New record of four Korean feather mites (Acari: Sarcoptiformes: Pterolichidae) isolated from the birds in the family Rallidae

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Four feather mite species, *Grallobia fulicae* (Trouessart, 1885), *Grallobia gallinulae* Gaud, 1968, *Grallolichus proctogamus* (Trouessart, 1885) and *Megniniella gallinulae* (Buchholz, 1869), previously unrecorded in South Korea are reported. Specimens of *Grallobia fulicae* and *Grallolichus proctogamus* were collected from the eurasian coot, *Fulica atra* in Cheongju-si. *Grallobia gallinulae* and *M. gallinulae* were found on the common moorhen, *Gallinula chloropus* in Yesan-gun. The genera *Grallobia* Hull, 1934, *Grallolichus* Gaud, 1960 and *Megniniella* Gaud, 1958 are new records for South Korea.

Here, we provide illustrations and morphological descriptions of these four feather mite species as well as the partial sequences of the mitochondrial cytochrome c oxidase subunit I (COI) as DNA barcodes.

Keywords: COI, feather mite, *Grallobia fulicae*, *Grallobia gallinulae*, *Grallolichus proctogamus*, *Megniniella gallinulae*, South Korea

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of a common moorhen, *Gallinula chloropus* in Yesan-gun. Collected mites were preserved directly in 95% ethyl alcohol. Preserved mite samples were cleared by lactic acid for 24 h and then mounted on micro slides using PVA (PVA stock solution 56%, lactic acid 22% and phenol 22%) as the mounting medium (Downs, 1943). The specimens were photographed using a microscopic digital camera (Leica, Wetzlar, Germany). Morphological terms and measurements follow Gaud and Atyeo (1996) and Norton (1998). All measurements are given in micrometers. All examined specimens were deposited in the National Institute of Biological Resources (NIBR) and Inha University, South Korea.

DNA sequencing

DNA was extracted from a single leg of each specimen using a Tissue DNA Purification Kit (Cosmogene-tech Inc., Seoul, South Korea). The partial mitochondrial COI sequence was obtained in accordance with methods described by Han et al. (2016).

**RESULTS AND DISCUSSION**

Order Sarcoptiformes Canestrini, 1891 옹진드기목
Family Pterolichidae Trouessart and Mégnin, 1884
깃사이진드기과
Genus *Grallobia* Hull, 1934
톱부기작은깃사이진드기속(신칭)

1. *Grallobia fulicae* (Trouessart, 1885)

물닭작은깃사이진드기(신칭)(Figs. 1, 2)

**Synonyms.** *Grallobia fulicae*: Dubinin, 1951; p. 132, fig. 6; 1956: p. 544-547, figs. 264-265; Gaud and Mouchet, 1963), USSR (Dubinin, 1951; 1956), Korea (Figs. 3, 4)

**Material examined.** Korea: 2♂♂, 3♀♀, Pyeongchon-dong, Sangdang-gu, Cheongju-si, Chungcheongbuk-do, 36°35’47.22”N, 127°29’52.34”E, 25 Jan 2017, collected using vacuum machine from wing feathers of the common coot, *Fulica atra* by Han Y.-D.

**Diagnosis. Male:** Length 235-240 of idiosoma from anterior end to bases of setae *h3*, width 130-135 at level of humeral shields (Fig. 1A).

Gnathosoma (Fig. 1B): Length 40-50 including palps, width 43-45.

Prodorsal shield (Fig. 1B): Length 64-68 along midline, width 68-69 at level of posterior part, posterolateral part slightly rounded, incision laterally to the level of setae *s*, with two internal vertical setae (*vi*).

Hysteronotal shield (Fig. 1C): Anterior part slightly concave, anterolateral angles slightly rounded, with faint reticular pattern of anteromedial part, length 152-162 from anterior margin to bases of setae *h3*, width 82-88 at anterior margin. Opisthosomal lobes trapezoid-shaped and short. Terminal cleft polygonal-shaped.

**Stereum** (Fig. 1D): Epimerites I fused into a Y-shape. Genital apparatus short, situated between leg III and IV.

**Female:** Idiosoma length 330-350, width 155-175 at level of humeral shields (Fig. 2A).

Gnathosoma (Fig. 2B): Shaped as in male, length 55-63 including palps, width 60-63.

Prodorsal shield (Fig. 2B): Mostly shaped as in male, length along center line 83-88, width 95-98.

Hysteronotal shield (Fig. 2C, E): Anterior region slightly concave, anterolateral margins slightly rounded, net-like pattern extending after level of gland openings (*gl*), length 240-245 from setae *c1* to setae *h3*, width 113-123 at level of setae *c1*. Supranal concavity circular-shape, located in center part of the pygidial shield. Posterior edge of opisthosomal lobe without tubercle.

Sternum (Fig. 2D): Epimerites I Y-shape. Epigynum inverted U-shape, length 55-58, width 35-43 at level of setae *4b*. Setae *4b* and genital papillae situated on posterior parts of epigynum.

**Remarks.** *Grallobia fulicae* was originally described by Trouessart (1885) based on the specimens collected from *F. atra* in Europe. Thereafter, *Grallobia fulicae* was redescribed by several mite taxonomists with detailed morphological descriptions and illustrations (Dubinin, 1951; 1956; Gaud and Mouchet, 1963). The morphology of the Korean male specimens was consistent with the description and illustration of Dubinin (1951; 1956).

*Grallobia fulicae* is distinguishable from other species in the genus *Grallobia* by several characteristics: (1) total body length less than 0.3 mm in males; (2) net-like pattern of hysteronotal shield; and (3) posterior edge of opisthosoma without tubercle in females (Gaud, 1968).

**Host.** This species was found on the surface of wing feathers of the common coot, *Fulica atra*.

**World distribution.** Bechuanaland, Rwanda (Gaud, 1968), Europe (Trouessart, 1885), France (Gaud and Mouchet, 1963), USSR (Dubinin, 1951; 1956), Korea (This study).

**Deposition.** NIBRIV0000754045 and NIBRIV0000811889-811892.

**Molecular data.** The *COI* sequences were obtained from two individuals and deposited in GenBank with accession numbers of MG545262 and MG545263.

**Identifiers.** Yeong-Deok Han and Gi-Sik Min.

2. *Grallobia gallinulae* Gaud, 1968

쇠물닭작은깃사이진드기(신칭)(Figs. 3, 4)

**Synonyms.** *Grallobia gallinulae*: Gaud, 1968, p. 30-32, fig. 13.

**Material examined.** Korea: 2♂♂, 2♀♀, Dongsan-ri, Dec.
Gwangsi-myeon, Yesan-gun, Chungcheongnam-do, 36°35‘15.91”N, 126°47‘16.65”E, Sept 17, 2013, collected using a vacuum machine from primary feathers on the wings of the common moorhen *Gallinula chloropus* by Han Y.-D.

**Diagnosis. Male:** Length 250-255 of idiosoma from anterior end to bases of setae *h*3, Width 120-135 at level of setae *cp* (Fig. 3A).

Gnathosoma (Fig. 3B): Length 40 including palps, width 38-40.

Prodorsal shield (Fig. 3B): Covers the entire prodorsum, posterior part straight, length 70-73 at base of setae *vi*, width 98 at level of posterior part, with two internal vertical setae of filiform.

Hysteronotal shield (Fig. 3C): Strong sclerotized on hysterosoma, anterior part slightly straight, without net-like pattern, length 360 from anterior margin to base of setae *h*3, width 100-103 at level of setae *c*2. Anterior part of terminal cleft oval-shape. Setae *h*3, *h*2 long hair-like shaped.

Sternum (Fig. 3D): Epimerites I fused. Genital apparatus shorted, situated between leg III and IV.
Female: Length 360-380 of idiosoma from anterior end to bases of setae \( h_3 \), width 155-160 at level of setae \( cp \) (Fig. 4A).

Gnathosoma (Fig. 4B): Shaped as in male. Length together with palps 55, width 48-50.

Prodorsal shield (Fig. 4B): Shaped as in male. Length 88-93 at base of setae \( vi \), width 120-130 at level of posterior part.

Hysteronotal shield (Fig. 4C, E): Anterior part slightly straight, length 270-295 from bases of setae \( c_1 \) to bases...
of setae $h_3$, width 120-135 at based of anterior margins. Posterior part of opisthosomal lobe rounded. Posterior edge of the spermatiduct protruding in small tubercle shape at the posterior end of opisthosomal lobe.

Sternum (Fig. 4D): Epigynum horseshoe-shaped, length 53-60, width 38 at level of setae $4b$. Setae $4b$ and genital papillae situated at posterior part of epigynum. Supranal concavity circular-shaped.

Remarks. Grallobia gallinulae was originally described by Gaud, 1968 based on the specimens collected from Gallinula chloropus in Rwanda.

While Grallobia gallinulae is very similar to Grallobia fulicae with regard to external traits, it can be clearly distinguished from Grallobia fulicae by the following characteristics: (1) prodorsal and hysteronotal shield strongly sclerotized on prodorsum and hysterosoma, respectively; (2) net-like pattern of hysteronotal shield absent; (3) posterior border of opisthosomal lobe with small tubercle in female (Gaud, 1968). The morphology of the Korean specimens were consistent with that those
of the original descriptions and illustrations by Gaud (1968).

**Host.** Specimens were collected from the surface of primary feathers on the wings of the common moorhen, *Gallinula chloropus.*

**World distribution.** Cameroun, Congo, Rwanda (Gaud,
1968), Korea (This study).

**Deposition.** NIBRIV00000812252 and NIBRIV000000812354-812356.

**Molecular data.** The COI sequences were obtained from two individuals and deposited in GenBank with accession numbers of MG545264 and MG545265.

**Identifiers.** Yeong-Deok Han and Gi-Sik Min.

Family Pterolichidae Trouessart and Mégnin, 1884

Genus *Grallolichus* Gaud, 1960

독부기코리깃털진드기(신칭)

3. *Grallolichus proctogamus* (Trouessart, 1885)

독부기코리깃털진드기(신칭)(Figs. 5, 6)

**Synonyms.** *Grallobia proctogamus* Dubinin, 1951: p. 132, 137, fig. 5; 1956, p. 551-555, figs. 269-270.

*Grallolichus proctogamus* Gaud & Mouchet, 1963, p. 638, fig. 3; Gaud, 1968, p. 46.

**Material examined.** Korea: 3♂♂♂, 3♀♀♀, Pyeongchon-gu, Cheongju-si, Chungcheongbuk-do, 36°35′29″N, 127°29′52″E, 25 Jan 2017, collected using vacuum machine from wing feathers of the common coot, *Fulica atra* by Han Y.-D.

**Diagnosis. Male:** Length 380-390 of idiosoma from anterior end to bases of setae *h*3, width 150-160 at level of setae *c*3 (Fig. 5A).

Gnathosoma (Fig. 5A): Small and rounded edges, length 53-58 including palps, width 50-55.

Prodorsal shield (Fig. 5B): Covers the entire prodorsum, surface with irregular reticulate-like ornamentation, length 125-130 along midline, width 155 at level of posterior part, with two internal vertical setae (*v*).

Hysteronotal shield (Fig. 5C, E): Strong sclerotized on hysterosoma, surface with colliculate pattern smaller than prodorsal shield, length 265-275 from anterior margin to bases of setae *h*3, width 140-155 at level of setae *c*1. Opisthosomal lobes semicircle-shaped, wide and short.

Sternum (Fig. 5D): Epimerites I fused into a Y-shape. Genital apparatus gradually thinned from the base towards the distal end, originating in front of setae *ps*3, longer than half-diameter of the anal discs including surrounding membrane with radial striae.

**Female:** Idiosoma length 550-580, width 165-180 at level of setae *c*3 (Fig. 6A).

Gnathosoma (Fig. 6A): Shaped as in male, length 75-78 including palps, width 70-75.

Prodorsal shield (Fig. 6B): Mostly shaped as in male, length along center line 165-180, width 140-150.

Hysteronotal shield (Fig. 6C, E): Shaped as in male, length 405-425 from setae *c*1 to setae *h*3, width 185-195. Pygidial shield clover-shaped, with each side by deep concavity between bases of setae *ps*2 and *f*2. Supranal concavity circular-shaped. Soft striated tegument broad, with thick and lanceolate setae *h*1.

Sternum (Fig. 6D): Epimerites I Y-shape. Epigynum short and bow-like, length 5-6, width 16-19.

**Remarks.** *Grallolichus proctogamus* was originally described by Trouessart (1885) based on the specimens collected from *F. atra* in Europe. Thereafter, *Grallolichus proctogamus* was redescribed by several mite taxonomists with detailed morphological descriptions and illustrations (Dubinin, 1951; 1956; Gaud and Mouchet, 1963; Gaud, 1968). The morphology of the Korean male specimens was consistent with the descriptions and illustrations of Dubinin (1951; 1956).

*Grallolichus proctogamus* is distinguishable from other species in the genus *Grallolichus* by several characteristics: (1) dorsal shields with colliculate pattern; (2) genital apparatus gradually thinned from the base towards the distal end, originating in front of setae *ps*3 in male; and (3) pygidial shield clover-shaped, with each side having deep concavity between bases of setae *ps*2 and *f*2 in females (Gaud, 1968).

**Host.** This species was found on the surface of wing feathers in the common coot, *Fulica atra*.

**World distribution.** Bechuanaland, Congo, Rwanda (Gaud, 1968), France (Gaud and Mouchet, 1963), USSR (Dubinin, 1951; 1956), Korea (This study).

**Deposition.** NIBRIV00000754046 and NIBRIV0000810175-810179.

**Molecular data.** The COI sequences were obtained from two individuals and deposited in GenBank with accession numbers of MG545266 and MG545267.

**Identifiers.** Yeong-Deok Han and Gi-Sik Min.

Family Analgidae Trouessart and Mégnin, 1884

깃털진드기과

Genus *Megniniella* Gaud, 1958

독부기꼬리깃털진드기(신칭)

4. *Megniniella gallinulae* (Buchholz, 1869)

쇠물닭꼬리깃털진드기(신칭)(Figs. 7, 8)

**Synonyms.** *Dermaleicus gallinulae* Buchholz, 1869, p. 27-28, fig. 14.

*Megniniella gallinulae* Gaud, 1968, p. 10-12, fig. 2; Almeida Pedroso and Hernandes, 2016, p. 6-8, figs. 7, 8.

**Material examined.** Korea: 2♂♂♂, 1♀♀♀, Dongsan-ri, Gwangsi-myeon, Yesan-gun, Chungcheongnam-do, 36°35′15.91″N, 126°47′16.65″E, Sept 17, 2013, collected using a vacuum machine from tail feathers of the common moorhen, *Gallinula chloropus* by Han Y.-D.

**Diagnosis. Male:** Length 510-520 of idiosoma from an-
terior end to bases of setae $h3$. Width 285-295 at level of humeral shields (Fig. 7A).

Gnathosoma (Fig. 7B): Length 73-75 including palps, Width 68.

Prodorsal shield (Fig. 7B): Narrow trapezoidal-shaped, posterolateral part slightly acute, with length 123-125 along midline, width 65-67 at level of setae $se$. Two internal vertical setae ($vi$) present.
Hysteronotal shield (Fig. 7C, E): Anterior part convex, anterolateral angles slightly acute, with vertical stripes, length 385-400 from anterior margin to bases of setae h3, width 195-205 at anterior margin. Opisthosomal lobes well developed, with large and acute apices. Terminal cleft oval-shaped. Supranal concavity opens posteriorly.
Terminal cleft oval-shaped.

Sternum (Fig. 7D): Epimerites I fused as elongated Y-shape, surrounded by sclerotized area. Adanal shield large, with pair of longitudinal band-shaped soft tegument.

**Female:** Idiosoma length 365, width 235 at level of humeral shields (Fig. 8A).

Gnathosoma (Fig. 8A): Shaped as in male, length 63 including palps, width 58.

Prodorsal shield (Fig. 8B): Mostly shaped as in male, length along center line 100, width 63 at level of setae se.

Hysteronotal shield (Fig. 8C): Present, anterior part rounded, length 158 from anterior end to setae h3, width 105 at level of setae e2.

Sternum (Fig. 8D): Epimerites I Y-shape. Epigynum bow-shape, length 10, width 30 at level of setae 4b.

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**Fig. 7. Megniniella gallinulae**, male. A, whole body; B, dorsal view of prodorsal shield; C, dorsal view of hysteronotal shield; D, ventral view of sternum; E, ventral view of opisthosoma. gap - genital apparatus, gp - genital papillae. Scale bars: A, 0.1 mm; B, 0.05 mm; C, 0.1 mm; D, E, 0.05 mm.
Remarks. *Megniniella gallinulae* was originally described by Buchholz (1869) based on the specimens collected from *Gallinula chloropus* in Europe. Thereafter, *M. gallinulae* was redescribed by several mite taxonomists with detailed morphological descriptions and illustrations (Gaud, 1968; Almeida Pedroso and Hernandes, 2016). The morphology of the Korean male specimens was consistent with the descriptions and illustrations of Gaud (1968).

*Megniniella gallinulae* is distinguishable from other species in the genus *Megniniella* by several characteristics: (1) epimerites I fused as elongated Y-shape in males; (2) anterior part of hysteronotal shield rounded in male; and (3) hysteronotal shield present, anterior region rounded in female.

Host. Specimens were collected from the surface of tail feathers of common moorhen, *Gallinula chloropus*.

World distribution. Brazil (Almeida Pedroso and
Hernandes, 2016), Cameroun, Congo, Rwanda (Gaud, 1968), China (Wang and Fan, 2010), Korea (This study).

**Deposition.** NIBRIV000000812253 and NIBRIV000000812357-812358.

**Molecular data.** The COI sequence was obtained from one individual and deposited in GenBank with accession numbers of MG545268.

**Identifiers.** Yeong-Deok Han and Gi-Sik Min.

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