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Previous volumes (2010-2018): 250 € / year (4 issues)
Acarologia, CBGP, CS 30016, 34988 MONTFERRIER-sur-LEZ Cedex, France
ISSN 0044-586X (print), ISSN 2107-7207 (electronic)

The digitalization of Acarologia papers prior to 2000 was supported by Agropolis Fondation under the reference ID 1500-024 through the « Investissements d’avenir » programme (Labex Agro: ANR-10-LABX-0001-01)

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ORIBATID FAUNA (ACARI, ORIBATIDA) FROM A CAVE IN SOUTH NIPPON (JAPAN), WITH A DESCRIPTION OF A NEW SPECIES

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(Received 09 September 2013; accepted 24 June 2014; published online 30 September 2014)

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ABSTRACT — Representatives of six oribatid mite species belonging to the cohort Brachypylina were collected from the upper wall and soil surface at the entrance of Kumaso cave in South Nippon (Japan). Of these, three were known species: Fissicepheus (Fissicepheus) takenouchiensis Fujikawa and Nishi, 2013, Scheloribates latipes C. L. Koch, 1841 and Peloribates (Peloribates) latus Fujikawa, 2006. One species of Humerobates (Humerobates) was described as a new species. Two other individuals did not match any described species and may represent two new species. However, as single individuals, we could not decide with certainty about their specific status. These individuals were respectively assigned to the genera Protoribates and Spatiodamaeus. Here, we provide only morphological descriptions of these single specimens. No typically cave-dwelling oribatid mites were found in the present investigation.

KEYWORDS — Fissicepheus; Humerobates (Humerobates); Kumaso cave; new species; oribatid mite; Peloribates; Protoribates; Scheloribates; South Japan; Spatiodamaeus

INTRODUCTION

Oribatid mite species have been recorded from caves worldwide (e.g. Iturroundobeitia and Arillo, 1997; Ducarme et al., 2004; Lundberg et al., 2010; Skubala et al., 2013).

In the first survey of oribatid fauna living in a cave in Japan, a total of 11 species, all belonging to Brachypylina, was recorded (Nakamura et al., 2010). Brachypylina has are characterized by the following combination of characters: holoid body type, brachypiline venter, genua of legs I-III shorter than tibiae and presence of Trägårdh’s organ (Norton and Behan-Pelletier, 2009). The strongly chitinized cuticle of adult brachypylinid species might have the ability to resist drought as suggested by Ducarme et al. (2004).

In order to get an overview of the Oribatid fauna living in another Japanese cave, we sampled soil inside and at the entrance (photic zone) of the Kumaso cave and recorded Oribatid mites found in both types of samples.

This article brings together the survey of Oribatid species found in these samples and the description of some specimens unassigned to any known species, with a designation of Humerobates (Humerobates) kumasoi as a new species.
FIGURE 1: Location of sampling.
**METHODS**

Study site — Kumaso cave (31°48’50”N; 130°45’19”E, about 82 m a.s.l, in the subtropical zone) is located at Hayato-cho, Kirishima-shi, Kagoshima Prefecture, South Japan (Fig. 1). The cave formed in welded tuff 3 million years ago (personal communication from Mr. M. Harada, 2013), and is now situated in a thick forest of Cryptomeria japonica, Castanopsis spp. and Quercus spp. on a hill on a property belonging to President T. Ishihara of Myoken Ishiharaso Co. Ltd. On the day of sampling (22 Sept. 2011), the temperature inside the cave (at 5 p.m.) was 21 °C at the floor surface and 18 °C 1 m above it. The temperature outside the entrance at 5.30 p.m. was 18.5 °C at the soil surface and 19 °C 1 m above it.

Sampling — Eight samples of about 200 cm$^3$ each were collected by hand-picking from sands in the cave and soil materials of top most part and the surface of the ground at the entrance on 22 Sept. 2011, by K. Nakamura. After extraction with a modified Tullgren apparatus, mites were kept in lactic acid for clearing during twenty days, then mounted on glass slides.

Terminology and classification — The notations and morphological terminology are mainly based on Balogh and Mahunka (1983), Grandjean (1952), Hammen (1989), Mahunka and Zombori (1985) and Norton and Pelletier (2009). Genito-anal setal formula refers to genital, aggenital, anal and adanal setae. The given number of tarsal claws is common to all legs of a species. The setal formula of legs includes the famulus but excludes solenidia. The solenidiotaxy is common to all examined species: I (1-2-2), II (1-1-2), III (1-1-0), IV (0-1-0). [Right-left] refers to the right and left sides of a specimen. Unless indicated, measurements (in µm) in the description relate to the holotype.

**RESULTS**

The survey of Oribatid fauna from soil sampled inside and at the entrance of the Kumaso cave was carried out on 22 Sept. 2011. The only mite found inside the cave was a specimen of the mesostigmatic genus Gamasiphis (Rhodacaridae). No oribatid mites were found inside the cave. However, representatives of seven oribatid species including one new species, were collected from soil materials of the top most part and the surface of the ground at the entrance, i.e. from the photic zone. Yet, as found in the Kumaya Cave of Iheya Village (Nakamura et al., 2010), all oribatid species belonged to the cohort Brachypylina. Six oribatid species are detailed in the present study. One specimen of Drepanopippia could not be studied because the body was broken.

**DESCRIPTION OF NEW SPECIES AND UNASSIGNED INDIVIDUALS**

**Cohort Brachypylina Hull, 1918**

**Humerobatidae Grandjean, 1970**

**Humerobates (Humerobates) kumasoi n. sp.**

[Japanese name: Kumaso-hanasujidani] (Figs. 2 – 4)


Material examined — Holotype (Adult female) (NSMT-Ac 13788) from the soil surface at the entrance of Kumaso cave; 4 paratypes (2 adult females and 2 adult males) (NSMT-Ac 13789): same data as holotype; 1 additional paratype (adult male) used in scanning electron microscopy: same data as holotype; 1 additional paratype (adult male) used in scanning electron microscopy: same data as holotype. Type specimens (NSMT-Ac 13788 and 13789) are deposited in the National Museum of Nature and Science, Tokyo. The other type specimen is deposited in the National Agricultural Research Center for Kyushu Okinawa Region, Kumamoto Prefecture.
Figure 2: *Humerobates* (*Humerobates*) *kumasoi* **n. sp.**, scanning electron micrographs (photos by Nakamura Y.-N. and Shirosaki T.). Adult female: A – Dorsal view; B – Rostral region, in: interlamellar seta, le: lamellar seta, ro: rostral seta, Tu: tutorium; C – Left bothridial region; D – Left leg I: solenidion of genu broken.
Figure 3: Humerobates (Humerobates) luminosus n. sp. (Paratype, 13789). A – Dorsal view; B – Ventral view. Legs removed.
Etymology — Named in honour of Kumaso, one of the former human races in Nippon (Japan).

Measurements and body appearance — Body size: females, length 286-307 µm, width 229 µm; males, length 286-307 µm, width 214-250 µm. Body color of live mite dark brown; body surface smooth.

Prodorsum — Anterior rostral margin projecting as a point on each side (Fig. 2B). Setae ro and le originating from tip of tutorium and lamella respectively, extending anteriorly to rostrum; setae ro (Right-left: 56-59 µm) thin, setiform, barbed unilaterally; le (54-63 µm) thin, setiform, barbed throughout length. Tutorium with cusp (6-12 µm) extending anterior to tip of lamella (Fig. 3A). Setae in (131-120 µm) thin, setiform, roughened throughout length, inserted near anterior notogastral margin, extending beyond rostrum (Fig. 2A). Sensilli (41-47 µm) composed of thin short stem and broad spatulate head, expanded distally without narrower apex, verrucose throughout length (Fig. 2C). Exobothridial setae (ex) thin, long (ca. 9 µm) inserted at lateral base of bothridia. Bothridia opening antero-dorsally, with ventrolateral and ventromedial scales; ventromedial scale large, dentate on anterior margin (Fig. 4A).

Notogaster — Nearly as long as wide, anterior margin rounded, bearing 10 pairs of vestigial notogastral setae. Anterior margin of pteromorphae not extending beyond dorsosejugal suture. Porose areas Aa (the major axis: ca. 7 µm) located between la and lm; A1 between lp and lh3; A2 antero-lateral to h3; A3 lateral to h1. Opisthonomal gland opening (gla) situated lateral to A1. Lyrifissures ia, im, ih and ips aligned obliquely, located posterior to c2, anterior to gla, antero-lateral to gla and anterior to p3, respectively. Lyrifissure ip aligned perpendicular to notogastral outline, located between p1 and p2.

Ventral region — Genito-anal setal formula: 6-1-2-3. Genital setae (14-19 µm) thin, setiform, roughened throughout length; g1 longest; g1, g2 inserted at same level near anterior margin of plates. Setae ag (ca. 14 µm) thin, smooth setiform, inserted postero-lateral to genital aperture. Setae an1 (ca. 14 µm), an2 (ca. 11 µm) thin, smooth setiform, inserted near posterior and anterior margin of plates, respectively. Adanal setae vestigial; ad1,2 aligned in postanal position; ad3 in adanal. Lyrifissures iad oriented parallel to outline of aperture, at level of an2 (Fig. 3B). Genital (34 µm) and anal (55 µm) apertures roughly circular in shape; distance between them (66 µm) about twice length of genital aperture. Sternal ridge indistinct. Epimeral borders 1, 2, sj distinct. Epiperal setal formula: 3-1-3-3; setae smooth, short, setiform (18-39 µm); 1c longest; 1a shortest; 3c thickest. Subcapitular setae three pairs; a (ca. 13 µm) thin, setiform, roughened throughout length; m (ca. 23 µm) thick, setiform, barbed throughout length; h (ca. 21 µm) thin, setiform, sparsely barbed throughout length (Fig. 4E). Pedipalp setal formula: 0-2-1-3-9[1]; solenidion bacilliform (Fig. 4D).

Legs — Heterotridactylous; median claw minutely dentate (24-26 µm) (Fig. 4C); median claw of leg II longest; median claw of IV shortest. Setal formula: I (1-5-3-4-20), II (1-4-3-4-15), III (2-2-1-3-14), IV (1-2-2-3-12). Measurements (µm) of [right-left] segments: I ([26-25]-[61-55]-[26-24]-[40-36]-[61-57]); II ([6-8]-[52-60]-[18-24]-[34-37]-[49-46]); III ([34-41]-[43-48]-[23-23]-[42-40]-[47-50]); IV ([39-39]-[44-41]-[25-31]-[51-46]-[61-59]). On tarsus I, famulus ε (ca. 9 µm) bacilliform, situated anterolateral to ω2 (ca. 39 µm); ω2 posterior to f1’ (ca. 10 µm); f1’ posterior to ω1 (ca. 46 µm); ω1, ω2 terminating in fine tip (Fig. 4B). Solenidion ϕ1 (ca. 127 µm) inserted near tip of tibia 1; ϕ2 (ca. 10 µm) lateral to ϕ1. On genu I, solenidion σ (ca. 101 µm) terminating in fine tip (Fig. 4F).

Remarks — According to Subías (2004), 15 species and three subspecies are known as members of the genus Humeroberates (Humeroberates) Sellnick, 1928, and a single species of the subgenus Humeroberates (Cordyloberates) Luxton, 1995 is known. The new species has some remarkable features in common with known species of Humeroberates (Humeroberates) such as narrow lamella without long cusp or translamella, lamellar seta originating from tip of lamella, long tutorium, sensillum with broad head, immovable pteromorph, 10 pairs of notogastral setae, four pairs of porose areas, opisthonomal gland opening, genito-anal setal formula 6-1-2-3, and heterotridactylous legs. However, the new species is
FIGURE 4: *Humerobates* (*Humerobates*) *kumasoi* n. sp. (Paratype, 13789): A – Right bothridial region; B – Right tarsus I; C – Tip of left tarsus II; D – Right pedipalp; E – Principal setae of ventral region; F – Right tibia I and genu I.
different from congeners in having anterior rostral margin projecting as a point on each side, bothridia with large ventromedial scale dentate on the anterior margin, sensilla composed of thin smooth short stems and broad spatulate heads verrucose throughout length, expanded distally without narrower apex, vestigial notogastral setae, vestigial adanal setae, thick medial subcapitular setae, and small body size (< 310 \( \mu \text{m} \) in length). All known members of subgenus \textit{Humerobatis} have round or straight anterior rostral margins and adanal setae. Moreover, most have notogastral setae. \textit{Humerobatis} (H.) \textit{varius} Ohkubo, 1982 recorded from Japan has vestigial notogastral setae like the new species. However, the new species differs from \textit{Humerobatis} (H.) \textit{varius} by anterior rostral margin projecting as a point on each side and vestigial adanal setae. Females and males of the new species had same range of body lengths and different ranges of widths. The cause of the fact is unknown in the present work.

\textbf{Damaeidae Berlese, 1896}  
\textit{Spatiodamaeus} sp.  
(Figs. 5 – 9)

In the present paper, one specimen was described as \textit{Spatiodamaeus} sp. Although it may prove in the future being representatives of new species, it was not designed as new species in the present paper because only a single, damaged specimen was found.

\textbf{Diagnosis} — Body length 536 \( \mu \text{m} \); width 429 \( \mu \text{m} \). Rostral anterior margin widely rounded. Prodorsal setae \( \text{ro}, \text{le}, \text{in}, \text{ss}, \text{ex} \), long, minutely barbed throughout length. Notogaster bearing exuviae with polygonal structure. Spinae adnatae acute. Of 11 pairs of notogastral setae, eight pairs smooth, hypertrophied, widened, blade-like; \( \text{p}_{1-3} \) setae long, setiform, minutely barbed throughout length Genito-anal setal formula: 6-1-2-3. Ventral tubercle (\( \text{Vt} \)) with long sharply pointed apex, bending to lateral side. Lyrifissures \( \text{iad} \) aligned obliquely. Epimeral setal formula: 3-1-3-3.

Material examined — One adult female (NSMT-Ac 13786) from the soil surface at the entrance of Kumaso cave. The specimen is deposited in the National Museum of Nature and Science, Tokyo.

Measurements and body appearance — Body length 536 \( \mu \text{m} \); width 429 \( \mu \text{m} \). Body colour of live mite dark brown; body surface smooth. Notogaster bearing concentrically arranged exuviae with polygonal structure (Fig. 5).

\textbf{Prodorsum} — Rostral anterior margin widely rounded. Rostral setae (\( \text{ro} \)) (ca. 129 \( \mu \text{m} \)) inserted just behind the border of the underlying rostrophragma (Fig. 3). Lamellar setae (\( \text{le} \)) (Right-left: 157-141 \( \mu \text{m} \)) reaching anterior rostral margin. Interlamellar setae (\( \text{in} \)) (159-150 \( \mu \text{m} \)) reaching rostral cavity. Sensilla (\( \text{ss} \)) (ca. 195 \( \mu \text{m} \)) long spiniform, minutely barbed throughout length. Exobothridial setae (\( \text{ex} \)) (61-77 \( \mu \text{m} \)) inserted at lateral side of bothridia. Setae \( \text{ro}, \text{le}, \text{in} \), and \( \text{ex} \) long setiform, minutely barbed throughout length. Bothridia opening latero-dorsally with large funnel-like extension of palmate laminated appearance.

\textbf{Notogaster} — Concentrically bearing arranged exuviae with polygonal structure (Fig. 5). Spinae adnatae acute (29 \( \mu \text{m} \)). Of 11 pairs of notogastral setae; eight pairs (\( \text{c}_{1-2}, \text{la}, \text{lm}, \text{lp}, \text{h}_{1-3} \)) (68-111 \( \mu \text{m} \)) smooth, hypertrophied, widened, blade-like (Fig. 6), arranged in two longitudinal rows; \( \text{p}_{1-3} \)-setae (86-152 \( \mu \text{m} \)) long setiform, minutely barbed throughout length; \( \text{p}_{3} \) longest; \( \text{lp} \) shortest. Lyrifissures \( \text{ia}, \text{ih}, \text{ips} \) aligned parallel to notogastral outline, located lateral to setae \( \text{c}_{2}, \text{lp} \), and \( \text{h}_{3} \), respectively; \( \text{im}, \text{ip} \) obliquely aligned, lateral to setae \( \text{lm} \) and \( \text{ps} \), respectively. Opisthonotal gland opening (\( \text{gla} \)) situated laterally between setae \( \text{lp} \) and \( \text{h}_{3} \).

\textbf{Ventral region} — Ventral tubercles (\( \text{Vt} \)) with long sharply pointed apex, bending laterally (Fig. 7). Genito-anal setal formula: 6-1-2-3; all setae thin, setiform, roughened. Genital setae (30-48 \( \mu \text{m} \)) aligned in longitudinal row; \( \text{g}_{1} \) longest. Setae \( \text{ag} \) (ca. 47 \( \mu \text{m} \)) inserting postero-laterally to genital aperture. Setae \( \text{an}_{1} \) (ca. 41 \( \mu \text{m} \)) inserted almost at mid-distance along plate; \( \text{an}_{2} \) (ca. 38 \( \mu \text{m} \)) near anterior margin of plate. Setae \( \text{ad}_{1} \) (34-34 \( \mu \text{m} \)) near postero-lateral corner of anal aperture; \( \text{ad}_{2,3} \) (ca. 45 \( \mu \text{m} \)) in adanal position; \( \text{ad}_{3} \) inserted at level of \( \text{an}_{1} \). Lyrifissures \( \text{iad} \) oriented obliquely, anterior to \( \text{ad}_{3} \). Genital (107 \( \mu \text{m} \)) and anal (96 \( \mu \text{m} \)) apertures almost pentagonal in shape; distance between them (18 \( \mu \text{m} \)) about one-sixth as long as anal aperture. Sternal ridge and...
epimeral borders 1-4, sj indistinct. Epimeral setal formula: 3-1-3-3; setae smooth, short, setiform (14-91 μm); lb longest; 4a shortest. Subcapitular setae 3 pairs, a (30-43 μm), m (48-43 μm), and h (55-57 μm); setae thin setiform; a, m roughened throughout length; h minutely barbed unilaterally. Cheliceral setae cha (ca. 38 μm) barbed unilaterally, terminating in fine tips; chb (ca. 27 μm) attenuate conspicuously and unilaterally pilose in distal portion (Fig. 8F). Pedipalpal setal formula: 0-2-1-3-9[1]; solenidion spiniform (Fig. 8A).

Legs — Monodactylous; claw smooth (45-61 μm) (Figs. 8D and E); claw of leg IV longest; claw of leg II shortest. Setal formula: I (1-6-4-19), II (1-5-4-16), III (2-4-4-3-14), IV (1-4-4-3-14). Measurements (μm) of [right-left] segments: I ([39-46]-[248-223]-[?-98]-[?-138]-[?-255]); II ([61-59]-[202-189]-[?-77]-[?-105]-[191-220]); III ([?-130]-[161-163]-[82-?-120]-[220-?]); IV ([150-186]-[145-186]-[89-?]-[154-?]-[263-275]). Setae long, setiform or bacilliform, verrucose throughout length (Fig. 9). On tarsus I, famulus ε (ca. 30 μm) consisting of fine tip and expanded basal portion, situated posteriorly, contiguous between ω1 (ca. 45 μm) and ω2 (ca. 27 μm); ω1, ω2 terminating in fine tip (Fig. 8C). Solenidion φ2 (ca. 41 μm) originating from smaller apophyses than that of φ1, lateral to φ1. On genu I, solenidion σ (ca. 36 μm) terminating in fine tip, shorter than seta d (Fig. 9A).

Remarks — Bulanova-Zachvatkina (1957) erected new subgenus Spatiodamaeus, belonging to the genus Damaeus, without original designation for type species, and described three new species, D. (S.) boreus, D. (S.) fageti and D. (S.) subverticillipes as members of the new subgenus. At the same time, she added five known species, Belba glabriseta Willmann, 1930, Damaeus phalangioides Michael, 1890, D. tecticola Michael, 1888, D. tenuipes Michael, 1885 and D. verticillipes Nicolet, 1855 to the new subgenus, of which D. phalangioides was referred to the genus Metabelbella Bulanova-Zachvatkina, 1957 (Arillo and Subías, 2006), and D. tecticola and D. tenuipes to the genus Epidamaeus Bulanova-Zachvatkina, 1957 (Luxton, 1989). Since then, Bulanova-Zachvatkina (1967) elevated Spatiodamaeus to generic status, designating D. verticillipes Nicolet, 1855 as the type. Norton (1977) reviewed it as a subgenus, while Balogh (1972), Balogh and Balogh (1992), Subías (2004) and Weigmann (2006) treated it as a genus. After eight species were listed as members of the genus Spatiodamaeus by Subías (2004), one species
FIGURE 6: Spatiodamaeus sp.: Dorsolateral view, legs removed (NSMT-Ac 13786).
FIGURE 7: Spatiolamacus sp.: Ventrolateral view, legs and pedipalps removed (NSMT-Ac, 13786).
FIGURE 8: Spatiodamaeus sp. (NSMT-Ac 13786): A – Left pedipalp; B – Right seta c₁; C – Right tarsus I; D – Claw and distal setae of left leg I; E – Claw and distal setae of left leg IV; F – Left chelicera.
FIGURE 9: *Spatiodamaeus* sp. (NSMT-Ac 13786): A – Right tibia I and genu I; B – Right tibia II and genu II; C – Left tibia III and genu III; D – Left tibia IV; E – Left genu IV.
Key to the species. Largest body length and width (in μm) are shown according to the original description.

1. Notogastral setae h₁, h₂ and h₃ longer than setae, c₁, c₂, la, lm, lp — Spatiomamaeus subverticillipes Bulanova-Zachvatkina, 1957; 840 × 640 μm
   — Notogastral setae h₁, h₂ and h₃ not longer than setae, c₁, c₂, la, lm, lp ................................. 2

2. Notogastral setae la, lm shorter than other setae — S. fageti Bulanova-Zachvatkina, 1957; 860 × 580 μm
   — Length of notogastral setae variable ...................... 3

3. Interlamellar setae in longer or as long as sensilli — S. eugloceus (Bulanova-Zachvatkina, 1957) 1-3 μm
   — Setae in shorter than sensilli ............................ 6

4. Genual setation: 5-5-4-4. — S. verticillipes (Nicolet, 1855); 740 × 7 μm
   — Genual setation: 4-4-4-4 ................................. 5

5. Setae c₁, c₂ thick, smooth as long as thin smooth h₁ — S. brevicaudata Bulanova-Zachvatkina, 1957; 680 × 480 μm
   — Setae c₁ thick, barbed longer than thin, smooth h₁, h₂ — S. crassispinosus Mihelčič, 1964; 850 × 520 μm

6. Ventral tubercles (Va) tuberculate — Spatiomamaeus subverticillipes
   — Ventral tubercles (Va) with long sharply pointed apex, bending laterally

----------------------------- Spatiomamaeus sp.; 536 × 429 μm

7. Setae, c₁, c₂, la, lm, lp thick, long, barbed; other setae h₁, h₃ and p₁, p₃ thin, short, smooth — S. similis (Willmann, 1954); 7 μm
   — Setae, c₁, c₂, la, lm thin, smooth — S. crassispinosus

8. Setae, c₁, c₂, la, lm, lp shorter than setae h₁, h₃ — S. glabriseta (Willmann, 1930); 740 × 495 μm
   — Setae, c₁, c₂, la, lm, lp longer than setae h₁, h₃ — S. diversipilis (Willmann, 1951); 600 × 360 μm
   — Setae, c₁ slightly longer than other setae — S. boemeensis Xie et al., 2012; 910 × 670 μm

Protoribatidae Balogh and Balogh, 1984

Protoribates (Protoribates) sp.
(Figs. 10 – 12)

In the present paper, one specimen was described as Protoribates sp. Although it may prove in the future being representatives of new species, it were not designed as new species in the present paper because only a single, damaged specimen wase found.


Material examined — One adult female (NSMT-Ac 13790) from the soil surface at the entrance of Kumaso cave. Specimen is deposited in the National Museum of Nature and Science, Tokyo.

Measurements and body appearance — Body length, 557 μm; width, 329 μm. Body colour light brown; body surface smooth.

Protoribates — Anterior rostral margin rounded (Fig. 10). Setae ro (59-55 μm) inserted laterally on rostrum. Lamellae thin, about 0.7 x length of prodorsum. Setae le (91-88 μm) originating from tip of lamella. Setae ro and le extending anterior to

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was added (Xie et al., 2012). D. (S.) verticillipes is microphytophagous (Schuster, 1956) and diploidoid (Norton, 1993). No member of this genus has been recorded from Japan to date. The present specimen was distinguished from congeners by (1) small body size (length 536 μm, width 429 μm); (2) spinae adnatae acute, (3) 11 pairs of notogastral setae, p₁, p₃ setae long setiform, minutely barbed throughout length, and the other setae smooth hypertrophied, widened, blade-like, and (4) ventral tubercle (Va) with long sharply pointed apex, bending laterally.
Figure 10: Protoribates sp. (NSMT-Ac 13790): Dorsal view, legs removed.
Figure 11: Protoribates sp. (NSMT-Ac 13790): Ventral view, legs removed.
Figure 12: *Protoribates* sp. (NSMT-Ac, 13790): A – Right leg I; B – Right femur II (arrow leg-fin); C – Principal setae of ventral region; D – Claws of right leg II, left leg III and right leg IV.
rostrum. Setae in (116-134 μm) reaching insertions of setae ro. Setae ro, le, in thin setiform, minutely, sparsely barbed throughout length. Sensilla (105-105 μm) composed of thin long stem and fusiform head, unilaterally barbed throughout length. Setae ex thick, smooth, spiniform (ca. 16 μm) inserted at lateral base of bothridia (Fig. 12C). Bothridia opening antero-dorsally. Relative length: (in-in) > (le-le) > (le-in) > (ro-ro) > (ro-le).

Notogaster — Anterior margin straight, bearing 10 pairs of minute, smooth notogastral setae. Pleurophragmata (hil) distinct. Porose areas Aa (the major axis: 16 μm) located anteriorly between la and lm; A1 anterior to ip; A2 posterior to hs; A3 lateral to ip. Opi stomotonal gland opening (gla) situated latero-anteriorly to hs. Lyrrifissures ia (9-14 μm), im (14-9 μm), ib (ca. 16 μm) and ips (9-9 μm) aligned obliquely, located lateral to c2, posterior to la, antero-lateral to im and posterior to A2, respectively. Lyrrifissure ip (9-9 μm) aligned perpendicular to notogastral outline, located between p1 (ca. 9 μm) and p2.

Ventral region — Genito-anal setal formula: 4[5]-1[0]-2-3; genital and aggenital setae variable in number, indicated by brackets. Genital setae (10-31 μm) setiform; g1 longest, thick, barbed throughout length; other setae thin, bearing sparse barbs. Setae ag (ca. 16 μm) thin, smooth setiform, inserted postero-laterally far from genital aperture. Setae an1 (ca. 32 μm), an2 (ca. 22 μm) thin, smooth setiform, inserted near mid-distance along plates. Adanal setae thin, smooth, setiform; ad1,2 (ca. 31 μm) aligned in post-anal position; ad3 (18-26 μm) in adanal, near anterior margin of aperture. Lyrrifissures iad (ca. 14 μm) located parallel to outline of aperture, anterior to level of an2, posterior to ad3 (Fig. 11). Genital (54 μm) and anal (141 μm) apertures roughly circular in shape; distance between them (154 μm) about one-third genital aperture length. Sternal ridge observable. Epimeral borders 1-3, sj distinct. Epimeral setal formula: 3-1-3-3; setae setiform (15-33 μm); 3c longest; 1a shortest; 1b thickest, sparsely barbed; other setae smooth. Subcapitular setae 3 pairs; a (ca. 35 μm) thick setiform, bearing few barbs; m (ca. 6 μm) thin, smooth setiform; n (ca. 36 μm) thick setiform, barbed throughout length (Fig. 12C).

Legs — Monodactylyous; claw minutely denticate (40 μm) (Fig. 12D). Setal formula: I (1-5-3-4-20), II (1-5-2-4-14), III (2-3-1-3-14), IV (1-2-2-3-14). Measurements (μm) of [right-left] segments: I (1-16-[91-96]-[97-98]-[97-98]-[97-98]); II (9-7-[91-24]-[91-19]-[66-66]-[62-64]); III (9-49-[72]-[27]-[55-59]-[55-53]); IV ([68-66]-[69-67]-[33-39]-[72-78]-[72-69]). On tarsus I, famulus ε (ca. 7 μm) consisting of obtuse tip and expanded basal portion, situated posterior to ω2; ω2 (ca. 44 μm) posterior to ω1 (ca. 36 μm); f′ (ca. 37 μm) posterior to ε2; ω1, ω2 terminating in obtuse tip (Fig. 12A). Solenidion φ1 (ca. 122 μm) inserted on apophyses (ca. 17 μm) protruding at the tip of tibia I; φ2 (ca. 27 μm) lateral to φ1 on the same apophyses. On genu I, solenidion σ (ca. 64 μm) terminating in a fine tip. Femora II, IV and trochanter IV bearing ventral keel (Fig. 12B).

Remarks — The genus Protoribates (Protoribates) contains 40 known species and three known subspecies worldwide, of which two species bear a superficial resemblance to the present specimen. P. (P.) mollicoma (Hammer, 1973) and P. (P.) yezenonis (Fujikawa, 1983) have straight anterior notogastral margin, long lamellar and interlamellar setae, and ad1,2 aligned in post-anal position as seen in the present specimen. However, the present specimen is different from P. (P.) mollicoma in length of ad1 and ad2, and insertion of ad3. The former has adanal setae ad1,3 of the same length, and ad3 inserted the anterior margin of the anal aperture, while the latter had adanal setae ad1,2 longer than ad3 and ad2 inserted in front of anterior margin of the anal aperture. The present specimen is different from P. (P.) yezenonis in the form of rostrum and insertion of un1,2. The former has a round rostrum, and setae un1,2 inserted near midway along the plates, while the latter has a rostrum with a median elevation, and seta un1 inserted near the posterior margin of the anal plate.

**RECORD OF KNOWN SPECIES**

**Tetracondyliidae Aoki, 1961**

*Fissicephus (Fissicephus) takenuchiensis* Fujikawa and Nishi, 2013

*Fissicephus (Fissicephus) takenuchiensis* Fujikawa

Material examined — One adult female (NSMT-Ac 13787): from the soil surface at the entrance of Kumaso cave. Specimen is deposited in the National Museum of Nature and Science, Tokyo.

Measurements — Body length 786 \( \mu \)m; width 429 \( \mu \)m. Body colour light brown.

Known record — Litter, humus, and soil from inside of old cut bamboo joint at a bamboo plantation of *Phyllostachys pubescens* Mazel (32°12′5″N, 130°54′5″E, 195 m a.s.l.), Asagiri-cho, Kumamoto Prefecture.

Remarks — The present specimen differs from the holotype in position of the cuticle hardened and darkened transverse band situated nearer to \((lm-lm)\) than to \((h_2-h_2)\).

**Scheloribatidae Jacot, 1935**

*Scheloribates latipes* C. L. Koch, 1841


*Scheloribates latipes*: Sellnick, 1928, p.16, fig. 30; Oudemans, 1937 Kritisch Historisch Overzicht der Acarologie, III (E & F), pp. 2662-2663; Fujikawa, 1983, Edaphologia, (29), pp. 3-4, figs. 4 & 5.

Material examined — One adult female (NSMT-Ac 13789), from the soil surface at the entrance of Kumaso cave, mounted together with *Humerobates kumasoi* sp. nov. Specimen is deposited in the National Museum of Nature and Science, Tokyo.

Measurements — Body length 307 \( \mu \)m; width 229 \( \mu \)m. Body colour light brown.

**DISCUSSION**

Whilst many oribatid species have been recorded from inside caves worldwide (e.g. Iturrondobeitia and Arillo, 1997; Ducarme et al., 2004; Lundberg et al., 2010; Skubała et al., 2013) and even in a Japanese cave (Nakamura et al., 2010), no oribatid mites were found in samples collected inside the Kumaso cave and seven genera were found at the entrance of the Kumaso cave only (*Drepanoppia*, *Fissicepheus*, *Humerobates* (*Humerobates*), *Peloribates*, *Protoribates*, *Scheloribates*, *Spatiiodamaeus*). Congeners of one of the entrance-sampled genera, namely *Protoribates*, were previously recorded from caves (Mahunka, 2009a; Nakamura et al., 2010) and members of *Damaeus*, in the same family (*Damaeidae*) as *Spatiiodamaeus*, have been recorded from many caves (Skubała et al., 2013). In contrast, congeners of the species belonging to the six remaining genera are not specifically known from caves. Some of them were even found in arboreal habitats: a congener of *Fissicepheus* and a congener of *Scheloribates* were collected from the canopy (Aoki, 1971; Behan-Pelletier and Winchester, 1998, resp.). As a result, although two species in the present samples might be true cave-dwellers, the presence of others at the cave’s entrance was likely fortuitous and unlinked to the cave habitat. The absence of oribatid mites from caves is not so uncommon: for example, 12 of 30 caves in Belgium lacked any oribatids (Skubała et al., 2013). In the present case, maybe the nature of the cave floor (covered with rocks that were pitted by water dripping from the ceiling, and with no organic materials available, such as litter, soil, bat
guano deposits or nests) was unsuitable for oribatid mites.

ACKNOWLEDGEMENTS

The authors wish to acknowledge their indebtedness to the Ishihara family of Myoken Ishiharaso Co. Ltd., especially Mrs. Reiko Ishihara and Mr. Yoshimichi Nakazaki who kindly gave the authors valuable suggestions to add to geographical and historical knowledge, and kindness in allowing them the sampling. The authors wish to express their sincere thanks to Dr. Tomohiro Shirosaki of Kumamoto Industrial Research Institute for making the photographs of scanning electronic microscope; to Emeritus Prof. Dr. Kazuo Ishikawa of Shinonome university, Ehime prefecture for his identifying mites other than oribatids; to Mr. Masafumi Harada of The Geological Society of Japan (JGS) for his valuable suggestion about geological information; to Ms Kanako Maeda of Kirishima Office; to Kagoshima Meteorological Observatory, Japan Meteorological Agency, and Geospatial Information Authority of Japan for their valuable suggestion about meteorological and geographical information. They are greatly indebted to Mrs. Ryō Imada and Mr. Toyomi Ōza of Asagiri-cho for their valuable suggestion about Kumaso cave and geological information; and to Emeritus Prof. Dr. Yoshio Nakamura for his kind help and encouragement for sampling and making photographs.

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