long dorsoseju-

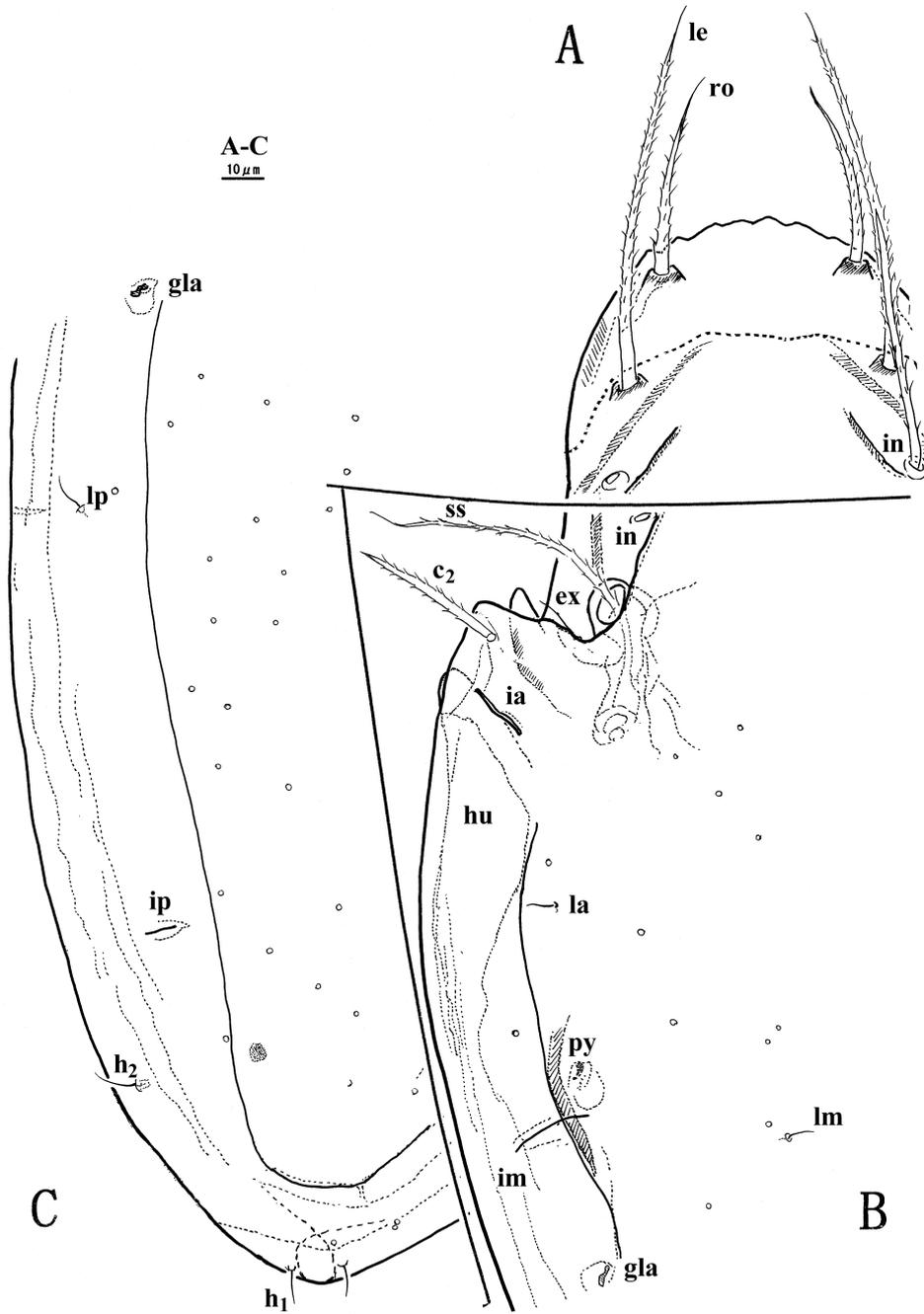


FIGURE 12: *Mabulatrachus kumayaensis* sp. nov. A, Prodorsum; B, Anterior half of left notogaster; C, Posterior half of left notogaster.

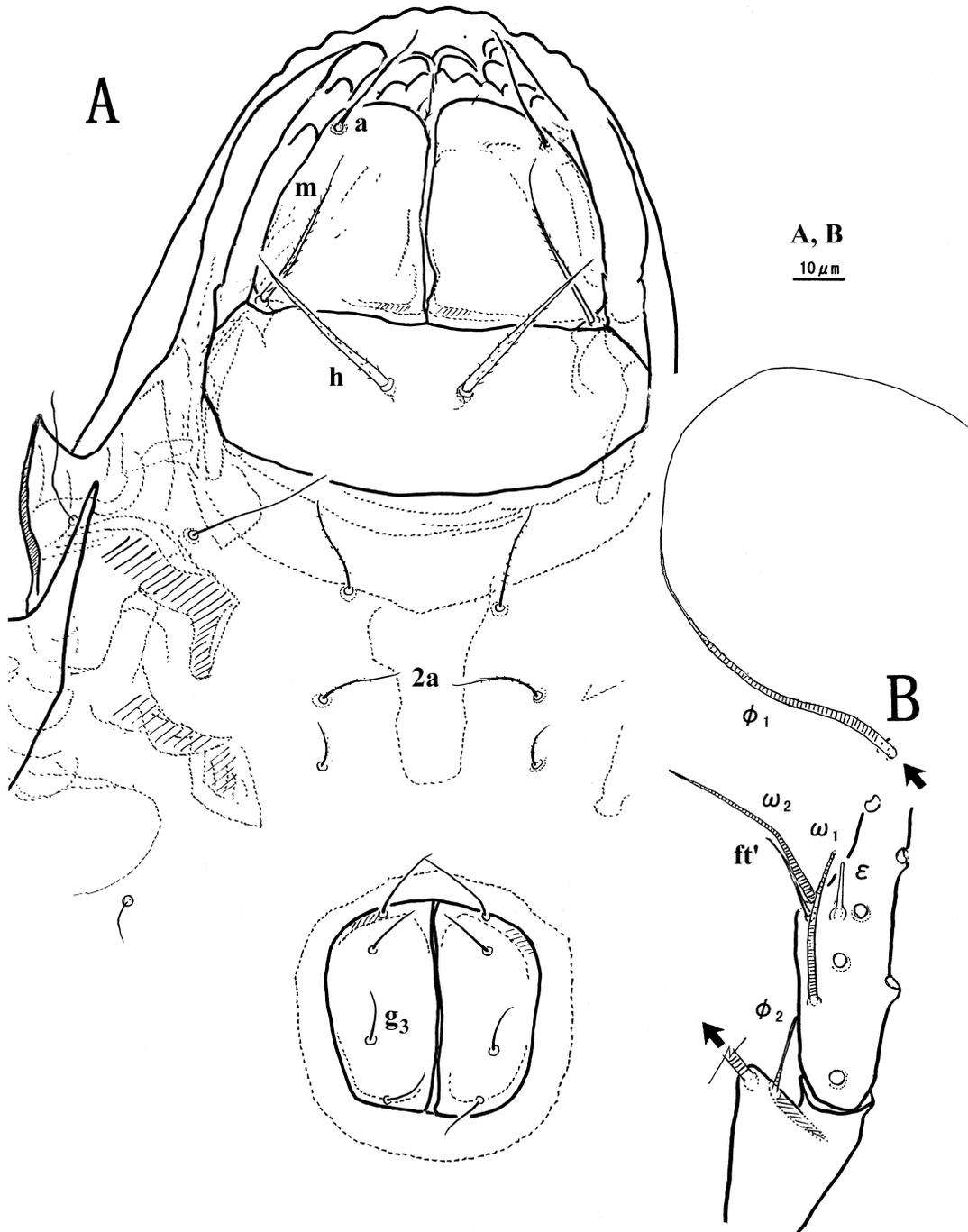


FIGURE 13: *Mabulatrachus kumayaensis* sp. nov. A, Anterior half of ventral region; B, Solenidial region on tarsus and tibia of leg I.

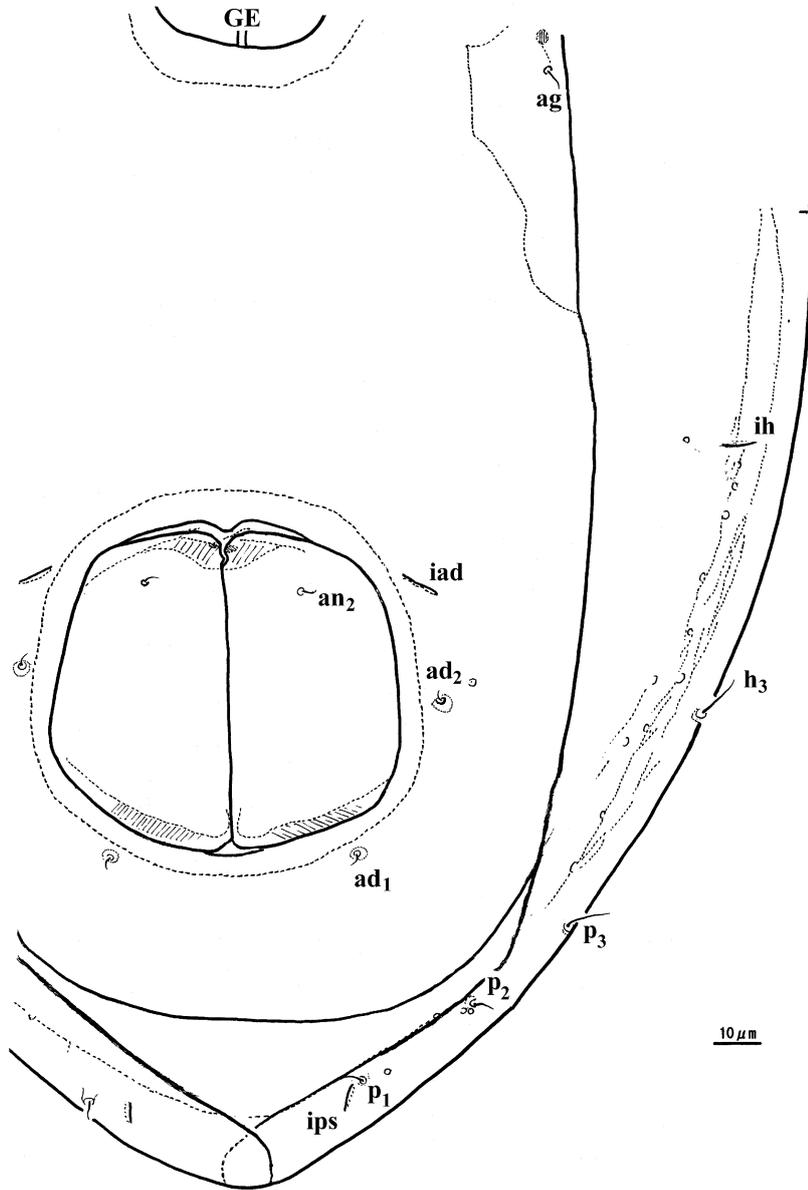


FIGURE 14: *Mabulatrachus kumayaensis* sp. nov. Posterior half of ventral region.

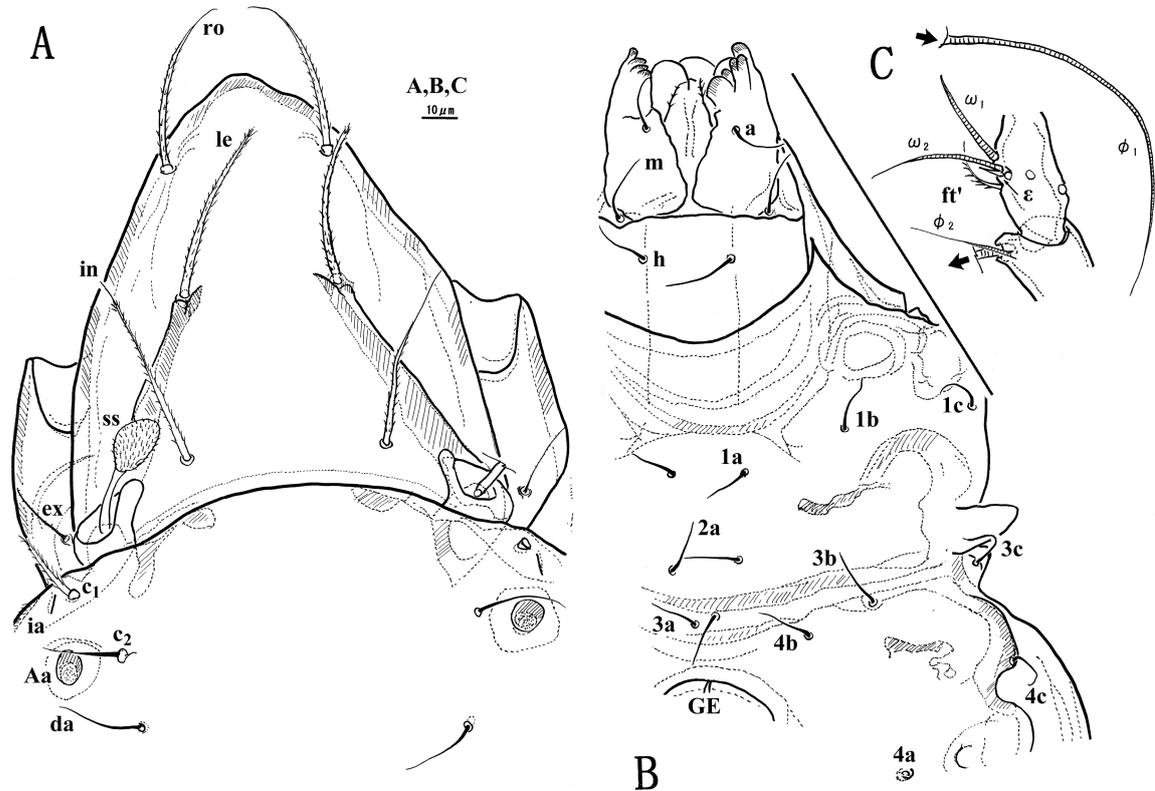


FIGURE 15: *Oribatula kumayaensis* sp. nov. A, Prodorsum; B, Anterior half of ventral region; C, Solenidial region on tarsus and tibia of leg I.

gal scissure, and trochanter IV bearing seta *v*, and from *M. iranicus* Akrami and Coetzee, 2007 by having round rostral dens and conspicuous piriform organ.

ORIBATULIDAE THOR, 1929

*Oribatula kumayaensis* sp. nov.

[Japanese name: Kumaya-koitadani]  
(Figs. 15 and 16)

Diagnosis — Body length 314 μm; width 193 μm. Rostral tip rounded, weakly protruding. Sensilli conspicuously verrucose club-shaped head. Four pairs of porose areas like deep cavity, surrounded by clearly sclerotized areas. Fourteen pairs of notogastral setae. Porose areas Aa situated posterior to

*c*<sub>1</sub> and lateral to *c*<sub>2</sub>; *da* posterior to *c*<sub>2</sub>. Genito-anal setal formula 4-1-2-3. Epimeral setal formula: 3-1-3-3. Heterotridactylous.

Material examined — Holotype (Male) (NSMT-Ac 13595) from point D.

Etymology — After the name of sampling point, Kumaya Cave.

Measurements and body appearance — Body length 314 μm; width 193 μm. Body colour light yellowish brown. Whole integument smooth.

Prodorsum — Rostral tip rounded, weakly protruding, bearing setae *ro* (47 μm) thick, ciliate, setiform, at lateral margins, extending anterior of rostrum for distance equal to half of their length (Fig. 15A). Lamellae convergent, extending from bothridia to about half-way along length of prodorsum, setae *le* (51 μm) arising at base of short extension,

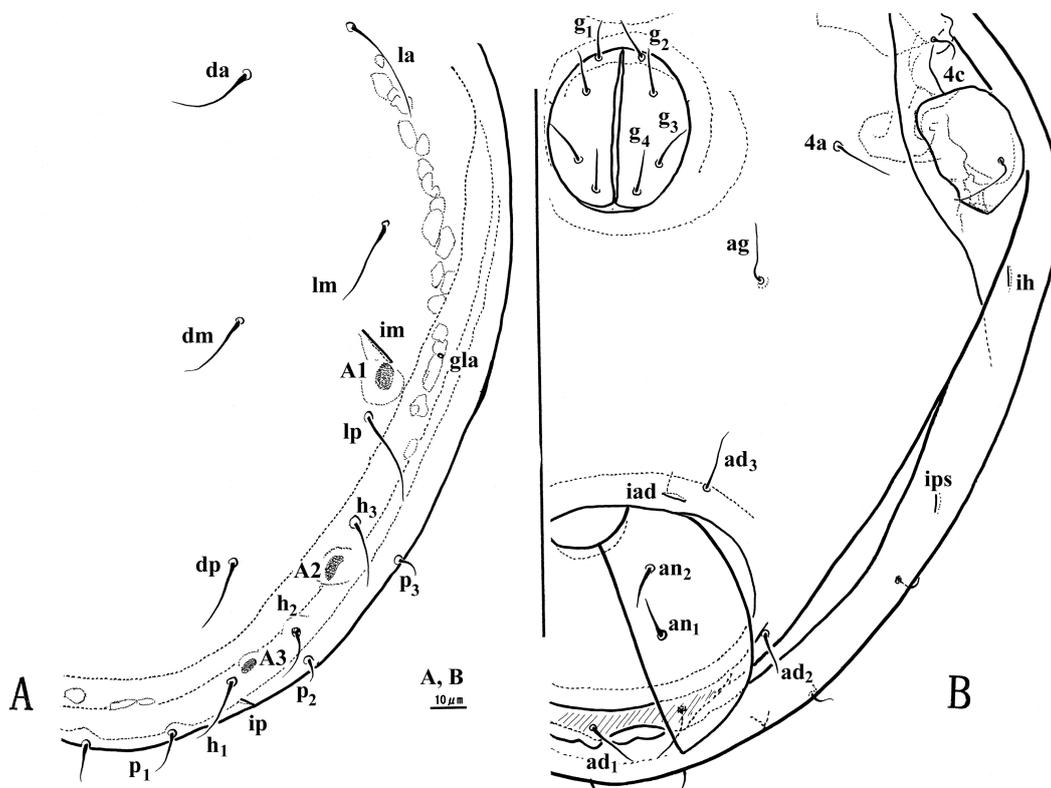


FIGURE 16: *Oribatula kumayaensis* sp. nov. A, Right half of notogaster; B, Genito-anal region.

without cusp nor translamella. Setae *le* and *in* (54 µm) thick spiniform, ciliate throughout length, extending for short distance anterior of insertions of setae *ro* and *le*, respectively. Relative distances, (*in* – *in*) (52 µm) > (*ro* – *ro*) (41 µm) > (*le* – *le*) (40 µm). Bothridia opened antero-laterally. Sensilli (*ss*) (34 µm) consisting of conspicuously verrucose club-shaped head and smooth thin long stem. Setae *ex* thin setiform, roughened throughout length.

Notogaster — Oval, bearing four pairs of porose areas like deep cavity (about 4 µm in depth, 9 µm in diameter), surrounded by clearly sclerotized areas (Fig. 16A). Fourteen pairs of notogastral setae present; *c*<sub>1</sub> (23 µm) barbed spiniform, thicker than the remainder; other setae thin, smooth setiform. Porose areas *Aa* situated posterior to *c*<sub>1</sub> and lateral to *c*<sub>2</sub>; *da* posterior to *c*<sub>2</sub>. Lyrifissures *ia* aligned obliquely lateral to *c*<sub>1</sub>; *im* obliquely immediately an-

terior to *A1*; *ih* and *ips* obliquely to notogastral outline; *ip* obliquely behind *h*<sub>1</sub>. A number of light spots arranged peripherally on notogaster.

Ventral region — Genital (42 µm) and anal (54 µm) apertures roughly circular; distance (78 µm) between them about 1.9x and 1.5x as long as length of genital and anal apertures, respectively (Fig. 16B). Genito-anal setal formula 4-1-2-3; all setae smooth setiform. Setae *g*<sub>1</sub> (12 µm) inserted at anterior margin of plates; setae *g*<sub>3</sub> near lateral margins. Setae *ag* (17 µm) inserted latero-posteriorly to genital aperture. Setae *an*<sub>1</sub> (12 µm) inserted almost mid-distance along plates. Setae *ad*<sub>1</sub> (15 µm) aligned in postanal position; *ad*<sub>2</sub> in adanal; *ad*<sub>3</sub> in preanal. Lyrifissures *iad* located postero-laterally to *ad*<sub>3</sub>, at anterior margin of anal aperture. Sternal ridge indistinct. Epimeral borders *bo*. 1, *sj* distinct. Epimeral setal formula: 3-1-3-3; setae thin, smooth setiform.

Diarthric subcapitulum bearing 3 pairs of setae: *a* (15  $\mu\text{m}$ ), *m* (19  $\mu\text{m}$ ) and *h* (19  $\mu\text{m}$ ); setae thin, smooth setiform (Fig. 15B).

Legs — Heterotridactylous. Setal formula: I (1-5-2-3-17), II (1-5-2-3-14), III (2-3-1-3-12), IV (1-2-2-3-12). On tarsus I, famulus  $\varepsilon$  setiform situated immediately posterior to solenidion  $\omega_2$ ;  $\omega_2$  posterior to  $\omega_1$ . Solenidion  $\omega_1$  bacilliform and  $\omega_2$  setiform. Solenidion  $\varphi_1$  on tibia I originating from apophysis;  $\varphi_2$  situated laterally at base of apophysis (Fig. 15C).

Remarks — The new species resembles in some respects of *Oribatula* (*Oribatula*) *sakamorii* Aoki, 1970 (Fujikawa, 1983; Bayartogtokh and Aoki, 2000). However, the new species differs from this latter species in having short lamellar setae, porose areas like deep cavity, sensilli with club-shaped head, long custodium, and mutual distances,  $(1a - 1a) \approx (2a - 2a)$ . As far as the authors know, form of porose areas such as found in the new species, was also, recorded in *O. magniporosa* Hammer, 1958, *O. exsudans* Travé, 1961, and *Zygoribatula dubita* Coetzer, 1967-1968. However, the new species has different insertion of *lp*, *h*<sub>2</sub> and *h*<sub>3</sub> than the ones of *O. magniporosa*, different form of humeral region, length of *le*, insertion of *c*<sub>2</sub> and direction of *im* than those of *O. exsudans*, and different form of rostral anterior margin and lamellae than those of *Z. dubita*. Sensilli and lamellar tips of the new species are similar in appearance to those of *O. parisi* Travé, 1961 and *O. interrupta* (Willmann, 1939). However, the new species can be distinguished from them by relative distances between their mutual distances of *ro*, *le* and *in*, and from *O. interrupta* by situation of porose areas Aa.

*Zygoribatula iheyaensis* sp. nov.

[Japanese name: Iheya-koitadani]  
(Figs.17 and 18)

Diagnosis — Body length 336  $\mu\text{m}$ ; width 214  $\mu\text{m}$ . Sensilli with spiculate clavate head not terminating in fine point. Relative lengths  $le \approx in > ss > ro > ex$ . Thirteen pairs notogastral setae. Four pairs of porose areas: Aa at a short distance from *la*; A1 posterior to *lp*; A3 near to *h*<sub>1</sub>. Genito-anal setal formula:

4-1-2-3. Epimeral setal formula: 3-1-3-3. Heterotridactylous.

Material examined — Holotype (Male) (NSMT-Ac 13596) from point B.

Etymology — After the name of sampling area, Iheya Village.

Measurements and body appearance — Body length 336  $\mu\text{m}$ ; width 214  $\mu\text{m}$ . Body colour light yellowish brown. Whole integument smooth.

Prodorsum — Rostral tip rounded, weakly protruding, bearing setae *ro* (38  $\mu\text{m}$ ) at lateral margins, extending anterior of rostrum for distance equal to half of their length (Fig. 17A). Lamellae convergent, extending from bothridia to about half-way along length of prodorsum, connected by thick translamella, arising setae *le* (58  $\mu\text{m}$ ) at apices; *le* extending anterior of rostrum for distance equal to one-third of their length. Setae *in* (58  $\mu\text{m}$ ) extending for short distance in front of translamella. Relative distances  $(ro - ro)$  (48  $\mu\text{m}$ )  $\approx (in - in) > (le - le)$  (21  $\mu\text{m}$ ). Bothridia opened antero-laterally. Sensilli (*ss*) (56  $\mu\text{m}$ ) with spiculate clavate head not terminating in fine point (17B). Setae *ex* (6  $\mu\text{m}$ ) short, thick. Relative lengths  $le \approx in > ss > ro > ex$ .

Notogaster — Oval, medially weakly protruding at anterior margin, bearing thirteen pairs notogastral setae and four pairs of porose areas. All notogastral setae thin, smooth setiform; setae *p*<sub>2</sub> absent. Porose areas Aa located lateral to setae *la*; A1 just behind *lp*; A2 postero-laterally to *h*<sub>3</sub>; A3 antero-laterally to *h*<sub>1</sub>. Lyrifissures *ia* aligned longitudinally postero-laterally to *c*<sub>1</sub> (19  $\mu\text{m}$ ); *im* obliquely anterior to *lp*; *ih* obliquely lateral to *lp*; *ips* obliquely posterior to *ih*; *ip* obliquely behind *h*<sub>1</sub>. Opening *gla* situated postero-laterally to *im*.

Ventral region — Genital (48  $\mu\text{m}$ ) and anal (77  $\mu\text{m}$ ) apertures roughly circular; distance (77  $\mu\text{m}$ ) between them nearly as long as length of anal aperture (Fig. 18B). Genito-anal setal formula: 4-1-2-3; all setae smooth setiform. Setae *g*<sub>1</sub> (10  $\mu\text{m}$ ) inserted at anterior margin of plates. Setae *ag* (10  $\mu\text{m}$ ) inserted latero-posteriorly to genital aperture. Setae *ad*<sub>1</sub> (10  $\mu\text{m}$ ) aligned in postanal position; *ad*<sub>2</sub> in adanal; *ad*<sub>3</sub> in preanal. Lyrifissures *iad* located lateral to *ad*<sub>3</sub>, in preanal position variable in direction. Epimeral borders bo. 1-3, *sj* interrupted medially. Sternal ridge

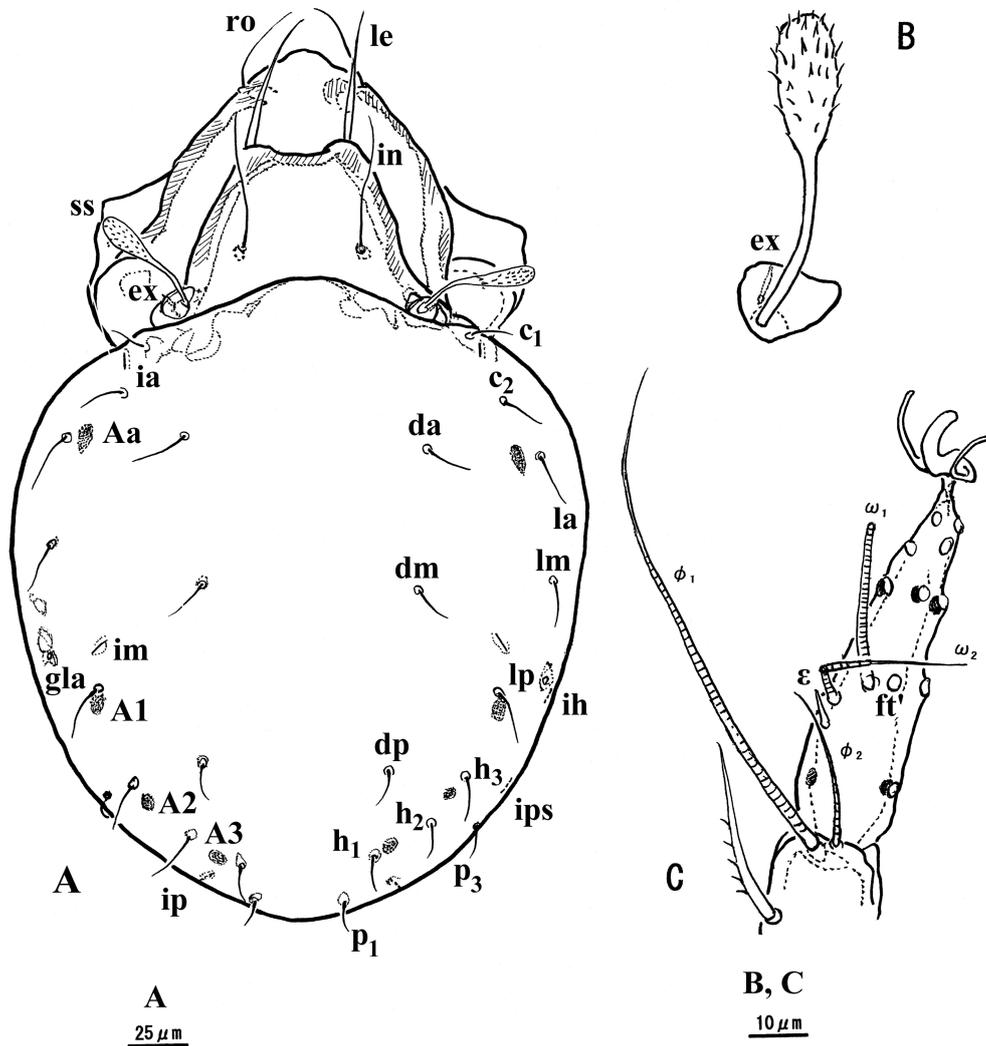


FIGURE 17: *Zygoribatula iheyaensis* sp. nov. A, Dorsal view; B, Bothridial region; C, Solenidial region on tarsus and tibia of leg I.

and bo 4 indistinct. Epimeral setal formula: 3-1-3-3; setae barbed setiform; setae 1a-c, 3b and 3c longer than other setae (Fig. 18A). Diarthric subcapitulum bearing 3 pairs of setae: *a* (4  $\mu$ m), *m* (9  $\mu$ m) and *h* (22  $\mu$ m); *a*, *m* thin, smooth setiform; *h* barbed longer than *a* and *m*.

Legs — Heterotridactylous. Setal formula: I (1-5-3-4-18), II (1-5-2-4-15), III (2-4-1-3-13), IV (1-2-2-3-12). On tarsus I, famulus  $\epsilon$  bacilliform situated posterior to solenidia  $\omega_2$ ;  $\omega_2$  setiform, sharply bending. Solenidion  $\omega_1$  bacilliform inserted latero-anterior to  $\omega_2$ . Solenidion  $\phi_2$  on tibia I lateral to  $\phi_1$  (Fig. 17C).

Remarks — The new species resembles in some respects *Zygoribatula truncata* Aoki, 1961, however, it differs from this latter species by long interlamellar setae, rounded tip of head of sensilli, protruding anterior medial margin of notogaster, and different situation of porose areas Aa, A1 and A3: Aa at a short distance from *la*, A1 posterior to *lp*, A3 near to *h\_1*. Notogastral setae  $p_2$  of the new species is absent as it is in *Z. connexa substriata* Grobler et Kok, 1993. However, the new species is different from *Z. connexa substriata* in notogastral surface without faint yellow striations. Situation of notogaster setae

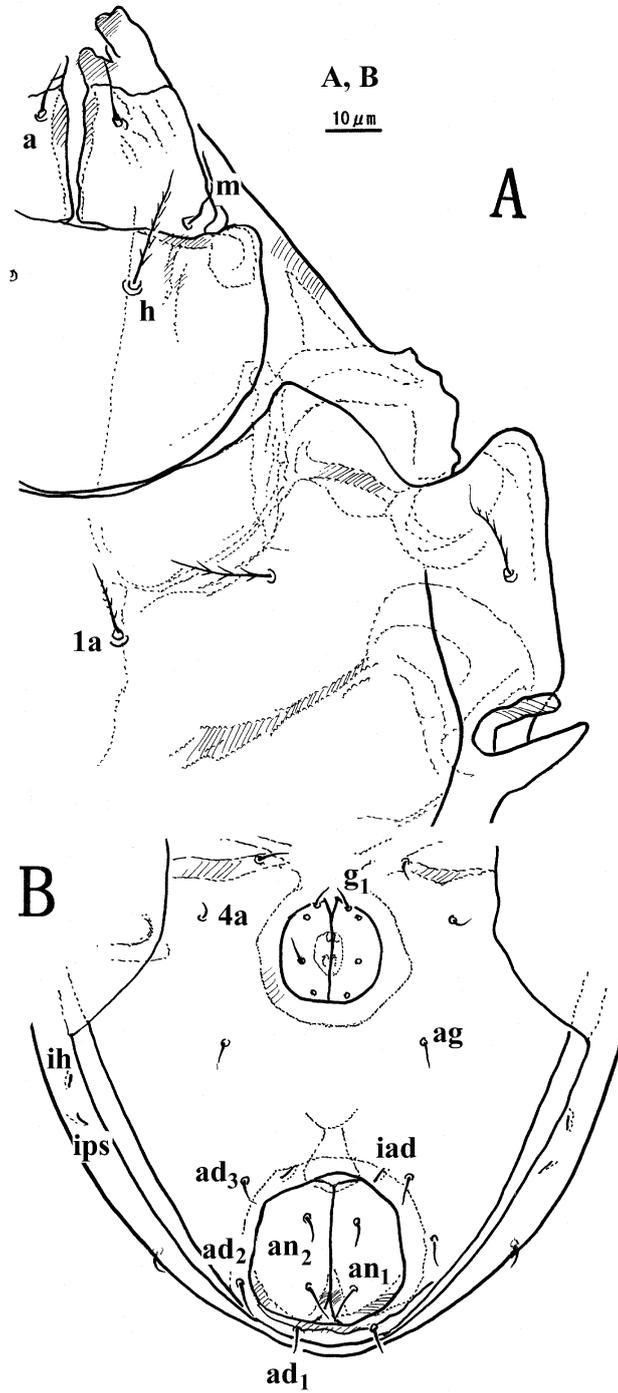


FIGURE 18: *Zygoribatula iheyaensis* sp. nov. A, Anterior half of left ventral region; B, Genito-anal region.

and porose areas of the new species are very similar in appearance to those of *Z. glabra* (Michael, 1890) and *Z. propinguus* (Oudemans, 1902). However, the new species differs from them because of a rounded rostrum.

## HAPLOZETIDAE GRANDJEAN, 1936

### *Protoribates kumayaensis* sp. nov.

[Japanese name: Kumaya-kosodedani]  
(Figs. 19 and 20)

Diagnosis — Body length 314  $\mu\text{m}$ ; width 150  $\mu\text{m}$ . Rostral with a pair of tooth-like tubercles (rt) in the interior. Setae *le* inserted far from lamellae, not reaching the insertions of rostral setae. Pteromorphs immovable. Pleurophragmata (hl) and dorsophragmatic apophyses (hy) conspicuously. Ten pairs of notogastral setae short. Four pairs of porose areas. Genito-anal setal formula: 5-1-2-3. Epimeral setal formula: 3-1-3-4. Monodactyle.

Material examined — Holotype (Female) (NSMT-Ac 13597) from point B.

Etymology — After the name of sampling point, Kumaya Cave.

Measurements and body appearance — Body length 314  $\mu\text{m}$ ; width 150  $\mu\text{m}$ . Body colour light yellowish brown. Body surface smooth. Body partly covered with tunic bearing dark granules.

Prodorsum — Rostral tip broadly rounded, with a pair of tooth-like tubercles (rt) in the interior, about 9  $\mu\text{m}$  in length (Fig. 19A). Setae *ro* (22  $\mu\text{m}$ ) smooth setiform, inserted on lateral margins of rostrum. Lamellae thin, situated at lateral sides, extending for two-third length (65  $\mu\text{m}$ ) of prodorsum, without sharply pointed apex or dens. Translamellar absent. Setae *le* (26  $\mu\text{m}$ ) short, smooth spiniform, inserted far from lamellae, not reaching the insertions of rostral setae. Setae *in* (58  $\mu\text{m}$ ) spiniform, barbed throughout length, extending for short distance anterior of setae *le*. Bothridia opened anterolaterally. Sensilli (*ss*) (65  $\mu\text{m}$ ) consisting of fusiform head and thin long stem, pectinate unilaterally (Fig.

19C). Setae *ex* (5  $\mu\text{m}$ ) short, barbed setiform. Relative lengths and distances of prodorsal setae:  $ss \approx in \approx 2x le$ ;  $le > ro$ ;  $(in - in)$  (62  $\mu\text{m}$ )  $> (le - in)$  (47  $\mu\text{m}$ )  $> (le - le)$  (42  $\mu\text{m}$ )  $> (ro - ro)$  (37  $\mu\text{m}$ )  $> (ro - le)$  (31  $\mu\text{m}$ ).

Notogaster — Pteromorphs immovable, not extending anteriorly beyond level of arched dorsosejugal scissure (Fig. 19B). Pleurophragmata (hl) and dorsophragmatic apophyses (hy) conspicuously long and dark colourful. Ten pairs of notogastral setae short, smooth setiform. Four pairs of porose areas present; Aa situated at the center of the isosceles triangle given by insertions of *c*<sub>2</sub> (7  $\mu\text{m}$ ), *la* and *lm* as three vertices; A1 immediately lateral to *lp*; A2 immediately antero-laterally to *h*<sub>2</sub>; A3 antero-laterally to *p*<sub>1</sub>. Lyrifissures *ia* aligned obliquely postero-laterally to *c*<sub>2</sub>; *im* transversely anterior to *h*<sub>3</sub>; *ih* transversely antero-laterally to *h*<sub>3</sub>; *ip* obliquely lateral to *p*<sub>1</sub>; *ips* obliquely postero-laterally to *p*<sub>3</sub>. Opening *gla* situated between *im* and *h*<sub>3</sub>.

Ventral region — Genital (40  $\mu\text{m}$ ) and anal (62  $\mu\text{m}$ ) apertures almost pentagonal and circle in form, respectively; length of anal aperture about 1.5x as long as that of genital aperture; distance (88  $\mu\text{m}$ ) between them twice as long as length of genital aperture (Figs. 20A and B). Genito-anal setal formula: 5-1-2-3; all setae smooth setiform. Genital setae (6  $\mu\text{m}$ ) aligned in a row; *g*<sub>1</sub> remote from anterior margin of plates. Setae *ag* (6  $\mu\text{m}$ ) inserted posterior to genital aperture. Setae *an*<sub>2</sub> inserted about half-way along length of anal plates. Setae *ad*<sub>1</sub> aligned in postanal position; *ad*<sub>2</sub> in adanal; *ad*<sub>3</sub> in preanal. Lyrifissures *iad* located along outline of anal aperture, at the level anterior of the insertions of *an*<sub>2</sub>. Sternal ridge and bo. 4 indistinct. Other epimeral borders interrupted medially. Epimeral setal formula: 3-1-3-4; setae short, smooth setiform. Diarthric subcapitulum bearing 3 pairs of setae; setae short, smooth; *a*, *m* thin, setiform; *h* spiniform. Relative lengths of ventral and subcapitular setae:  $an$  (15  $\mu\text{m}$ )  $\approx ad > a$  (13  $\mu\text{m}$ )  $\approx m > h$  (10  $\mu\text{m}$ )  $> g$  (6  $\mu\text{m}$ )  $\approx ag \approx 1a$ .

Legs — Monodactyle. Trochantera IV bearing carina protruding in a sharp point. Legs not studied.

Remarks — The new species has remarkable characters, a pair of tooth-like tubercles (rt) of rostrum in the interior and conspicuously pleu-

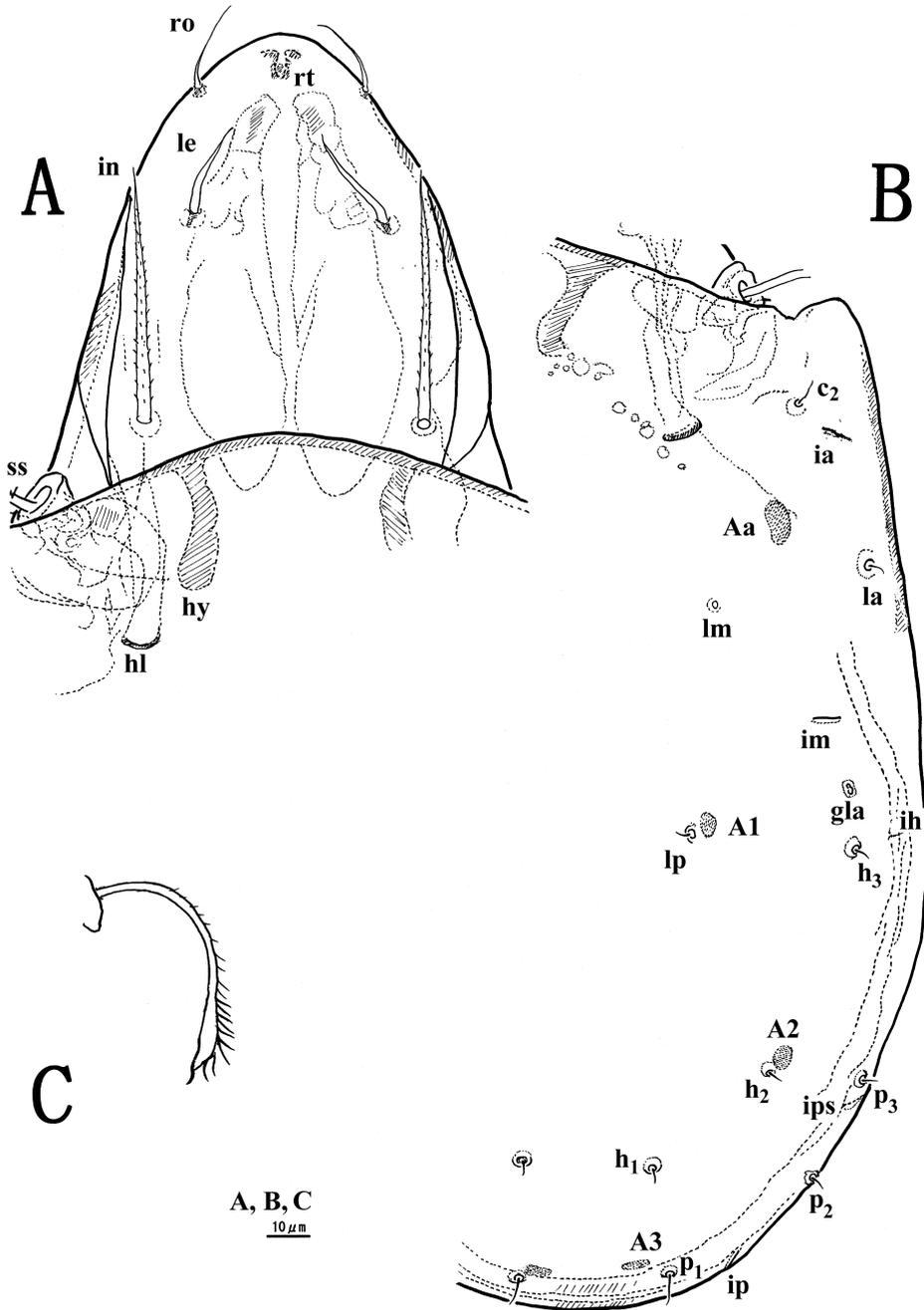


FIGURE 19: *Protoribates kumayaensis* sp. nov. A, Prodorsum; B, Right half of notogaster; C, Right sensillus.

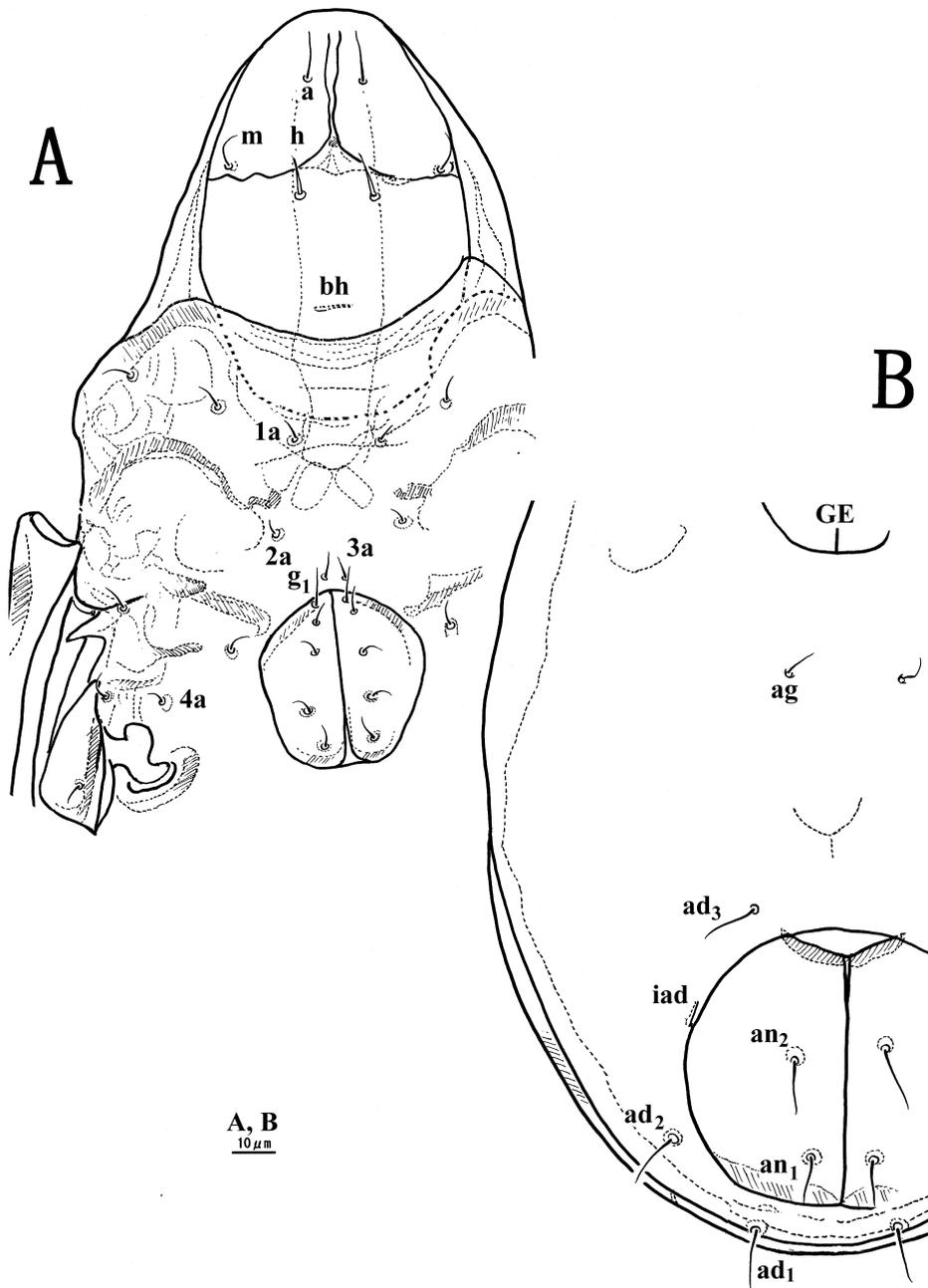


FIGURE 20: *Protoribates kumayaensis* sp. nov. A, Anterior half of ventral region; B, Posterior half of ventral region.

rophragmata (hl) such as found in *Protoribates capucinus* Berlese, 1908 according to Hammer, 1961. However, the new species is distinguished from *P. capucinus* by the form of tubercles (rt), thickness of lamellar and interlamellar setae, and distances ( $le - in$ ) > ( $le - le$ ) and ( $ro - ro$ ) > ( $ro - le$ ). According to Hammer (1973), *P. capucinus* has eleven pairs of notogastral setae, however the new species has ten pairs of notogastral setae. The new species has smaller body size than Italian specimen 420  $\mu\text{m}$  in length and 250  $\mu\text{m}$  in width (Berlese, 1908).

***Protoribates hirokous* sp. nov.**

[Japanese name: Hiroko-kosodedani]  
(Figs. 21 and 22)

Diagnosis — Body length 429 (468) 507  $\mu\text{m}$ ; width 279 (300) 321  $\mu\text{m}$ . Thin lamellar ridges situated marginally. Pteromorphae movable. Ten pairs of notogastral setae. Genito-anal setal formula: 5-1-2-3. Setae  $ad_1$  and  $ad_2$  longer than  $ad_3$ . A short Trägårdh's organ terminating in a fine apex. Monodactyl.

Material examined — Holotype (Female) (NSMT-Ac 13598) from point D; 2 paratypes (Female and male) (NSMT-Ac 13599 and 13600): same data as holotype.

Etymology — The new species is dedicated to Miss Hiroko Fukumori who gave the authors helpful suggestions for sampling.

Measurements and body appearance — Body length 429 (468) 507  $\mu\text{m}$ ; width 279 (300) 321  $\mu\text{m}$ . Body colour light brown. Whole integument smooth. Muscle sigillae seen as a number of light spots arranged on epimeres and peripherally on notogaster.

Prodorsum — Prodorsum triangular (Fig. 21A). Rostral tip round bearing setae  $ro$  laterally. Setae  $ro$  (75  $\mu\text{m}$ ) long setiform, extending for two-third length of seta beyond rostral margin. Thin lamellar ridges situated at marginal position of prodorsum, extending forwards from bothridia to almost mid-distance along prodorsum setae  $le$  arising at base of short extension, without cuspis or translamellar;  $le$  short (35  $\mu\text{m}$ ) setiform, reaching insertions of setae

$ro$ . Setae  $in$  long (75  $\mu\text{m}$ ) spiniform, extending for short distance anterior of insertions of setae  $le$ . Setae  $ro$ ,  $le$  and  $in$  ciliate throughout length. Bothridia opened anterolaterally. Sensilli ( $ss$ ) (75  $\mu\text{m}$ ) pectinate unilaterally, consisting of fusiform head and long stem, strongly elbowed near base (Fig. 21D). Setae  $ex$  (5  $\mu\text{m}$ ) short, smooth setiform. Relative lengths and distances of prodorsal setae:  $ro \approx in \approx ss \approx 2x le > ex$ ; ( $in - in$ ) (123  $\mu\text{m}$ ) > ( $le - le$ ) (83  $\mu\text{m}$ ) > ( $le - in$ ) (63  $\mu\text{m}$ ) > ( $ro - ro$ ) (56  $\mu\text{m}$ ) > ( $ro - le$ ) (35  $\mu\text{m}$ ).

Notogaster — Pteromorphae movable, without acute angle, not extending anteriorly beyond level of arched dorsosejugal suture. Ten pairs of notogastral setae short smooth setiform. Four pairs of porose areas present: Aa largest, roughly triangle (Fig. 21C) situated anterior to mid-distance between  $la$  and  $lm$ ; A1, A2 elliptical; A1 immediately anterior to  $lp$ ; A2 between  $h_2$  and  $h_3$ ; A3 oval, lateral to  $p_1$ . Opening  $gla$  situated lateral to  $lp$ . Lyrifissures  $ia$  aligned obliquely at the level of Aa on the pteromorphae;  $im$  transversely antero-laterally to  $gla$ ;  $ip$  obliquely between  $p_1$  and  $p_2$ . Relative distances central notogastral setae: ( $lp - h_1$ ) (110  $\mu\text{m}$ ) > ( $lm - lm$ ) (104  $\mu\text{m}$ )  $\approx$  ( $lm - lp$ ) > ( $lp - lp$ ) (87  $\mu\text{m}$ ) > ( $h_1 - h_1$ ) (54  $\mu\text{m}$ ) > ( $p_1 - p_1$ ) (48  $\mu\text{m}$ ).

Ventral region — Genital (48  $\mu\text{m}$ ) and anal (106  $\mu\text{m}$ ) apertures roughly circle in form; length of anal aperture about 2x as long as that of genital aperture; distance (123  $\mu\text{m}$ ) between them appreciably 2.5x as long as length of genital aperture (Fig. 21B). Genito-anal setal formula: 5-1-2-3; setae  $g$ ,  $ag$ ,  $an$  smooth setiform. Setae  $g_1$  (11  $\mu\text{m}$ ) remote from anterior margin of the plate. Setae  $ag$  (11  $\mu\text{m}$ ) inserted latero-posteriorly to genital aperture. Setae  $an_1$  and  $an_2$  (33  $\mu\text{m}$ ) remote from each other and margins of plates. Adanal setae variable in form and length:  $ad_1$  and  $ad_2$  (45  $\mu\text{m}$ ) spiniform, barbed unilaterally, longer than  $ad_3$  (21  $\mu\text{m}$ );  $ad_3$  short, smooth setiform. Setae  $ad_1$  aligned in postanal position;  $ad_2$  in adanal;  $ad_3$  in preanal. Lyrifissures  $iad$  located at level of insertions of setae  $an_2$ . Sternal ridge distinct at bo 2. Epimeral borders bo. 1-3, sj distinct. Epimeral setal formula: 3-1-3-3;  $1b$ ,  $3b$ ,  $3c$  barbed throughout length, longer (33  $\mu\text{m}$ ) than others; others simple. Diarthric subcapitulum bearing 3 pairs of setae;  $a$  (30  $\mu\text{m}$ ) smooth spiniform;  $m$  (11  $\mu\text{m}$ ) short seti-

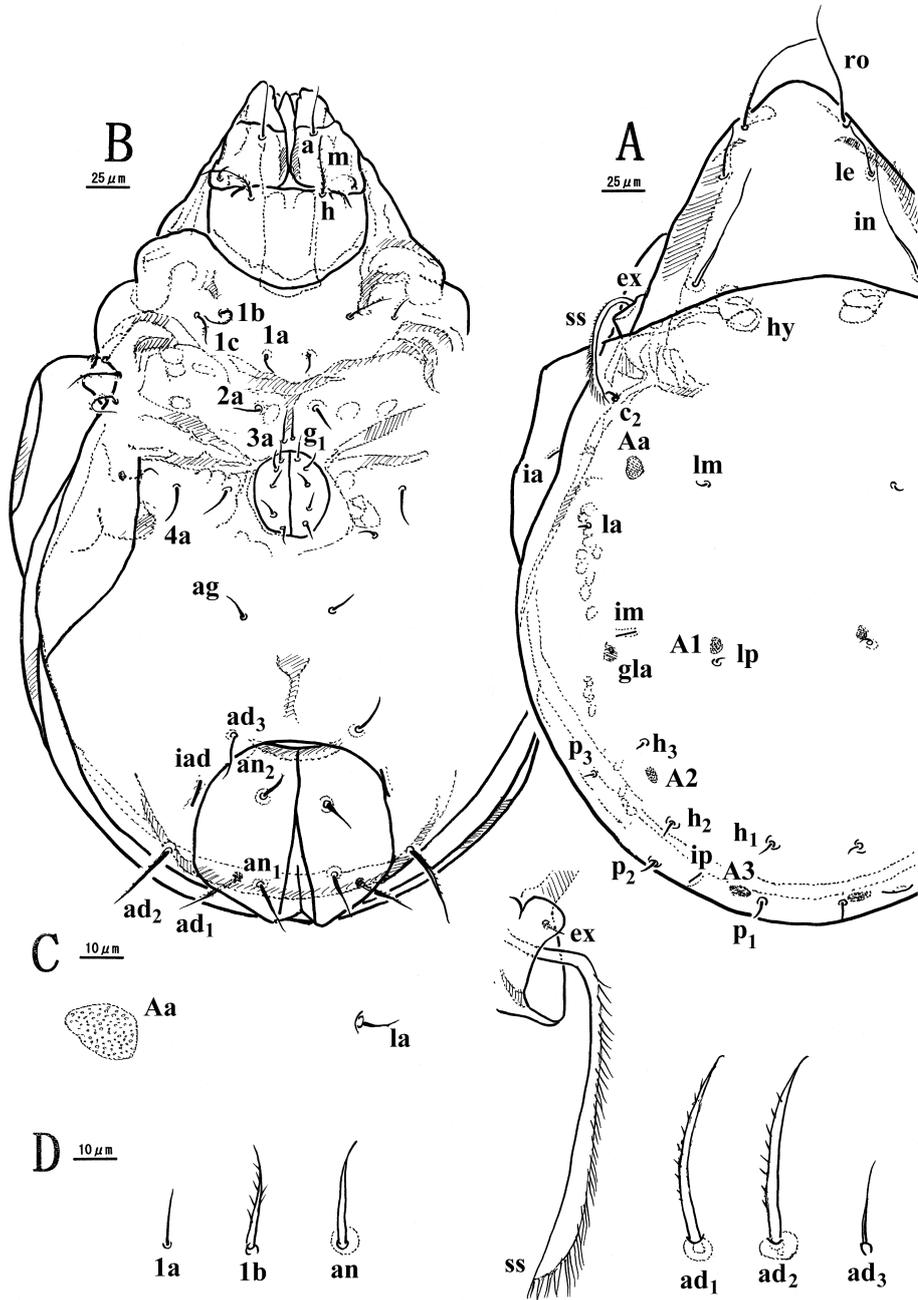


FIGURE 21: *Protoribates hirokous* sp. nov. A, Dorsal view; B, Ventral view; C, Aa region; D, Setae.

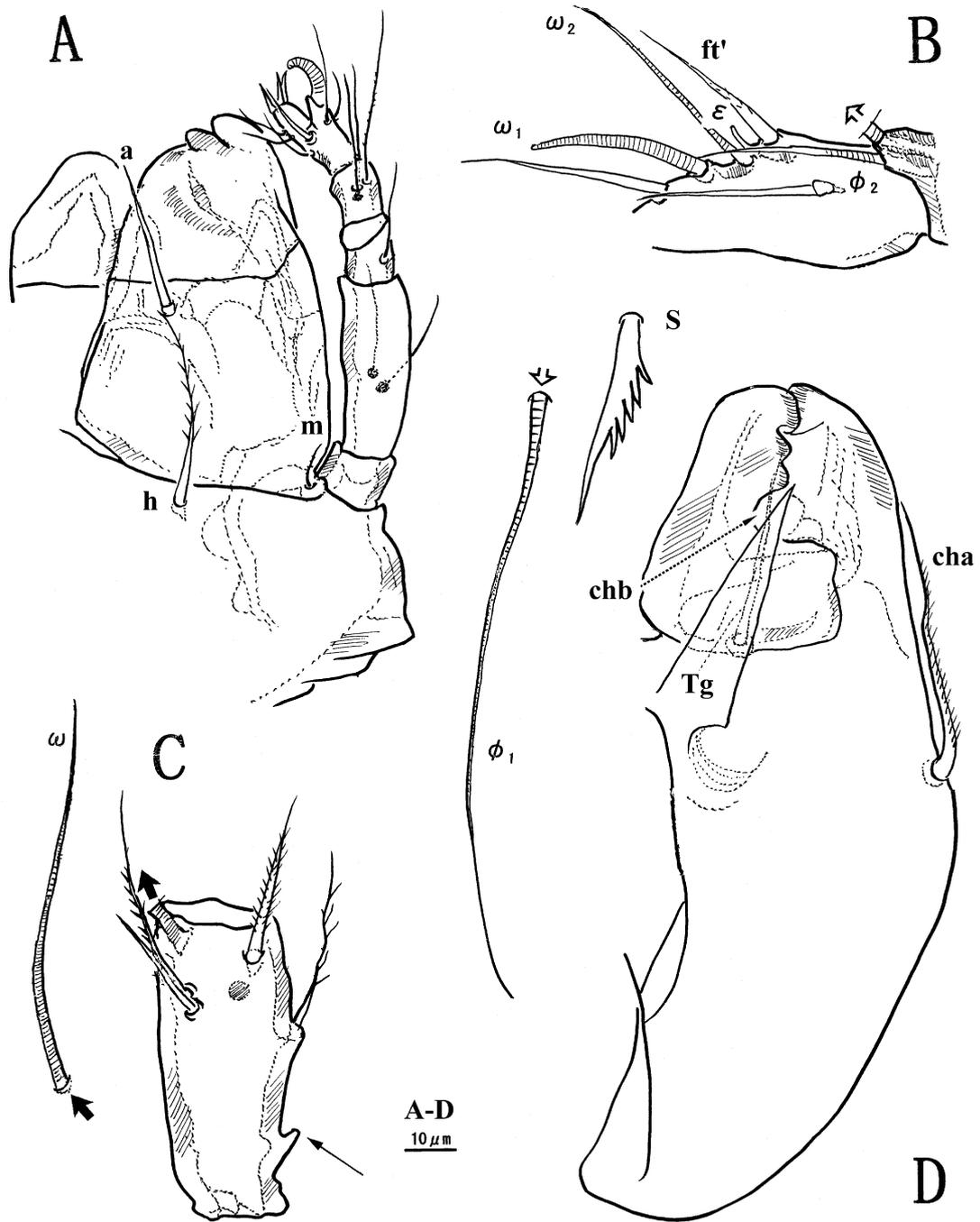


FIGURE 22: *Protoribates hirokous* sp. nov. A, Gnathosomal region; B, Solenidial region on tarsus and tibia of leg I; C, Tibia II (narrow arrow: spur); D, Chelicera.

form, sparsely, minutely barbed; *h* (38  $\mu\text{m}$ ) closely barbed throughout length (Fig. 22A). Pedipalpal setal formula 0-2-1-3-9[1]; solenidion thick, strongly elbowed, originating from apophysis, coupled with *acm*. Chelicera bearing a short Trägårdh's organ terminating in a fine apex; *cha* unilaterally ciliate and *chb* smooth; *cha* longer than *chb* (Fig. 22D).

Legs — Monodactyl; claws without dens. Setal formula: I (1-5-3-4-22), II (1-5-3-4-15), III (2-3-1-3-15), IV (1-2-2-3-12). Tibiae II bearing small spur at proximal portion (Fig. 22C). On tarsus I, famulus  $\varepsilon$  bacilliform situated between solenidion  $\omega_2$  and fastigial seta *ft'* (Fig. 22B). Solenidion  $\omega_1$  bacilliform;  $\omega_2$  setiform, inserted behind  $\omega_1$ ;  $\omega_1$  shorter than  $\omega_2$ ; seta *ft'* as long as,  $\omega_1$ . Solenidion  $\varphi_1$  originating from apophysis;  $\varphi_2$  contiguous to  $\varphi_1$ .

Remarks — The new species has short lamellar setae such as in *Protoribates paracapucinus* (Mahunka, 1988) and *P. brevisetosus* (Fujita, 1989). However, it differs from them in distances among central notogastral setae, *lm*, *lp* and  $h_1$ , and notogastral setae  $h_2$  inserted remote from porose areas A2. The prodorsal triangular form and arched dorsosejugal scissure extending beyond pteromorphae of the new species is very similar in appearance to those of *P. dentatus* (Berlese, 1883). However the new species has short lamellar, interlamellar and notogastral setae, and monodactyl, while *P. dentatus* has long prodorsal and notogastral setae, and tridactylous (Berlese, 1916 [1917]; Pérez-Iñigo, 1992).

***Haplozetes makii* sp. nov.**

[Japanese name: Maki-koitadani]  
(Figs. 23 and 24)

Diagnosis — Body length 329  $\mu\text{m}$ ; width 193  $\mu\text{m}$ . Four pairs of saccules. Pteromorphs movable. Ten pairs of notogastral setae. Sensilli consisting of capitate spiculate head and long, smooth, thin stem. Thin lamellar ridges converge. Diarthric subcapitulum. Genito-anal setae: 4-1-2-3; all setae smooth, thin setiform. Heterotridactylous.

Material examined — Holotype (Female) (NSMT-Ac 13601) from point D; 1 paratype (Female) (NSMT-Ac 13602): same data as holotype.

Etymology — The new species is dedicated to Miss Maki Fukumori for her continual encouragement.

Measurements and body appearance — Body length 329  $\mu\text{m}$ ; width 193  $\mu\text{m}$ . Body colour light brown. Whole integument smooth. A number of light spots arranged peripherally on notogaster.

Prodorsum — Rostrum protruding with blunt tip, bearing setae *ro* at lateral sides (Fig. 23A). Setae *ro* long (40  $\mu\text{m}$ ) setiform bearing long and short barbs, antiaxially and paraaxially, respectively, extending for two-third length of seta anterior of rostral margin. Thin lamellar ridges convergent, situated not submarginal, extending anterior from bothridia to short distance in front of mid-distance along the prodorsum, setae *le* arising at ends, without cusp or translamellar; *le* long (58  $\mu\text{m}$ ) setiform, extending for short distance beyond rostral tip. Setae *le* and *in* barbed throughout length. Setae *in* (58  $\mu\text{m}$ ) extending for short distance anterior of insertions of setae *le*. Bothridia opened anterolaterally. Sensilli (*ss*) (43  $\mu\text{m}$ ) consisting of capitate spiculate head and long, smooth, thin stem (Fig. 23C). Setae *ex* (7  $\mu\text{m}$ ) short, smooth spiniform. Relative distances of prodorsal setae: (*in* – *in*) (48  $\mu\text{m}$ ) > (*le* – *le*) (44  $\mu\text{m}$ ) > (*le* – *in*) (37  $\mu\text{m}$ ) > (*ro* – *ro*) (35  $\mu\text{m}$ ) > (*ro* – *le*) (25  $\mu\text{m}$ ).

Notogaster — Pteromorphs movable, without acute angle, not extending anteriorly beyond level of arched dorsosejugal scissure. Ten pairs of notogastral setae short smooth setiform; variable in number, namely one specimen without pair of  $p_2$ . Four pairs of saccules present: Sa and S1 situated anterior-laterally to *lm* and *lp*, respectively; S2 immediately postero-laterally to  $h_2$ ; S3 lateral to  $h_1$ . Opening *gla* situated lateral to *lp*. Lyrifissures *ia* aligned nearly along joint of notogaster and pteromorph; *im* obliquely antero-laterally to S1; *ip* perpendicular to notogastral outline behind  $h_2$ ; *ih* and *ips* obliquely. Relative distances among central notogastral setae: (*lm* – *lm*) (96  $\mu\text{m}$ )  $\approx$  ( $h_2$  –  $h_2$ ) > (*lp* – *lp*) (87  $\mu\text{m}$ ) > (*lm* – *lp*) (73  $\mu\text{m}$ ) > (*lp* –  $h_2$ ) (58  $\mu\text{m}$ ).

Ventral region — Genital (48  $\mu\text{m}$ ) and anal (67  $\mu\text{m}$ ) apertures roughly circle in form; length of anal aperture about 1.4x as long as that of genital aperture; distance (100  $\mu\text{m}$ ) between them about twice as

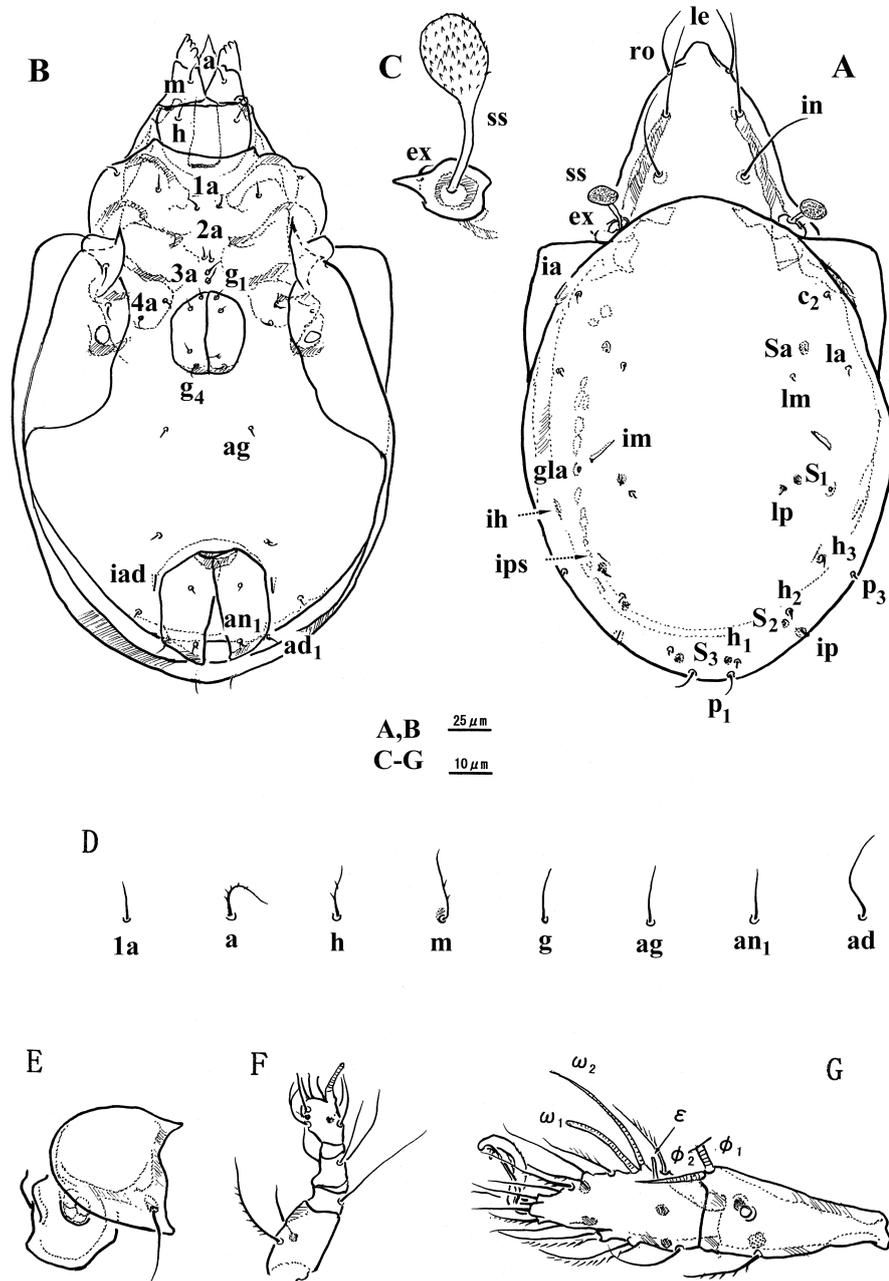


FIGURE 23: *Haplozetes makii* sp. nov. A, Dorsal view; B, Ventral view; C, Bothridial region; D, Setae; E, Trochanter IV; F, Pedipalp; G, Tarsus and tibia of leg I.

long as length of genital aperture (Fig. 23B). Genito-anal setae: 4-1-2-3; all setae smooth, thin setiform. Setae  $g_1, g_2$  remote from  $g_3, g_4$ . Setae  $ag$  inserted latero-posteriorly to genital aperture. Setae  $an_1$  inserted near the mid-ventral line shorter than  $an_2$ . Setae  $ad_1$  aligned in latero-posteriorly to aperture;  $ad_2$  in adanal position;  $ad_3$  in preanal. Lyrifissures  $iad$  located at level of insertions of setae  $an_2$ , along outline of aperture. Sternal ridge and  $bo\ 4$  indistinct. Epimeral borders  $bo\ 1-3$ ,  $sj$  interrupted medially. Epimeral setal formula: 3-1-3-3; all setae short, thin, simple (Fig. 24).

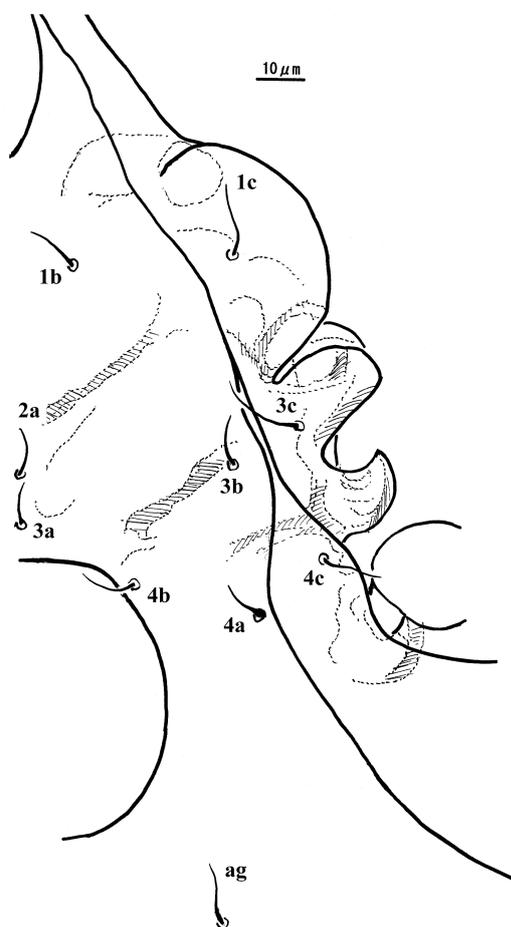


FIGURE 24: *Haplozetes makii* sp. nov. A part of left epimeral region.

Diarthric subcapitulum bearing 3 pairs of setae; all setae sparsely, minutely barbed (Fig. 23D). Pedipalpal setal formula: 0-2-1-3-9[1]; solenidion

thick, originating from apophysis (Fig. 23F). Relative lengths of ventral and subcapitular setae  $ad\ (23\ \mu\text{m}) > m\ (20\ \mu\text{m}) > a\ (19\ \mu\text{m}) > 1a\ (17\ \mu\text{m}) > ag\ (15\ \mu\text{m}) > an\ (14\ \mu\text{m}) > g \approx h\ (13\ \mu\text{m})$ .

Legs — Heterotridactylous; claws minutely dentate. Setal formula: I (1-5-3-4-18), II (1-5-3-4-16), III (2-3-1-3-14), IV (1-2-2-3-12). Trochantera IV bearing carina terminating in fine point dorsally and ventrally (Fig. 23E). On tarsus I, famulus  $\varepsilon$  bacilliform situated posterior to  $\omega_2$  and lateral to seta  $ft'$  (Fig. 22B). Solenidion  $\omega_1$  bacilliform;  $\omega_2$  setiform, inserted behind  $\omega_1$ ;  $\omega_1$  shorter than  $\omega_2$ ; seta  $ft'$  as long as  $\omega_1$ . Solenidion  $\varphi_1$  originating from apophysis;  $\varphi_2$  contiguous to  $\varphi_1$  (Fig. 23G).

Remarks — The new species is similar in form of rostrum and sensilli, length of notogastral setae and size of lamellae to *Haplozetes angustus* (Hammer, 1967) and *H. nudus* (Hammer, 1961). However, the new species differs from them in having sacculi S2 posterior to setae  $h_2$  and their mutual distance of  $lp$  smaller than those of  $lm$  and  $h_2$ .

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