

The First Report of Two Feather Mites (Acariformes: Astigmata) from the Eastern Spot-billed Duck, *Anas zonorhyncha* (Anseriformes: Anatidae), in Korea

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ABSTRACT

Two feather mites, *Brephosceles anatina* Dubinin, 1951 (Analgoidea: Alloptidae) and *Freyana anatina* (Koch, 1844) (Pterolichoidea: Freyanidae), have been reported for the first time from the Eastern Spot-billed Duck, *Anas zonorhyncha* Swinhoe, 1866 (Anseriformes: Anatidae), in Korea. The genera *Brephosceles* Hull, 1934 and *Freyana* Haller, 1877 are new records of Korean fauna. The morphology of *B. anatina* is distinguished from three species of the *lambda* species group in having legs IV extending the level of setae *e2* with the distal end of the tarsus in males, and the incision on the posterior margin of the hysteronotal shield triangular-shaped and distinctly longer than its greatest width in females. *Freyana anatina* is distinguished from *F. nyrocae* and *F. obliquasetae* in having setae *ps1* with a rectangle bend in homeomorphic males, and setae *ps1* obliquely ovate and divergent, with the inner canal going obliquely across the membranous part of these setae in females. This study provides morphological redescriptions of both feather mite species supplemented with partial sequences of mitochondrial cytochrome *c* oxidase subunit I (*COI*), based on specimens collected in Korea.

Keywords: *Brephosceles anatina*, *COI*, Eastern Spot-billed Duck, feather mite, *Freyana anatina*

INTRODUCTION

The Eastern Spot-billed Duck, *Anas zonorhyncha* Swinhoe, 1866 (Anseriformes: Anatidae), was originally considered one of the three subspecies of the Indian Spot-billed Duck, *A. poecilorhyncha* Forster, 1781, but is now recognized as a separate species (Park, 2022; Gill et al., 2023). This bird is distributed across various countries and territories of East Asia, including Southeastern Siberia, Mongolia, Northeast China, Korea, Taiwan, and Japan (Park, 2022; Gill et al., 2023). This duck is commonly observed as a wild bird species during winter in South Korea, with approximately 50,000–140,000 individuals wintering (NIBR, 2022). Furthermore, since its breeding was confirmed in the 1960s, this bird has become a common breeding resident bird in grasslands near wetlands, reservoirs, and rice paddies nationwide (Park, 2022). *Anas*

zonorhyncha (= *A. poecilorhyncha zonorhyncha*) has been documented as a host of three feather mites: *Bdellorhynchus polymorphus* Trouessart, 1885 (Analgoidea: Avenzoariidae), *Freyana anatina* (Koch, 1844), and *F. largifolia* Mégnin and Trouessart, 1884 (Pterolichoidea: Freyanidae) (Dubinin, 1950, 1953, 1956). All three feather mites have been recorded in *A. zonorhyncha* in Russia, and no studies on feather mites associated with this bird or other wild ducks have been conducted in Korea.

The feather mite genus *Brephosceles* Hull, 1934 (Analgoidea: Alloptidae) comprises approximately 50 species and is generally associated with five orders of aquatic birds (Aves: Anseriformes, Charadriiformes, Gaviiformes, Gruiformes, and Procellariiformes) (Peterson, 1971; Mironov, 2007; Mironov et al., 2022). This genus is classified as one of the basal and morphologically archaic lineages within the sub-

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family Alloptinae based on morphological features such as idiosomal and leg chaetomes and non-modified free opisthosomal lobes in males (Mironov et al., 2022).

The genus *Freyana* Haller, 1877 (Pterolichoidea: Freyanidae) comprises 35 species that inhabit the anseriform birds of the subfamilies Anatinae and Anserinae (Gaud and Atyeo, 1985; Vasyukova and Mironov, 1991). This genus is the most species-rich in the subfamily Freyaninae and is morphologically less modified than other genera associated with hosts of the family Anatidae (Gaud and Atyeo, 1975; Ehrnsberger et al., 2001). Male polymorphism is strongly pronounced in this genus; in homeomorphs, the epimerites of all coxae are similar to those in females, whereas in heteromorphs, the inner ends of all epimerites are fused to form an entire network of closed coxal fields. Most *Freyana* species are arranged in the *anatina* and *largifolia* species groups based on the shape of setae *f*₂ in males and the curvature of epimerite II in females and homeomorphic males (Gaud and Atyeo, 1985; Vasyukova and Mironov, 1991).

Conducting the Korean Indigenous Species Investigation Project (Invertebrate), we examined the carcass of *A. zonorhyncha* and collected two feather mites: *Brephosceles anatina* and *Freyana anatina*. In the present study, we provide morphological redescrptions of these feather mites supplemented with partial mitochondrial cytochrome *c* oxidase subunit I (*COI*) sequences as DNA barcodes.

MATERIALS AND METHODS

Material sampling

The wings of *A. zonorhyncha* collected in Chungcheongbuk-do were donated by the Wildlife Center of Chungbuk (WCC) to the authors for parasitological study. Mites were manually collected from flight feathers and immediately preserved in 95% ethanol. The specimens were then cleared in 10% lactic acid for 24 h at room temperature and subsequently mounted on microscope slides using polyvinyl alcohol mounting medium (BioQuip, CA, USA). Specimens were imaged using a Canon EOS 7D camera (Canon, Tokyo, Japan) attached to a Leica DM 2500 microscope (Leica, Wetzlar, Germany). Descriptions of the mites were provided according to the standard formats used for the species of the corresponding feather mite families (Dabert, 1987; Aksin, 2007; Han et al., 2022; Mironov et al., 2022). Terminology, idiosomal and leg chaetotaxies followed those of Gaud and Atyeo (1996), with minor corrections for coxal chaetotaxy by Norton (1998). The classification and scientific names of the birds followed those provided by Gill et al. (2023). All measurements are in micro-

meters (µm). The examined specimens have been deposited at the National Institute of Biological Resources (NIBR), Korea.

DNA sequencing

The genomic DNA was extracted from two specimens of *B. anatina* and single specimen of *F. anatina*, using a LaboPas Tissue Genomic DNA Isolation Kit Mini (Cosmo Genetech Inc., Seoul, Korea) as per the manufacturer's instructions. The *COI* barcode fragment was amplified using site-specific primers (bcdF05: 5'-TTTTCTACHAAYCATAAAGATATGTC-3' and bcdR04: 5'-TATAAACYTCDGGATGNCCAAA AAA-3') under the following cycling conditions (Dabert et al., 2008): 2 min at 94°C; 40 cycles of 98°C for 15 s, 50°C for 30 s, and 68°C for 60 s; and a final extension at 68°C for 5 min. The amplified products were then sequenced using an ABI 3100 automated sequencer (Perkin-Elmer, CA, USA). The sequence assembly, alignment, and trimming were performed using the Geneious 8.1.9 software (Kearse et al., 2012).

SYSTEMATIC ACCOUNTS

Order Sarcoptiformes Reuter, 1909

Superfamily Analgoidea Trouessart and Mégnin, 1884

Family Alloptidae Gaud, 1957

¹*Genus *Brephosceles* Hull, 1934

²**Brephosceles anatina* Dubinin, 1951b (Figs. 1–3)

Brephosceles anatina Dubinin, 1951b: 223, 224, fig. 52; Peterson, 1971: 138; Vasyukova and Mironov, 1986: 17, 49, fig. 10; 1990: 12, 13; 1991: 110, 112, fig. 84; Vasyukova and Gerasimov, 1992: 51; Mironov, 1997: 466.

Material examined. 3 males and 4 females (NIBR No. NIBRIV0000909903–NIBRIV0000909909) from the Eastern Spot-billed Duck, *A. zonorhyncha* (Swinhoe) (Anseriformes: Anatidae), Korea, Chungcheongbuk-do (36°57'49"N, 127°55'15"E), 4 Jun 2015, coll. Han Y.-D.

Description. Male (range for two specimens) (Figs. 1, 3). Idiosoma, length × width, 290–300 × 118–200, length of hysterosoma 185–193. Prodorsal shield (Fig. 1A): separated from scapular shields, anterolateral extensions short and angular, posterior margin with median blunt-angular extension, posterior corners nearly rectangular, length 97–98, width 68–70. Bases of scapular setae *se* separated by 62–63. Scapular shields wide. Setae *c*₂ short spiculiform, 6–7 long, situated on anteromedian margins of humeral shields. Subhumeral setae *c*₃ spiculiform, 9–10 long. Distance between prodorsal

Korean name: ¹*물새날개털깃털진드기속 (신칭), ²*오리날개털깃털진드기 (신칭)

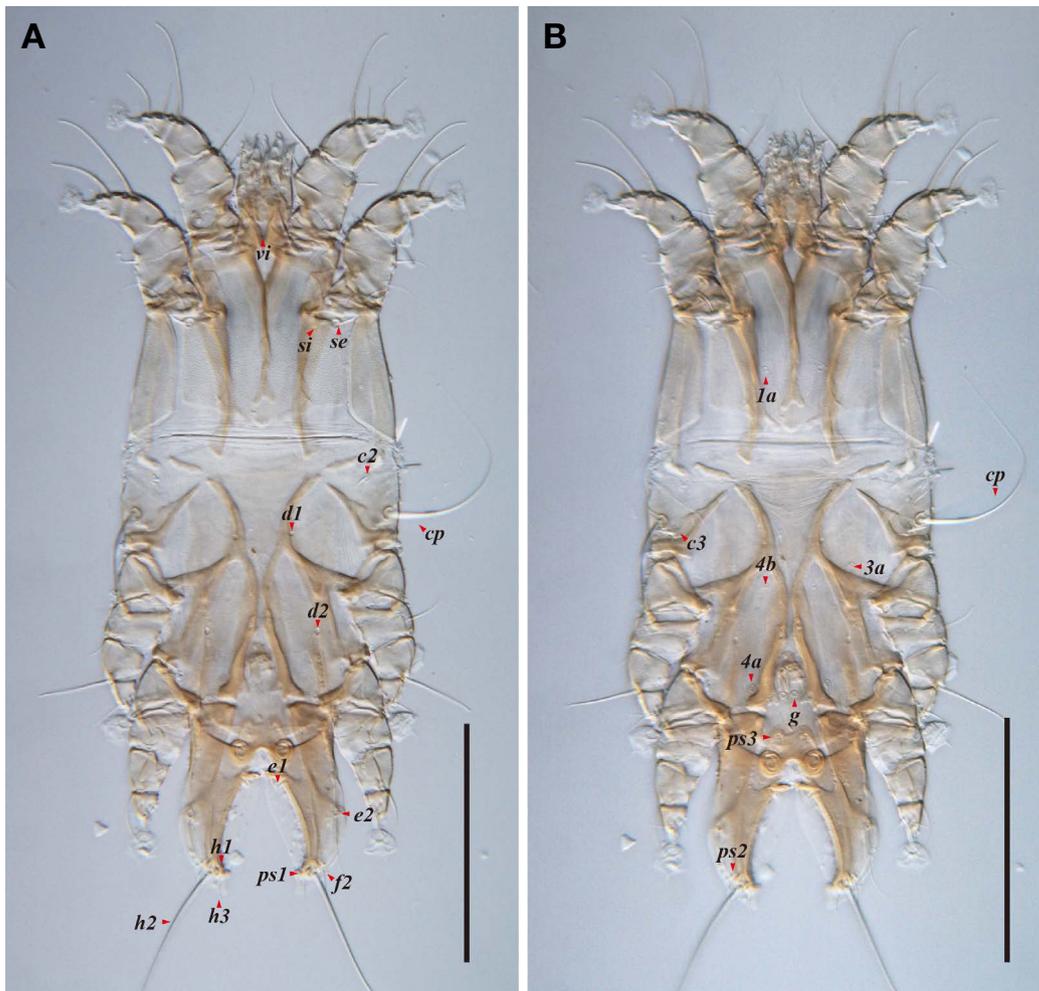


Fig. 1. Male of *Brephosceles anatina* Dubinin, 1951. A, Dorsal view; B, Ventral view. Scale bars: A, B = 100 µm.

and hysteronotal shields along midline 11–25. Hysteronotal shield: anterior margin straight, greatest length 178–180, width at anterior margin 70–82, surface without ornamentation, area at base of opisthosomal lobes with a pair of big transverse non-sclerotized lacunae. Supranal concavity not developed. Opisthosomal lobes short, about 1/4 the total body length, slightly divergent and with distal ends curved medially (Fig. 1A). Terminal cleft cordiform, length from anterior end to level of setae *h2* 32–35, lateral margins at level of anterior 1/4 with a pair of sclerotized extensions. Interlobar lamellae wide, developed along all lateral margins of terminal cleft. Lateral lamellae short and narrow, situated submarginally in posterior part of lobes. Lobar apices with triangular terminal lamellae. Setae *e1* slightly posterior to extensions on lateral margins of terminal cleft. Setae *e2* approximately at mid-length of opisthosomal lobes, extending to lobar apices. Setae *h1* and *ps1*, adjacent to each other and situated near curved apex of opisthosomal lobe; setae *h1* short filiform, not extend-

ing beyond posterior margins of terminal lamellae; setae *ps1* minute, barely distinct (Fig. 3). Setae *f2* filiform, extending slightly beyond apices of terminal lamellae. Setae *h3* and *ps2* short spiculiform and slightly curved. Length of lobar setae: *e2* 30–37, *f2* 7–8, *h3* 7–8, *ps1* 7–11, *ps2* 8–10. Distances between dorsal setae: *c2*:*d2* 63–65, *d2*:*e2* 75–77, *e2*:*h2* 26–27, *d1*:*d2* 40–45, *e1*:*e2* 62–66, *h2*:*h2* 44–49.

Epimerites I fused into a long Y, with stem about 4/5 the total length of epimerites. Epimerites I and II with narrow sclerotized areas; these areas connected to each other by wide sclerotized bands flanking bases of trochanters I (Fig. 1B). Setae *1a* on soft tegument. Combined epimerites IIIa + IV with narrow sclerotized areas along inner margins; anterior ends of epimerites IIIa strongly elongated, curved laterally and reaching tips of epimerites III. Coxal fields III almost closed, open only in anterior angle. Paragenital apodemes (derivatives of epimerites IVa) long, with anterior ends fused with middle parts of corresponding epimerites IIIa. Coxal

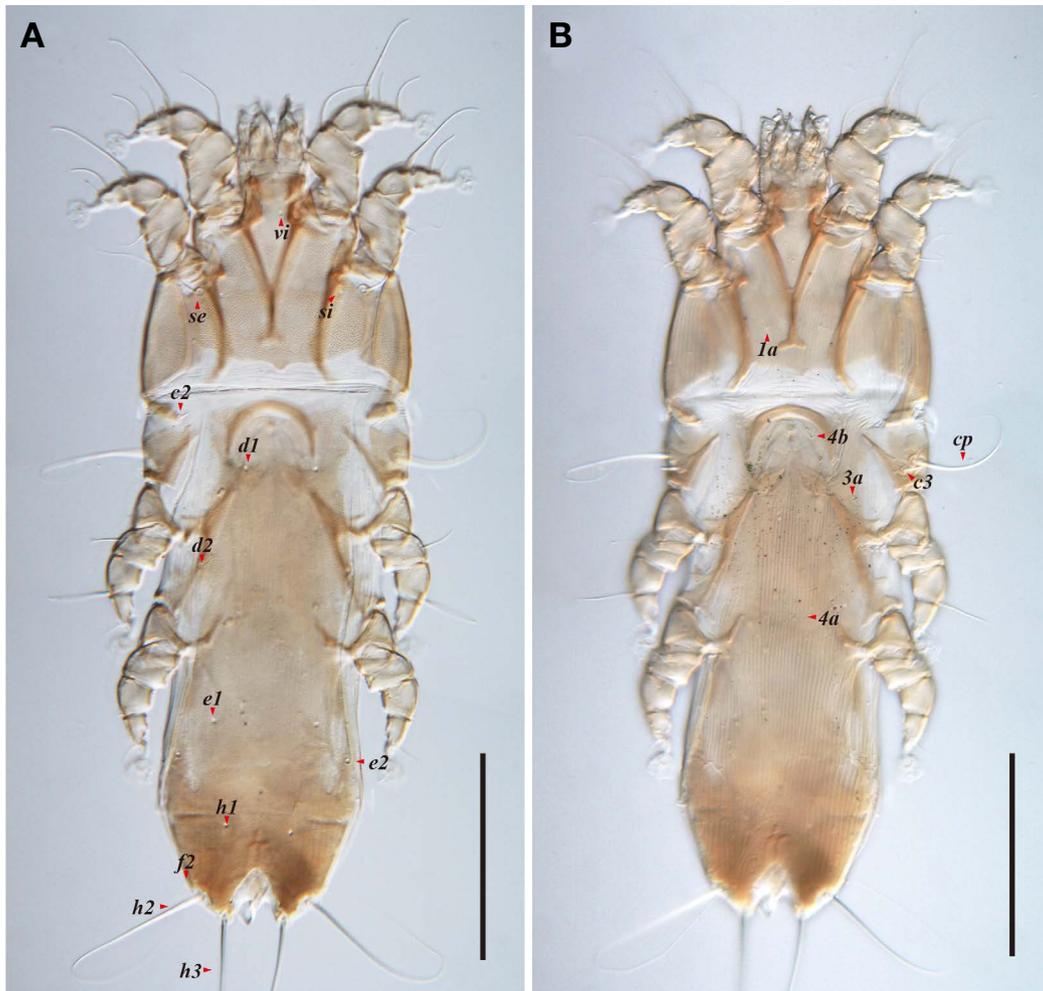


Fig. 2. Female of *Brephosceles anatina* Dubinin, 1951. A, Dorsal view; B, Ventral view. Scale bars: A, B=100 μm.

fields IV closed, with large central areas of soft tegument bearing setae *4a* and *4b*. Genital apparatus small, 17–18 × 12–13; aedeagus short and spiculiform, 16–18 long, extending to bases of setae *g* (Fig. 1B). Genital papillae on inner margins of paragenital apodemes, anterior to genital apparatus. Genital shield absent, setae *g* on soft tegument immediately posterior to genital arch. Adanal shields claw-shaped, with setae *ps3* on inner margins. Adanal suckers 8–9 in diameter, corolla with radial striation. Setae *4b* posterior to setae *3a*, setae *4a* slightly anterior to setae *g*. Distance between ventral setae: *3a*:*4b* 8–10, *4b*:*4a* 40–43, *g*:*ps3* 16–19, *ps3*:*h3* 67–68, *ps3*:*ps3* 10–11.

Femora III, IV with small lateral spine. Genual setae *cGI*, II spiniform, setae *mGI* filiform with slightly thickened basal part, setae *mGII* simple filiform. Trochanteral setae *sRIII* filiform. Solenidion σ of genu I 2.7–3 times longer than this segment. Solenidion σ of genu III 2.2–2.5 times longer than this segment. Solenidia ϕ of tibiae III, IV 2.5–3 times longer than

corresponding tarsi. Legs III and IV subequal in size. Tarsi of legs IV extending to level of setae *e2* or slightly beyond them. Tarsus IV 11–12 long, modified setae *d*, *e* minute stick-like. Length of solenidia: σ I 33–37, σ III 16–18, ϕ IV 30–32.

Female (range for three specimens, Fig. 2). Idiosoma, length × width, 360–365 × 130–140, length of hysterosoma 245–260. Prodorsal shield (Fig. 2A): shaped almost as in the male, but lateral margins fused with scapular shields, length 95–100, width 78–88. Bases of setae *se* separated by 79–85. Distance between prodorsal and hysteronotal shields along midline 22–25. Setae *c2* short spiniform, 7–7.5 long, situated on soft tegument anterior to humeral shields. Setae *c3* narrowly lanceolate, 8–10 long. Hysteronotal shield (Fig. 2A): anterior margin straight, greatest length 240–250, width at anterior margin 67–70, surfaces without ornamentation. Opisthosomal lobes short, roughly angular, without membranous terminal processes. Terminal cleft short, shaped as a wide U, length from anterior margin to bases of setae *h3* 23–27. Inci-

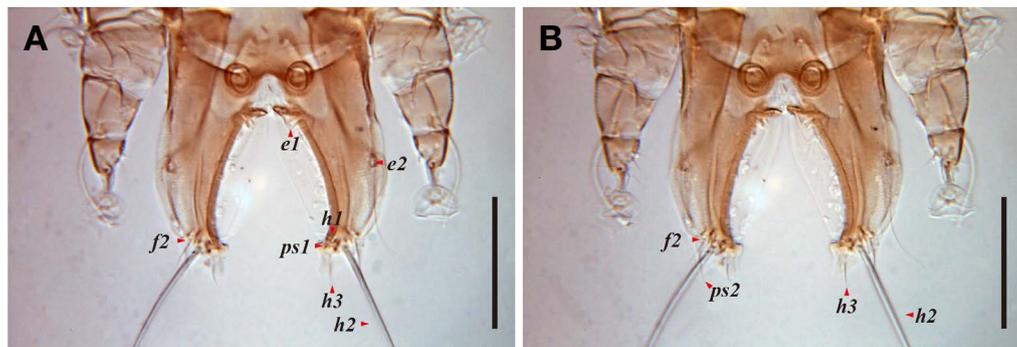


Fig. 3. Opisthosoma of *Brephosceles anatina* Dubinin, 1951 male. A, Dorsal view; B, Ventral view. Scale bars: A, B=40 μ m.

sion on posterior margin of hysteronotal shield roughly triangular and longer than its greatest width at level of setae *ps1*. Setae *h1* equidistant from levels of setae *e2* and *h2*. Setae *ps1* slightly posterior to level of setae *h2*. Distances between dorsal setae: *c2* : *d2* 68–74, *d2* : *e2* 88–91, *e2* : *h2* 65–70, *h2* : *h3* 9–11, *d1* : *d2* 43–49, *e1* : *e2* 15–17, *h1* : *h2* 32–37, *h2* : *ps1* 2–4, *h2* : *h3* 51–55, *h3* : *h3* 28–30.

Epimerites I fused into a Y with stem about 1/2 the total length of epimerites. Epimerites I and II surrounded by narrow sclerotized areas; these areas connected by narrow transverse bands at bases of trochanters I. Setae *1a* situated on soft tegument of coxal fields I. Combined epimerites IIIa + IV with small triangular sclerotized area at bases of trochanters IV (Fig. 2B). Epimerites IVa small, without large sclerotized areas. Epigynum horseshoe-shaped, separated from anterior tips of epimerites IIIa, 25–28 long, 42–45 wide.

Legs I, II as in male. Solenidion σ of genu III approximately 1.1–1.2 times longer than this segment. Solenidion ϕ of tibiae III 2.3–2.5 times longer than tarsi III. Length of tibial solenidion ϕ IV 2–3. Legs IV with ambulacral disc extending beyond setae *e2*. Lengths of solenidia: σ I 35–38, σ III 18–19, ϕ III 27–28, ϕ IV 2–3.

Remarks. *Brephosceles anatina* was described by Dubinin (1951b) based on specimens from Mallards, *Anas platyrhynchos* Linnaeus, 1758, collected at Lake Chany in Western Siberia, and near Saint Petersburg (=Leningrad), Russia. Since then, this feather mite has been recorded from seven more duck species, *Anas acuta* Linnaeus, 1758, *A. crecca* Linnaeus, 1758, *Mareca falcata* (Georgi, 1775), *M. penelope* (Linnaeus, 1758), *Sibirionetta formosa* (Georgi, 1775), *Spatula clypeata* (Linnaeus, 1758), and *S. querquedula* (Linnaeus, 1758), in the Eurasian continent (Dubinin, 1951b; Vasyukova and Mironov, 1990, 1991; Mironov, 1997). *Brephosceles anatina* belongs to the *lambda* species group (Peterson, 1971) restricted to Anseriformes and is most closely related to *B. arcti-*

cus Vasyukova and Mironov, 1986, *B. bucephali* Mironov, 1985, and *B. mergi* Vasyukova and Mironov, 1986 in sharing the following features in males: the anterior ends of the paragenital apodemes are fused with epimerites IIIa and the terminal cleft is relatively wide, with the length exceeding its greatest width by less than two times.

Brephosceles anatina is distinguished from these three species by the following combination of characteristics: in males, legs IV extend to the level of setae *e2* with the distal end of the tarsus; in females, the incision on the posterior margin of the hysteronotal shield is triangular and distinctly longer than its greatest width. In males of the three aforementioned species, legs IV extend beyond the level of setae *e2* with the whole tarsus, or with the tarsus and distal half of the tibia; in females, the incision on the posterior margin of the hysteronotal shield is approximately half as long as its greatest width (Vasyukova and Mironov, 1986, 1991).

Molecular data. Partial *COI* sequences were obtained from the two specimens and deposited in GenBank under the accession numbers OR536772–OR536773.

Superfamily Pterolichoidea Trouessart and Ménégnin, 1884

¹*Family Freyanidae Dubinin, 1953

²*Genus *Freyana* Haller, 1877

³**Freyana anatina* (Koch, 1844) (Figs. 4–6)

Dermaleichus anatinus Koch, 1844: heft. 38, fig. 23; Haller, 1877: 81, figs. 5–13; Ménégnin and Trouessart, 1884a: 403, 404, fig. 5.

Freyana (Eufreyana) anatina: Canestrini and Kramer, 1899: 32.

Freyana anatina: Ménégnin and Trouessart, 1884b: 99; Vitzthum, 1929: 85; Gaud, 1952: 103; Radford, 1953: 199; Turk, 1953: 83; Gaud & Mouchet, 1959: 489; Gaud and Till, 1961: 231, fig. 140; Buscher, 1965: 220; Černý,

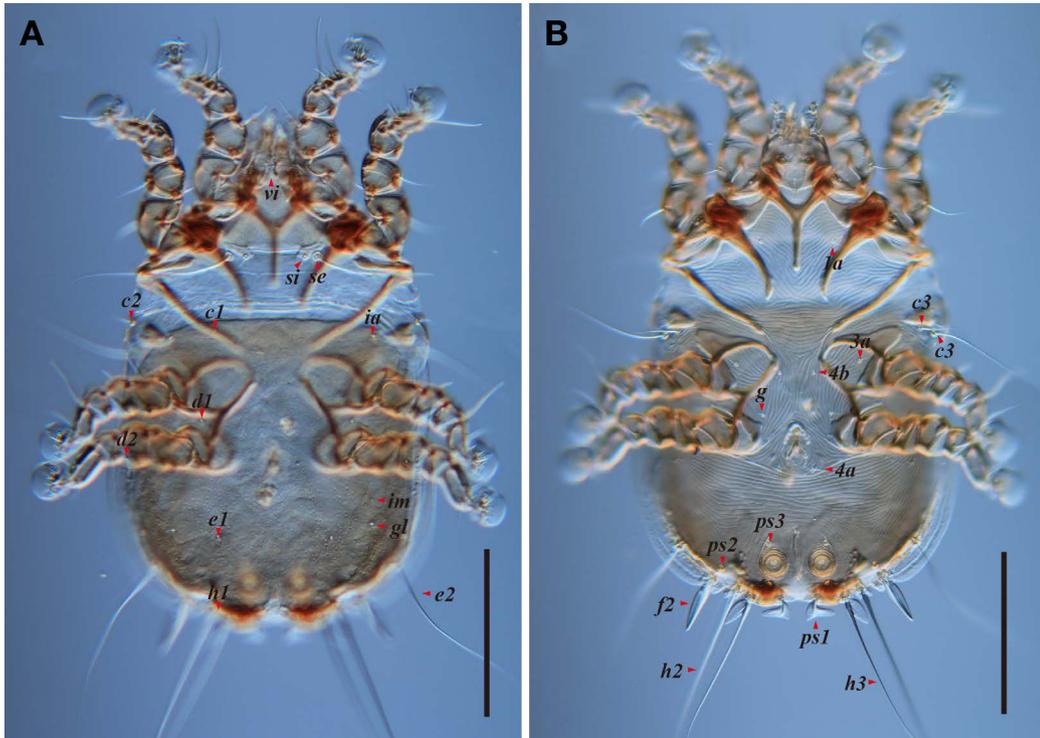


Fig. 4. Male of *Freyana anatina* (Koch, 1844). A, Dorsal view; B, Ventral view. Scale bars: A, B = 200 μ m.

1967: 5–7; Wilson and Haas, 1980: 550; Gaud & Atyeo, 1985: 387–389, figs. 1, 4; Dabert, 1987: 239–262, figs. 1–14; Vasyukova and Mironov, 1990: 12, 13; 1991: 178; Vasyukova and Gerasimov, 1992: 51; Mironov, 1997: 467; Dabert, 2000: 310; Dabert et al., 2001: 127; Mironov and Galloway, 2002: 186; Aksin, 2007: 302–305, fig. 1; Galloway et al., 2014: 163, 164, 184.

Freyana anatina anatina: Dubinin, 1950: 22, 23, figs. 21, 27; 1951a: 24, 25, fig. 10; 1951b: 212, 215; 1953: 248–251, figs. 86b, 90, 91, 97–99; Estrada Peña et al., 1981: 424, figs. 1–7.

Material examined. Korea: 3 males and 3 females (NIBR No. NIBRIV0000909897–NIBRIV0000909902) from the Eastern Spot-billed Duck, *A. zonorhyncha* (Swinhoe) (Anseriformes: Anatidae), Korea, Chungcheongbuk-do (36°57'49"N, 127°55'15"E), 4 Jun 2015, coll. Han Y.-D.

Description. Homeomorphic male (range for two specimens) (Figs. 4, 6A, B). Idiosoma, length \times width, 550–560 \times 365–370, length of hysterosoma 390–400. Prodorsal shield (Fig. 4A): widely triangular in form, occupying most part of prodorsum, posterior corners extending to lateral margins of propodosoma and fused with inflated bases of epimerites II, posterior margin straight, most surface and areas around setae *si* heavily sclerotized, narrow band posterior to

scapular setae and area between setae *si* poorly sclerotized, length along midline 132–138. Bases of setae *se* separated by 105–110. Humeral shields shaped as oblique sclerotized bands with anteromedian ends almost reaching prodorsal shield. Hysteronotal shield: covering entire hysterosoma, anterior margin straight, anterolateral corners widely rounded, lateral margins slightly convex, posterior part with minute and poorly pronounced circular lacunae, length 375–380, greatest width 345–360. Lateral margins of idiosoma with lateral membranes stretching from level of trochanters IV to bases of setae *f2*. Opisthosomal lobe short, much wider than long and heavily sclerotized dorsally, terminal cleft short and barely distinct between lobes (Figs. 4B, 6B). Setae *f2* lanceolate, 70–72 \times 14–15. Setae *h1* filiform, 55–60 long. Macrosetae *h2* simple, bases of macrosetae *h3* with lanceolate lateral extension 40–42 long and 13–16 wide. Bases of setae *f2* and *h2* with bilobate membranous extensions. Setae *ps1* membranous L-shaped, with distinct apical angle and long lateral extension, length 26–30 and greatest width 34–36 (Fig. 6A, B). Distance between dorsal setae: *c2* : *d2* 170–172, *d2* : *e2* 125–127, *e2* : *h3* 57–75, *h3* : *h3* 125–127 *ps1* : *ps1* 48–57.

Epimerites I fused into a Y with stem about 2/3 the length of epimerites. Posterior ends of epimerites II smoothly curved, bases inflated and heavily sclerotized. Posterior ends of stem and epimerites II not fused to each other, coxal fields

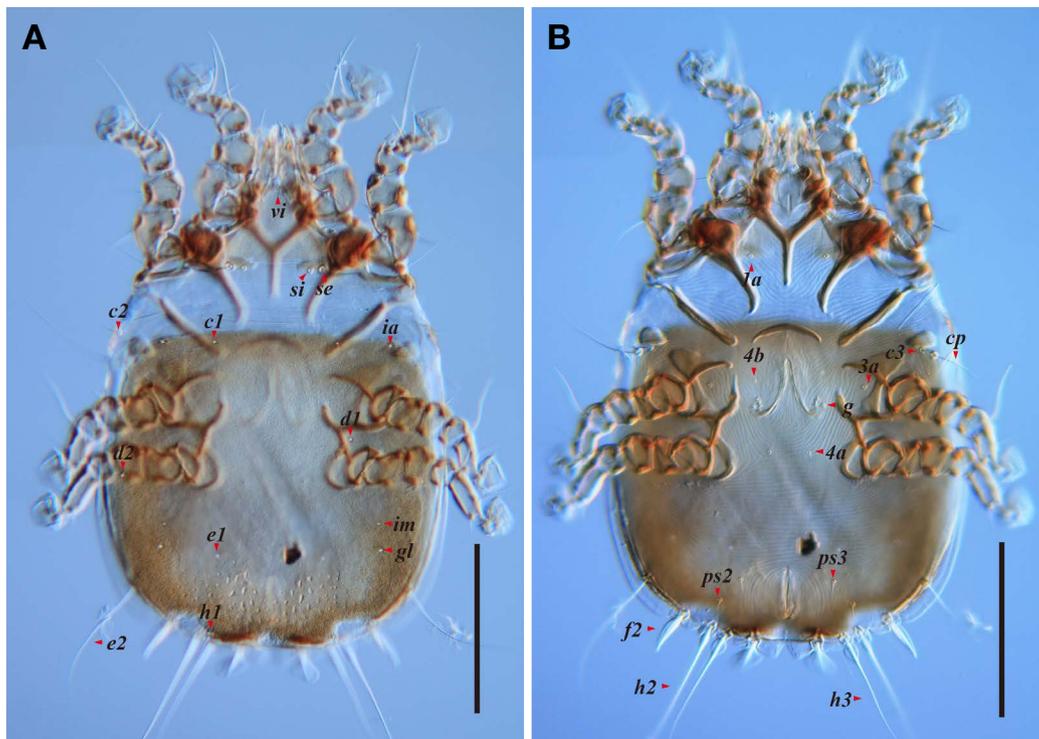


Fig. 5. Female of *Freyana anatina* (Koch, 1844). A, Dorsal view; B, Ventral view. Scale bars: A, B=200 μ m.

I, II open (Fig. 4B). Bases of epimerites I, II and IIa connected by sclerotized bands flanking bases of corresponding trochanters I, II. Humeral shields roughly egg-shaped, situated ventrally, not connected with lateral sclerotized fields of epimerites III. Setae *c3* near posterior margins of humeral shields. Tips of epimerites III and IIIa fused making coxal fields III closed; inner margins of coxal fields III not fused to each other at midline. Bases of epimerites III, IIIa and IV, IVa connected by sclerotized bands. Genital apparatus at level of trochanters IV, genial arch 39–40 long and 25–27 wide, aedeagus shorter than genial arch. Epiandrum (pregenital apodeme) small arch-shaped, 24–25 long and 32–33 wide, not connected with epimerites of coxal fields III and IV (Fig. 4B). Genital papillae situated approximately at midlevel of genital apparatus. Genital shields absent. Setae *4b* situated slightly posterior to level of setae *3a*. Diameter of adanal suckers 35–38. Opisthoventral shields represented by irregular heavily sclerotized plates situated posterior and posterolateral to adanal suckers. Cupules *ih* on anterior margin of opisthoventral shields. Distance between ventral setae: *4b*:*3a* 10–13, *g*:*4b* 48–53, *g*:*4a* 63–75, *4a*:*ps3* 90–95.

Distal end of tibia I without dorsal crest. Dorsal crest of tibia II with small angular extension on anterior margin. Other segments of legs I–IV without dorsal crests. Setae *d* and *e* of tarsus IV spiculiform, 28–29 and 18–18.5 long, respectively.

Female (range for three specimens) (Figs. 5, 6C, D). Length of idiosoma 525–540, greatest width 370–390, length of hysterosoma 130–135. Prodorsal shield (Fig. 5A): shape and sclerotization as in the male, length along midline 132–138. Bases of setae *se* separated by 105–110. Scapular shields as in the male. Distance between prodorsal and hysteronotal shields 23–32. Hysteronotal shield (Fig. 5A): covering entire hysterosoma, anterior margins straight or slightly convex, anterior corners widely rounded, lateral margins slightly convex, most surface without ornamentation, posteromedian area with small circular and irregularly shaped lacunae, length 310–330, greatest width 115–120. Lateral margins of hysterosoma with narrow lateral membrane stretching from level of trochanters IV to bases of setae *f2*. Setae *f2* lanceolate, 56–73 \times 10–13. Setae *h1* filiform, 60–65 long. Macrosetae *h2* simple setiform, macrosetae *h3* setiform with short lanceolate enlargement in basal part. Bases of setae *f2* and *h2* with membranous bilobate extensions. Setae *ps1* membranous, obliquely ovate, with inner channel obliquely crossing the membranous part, length 33–37 (Figs. 5B, 6C). Posterior margin of opisthosoma between bases of setae *ps1* with a pair of small and truncate membranous extensions, incision between these extensions triangular, 14–18 long. Distance between dorsal setae: *c2*:*d2* 170–175, *d2*:*e2* 120–140, *e2*:*h3* 60–68, *h3*:*h3* 132–140, *ps1*:*ps1* 68–73.

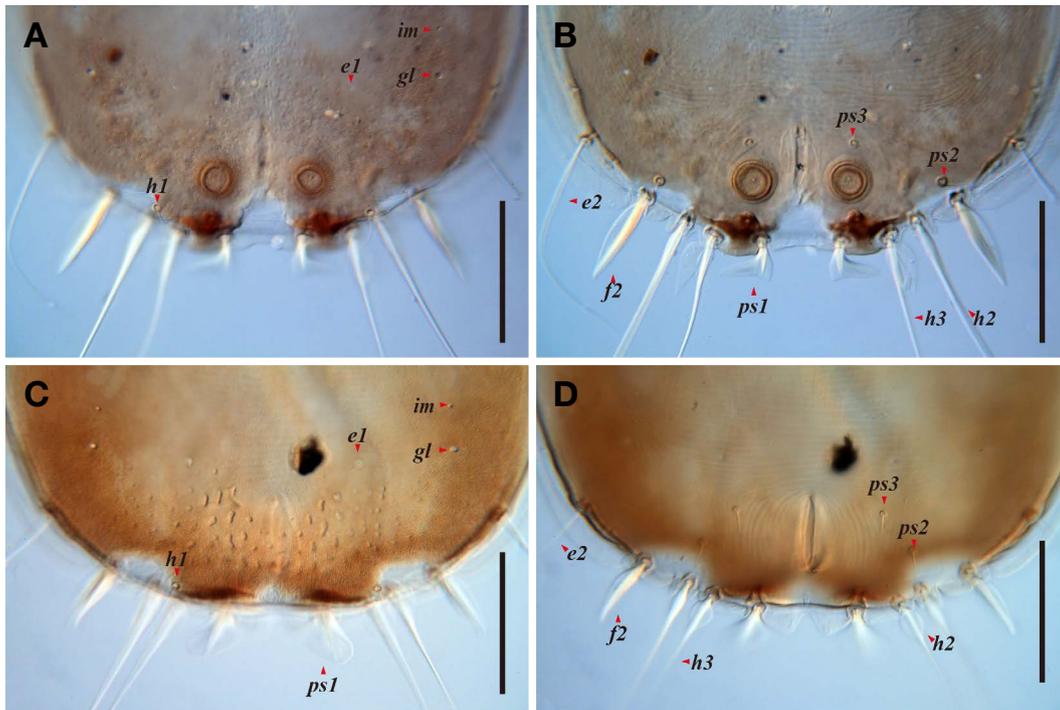


Fig. 6. Opisthosoma of *Freyana anatina* (Koch, 1844). A, Dorsal view of male; B, Ventral view of male; C, Dorsal view of female; D, Ventral view of female. Scale bars: A–D=100 μ m.

Epimerites I fused into a Y with stem half as long as epimerites. Posterior ends of epimerites II smoothly curved, bases inflated and heavily sclerotized. Posterior ends of stem and epimerites II not fused to each other, coxal fields I, II open. Bases of epimerites I, II and IIa connected by narrow sclerotized bands flanking bases of trochanters I, II. Humeral shields roughly egg-shaped, situated ventrally, not connected with lateral sclerotized fields of epimerites III (Fig. 5B). Setae *c*3 near posterior margins of humeral shields. Coxal fields III open. Bases of epimerites III, IIIa and IV, IVa connected by curved sclerotized bands. Epigynum shaped as low bow, 20–23 long and 71–78 wide. Oviporus at level of trochanters III. Genital papillae and setae *g* at level of posterior 1/4 of oviporus (Fig. 5B). Copulatory opening on small cone-like extension near posterior margin of opisthosoma (Fig. 6D). Setae *4b* on soft tegument, anterior to level of setae *3a*. Distance between ventral setae: *4b*:*3a* 10–25, *g*:*4b* 40–43, *g*:*4a* 55–65, *4a*:*ps*3 145–155.

Distal end of tibia I without dorsal crest. Dorsal crest of tibia II with angular extension on anterior margin more rounded than in homeomorphic male. Other segments of legs I–IV without crests.

Remarks. *Freyana anatina* was initially described from *A. platyrhynchos* in Europe. Dubinin (1950, 1953) described 10 new subspecies of *F. anatina*, each associated with particular

species or genera of ducks and geese (Anatidae). In the generic revision of the family Freyanidae, Gaud and Atyeo (1985) elevated all these subspecies to full species. The former subspecies of *F. anatina* currently constitute the *anatina* species group, characterized by a smoothly curved epimerites II in females and homeomorphic males (Vasyukova and Mironov, 1991). In contrast, species of the *largifolia* group (former subspecies of *F. largifolia* Mégnin and Trouessart, 1884 established by Dubinin) are characterized, in females and homeomorphic males, by epimerites II bent abruptly, with a distinct L-shaped angle.

According to modern taxonomic concepts, *F. anatina* is distributed worldwide on ducks of the genus *Anas* sensu lato (presently, the genera *Anas*, *Mareca*, *Sibirionetta*, and *Spatula*) (Dubinin, 1950, 1953; Vasyukova and Mironov, 1990, 1991; see references in synonymy). However, earlier re-descriptions of this species, even those provided by (Dubinin 1950, 1953), were unclear in some details, that led to errors in the identification of *Freyana* species (Estrada Pena et al., 1981). Dabert (1987) provided a detailed re-description of all stages of the life cycle of *F. anatina*.

Freyana anatina is most close to *F. nyrocae* Dubinin, 1950 (from *Aythya* spp.) and *F. obliquasetae* Dubinin, 1950 (from *Tadorna* and *Rajah* spp.) and can be distinguished by the following features: in homeomorphic males, setae *ps*1 have a

rectangle bend (vs. with the angle of setae *ps1* distinctly acute in *F. nyrocae*, the bent part of setae with a concave posterior margin in *F. obliquasetae*); in females, setae *ps1* are obliquely ovate and divergent, with the inner canal going obliquely across the membranous part (vs. setae *ps1* straightly ovate, with the canal going approximately along the midline of the membranous part in *F. nyrocae* and *F. obliquasetae*) (Dubinin, 1950, 1951a, 1951b, 1953; Dabert, 1987).

Molecular data. Partial *COI* sequence was obtained from a single specimen and deposited in GenBank under the accession number OR536774.

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CONFLICTS OF INTEREST

Gi-Sik Min, a contributing editor of the *Animal Systematics, Evolution and Diversity*, was not involved in the editorial evaluation or decision to publish this article. The remaining authors declare no conflicts of interest.

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