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

Kazunori NAKAMURA¹, Yoshi-Nori NAKAMURA² and Tokuko FUJIKAWA³

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¹ Graduate School of Agricultural Science, Tohoku University, 232-3 Yomogida, Naruko-onsen, Osaki, 989-6711, Nippon. knakamura@eco.civil.tohoku.ac.jp
² National Agricultural Research Center for Kyushu Okinawa Region (KONARC), NARO, Koshi, 861-1192, Nippon. yn1124@affrc.go.jp
³ Ueminami 1346-3, Asagiri-cho, Kumamoto Pref., 868-0423, Nippon.

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. Iturrodobeitia 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 have 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 brachypyllinid 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 cm³ 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 Behan-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 mesostigmatid 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, ie. 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 Drepanoppia 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. Additional 1 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.
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 colour 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 through- out length. Tutorium with cusp (6-12 µm) extending anterior to tip of lamella (Fig. 3A). Setae in (131-120 µm) thin, setiform, roughened through- out length, inserted near anterior notogastral margin, extending beyond rostrum (Fig. 2A). Sensilli (41-47 µm) composed of thin short stem and broad spatulate head, extended 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 h3; A2 antero-lateral to h3; A3 lateral to h1. Opisthontal 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, rough- ened throughout 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 post- anal 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. Epimeral 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). Pedipalpal 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 fl' (ca. 10 µm); fl' posterior to ω1 (ca. 46 µm); ω1, ω2 terminating in fine tip (Fig. 4B). Solenidion φ1 (ca. 127 µm) inserted near tip of tibia I; 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 Humerobates (Humerobates) Sellnick, 1928, and a single species of the subgenus Humerobates (Cordylobates) Luxton, 1995 is known. The new species has some remarkable features in common with known species of Humerobates (Humerobates) such as narrow lamella without long cusp ot 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, opisthontal gland opening, genito-anal setal formula 6-1-2-3, and heterotridactylous legs. However, the new species is
FIGURE 4: *Humerobates (Humerobates) kunasoi* 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 anal setae, thick medial subcapitular setae, and small body size (< 310 µm in length). All known members of subgenus Hemerobates have round or straight anterior rostral margins and anal setae. Moreover, most have notogastral setae. Hemerobates (H.) varius Ohkubo, 1982 recorded from Japan has vestigial notogastral setae like the new species. However, the new species differs from Hemerobates (H.) varius by anterior rostral margin projecting as a point on each side and vestigial anal 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.

Damaeidae Berlese, 1896
Spatiodamaeus sp.
(Figs. 5 – 9)

In the present paper, one specimen was described as 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.


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 µm; width 429 µm. Body colour of live mite dark brown; body surface smooth. Notogaster bearing concentrically arranged exuviae with polygonal structure (Fig. 5).

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

Notogaster — Concentrically bearing arranged exuviae with polygonal structure (Fig. 5). Spinae adnatae acute (29 µm). Of 11 pairs of notogastral setae; eight pairs (c₁₂, la, bm, lp, h₁₃) (68-111 µm) smooth, hypertrophied, widened, blade-like (Fig. 6), arranged in two longitudinal rows; p₁₃ setae (86-152 µm) long setiform, minutely barbed throughout length; p₃ longest; lp shortest. Lyrifissures ia, ih, ips aligned parallel to notogastral outline, located lateral to setae c₂, lp and h₃, respectively; im, ip obliquely aligned, lateral to setae lm and p₃, respectively. Opisthognal gland opening (gla) situated laterally between setae lp and h₃.

Ventral region — Ventral tubercles (Vi) 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 µm) aligned in longitudinal row; g₁ longest. Setae ag (ca. 47 µm) inserting posterolaterally to genital aperture. Setae a₀₁ (ca. 41 µm) inserted almost at mid-distance along plate; a₀₁₂ (ca. 38 µm) near anterior margin of plate. Setae ad₁ (34-34 µm) near posterolateral corner of anal aperture; ad₂₃ (ca. 45 µm) in adanal position; ad₃ inserted at level of a₀₁. Lyrifissures iad oriented obliquely, anterior to ad₃. Genital (107 µm) and anal (96 µm) apertures almost pentagonal in shape; distance between them (18 µm) 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, terminat-
ing in fine tips; chb (ca. 27 µm) attenuate conspicu-
ously and unilaterally pilose in distal portion (Fig. 
8F). Pedipalpal setal formula: 0-2-1-3-9[1]; solenid-
ion 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 (1-5-4-4-
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]-[?]-120-7]-
[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 be-
tween ω₁ (ca. 45 µm) and ω₂ (ca. 27 µm); ω₁, ω₂ ter-
minating in fine tip (Fig. 8C). Solenidion φ₁ (ca. 143 
µm) originating from small apophysis on tip of tibia 
I; 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 Will-
mann, 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, des-
ing D. verticillipes Nicolet, 1855 as the type. 
Norton (1977) reviewed it as a subgenus, while 
Balogh (1972), Balogh and Balogh (1992), Subías 
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: Spatiolamaeus sp.: Ventrolateral view, legs and pedipalps removed (NSMT-Ac, 13786).
FIGURE 8: *Spatiodamaeus* sp. (NSMT-Ac 13786): A – Left pedipalp; B – Right seta \( c_1 \); 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.
was added (Xie et al., 2012). D. (S.) verticillipes is microphytophagous (Schuster, 1956) and diplodiploid (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, p1-3 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 to lateral side.

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 — Spatiodamaeus subverticillipes Bulanova-Zachvatkina, 1957; 840 × 640 µm
   — Notogastral setae h1, h2 and h3 not longer than setae, c1, c2, la, lm, lp — S. fageti Bulanova-Zachvatkina, 1957; 860 × 580 µm
   — Length of notogastral setae variable ................. 2

2. Notogastral setae la, lm shorter than other setae — S. fogatii Bulanova-Zachvatkina, 1957; 840 × 640 µm
   — Length of notogastral setae variable ................. 3

3. Interlamellar setae in longer or as long as sensilli — S. fagati Bulanova-Zachvatkina, 1957; 860 × 580 µm
   — Setae in shorter than sensilli .......................... 6

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

5. Setae c1, c2 thick, smooth as long as thin smooth h1 — S. boreus Bulanova-Zachvatkina, 1957; 680 × 480 µm
   — Setae c1 thick, barbed longer than thin, smooth h1, 3 — S. crassispinosus Mihelčić, 1964; 850 × 520 µm

6. Ventral tubercles (Va) tuberculate .......................... 7
   — Ventral tubercles (Va) with long sharply pointed apex, bending laterally ......................

7. Setae, c1, c2, la, lm, lp thick, long, barbed; other setae h1-3 and p1-3 thin, short, smooth — S. similes (Willmann, 1954); ? × ? µm
   — Setae, c1, c2, la, lm thin, smooth ................. 8

8. Setae, c1, c2, la, lm, lp shorter than setae h1-3 — S. glabriseta (Willmann, 1930); 740 × 495 µm
   — Setae, c1, c2, la, lm, lp longer than setae h1-3 — S. diversiplis (Willmann, 1951); 600 × 360 µm
   — Setae, c1 slightly longer than other setae — S. borensis 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 was 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 × length of prodorsum. Setae le (91-88 µm) originating from tip of lamella. Setae ro and le extending anterior to
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 h3; A3 lateral to ip. Opisthontal gland opening (gla) situated latero-anteriorly to h3. Lyrifissures ia (9-14 µm), im (14-9 µm), ih (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. Lyrifissure 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. Lyrifissures 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 bars; m (ca. 6 µm) thin, smooth setiform; h (ca. 36 µm) thick setiform, barbed throughout length (Fig. 12C).

Legs — Monodactylous; claw minutely dentate (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]-[?31]-[?80]-[?71]); II ([?9]-[?91]-[24-19]-[66-56]-[62-64]); III ([?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); r’ (ca. 37 µm) posterior to ε; 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.) yezoensis (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 ad3 inserted in front of anterior margin of the anal aperture. The present specimen is different from P. (P.) yezoensis in the form of rostrum and insertion of an1, 2. The former has a round rostrum, and setae an1, 2 inserted near midway along the plates, while the latter has a rostrum with a median elevation, and seta an1 inserted near the posterior margin of the anal plate.

**Record of known species**

**Tetracondylidae Aoki, 1961**

_Fissicephus(Fissicephus) takenouchiensis_ Fujikawa and Nishi, 2013

_Fissicephus(Fissicephus) takenouchiensis_ 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 \( \mu \text{m} \); width 429 \( \mu \text{m} \). Body colour light brown.

Known record — Litter, humus, and soil from the bank of the intertidal zone of Miyajima, Hiroshima prefecture (34°17'50"N, 132°19'13"E, 0 m a.s.l.).

Remarks — The present specimen differs from the holotype in relative distances of two setal pairs: \( (\text{in-in}) < (\text{le-le}) \).

**DISCUSSION**

Whilst many oribatid species have been recorded from inside caves worldwide (e.g. Iturrondebeitia 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, Spatiodamaeus). 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 Spatiodamaeus, 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 Deposited in the National Museum of Nature and Science, Tokyo.

Measurements — Body length 307-379 \( \mu \text{m} \); width 264-357 \( \mu \text{m} \). Body colour light brown.

Known record — Litter and humus, and soil from the bank of the intertidal zone of Miyajima, Hiroshima prefecture (34°17'50"N, 132°19'13"E, 0 m a.s.l.).

Remarks — The present specimens differ from the holotype in relative distances of two setal pairs: \( (\text{in-in}) < (\text{le-le}) \).
guano deposits or nests) was unsuitable for oribatid mites.

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