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# New record of two Korean feather mites (Acari: Sarcoptiformes: Astigmata) isolated from water birds

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Two feather mites, *Scutomegninia phalacrocoracis* Dubinin and Dubinina, 1940 and *Ptiloxenus major* (Mégnin and Trouessart, 1884) are reported for the first time in Korea. Specimens of *S. phalacrocoracis* and *P. major* were collected from the great cormorant, *Phalacrocorax carbo* and great crested grebe, *Podiceps cristatus*, respectively. The genera *Scutomegninia* Dubinin, 1951 and *Ptiloxenus* Hull, 1934 are also new reports for South Korea. Here, we provide morphological descriptions and illustrations of these two species. Additionally, we provide partial sequences of the mitochondrial cytochrome c oxidase subunit I (*COI*) as DNA barcodes.

Keywords: *COI*, feather mite, great cormorant, great crested grebe, *Ptiloxenus major*, *Scutomegninia phalacrocoracis*, South Korea

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## Introduction

Feather mites (Astigmata: Pterolichoidea and Analgoidea) are symbiotic with bird hosts and, as a group, contain approximately 2,500 species (Mironov, 2003; Proctor, 2003). Mites in the genera *Scutomegninia* Dubinin, 1951 and *Ptiloxenus* Hull, 1934 mites are observed mainly in birds that live on or around water (Dubinin, 1956; Gaud and Atyeo, 1996; Dabert and Ehrnsberger, 1998; Mironov, 2000).

The genus *Scutomegninia* is one of 33 genera belonging to the family Avenzoariidae Oudemans, 1905 that is comprised of 28 species generally associated with birds in the orders Ciconiiformes and Suliformes (Mironov, 1990; 2000; Gaud and Atyeo, 1996). The genus *Scutomegninia* has the following diagnostic characteristics: (1) internal vertical setae absent; (2) laterocoxal organ bifurcated and barbed shape; (3) epimerites I fused into a Y-shape; (4) setae *cp* located slightly anterior to setae *c3*; and (5) tibiae of legs I and II exist as acute or bidentate ventral processes (Mironov, 1990; 2000).

The genus *Ptiloxenus* is one of four genera that belong to the family Ptiloxenidae Gaud, 1982 and contains two species (Gaud, 1982; Gaud and Atyeo, 1996; Dabert and Ehrnsberger, 1998). This genus was found on flight feather surfaces on the wings of two orders, Gaviiformes and Podicipediformes. The genus *Ptiloxenus* has the following diagnostic characteristics in males: (1) Interlobar membranes present; (2) setae *h3* leaf-shaped; (3) setae *cG* of genua I and II shaped hair-like; and (4) tarsi IV exist as a hook-like apophyse (Gaud and Atyeo, 1996; Dabert and Ehrnsberger, 1998).

Here, we provide descriptions and illustrations of *S. phalacrocoracis* and *P. major* based on morphology. Additionally, we provide the partial sequences of the mitochondrial cytochrome c oxidase subunit I (*COI*) as DNA barcodes.

## Materials and Methods

Specimens of *S. phalacrocoracis* and *P. major* were collected from feathers of great cormorant, *Phalacrocorax carbo* from Cheongju-si and great crested grebe, *Podiceps cristatus* from Asan-si, respectively, using a vacuum machine. Collected mites were preserved directly in 95% ethyl alcohol. The mite specimens 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 with a microscopic digital camera (Leica, Wetzlar, Germany). The terms and measurements follow Gaud and Atyeo (1996) and Norton (1998). All measurements are given in μm. All examined specimens were deposited in the National Institute of Biological Resources (NIBR) and Inha University, Korea.

**DNA sequencing**

DNA was extracted from single leg of each specimen using a Tissue DNA Purification Kit (Cosmogenetech Inc., Seoul, Korea) according to the manufacturer's instructions. PCR amplification, purification and sequencing were performed according to the methods described by Han et al. (2016).

## Results and Discussion

Order Sarcoptiformes Canestrini, 1891 옴진드기목
Family Avenzoariidae Oudemans, 1905 깃털진드기과
Genus *Scutomegninia* Dubinin, 1951
방패깃털진드기속 (신칭)

**1. *Scutomegninia phalacrocoracis* Dubinin and Dubinina, 1940**
민물가마우지방패깃털진드기 (신칭) (Figs. 1-3)

**Synonyms.** *Scutomegninia phalacrocoracis*: Dubinin, 1951, p. 220, fig. 50; Dubinin and Sosnina, 1952, p. 104; Atyeo and Peterson, 1967, p. 100, figs. 5-8; Mironov, 1990, p. 49, figs. 2-3; Mironov, 2000, p. 13, figs. 3-4.

**Material examined.** Korea: 3♂♂, 3우우, Namgye-ri, Munui-myeon, Sangdang-gu, Cheongju-si, Chungcheongnam-do, 36°32′N, 127°29′E, 10 Jun 2017, collected using vacuum machine from wings feathers in the great cormorant, *Phalacrocorax carbo* by Han Y.-D.

**Diagnosis. Male:** Length 460-530 of idiosoma from anterior end to bases of setae *h3*. Width 315-345 at level of humeral shields (Fig. 1A).

Gnathosoma (Fig. 1B): Lateral margins with spine-like process. Length 75-83 including palps, Width 68-75.

Prodorsal shield (Fig. 1B): Length 100-108 along midline, width 58-70, triangular shape, narrowed in anterior part, lateral sclerites extending at level setae *si*, posterior part with blunt protrusion, setae *vi* absent.

Hysteronotal shield (Fig. 1C): Anterior part slightly sinuous, anterior angles acute, length 325-365 from anterior margin to bases of setae *h3*, width 195-225 at anterior margin. Anterior part of terminal cleft oval-shape, terminal cleft length 150-158 from anterior end to bases of setae *h3*, width 80-88 at level of setae *ps1*. Interlobar membrane extending to lobar ends, with little tooth-like process on each posterior end. Incision in interlobar membrane triangular-shape. Setae *h3* slightly enlarged in medial part.

Sternum (Fig. 1D, E): Epimerites I fused into a Y-shape. Epimerites III and IV fused. Genital apodemes fused with internal ends of epimerites IV. Anteromedial part of Adanal shields slightly rounded or rectangular-shape. Medial and lateral adanal shields mushroom-shape, with many acute teeth on anterior parts. Medial adanal shields not fused, with rounded posterior edges. The posterior edges of lateral adanal shields acute-shaped.

Legs: Apical spine-like processes of tarsi I and II absent. Genua I and II with filiform setae *mG*. Setae *s* apex of tarsi III with two adjacent teeth (Fig. 3A). Tarsi IV with dorsobasal processes (Fig. 3B).

**Female:** Idiosoma length 420-430, width 255-265 (Fig. 2A).

Gnathosoma (Fig. 2B): Shaped as in male, length 75-83 including palps, width 70-72.

Prodorsal shield (Fig. 2B): Mostly shaped as in male, length along center line 83-95, width 73-75 at level of setae *se*.

Hysteronotal shield (Fig. 2C): Anterior margins with bifurcated wing-shaped, posterior part with deep triangle-like incision, length 240-250, width 200-210 at anterior margin. Setae *c2* situated inside rather than anterior angles edge of hysteronotal shield. Setae *h1* situated off hysteronotal shield.

Pygidial shield (Fig. 2D): paired, divided from hysteronotal shield.

Sternum (Fig. 2E): Epimerites I fused. Epigynum length 58-63, width 85-90 at level of setae *g*. Setae *g* situated between genital papillae.

**Remarks.** *Scutomegninia phalacrocoracis* was originally described by Dubinin and Dubinina (1940) based on specimens collected from *Phalacrocorax carbo sinensis* in the Volga Delta of Russia.

*Scutomegninia phalacrocoracis* is distinguishable from other species in the genus *Scutomegninia* by several characteristics in males: (1) seta *s* apex of tarsus III with two adjacent teeth; (2) anteromedial angles of adanal apodemes slightly round or rectangular; and (3) length of terminal cleft approximately 1/3 of the idiosoma length (Mironov, 2000).

*Scutomegninia phalacrocoracis* is very similar to *S. serrulata* (Berlese, 1898) with regard to external traits. However, *S. phalacrocoracis* can be clearly distinguished from *S. serrulata* by the following characteristics: length of terminal cleft approximately 1/3 of the idiosomal length in males; setae *c2* situated inside, rather than at anterior angles to, edge of hysteronotal shield in females; setae g located between genital papillae in females (Mironov, 1990; 2000). The morphology of Kore-

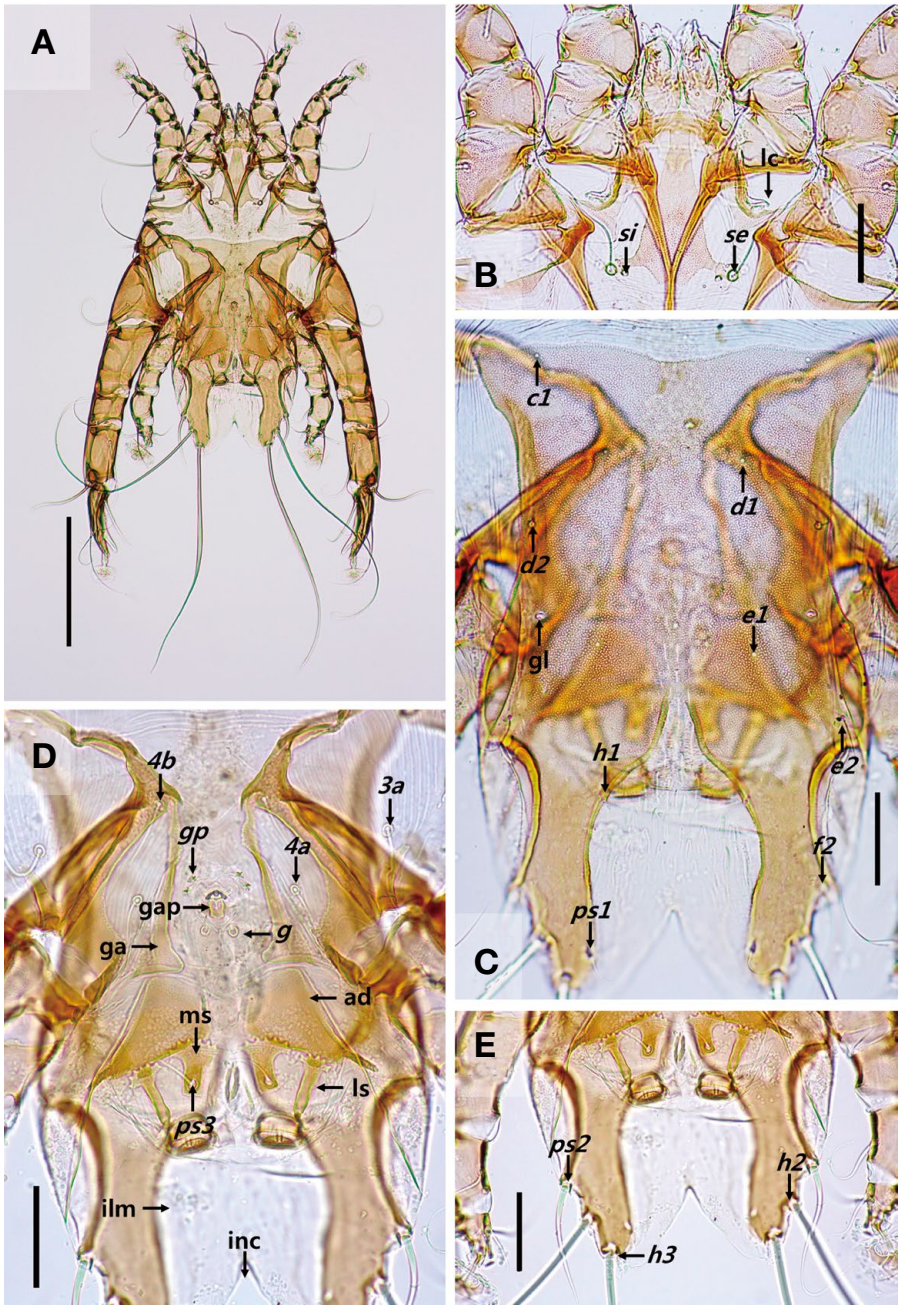


**Fig. 1.** *Scutomegninia phalacrocoracis*, male. A, whole body; B, dorsal view of prodorsal shield; C, dorsal view of hysteronotal shield; D, ventral view of sternum; E, ventral view of opisthosoma. ad - adanal apodeme, ga - genital apodemes, gap - genital apparatus, gl - opening of dorsal hysteronotal glands, ilm - interlobar membrane, inc - incision in interlobar membrane, lc - latercoxal organ, ls - lateral adanal shield, ms - medial adanal shield. Scale bars: A, 0.2 mm; B-E, 0.05 mm.

an male specimens were consistentwith the descriptions and illustrations provided by Mironov (1990; 2000).

**Host.** This species was found on the surface of wings feathers in the great comorant, *Phalacrocorax carbo*.

**Distribution.** Russia (Dubinin and Sosnina, 1952), Kazakhstan, Japan, New Zealand (Mironov, 2000), Korea (this study).

**Deposition.** NIBRIV0000754006 and NIBRIV0000810 164-0000810168.

**Molecular characteristics.** The *COI* sequences with 597 bp lengths were obtained from two individuals (GenBank accession numbers: MG459418 and MG459419). The sequence alignment did not contain any insertions or deletions. No frame shift was detected after amino

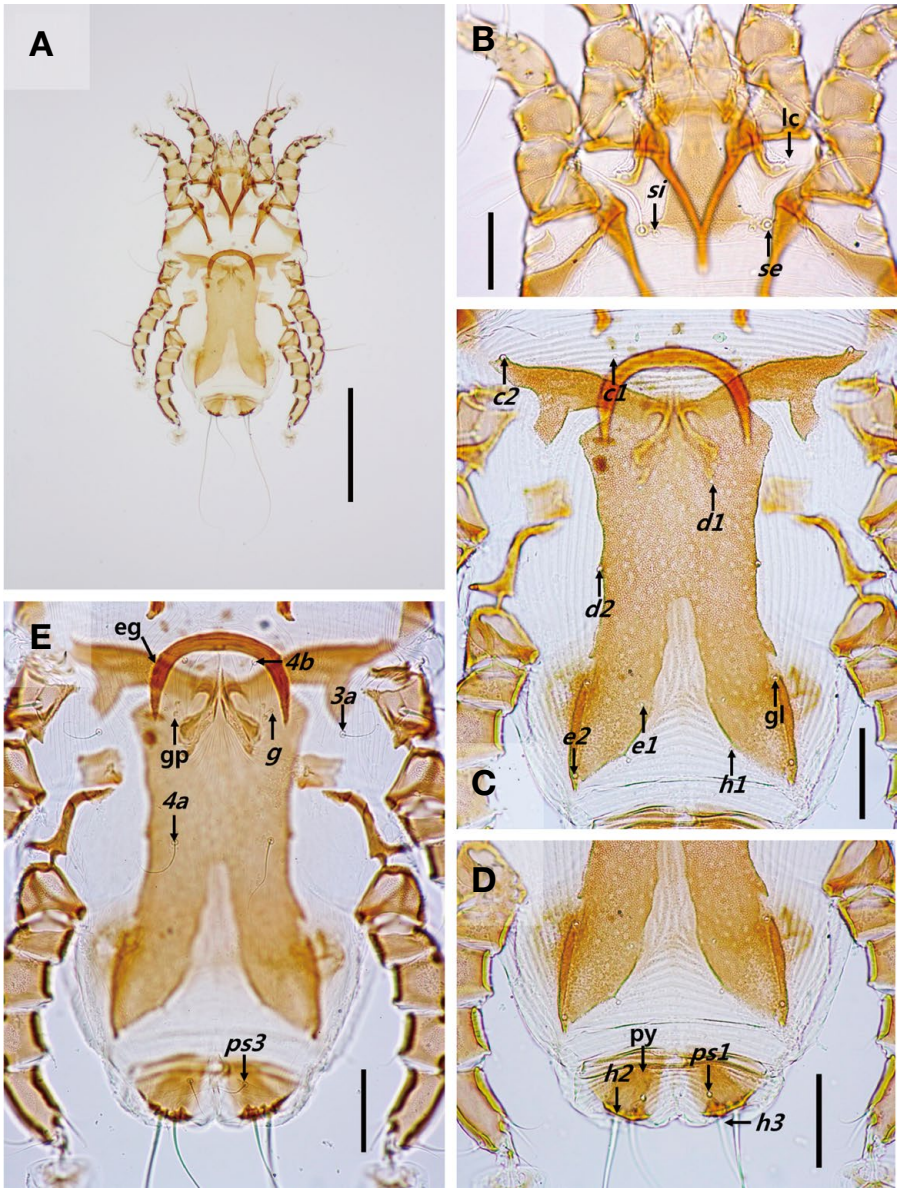


**Fig. 2.** *Scutomegninia phalacrocoracis*, female. A, whole body; B, dorsal view of prodorsal shield; C, dorsal view of hysteronotal shield; D, dorsal view of pygidial shield; E, ventral view of sternum. eg - epigynum, gl - opening of dorsal hysteronotal glands, gp - genital papillae, lc - latercoxal organ, py - pygidial shield. Scale bars: A, 0.2 mm; B-E, 0.05 mm.

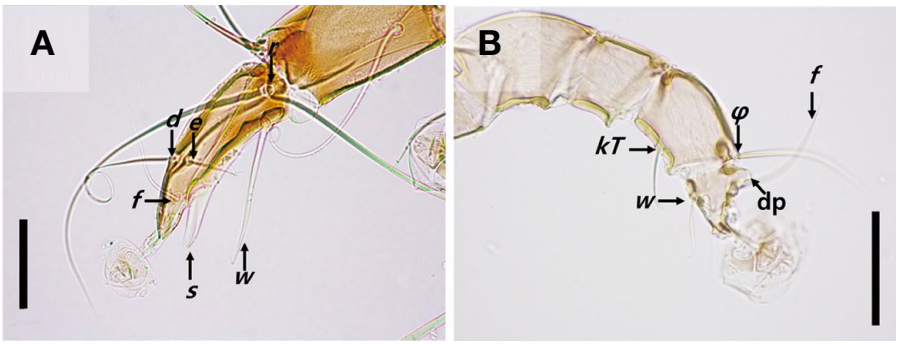


**Fig. 3.** *Scutomegninia phalacrocoracis*, legs of male. A, tarsus III; B, leg IV. dp - dorsobasal processes. Scale bar: 0.05 mm.

acid conversion using the invertebrate mitochondrial genetic code.

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

Family Ptiloxenidae Gaud, 1982
깃표면진드기과(신칭)
Genus *Ptiloxenus* Hull, 1934 깃표면진드기속(신칭)

**2. *Ptiloxenus major* (Mégnin and Trouessart, 1884)**
논병아리큰깃표면진드기(신칭) (Figs. 4, 5)

**Synonyms.** *Pterolichus colymbi* var. *maior* Mégnin and Trouessart, 1884: 429-430.

*Ptiloxenus major*: Bedford, 1936: 71; Dubinin, 1951, p. 147-148, fig. 15; 1956: p. 527-530, figs. 258-259; Gaud and Atyeo, 1996, Part II, p. 419, fig. 430; Davert and Ehrnsberger, 1998, p. 151; Krantz and Walter, 2009, p. 638, fig. 16.37.

**Material examined.** Korea: 3♂♂, 3우우, Gwongok-dong, Asan-si, Chungcheongnam-do, 36°47′22.36″N, 127°0′33.64″E, July 5, 2013, collected using vacuum machine from flight feathers on the wings of great crested grebe, *Podiceps cristatus* by Han Y.-D.

**Diagnosis. Male:** Length 400-415 of idiosoma from anterior end to bases of setae *h3*, width 220-230 at level of humeral shields (Fig. 4A).

Gnathosoma (Fig. 4B): Slightly widened in the posterior part, with rounded posterolateral margin, length 55-

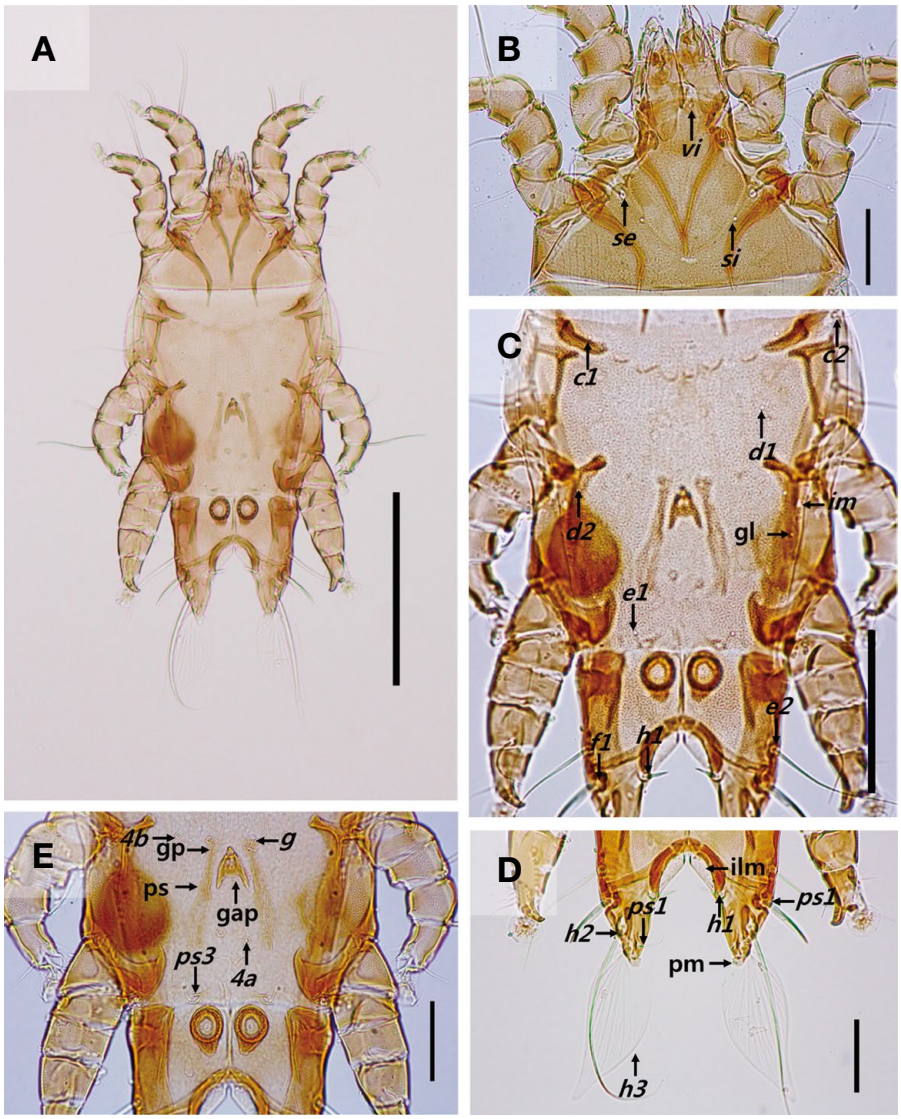


**Fig. 4.** Ptiloxneus *major*, male. A, whole body; B, dorsal view of prodorsal shield; C, dorsal view of hysteronontal shield; D, ventral viewe of sternum; E, ventral view of opisthosoma lobes. gap - genital apparatus, gl - opening of dorsal hysteronotal glands, gp - genital papillae, ilm - interlobar membrane, ps - paragenital sclerite, pm - postlobar membrane. Scale bars: A, 0.2 mm; B, 0.05 mm; C, 0.1 mm; D, E, 0.05 mm.

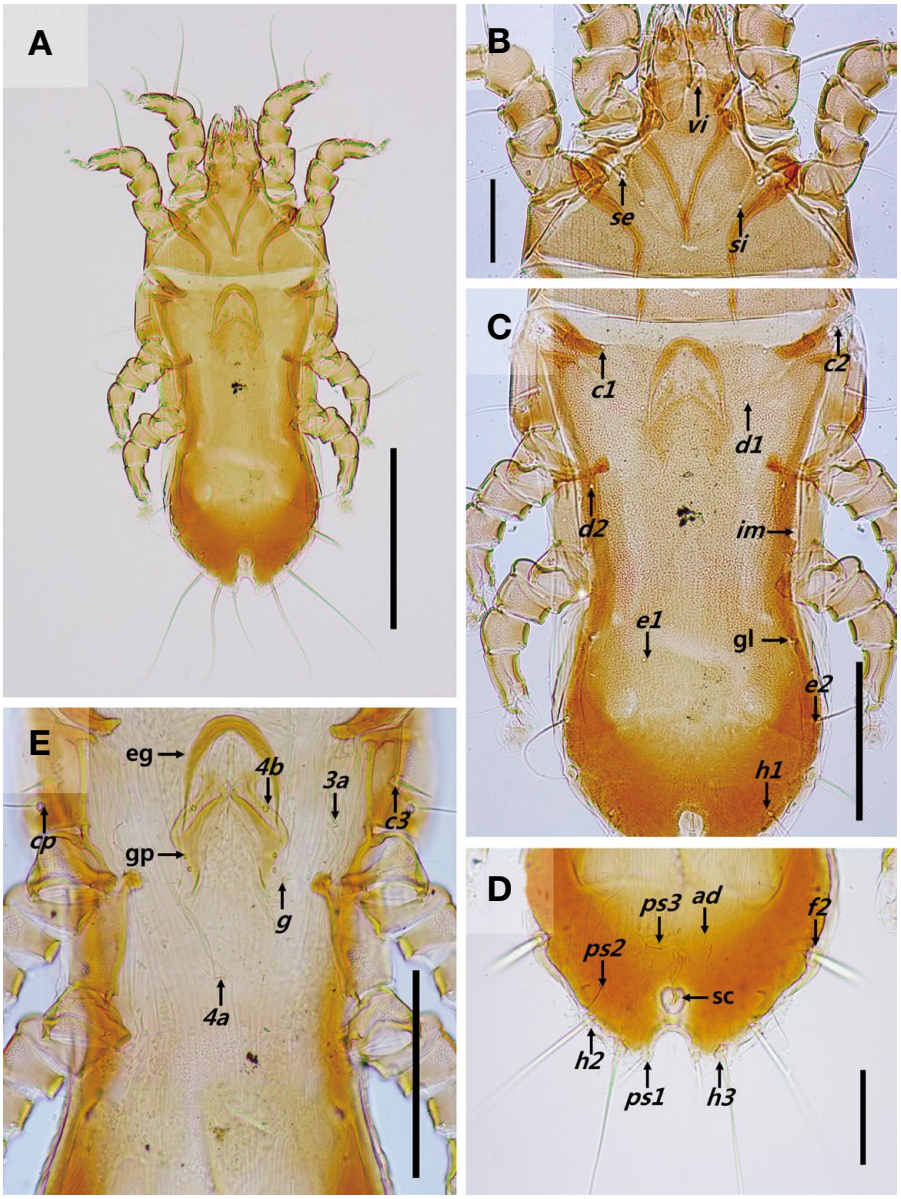


**Fig. 5.** *Ptiloxenus major*, female. A, whole body; B, dorsal view of prodorsal shield; C, dorsal view of hysteronontal shield; D, ventral viewe of sternum; E, ventral view of opisthosoma. eg - epigynum, gl - opening of dorsal hysteronotal glands, gp - genital papillae, sc - supranal concavity. Scale bars: A, 0.2 mm; B, 0.05 mm; C, D, 0.1 mm; E, 0.05 mm.

58 together with palps, width 48-50.

Prodorsal shield (Fig. 4B): Covers the entire pronotum, with a dot-like pattern on the surface, length 105-110 along midline, width 173-178, with two internal vertical seta (*vi*) of filiform.

Hysteronotal shield (Fig. 4C): Strong sclerotized on hysteronotum, anterior part with transverse line of semicircular sclerites, length 305-320 from anterior margin to base of setae *h3*, width 188-190 at level of setae *c2*. Opisthosomal lobes shot, triangle-shaped. Interlobar membranes situated from base of terminal cleft to level of setae *h1*. Setae *h3* wide leaf-like shaped, with longitudinal line.

Sternum (Fig. 4D, E): Epimerites I fused. Genital apparatus small, located between legs III and IV. Setae *g* and genital papillae situated on paragenital sclerites (ps). Paragenital sclerites band-shaped, situated on both sides of genital apparatus, anterior part not fused, extending after level of setae *4a*. Setae *ps3* situated on adanal sclerites. Adanal discs present. Postlobar membranes (pm) tongue-shaped, with internal extension.

Legs: Genua I and II with setae *cG* of hair-shape. Tar-

si IV with hook-like apophyses (Fig. 4D).

**Female:** length 440-445 of idiosoma from anterior end to bases of setae *h3*, width 200-220 at level of setae *c2* (Fig. 5A).

Gnathosoma (Fig. 5B): length 75-83 including palps, width 60-63.

Prodorsal shield (Fig. 5B): Shaped as in male. Length 180-183 at based of setae *vi*, width 113-120 at posterior part.

Hysteronotal shield (Fig. 5C): Anterior part slightly concave, length 330-335, width 185-195 at based of setae *c2*. Opisthosomal lobes with shallow terminal cleft. Interlobar and lateral membranes absent.

Sternum (Fig. 5D, E): Epigynum horseshoe-shaped, length 56-58, width 45-48. Supranal concavity circular-shaped, divided from terminal cleft.

**Remarks.** *Ptiloxenus major* was originally described without illustration by Mégnin and Trouessart (1884) based on specimens collected from the great crested grebe (*Podiceps cristatus*) and red-throated diver (*Gavia stellata=Colymbus septentrionalis*) in Europe. Thereafter, this species was redescribed by several mite taxonomists with detailed morphological descriptions and illustrations (Dubinin, 1951; 1956; Gaud and Atyeo, 1996; Krantz and Walter, 2009). Their descriptions and illustrations are very similar, except for some differences in the position of the setae on the genital area, and the shape of the paragenital sclerites. Korean specimens matched well with those of Gaud and Atyeo (1996), although some differences were found in the following characteristics in males: (1) transverse line of semi-circle located on anterior part of hysteronotal shield; and (2) genital papillae located on paragenital sclerites.

**Host.** Specimens were collected from the surface of flight feathers on the wings of great crested grebe, *Podiceps cristatus*.

**Distribution.** Canada (Krantz and Walter, 2009), Europe (Dubinin, 1951; 1956; Davert and Ehrnsberger, 1998; Gaud and Atyeo, 1996), Korea (this study).

**Deposition.** NIBRIV0000754047 and NIBRIV0000810 159-0000810163.

**Molecular characteristics.** The *COI* sequences with 597 bp lengths were obtained from two individuals of *P. major* (GenBank accession numbers: MG459420-459421). The sequence alignment did not contain any insertions or deletions. No frame shift was detected after amino acid conversion using the invertebrate mitochondrial genetic code.

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

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