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$^3$ 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; 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; Mabulatrichus kumayaensis sp. nov., Protoribates kumayaensis sp. nov. and Zygorybatula iheyaensis sp. nov. from B; Tectocepheus kumayaensis sp. nov. from C; Tectocepheus 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$^2$ (Arakaki and Ooshiro, in Montpellier INRA, 2010).
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 abyssal 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 cm³ 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 collemboles were collected in sand, a fragment of psephite, and litter of Ficus microcarpa L.; 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 including one nymph were collected from litter and humus of F. microcarpa and Cassytha 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; c1,3, da, dm, dp. la, lm, lp, hdown1-3, p1-3: notogastral setae; cha, chib: posterior and anterior setae of chelicerae, respectively; f’t: fastigial seta of legs; g1-7, ag, an1-3, ad1-3: genital, aggenital, anal and analanal setae, respectively; gla: opisthonotal gland; hy: dorsiophragmatic 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; ε: famulus on tarsus of leg I; ω1-2, φ1-2, δ: solenidia on tarsi, tibiae and genua of legs, respectively; ω 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 (μm) 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).

Neolioididae Sellnick, 1928

Neoliodes iheyaensis sp. nov.

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

Diagnosis — Body length (15 exs.) 771 (1098) 1214 μm; width 643 (742) 893 μm. 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. Noto- gaster 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, lh and p1-3 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 μm; width 643 (742) 893 μm.
FIGURE 2: Neoliodes iheyaensis sp. nov. A, Prodorsum; B, Notogaster.
FIGURE 3: Neoliodes iheyaensis 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: Neolioodes iheyaensis 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: *Neoliosdes 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.
μm. Body colour purplish brown. Integument of prodorsum and legs reticulate: marginal region of prodorsum and notogaster, epimeral region and anal plates cosulate; central region of notogaster alveolate (Plate 1).

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

Notogaster — Oval in shape bearing porose area (Apo) at the center such as found in Calumnidae. A pair of conspicuous large hollow present laterally (Fig. 2B). Hollows elliptical in form, about 69-81 μm in length, directed laterally, considered as opisthonotal gland (gli), as it is in Hermanniellidae and Plasmodatidae. Five pairs of setae, lp, h1 and p1-3 at the posterior margin; setae short, smooth spiniform about 31 μm in length according to depressed specimens (Fig. 4F). Relative distances: (p1 ~ p1) ≈ (p1 ~ p2) (150 μm) ≈ 8x(lp ~ lp) (19 μm); (p2 ~ p3) (58 μm) ≈ 3x(lp ~ lp); (h1 ~ h1) ≈ (lp ~ lp). Lyrifissures ia aligned transversely; im obliquely antero-lateral to hollow; ip extending obliquely between setae p1 and p2.

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 g7. Adanal setae aligned in adanal. Lyrifissures ian and iad inverse apanal, 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 μm), m (70 μm) and h (46 μm); setae smooth spiniform; m longest inserted near mid-ventral line (Fig. 3B). Setae cha and chb long spiniform bearing minute bars 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 genua and femora bearing carina (Fig. 3A). One solenidion of all tibiae and genua with coupled seta. On tarsus I, famulus ε spiniform situated posterior to solenidia ω2; ω2 lateral to ω1 (Fig. 4E). Solenidion ω1 and ω2 setiform. Solenidion ϕ1 on tibia I originating from apophysis, coupled with seta d.

Immature (Plate 1 E-F) — Five tritonymphs: length 921 μm; width 571 μm. 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, opisthobital 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.


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 \( \mu m \); width 150 \( \mu m \). 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 \( \mu m \); width 150 \( \mu m \). 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 Tectocepheus velatus (Michael, 1880) was not found from crevice the species rared with the same condition with O. nova.

**TECTOCEPHEIDAE GRANDJEAN, 1953[1954]**

*Tectocepheus kumayaensis* sp. nov.  
[Japanese name: Kumaya-kuwagatadani]  
(Figs. 6 and 7)


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.
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Measurements and body appearance — Body length 264 µm; width 178 µm. Body colour light brown. Whole body surface covered cerotegument; cerotegument irregularly granulate.

**Figure 7:** Tectocepheus 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 µm) and le (30 µm) 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 µm) small trigonal pyramidal, roughened throughout length. Sensilli (45 µm) composed of thin, roughened stem and globular head which bears dark coloured spines. Setae ex (8 µm) 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 c2; im obliquely, laterally to lp; ip perpendicular to notogastral outline between p1 and p2. Setae h3 inserted antero-lateral to gla.

**Ventral region** — Genital (36 µm) and anal (57 µm) apertures almost pentagonal in form; distance (22 µm) 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 g3 and g2 inserted nearer anterior margin of plates. Setae ag inserted latero-posteriorly to genital aperture. Setae ad1 and ad2 aligned in postanal position, ad3 in adanal. Lyrifissures iad located along, near anterior margin of anal aperture. Ectal ridge distinct at epimeres borders 2-4; bo. 1, 2, sj distinct. Epimeral setal formula: 3-1-3-3; setae smooth, minute setiform. Diarthritic subcapitulum bearing 3 pairs of setae: a (13 µm), m (2 µm) and h (11 µm); setae thin smooth setiform; relative lengths: a ≈ 6x h; m ≈ 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 ε trigonal pyramidal situated between solenidia bacilliform ω1 and setiform ω2 (Fig. 7A). Solenidion ϕ1 on tibia I originating from apophysis, about three times longer than the length of ω1.

Remarks — Rostrum with two concavities of the new species is similar in appearance to those of Tectocepheus 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 Knüll, 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 stricking 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 anterial 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 $T. velatus$ and $T. cuspidentatus$ 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 $\mu$m; width 179 $\mu$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 cusps 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 $\mu$m) nearly as long as $le$. Setae $in$ smooth, small bacilliform. Sensilli (38 $\mu$m) composed of thin, smooth stem and globular head which bears dark coloured spines. Setae $ex$ (7 $\mu$m) smooth, short, shorter than setae $in$ (11 $\mu$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 $c_2$; $im$ 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 $h_3$; $ip$ anterior to $p_2$. Setae $h_3$ inserted postero-laterally to $glu$. Posterior margin of notogaster with broadly truncate elevation bearing setae $h_2$ at corners.

**Ventral region** — Genital (42 $\mu$m) and anal (76 $\mu$m) apertures almost pentagonal in form; distance (24 $\mu$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 $g_1$ and $g_2$ inserted nearer anterior margin of plates; setae $g_1$ (14 $\mu$m) about more than twice as long as the rest setae (6 $\mu$m). Setae $ag$ (6 $\mu$m) inserted latero-posteriorly to genital aperture. Setae $ad_1$ and $ad_2$ aligned in postanal position; $ad_3$ in adanal. Lyrifissures $iad$ located transversely near anterior margin of anal aperture. Ectal 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 $a$
and h thin smooth; a spiniform; m and h setiform; m sparsely barbed; relative lengths: $a \approx m (19 \mu m) \approx 2x h (10 \mu m)$ (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 ε 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 $\mu m$) about four times longer than the length of $\omega_1$ (18 $\mu m$); $\varphi_2$ 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 Tectocepheus velatus (Michael, 1880) and T. velatus sarekensis Trägårdh, 1910 (Fujikawa, 1988; Laumann et al., 2007; Weigmann, 2002). However, 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 $\mu m$; width 486 $\mu m$. 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: Tectocephus iheyaensis sp. nov. A, Notogaster; B, Genito-anal region.
FIGURE 10: *Eupelops kunayaensis* 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. Heterotridactylyous.

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 μm; width 486 μm. 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 extending for short distance anterior of rostral margin. Setae g1 and g2 inserted at anterior margins of plates; g6 at posterior margins. Setae ag inserted latero-posteriorly to genital aperture. Setae an1 and an2 inserted near anterior and posterior margin of plates, respectively. Setae ad1 and ad2 aligned in postanal position; ad3 in anal.

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. 11D). Chelicerae bearing two Trägårdh’s organs. Chelicera with two Trägårdh’s organs.

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 h3, and chelicera with two Trägårdh’s organs.
E. acronios (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]

Mabulatrichus kumayaensis sp. nov.

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


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 μm; width 229 μm. Body colour light brown. Whole integument smooth, with numerous notogastral micropores.

Prodoms — 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 μm), le (89 μm) and in (59 μm) spiniform, ciliate throughout length, originating from small apophyses. Bothridia opened antero-laterally. Sensilli (ss) (64 μm) setiform, ciliate throughout length; relative lengths ss ≈ 1.3x ro. Setae ex (15 μm) thin, short, smooth, setiform.

Noto-gaster — Medially interrupted dorsosejugal scissure directed forwards, ending at level of mid-distance between setae le and in. Humeral region developed, bearing barbed spiniform setae c2 (36 μm). Humeral saccule (hu) large. Piriform organ (py) conspicuous (Fig. 12B). Other nine pairs of notogastral setae except for c2, thin, smooth, short setiform (8 μm). Lyrifissures ia (16 μm) and im (18 μm) remarkable long, aligned almost perpendicular to notogastral outline; ih and ip transversely aligned; ips obliquely aligned to notogastral outline. Noto-gaster with marginal line between anterior of setae la (Fig. 12C). Noto-gaster separated medially and overlapping at posterior border (Fig. 14).

Ventral region — Genital aperture (41 μm) almost square in form; anal aperture (69 μm) rectangular; distance (99 μm) 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 μm) about 4x longer than anal (3 μm) and anal (3 μm) setae, and about 2.5x longer than aggenital setae (6 μm). Setae an1 and ad3 absent. Genital setae (g1) 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 ad1 aligned in postanal position, ad2 in anal. 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 μm), m (35 μm) and h (35 μm); setae barbed; a and m setiform; h spiniform. Custodium sharp, long, extending anteriorly of setae 1c (Fig. 13A).

Legs — Heterotridactylyous; 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 ε minute bacilliform, situated lateral to seta ft’ (Fig. 13B). Solenidion ω1 bacilliform, inserted posterior to famulus. Solenidion ω1 setiform, situated anterior to ft’. Solenidion ϕ1 on tibia I originating from apophysis; ϕ2 situated lateral to the base of apophysis of ϕ1.

Remarks — The new species is distinguished from all the species of the genus Mabulatrichus, 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: *Mabulatrichus kumayaensis* sp. nov. A, Prodorsum; B, Anterior half of left notogaster; C, Posterior half of left notogaster.
FIGURE 13: *Mabulatrichus kumayensis* sp. nov. A, Anterior half of ventral region; B, Solenidial region on tarsus and tibia of leg I.
FIGURE 14: *Mabulatrichus kumayaensis* sp. nov. Posterior half of ventral region.
**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 \( c_1 \) and lateral to \( c_2 \); da posterior to \( c_2 \). 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 extention,
without cusp nor translamella. Setae le and in (54 \( \mu \text{m} \)) thick spiniform, ciliate throughout length, extending for short distance anterior of insertions of setae ro and le, respectively. Relative distances, (in – in) (52 \( \mu \text{m} \)) > (ro – ro) (41 \( \mu \text{m} \)) > (le – le) (40 \( \mu \text{m} \)). Bothridia opened antero-laterally. Sensilli (ss) (34 \( \mu \text{m} \)) 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 \( \mu \text{m} \) in depth, 9 \( \mu \text{m} \) in diameter), surrounded by clearly sclerotized areas (Fig. 16A). Fourteen pairs of notogastral setae present; c1 (23 \( \mu \text{m} \)) barbed spiniform, thicker than the remainder; other setae thin, smooth setiform. Porose areas Aa situated posterior to c1 and lateral to c2; da posterior to c2. Lyrifissures ia aligned obliquely lateral to c1; im obliquely immediately anterior to A1; ih and ips obliquely to notogastral outline; ip obliquely behind h1. A number of light spots arranged peripherally on notogaster.

Ventral region — Genital (42 \( \mu \text{m} \)) and anal (54 \( \mu \text{m} \)) apertures roughly circular; distance (78 \( \mu \text{m} \)) 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 g1 (12 \( \mu \text{m} \)) inserted at anterior margin of plates; setae g3 near lateral margins. Setae ag (17 \( \mu \text{m} \)) inserted latero-posteriorly to genital aperture. Setae an1 (12 \( \mu \text{m} \)) inserted almost mid-distance along plates. Setae ad1 (15 \( \mu \text{m} \)) aligned in postanal position; ad2 in adanal; ad3 in preanal. Lyrifissures iad located postero-laterally to ad3, 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 \(\mu\)m), \(m\) (19 \(\mu\)m) and \(h\) (19 \(\mu\)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 \(5-2-3-17\), II (1-5-2-3-14), III (2-3-1-3-12), IV (1-2-2-3-12). On tarsus I, famulus \(5 \approx 6 \approx 7\) setiform situated immediately posterior to solenidion \(\omega_2\); \(\omega_2\) posterior to \(\omega_1\). Solenidion \(\varphi \approx \omega_1\) 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 \(lp\), \(h_2\) and \(h_3\) than the ones of *O. magniporosa*, different form of humeral region, length of \(le\), insertion of \(c_2\) 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 \(\mu\)m; width 214 \(\mu\)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 \(h_1\). 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 \(\mu\)m; width 214 \(\mu\)m. Body colour light yellowish brown. Whole integument smooth.

Prodorsum — Rostral tip rounded, weakly protruding, bearing setae \(ro\) (38 \(\mu\)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 halfway along length of prodorsum, connected by thick translamella, arising setae \(le\) (58 \(\mu\)m) at apices; \(le\) extending anterior of rostrum for distance equal to one-third of their length Setae \(in\) (58 \(\mu\)m) extending for short distance in front of translamella. Relative distances \((ro - ro)\) (48 \(\mu\)m) \(\approx (in - in) > (le - le)\) (21 \(\mu\)m). Bothridia opened antero-laterally. Sensilli (\(ss\)) (56 \(\mu\)m) with spiculate clavate head not terminating in fine point (17B). Setae \(ex\) (6 \(\mu\)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 \(p_2\) absent. Porose areas \(Aa\) located lateral to setae \(la\); \(A1\) just behind \(lp\); \(A2\) posterolaterally to \(h_3\); \(A3\) antero-laterally to \(h_1\). Lyrifissures \(ia\) aligned longitudinally posterolaterally to \(c_1\) (19 \(\mu\)m); \(im\) obliquely anterior to \(lp\); \(ih\) obliquely lateral to \(lp\); \(ips\) obliquely posterior to \(ih\); \(ip\) obliquely behind \(h_1\). Opening \(gla\) situated posterolaterally to \(im\).

Ventral region — Genital (48 \(\mu\)m) and anal (77 \(\mu\)m) apertures roughly circular; distance (77 \(\mu\)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 \(g_1\) (10 \(\mu\)m) inserted at anterior margin of plates. Setae \(ag\) (10 \(\mu\)m) inserted latero-posteriorly to genital aperture. Setae \(ad_1\) (10 \(\mu\)m) aligned in postanal position; \(ad_2\) in adanal; \(ad_3\) in preanal. Lyrifissures \(iad\) located lateral to \(ad_3\), 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.

**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 h₁. Notogastral setae p2 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

and bo 4 indistinct. Epimeral setal formula: 3-1-3-3; setae barbed setiform; setae la-c, 3b and 3c longer than other setae (Fig. 18A). Diarthric subcapitulum bearing 3 pairs of setae: a (4 µm), m (9 µm) and h (22 µm); 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 ε bacilliform situated posterior to solenidia ω₂, ω₂ setiform, sharply bending. Solenidion ω₁ bacilliform inserted latero-anterior to ω₂. Solenidion ϕ₂ on tibia I lateral to ϕ₁ (Fig. 17C).
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 \(\mu m\); width 150 \(\mu m\). 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. Pleurophrag-mata (hl) and dorosphragmatic 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 \(\mu m\); width 150 \(\mu m\). 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 \(\mu m\) in length (Fig. 19A). Setae ro (22 \(\mu m\)) smooth setiform, inserted on lateral margins of rostrum. Lamellae thin, situated at lateral sides, extending for two-thirds length (65 \(\mu m\)) of prodorsum, without sharply pointed apex or dens. Translamellar absent. Setae le (26 \(\mu m\)) short, smooth spiniform, inserted far from lamellae, not reaching the insertions of rostral setae. Setae in (58 \(\mu m\)) spiniform, barbed throughout length, extending for short distance anterior of setae le. Bothridia opened anterolaterally. Sensilli (ss) (65 \(\mu m\)) consisting of fusiform head and thin long stem, pectinate unilaterally (Fig. 19C). Setae ex (5 \(\mu m\)) short, barbed setiform. Relative lengths and distances of prodorsal setae: ss \(\approx\) in \(\approx\) 2x le; le > ro; (in – in) (62 \(\mu m\)) > (le – in) (47 \(\mu m\)) > (le – le) (42 \(\mu m\)) > (ro – ro) (37 \(\mu m\)) > (ro – le) (31 \(\mu m\)).

Notogaster — Pteromorphs immovable, not extending anteriorly beyond level of arched dorsojejugal scissure (Fig. 19B). Pleurophrag-mata (hl) and dorosphragmatic 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 c2 (7 \(\mu m\), la and lm as three vertices; A1 immediately lateral to lp; A2 immediately antero-laterally to hl; A3 antero-laterally to p1. Lyrifissures ia aligned obliquely posterolaterally to c2; im transversely anterior to hl; ih transversely antero-laterally to hl; ip obliquely lateral to p1; ips obliquely posterolaterally to p3. Opening gla situated between im and hl.

Ventral region — Genital (40 \(\mu m\)) and anal (62 \(\mu m\)) apertures almost pentagonal and circle in form, respectively; length of anal aperture about 1.5x as long as that of genital aperture; distance (88 \(\mu m\)) 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 seta (6 \(\mu m\)) aligned in a row; g1 remote from anterior margin of plates. Setae ag (6 \(\mu m\)) inserted posterior to genital aperture. Setae anz inserted about half-way along length of anal plates. Setae ad2 aligned in postanal position; ad2 in anal; ad3 in preanal. Lyrifissures iad located along outline of anal aperture, at the level anterior of the insertions of anz. 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 \(\mu m\)) \(\approx\) ad > a (13 \(\mu m\)) \(\approx\) m > h (10 \(\mu m\)) > g (6 \(\mu m\)) \(\approx\) 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 kumaensis sp. nov. A, Anterior half of ventral region; B, Posterior half of ventral region.
Protoribates hirokous sp. nov.

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


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 µm; width 279 (300) 321 µm. 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 µm) 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 cusps or translamellar; le short (35 µm) setiform, reaching insertions of setae ro. Setae in long (75 µm) spiniform, extending for short distance antterior of insertions of setae le. Setae ro, le and in ciliate throughout length. Bothridia opened anterolaterally. Sensilli (ss) (75 µm) pectinate unilaterally, consisting of fusiform head and long stem, strongly elbowed near base (Fig. 21D). Setae cx (5 µm) short, smooth setiform. Relative lengths and distances of prodorsal setae: ro ≈ in ≈ ss = 2x le > cx; (in – in) (123 µm) > (le – le) (83 µm) > (le – in) (63 µm) > (ro – ro) (56 µm) > (ro - le) (35 µm).

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 l₂ and l₃; A₃ oval, lateral to p₁. 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 p₁ and p₂. Relative distances central notogastral setae: (lp – h₁) (110 µm) > (lm – lm) (104 µm) > (lm – lp) > (lp – lp) (87 µm) > (h₁ – h₁) (54 µm) > (p₁ – p₁) (48 µm).

Ventral region — Genital (48 µm) and anal (106 µm) apertures roughly circle in form; length of anal aperture about 2x as long as that of genital aperture; distance (123 µm) 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 g₁ (11 µm) remote from anterior margin of the plate. Setae ag [11 µm] inserted latero-posteriorly to genital aperture. Setae an₁ and an₂ [33 µm] remote from each other and margins of plates. Adanal setae variable in form and length: ad₁ and ad₂ (45 µm) spiniform, barbed unilaterally, longer than ad₃ (21 µm); ad₃ short, smooth setiform. Setae ad₁ aligned in postanal position; ad₂ in adanal; ad₃ in preanal. Lyrifissures iad located at level of insertions of setae an₂. 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 µm) than others; others simple. Diarthric subcapitulum bearing 3 pairs of setae; a (30 µm) smooth spiniform; m (11 µm) 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 \( \mu \)m) closely barred 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; \( \chi a \) 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 \( e \) bacilliform situated between solenidion \( \omega_2 \) and fastigial seta \( f' \) (Fig. 22B). Solenidion \( \omega_1 \) bacilliform; \( \omega_2 \) setiform, inserted behind \( \omega_1 \); \( \omega_1 \) shorter than \( \omega_2 \); seta \( f' \) as long as \( \omega_1 \). Solenidion \( \phi_1 \) originating from apophysis; \( \phi_2 \) contiguous to \( \phi_1 \).

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, \( h_m \), \( l_p \) and \( h_1 \), and notogastral setae \( h_2 \) inserted remote from porose areas A2. The prodorsal triangular form and arched dorsosejugal scissure extending beyond pteromorphs 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 \( \mu \)m; width 193 \( \mu \)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. Heterotrideridactylous.

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 \( \mu \)m; width 193 \( \mu \)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 \( \mu \)m) setiform bearing long and short barbs, antiaxialy 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 \( \mu \)m) setiform, extending for short distance beyond rostral tip. Setae \( le \) and \( in \) barbed throughout length. Setae \( in \) (58 \( \mu \)m) extending for short distance anterior of insertions of setae \( le \). Bothridia opened anterolaterally. Sensilli (ss) (43 \( \mu \)m) consisting of capitate spiculate head and long, smooth, thin stem (Fig. 23C). Setae ex (7 \( \mu \)m) short, smooth spiniform. Relative distances of prodorsal setae: \( (in – in) \) (48 \( \mu \)m) > \( (le – le) \) (44 \( \mu \)m) > \( (le – in) \) (37 \( \mu \)m) > \( (ro – ro) \) (35 \( \mu \)m) > \( (ro – le) \) (25 \( \mu \)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 \( l_m \) and \( l_p \), respectively; \( S_2 \) immediately postero-laterally to \( h_2 \); \( S_3 \) lateral to \( h_1 \). Opening \( gla \) situated lateral to \( l_p \). Lyriifissures \( ia \) aligned nearly along joint of notogaster and pteromorph; \( im \) obliquely antero-laterally to \( S_1 \); \( ip \) perpendicular to notogaster outline behind \( h_2 \); \( ih \) and \( ips \) obliquely. Relative distances among central notogastral setae: \( (l_m – l_m) \) (96 \( \mu \)m) \( \approx \) \( (h_2 – h_2) \) > \( (l_p – l_p) \) (87 \( \mu \)m) > \( (l_m – l_p) \) (73 \( \mu \)m) > \( (l_p – h_2) \) (58 \( \mu \)m).

Ventral region — Genital (48 \( \mu \)m) and anal (67 \( \mu \)m) apertures roughly circle in form; length of anal aperture about 1.4x as long as that of genital aperture; distance (100 \( \mu \)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 g1, g2 remote from g3, g4. Setae ag inserted latero-posteriorly to genital aperture. Setae an1 inserted near the mid-ventral line shorter than an2. Setae ad1 aligned in latero-posteriorly to aperture; ad2 in adanal position; ad3 in preanal. Lyrifissures iad located at level of insertions of setae an2, along outline of aperture. Sternal ridge and bo 4 indistinct. Epimeral borders bo. 1-3, sj interrupted medi-ally. Epimeral setal formula: 3-1-3-3; all setae short, thin, simple (Fig. 24).

**Figure 24:** *Haplozetes maki* 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 µm) > m (20 µm) > a (19 µm) > 1a (17 µm) > ag (15 µm) > an (14 µm) > g ≈ h (13 µm).

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). Trochanter I bearing carina terminating in fine point dorsally and ventrally (Fig. 23E). On tarsus I, famulus ε bacilliform situated posterior to ω2 and lateral to seta ft′ (Fig. 22B). Solenidion ω1 bacilliform; ω2 setiform, inserted behind ω1; ω1 shorter than ω2; seta ft′ as long as, ω1. Solenidion ϕ2 contiguous to ϕ1 (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 h2 and their mutual distance of lp smaller than those of lm and h2.

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