

New genera and species of feather mites of the family Gabuciniidae (Astigmata: Pterolichoidea) from New World raptors (Aves: Falconiformes)

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Abstract—We describe four new species of feather mites of the family Gabuciniidae collected from Accipitridae and Falconidae (Falconiformes) from South and North America. Three of these belong to new genera, *Metagabucinia* **gen. nov.** with one new species and *Proaposolenidia* **gen. nov.** with two new species. We also describe one new species of the genus *Aposolenidia* Gaud and Atyeo. The new species and host records are *Aposolenidia striata* **sp. nov.** from the pearl kite, *Gampsonyx swainsonii* Vigors, *Metagabucinia caracarae* **sp. nov.** from the red-throated caracara, *Ibycter americanus* (Boddaert), *Proaposolenidia accipitris* **sp. nov.** from the Cooper's hawk, *Accipiter cooperii* (Bonaparte), and *Proaposolenidia elanoides* **sp. nov.** from the swallow-tailed kite, *Elanoides forficatus* (Linnaeus). *Aposolenidia*, *Metagabucinia*, and *Proaposolenidia* constitute a morphologically distinct group within the Gabuciniidae. This “*Aposolenidia* genus group” is characterized by the following features: bases of epimerites of legs I and II inflated, ball-shaped, heavily sclerotized, and connected by sclerotized dorsolateral bridges; tarsi of legs I and II with dorsal walls strongly thickened and dorsobasal part of tarsus I inflated. Members of this group coexist on falconiforms with other gabuciniid taxa that exhibit longer and more extensively sclerotized bodies, such as the genera *Aetacarus* Gaud and Atyeo, *Hieracolichus* Gaud and Atyeo, and *Ramogabucinia* Gaud and Atyeo.

Résumé—Nous décrivons quatre nouvelles espèces d'acariens des plumes de la famille des Gabuciniidae récoltées sur des Accipitridae et des Falconidae (Falconiformes) d'Amérique du Nord et du Sud. Trois d'entre elles appartiennent aux nouveaux genres *Metagabucinia* **gen. nov.** avec une espèce nouvelle et *Proaposolenidia* **gen. nov.** avec deux espèces nouvelles. Nous décrivons aussi une espèce nouvelle du genre *Aposolenidia* Gaud et Atyeo. Ces nouvelles espèces et leurs hôtes respectifs sont *Aposolenidia striata* **sp. nov.** sur l'élanion perle, *Gampsonyx swainsonii* (Vigors), *Metagabucinia caracarae* **sp. nov.** sur le caracara à gorge rouge, *Ibycter americanus* (Boddaert), *Proaposolenidia accipitris* **sp. nov.** sur l'épervier de Cooper, *Accipiter cooperii* (Bonaparte), et *Proaposolenidia elanoides* **sp. nov.** sur le milan à queue fourchue, *Elanoides forficatus* (L.). *Aposolenidia*, *Metagabucinia* et *Proaposolenidia* forment un groupe morphologiquement distinct chez les Gabuciniidae. Ce “groupe de genres” d'*Aposolenidia* se distingue par les caractères suivants: bases des épimérites des pattes I et II enflées, ballonnées, fortement sclérifiées et reliées entre elles par un pont dorsolatéral sclérifié; tarses des pattes I et II avec parois dorsales fortement épaissies; partie dorsobasale du tarse I enflée. Les membres de ce groupe cohabitent chez les falconiformes avec d'autres taxons de gabuciniidés qui possèdent un corps plus allongé et plus complètement sclérifié, tels qu'*Aetacarus* Gaud et Atyeo, *Hieracolichus* Gaud et Atyeo et *Ramogabucinia* Gaud et Atyeo.

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Introduction

Feather mites (Acari: Astigmata: Analgoidea: Pterolichoidea) include more than 2000 species of mites that are permanent obligatory symbionts of birds (Gaud and Atyeo 1996). In the course of their systematic revision of the pterolichoid feather mites, Gaud and Atyeo (1975) established the family Gabuciniidae (Astigmata: Pterolichoidea) with 13 genera, of which 11 were described as new. Since then, only a few new taxa have been added, the present total being 56 species in 14 genera (Gaud and Atyeo 1975; Gaud 1978, 1983; De Alzuet *et al.* 1988; Mironov and Galloway 2003; Proctor *et al.* 2006). Most gabuciniids are relatively large-bodied mites specialized for inhabiting the ventral surface of flight feathers. The main features that distinguish this family from other pterolichoid mites are the loss of tibial setae *kT* on legs IV in both sexes and the position of the genital papillae in females much posterior to the egg-laying opening (oviporus), approximately at the level of coxal fields IV (Gaud and Atyeo 1975, 1996).

Mites of the family Gabuciniidae are currently recorded from birds belonging to eight orders; however, almost half of these species (25 species in five genera) are recorded from the order Falconiformes (in the traditional sense, including the New World vultures, Cathartidae). The gabuciniids associated with falconiforms have been most extensively surveyed in Africa (Gaud and Mouchet 1959; Gaud 1983) and Europe (Dubinin 1956; Gaud and Atyeo 1975), whereas in other regions these mites remain almost unexplored. A synopsis of feather mites, including gabuciniids, associated with raptors of the world was compiled by Philips (2000). On raptors in the New World, only 2 gabuciniid species have been formally recorded up to now, 1 each on the turkey vulture, *Cathartes aura* (Linnaeus), and the swallow-tailed kite, *Elanoides forficatus* (Linnaeus) (Mironov and Galloway 2003; Proctor *et al.* 2006). Gabuciniids have been reported from 5 other falconiform species from this region but were tentatively identified only to genus level (Philips 2000).

In the course of accumulating feather mite material from birds of North and South America, we recovered two new genera and four new species of the family Gabuciniidae from New World falconiforms. In the present paper we describe these new mite taxa, establish the "*Aposolenidia* genus group" within the family Gabuciniidae,

and discuss morphological peculiarities and host associations of this grouping. We also provide a table of diagnostic characters for all described genera of the family Gabuciniidae.

Materials and methods

The specimens used in the study came from three sources. One of us (M.B.) collected mites by gently ruffling the feathers of dried museum skins of host birds from the Museum of the Universidad del Valle, Valle, Colombia. Mites were collected from live *E. forficatus* by G.Z. Approximately 1 tablespoon per bird of a pyrethrin-containing flea and tick powder for dogs (Zema Z3, St. Jon Laboratories Inc., Harbor City, California, United States of America) was massaged onto the feathers of one wing, the back, the rump, around the keel, and the underside of tail for 5 min to dislodge mites and other arthropods (Clayton and Drown 2001), which were then picked up using forceps. H.P. removed mites from a dead, frozen specimen of Cooper's hawk, *Accipiter cooperii* (Bonaparte), by washing it in a mixture of ethanol, water, and dish soap, and then straining the liquid through 53 µm mesh. Mite specimens were cleared in lactic acid and mounted on slides in PVA medium (No. 6371A, BioQuip Products Inc., Rancho Dominguez, California, United States of America). Slides were cured for a minimum of 4 days at approximately 45 °C. Drawings were made by S.M. using a drawing tube attached to an Olympus BH-2 light microscope with differential interference contrast (DIC) illumination.

General morphological terms and leg and idiosomal chaetotaxy follow Gaud and Atyeo (1996). Descriptions of new genera and species are given in the standard form used for gabuciniids and other pterolichoid mites (Gaud and Atyeo 1975; Mironov and Galloway 2003; Proctor *et al.* 2006). All measurements in the descriptions are given in micrometres (µm). We used the following measuring techniques for particular structures:

- (i) idiosoma length is from the anterior margin of the propodosoma to the bases of setae *h3*, and width is the greatest width at the level of the humeral shields;
- (ii) hysterosoma length is from the level of the sejugal furrow to the bases of setae *h3*;
- (iii) the distance between different pairs of setae is the shortest distance between the transverse levels formed by the setae of respective pairs;

(iv) prodorsal shield length is along the midline;

(v) hysteronotal shield length in males is the greatest length from the anterior margin to the bases of setae *h3*, and width is measured at the anterior margin;

(vi) gnathosoma length includes the palps, and width is measured at the base of the subcapitulum.

Specimen depositories are referred to as follows:

UASM E.H. Strickland Entomological Museum, University of Alberta, Edmonton, Alberta, Canada

UVS Facultad de Salud, Universidad del Valle, Cali, Valle, Colombia

ZISP Zoological Institute, Russian Academy of Sciences, Saint Petersburg, Russia

Classification and scientific names of birds follow Dickinson (2003).

Systematics

Family Gabuciniidae Gaud and Atyeo, 1975

Genus *Proaposolenidia* Mironov and Proctor, gen. nov.

Type species: *Proaposolenidia accipitris* Mironov and Proctor, sp. nov.

Etymology

The name is a combination of *pro* (Latin; “before”, “in front of”) and *Aposolenidia*, the morphologically most similar mite genus; feminine.

Diagnosis

Proaposolenidia differs from other genera of the family by the following combination of features: in both sexes, bases of epimerites I, II modified as inflated, heavily sclerotized ball-shaped structures; homolateral inflations of epimerites I, II connected by heavily sclerotized dorsolateral bridges; bases of epimerites I connected to each other by ventral transverse bridge, solenidion $\sigma 1$ present on genua I–III; in males, genital setae *g* anterior to genital papillae; in females, setae *4a* and genital papillae situated between levels of trochanters III and IV. Table 1 summarizes the similarities and differences between *Proaposolenidia* and all other genera of gabuciniid mites.

Description

Both sexes. Two vertical setae *vi* present, distance between them slightly less than distance between internal scapular setae *si*. Dorsal setae of idiosoma simple, not branched. Scapular setae *si* spiculiform, situated closer to midline than to respective homolateral setae *se*. Subhumeral setae *c3* setiform, long. Dorsolateral setae *c2* spiculiform, noticeably shorter than setae *c3*. Hysteronotal gland openings *gl* indistinct. Bases of epimerites I, II modified as inflated, heavily sclerotized ball-shaped structures; inflations of epimerites I connected by transverse sclerotized bridge on ventral side of idiosoma and by dorsolateral bridges with respective homolateral inflations of epimerites II. Lateral parts of prodorsal shield fused with inflations of epimerites I and dorsolateral bridges. Tarsi I, II more than twice length of palps, dorsal wall of these segments greatly thickened, dorsobasal part of tarsus I noticeably inflated. Solenidion $\sigma 1$ present on genua I–II, seta *cG* of genu I setiform, much longer (2.5–3 times) than this segment, solenidion $\sigma 1$ of genu III in middle part of segment.

Male. Opisthosomal lobes well developed, terminal cleft with rectangular ledge on inner margins of lobes; interlobar membrane absent, short terminal membranes present. Setae *e2*, *f2* spiculiform, setae *h1* spiculiform or narrowly lanceolate. Hysteronotal shield entire, lobar parts not separated from main body of shield. Supranal concavity not expressed. Corolla of anal suckers with indentations. Adanal apodemes present and extending from lateral margins of opisthosoma. Genital apparatus at level of trochanters IV or slightly posterior. Genital papillae posterior to genital setae *g*.

Female. Lateral sclerotized bands of hysteronotal shield clearly separated from main part of shield. Epigynium thick, bow-shaped or semicircular, situated anterior to levels of epimerites III and humeral setae, tips of epigynium not extending to level of setae *3a*. Setae *4a* and genital papillae close to genital setae *g* and situated between levels of trochanters III and IV. Hysteronotal shield extending to posterior margin of opisthosoma, posterior end of the shield with single or paired incision. Setae *e2*, *f2* setiform or thin spiculiform.

The genus includes two species.

Proaposolenidia accipitris Mironov and Proctor, sp. nov.

(Figs. 1–3)

Type material

Holotype (male, UASM 80501): CANADA: Alberta (no other location data), *ex* body

Table 1. Main diagnostic characters for genera of the family Gabuciniidae.

Character and codes for states	<i>Anepigynia</i>	<i>Artamacarus</i>	<i>Coraciacarus</i>
Both sexes			
Basal inflation of epimerites I, II: absent (A), present (B)	B	A	A
Dorsolateral sclerotized bridge connecting epimerites I and II: absent (A), present (B)	A	A	A
Sclerotized bridge connecting bases of epimerites I: absent (A), present (B)	A	A	A
No. of setae <i>vi</i> : 2 setae (A), 1 seta (B)	B	A	A
Setae <i>si</i> , form: thin (A), thickened, needle-like (B)	A	A	A
Setae <i>si</i> , position: close to <i>se</i> (A), equidistant from midline and <i>se</i> (B)	B	A	A
Setae <i>c2</i> : filiform (A), dilated or needle-like (B), branched (C)	A	A	A
Setae <i>c3</i> : setiform (A), dilated (B)	A	B	A
Ratio of tarsus II to palp: equal to or more than twice length of palp (A), less than twice length of palp (B)	B	B	B
Solenidion σ 1 of genu I: present (A), absent (B)	A	A	A
Solenidion σ 1 of genu II: present (A), absent (B)	A	B	A
Solenidion σ 1 of genu III: present (A), absent (B)	B	B	A,B
Solenidion σ 1 of genu III, position in segment: medial (A), basal (B)	—	—	B
Seta <i>cG</i> on genu I: longer than segment (A), shorter (B)	A	A	A
Males			
Opisthosomal lobes: well developed (A), short (B)	B	A	A
Rectangular ledge on inner margin of opisthosomal lobes: absent (A), present (B)	A	A	A
Corolla of anal suckers: indented (A), smooth (B)	A	A	A
Setae <i>g</i> , position with respect to genital papillae: anterior (A), posterior (B)	B	B	A
Females			
Epigynium: present (A), absent (B)	B	A	A
Setae <i>e2</i> : setiform (A), dilated (B)	A	B	B
Setae <i>f2</i> : setiform (A), dilated (B)	A	A	A
Setae <i>4a</i> , position relative to genital papillae: posterior (A), at level of papillae (B), anterior (C)	A	A	A

Note: A, B, and C are codes for character states; a dash indicates that a character state is inapplicable because of the

washing of a Cooper's hawk, *Accipiter cooperii* (Bonaparte) (Accipitridae), collected 3.v.2002, G. Randall. **Paratypes:** CANADA: Alberta: 1 male and 1 female paratypes, same data as holotype. Holotype, 1 female paratype UASM, 1 male paratype ZISP.

Etymology

The specific epithet is the genitive of *Accipiter*, the generic name of the host.

Diagnosis

In both sexes, setae *cG* of genu I long, setiform, about 2.5–3 times longer than segment, hysteronotal shield with poorly expressed striation pattern, idiosomal macrosetae *se*, *cp*

filamentous apically; genua of legs I, II without inflation on ventral side; trochanters III, IV not flanked by sclerotized band. In males, prodorsal shield not touching or encompassing bases of scapular setae, hysteronotal shield not encompassing bases of setae *c1* and cupules *ia*. In females, anterior margin of hysteronotal shield rough and slightly concave, cupules *im* and *ip* clearly visible.

Description

Male (holotype, measurements for 1 paratype in parentheses). Idiosoma length 376 (351), idiosoma width 261 (240). Gnathosoma: length including palps 57 (54), width at base 65 (63). Prodorsal shield: trapezoidal in form; lateral

<i>Coracitibia</i>	<i>Capitolichus</i>	<i>Gabucinia</i>	<i>Paragabucinia</i>	<i>Piciformobia</i>	<i>Tocolichus</i>	<i>Aetacarus</i>	<i>Cathartacarus</i>	<i>Hieracolicus</i>	<i>Ramogabucinia</i>	<i>Aposolenidia</i>	<i>Metagabucinia</i>	<i>Proaposolenidia</i>
A	A	A	A	A	A	A	A	A	A	B	B	B
A	A	A	A	A	A	A	A	A	A	B	B	B
A	A	A	A	A	A	A	A	A	A	B	A	B
A	A	A	A	A	A	A	A	A	A	A	A	A
A	A	B	A	A	A	B	B	B	B	B	A	B
A	B	B	A	B	B	B	B	B	B	B	A	B
A	A	A	A	B	B	A, B	B	A	C	B	B	B
B	B	A	A	B	B	A, B	B	A	A	A	A	A
B	B	B	A	B	B	A	A	A	A	A	A	A
A	A	A	A	A	A	A	A	A	A	B	A	A
B	A	A	A	A	A	A	A	A	A	B	A	A
B	B	A	A	A	A	A	A	A	B	B	B	A
—	—	A	A	B	B	B	B	A	—	—	—	A
A	A	A	A	A	B	A	A	A	A	A	A	A
A	A	A	A	A	A	A	A	A	A	A	A	A
A	A	A	A	A	A	A	A	A	A	B	A	B
A	A	A	A	A	A	A	A	A	B	A	A	A
B	B	B	A	A	B	A	A	A	A	A	A	A
A	A	A	A	A	A	A	A	A	A	A	A	A
A	B	A	A	B	B	A, B	B	A	B	A	A	A
A	B	A	A	B	A	A	A	A	A	A	A	A
A	A	A	A	A	C	A	C	C	B	B	B	B

absence of a relevant structure.

parts of the shield fused with heavily sclerotized ball-shaped bases of epimerites I, II, therefore lateral margins of shield indistinct; posterior end not touching bases of scapular setae *se*, *si*; length along midline 56 (61), width at posterior margin 115 (114). Setae *si* spiculiform, 58 (52) long. Distance between bases of prodorsal setae: *vi:vi* 15 (18), *si:si* 18 (20), *se:se* 66 (71). Length of hysterosoma 245 (233). Hysteronotal shield: anterior margin slightly convex; greatest length 233 (230), width at anterior margin 211 (208); surface with poorly expressed sparse transverse striae. Setae *c1* and cupules *ia* off hysteronotal shield; setae *c2* off humeral shields. Subhumeral setae *c3* as long as half of hysterosoma width. Macrosetae *se*, *cp* thick basally with filiform

apical part. Hysteronotal setae: *c2* spiculiform 41 (43) long; *e2* spiculiform, 52 (setae unequal in paratype: 50, 56) long; *f2* narrowly lanceolate, 40 (42) long; setae *h1* narrowly lanceolate, 31 (36) long. Distance between dorsal setal rows: *c2:d2* 88 (83), *d2:e2* 96 (99), *e2:h3* 54 (50). Terminal cleft with large rounded ledge, total length of cleft (from anterior end to level of setae *h3*) 62 (56), width of posterior part 90 (85). Terminal membrane short, with rounded posterior end, 12–14 (14–16) long (length of membrane unequal on different lobes). Bases of trochanters III, IV not flanked by sclerotized bands. Genital apparatus at level of posterior margin of trochanters IV, 15 × 17 (16 × 17). Setae *3a*, *3b* approximately at same transverse level, slightly anterior to trochanters III. Setae *g*

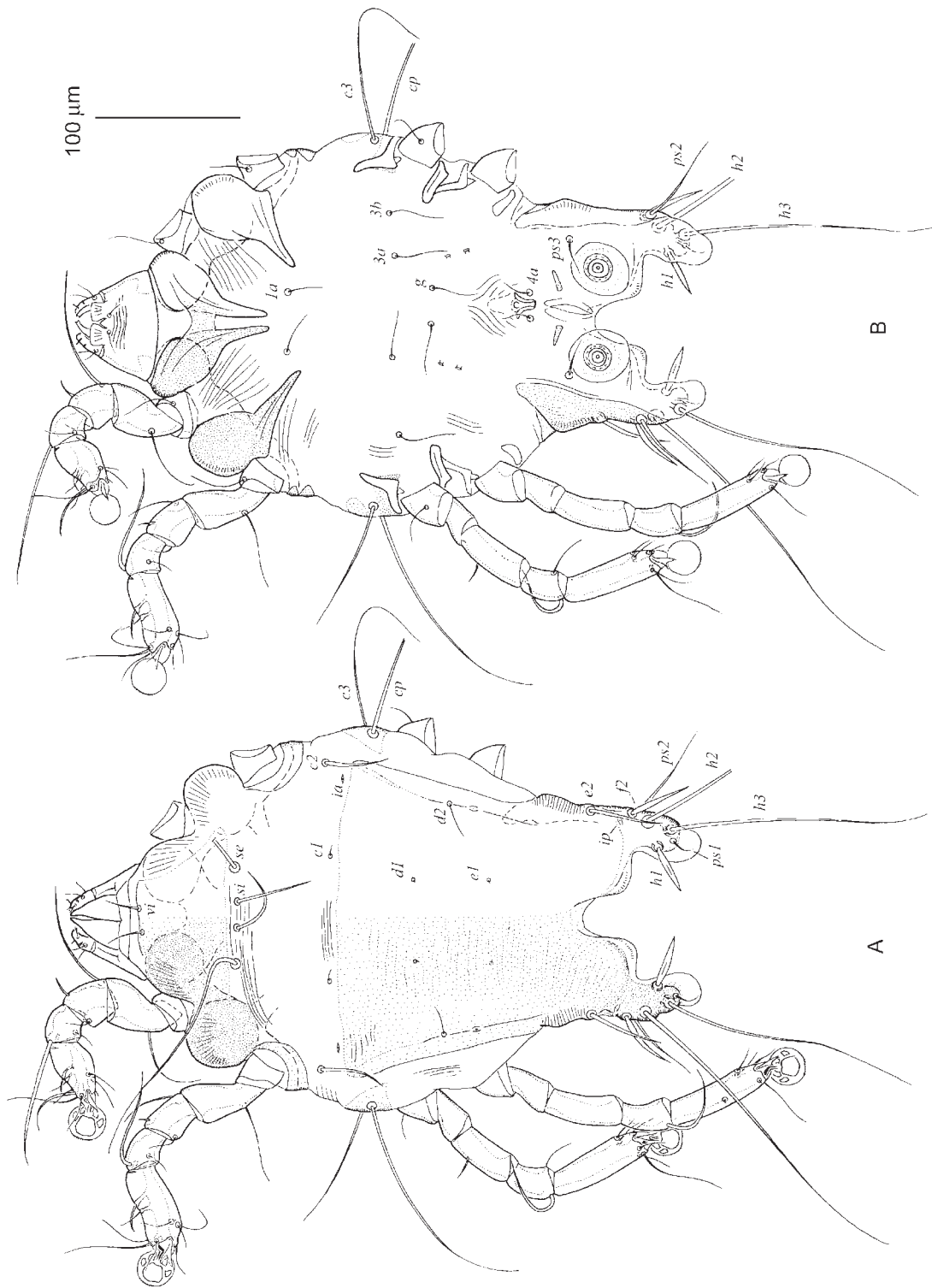
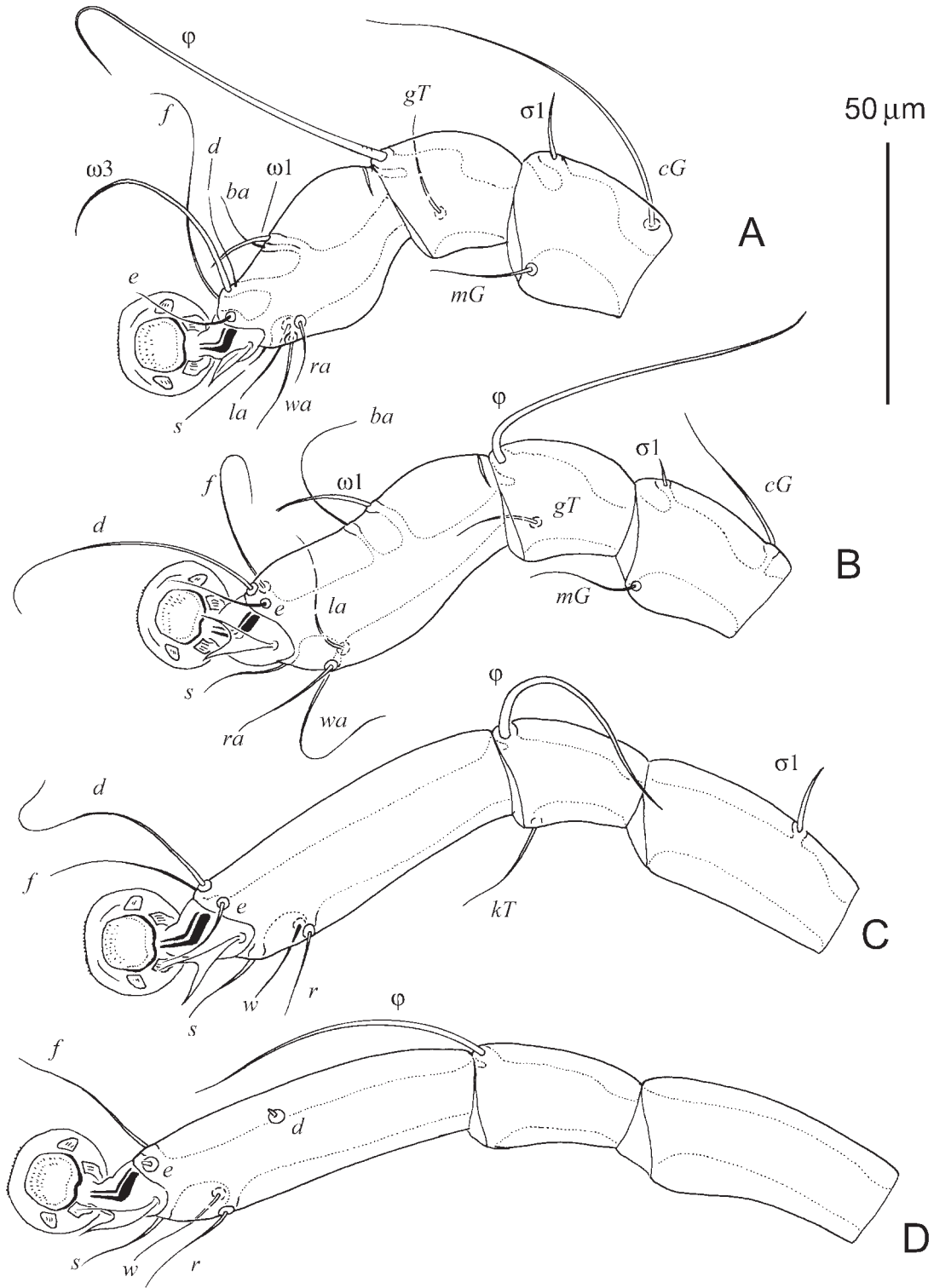


Fig. 1. *Proaposolenidia accipitris*, male: A, dorsal view; B, ventral view.

Fig. 2. Genu, tibia, and tarsus of legs I–IV in male *Proaposolenidia accipitris*: A, leg I; B, leg II; C, leg III; D, leg IV.



at midlevel of trochanters III. Genital papillae slightly posterior to level of setae *g*. Distance between ventral setal rows: *3a:g* 23 (24), *g:4a* 64 (67). Anterior ends of adanal apodemes extending to level of base of genital apparatus. Adanal shields as small transverse sclerites. Diameter of anal suckers 19 (18). Ventral surface of genua I–IV not inflated. Setae *cG* of genu II setiform, long, nearly 3 times longer than segment, 75 (setae unequal in length in paratype: 75, 77). Length of tarsi: I 40 (37), II 54 (52), III 64 (62), IV 68 (67). Modified seta *d* approximately at midlength of tarsus IV.

Female (paratype). Idiosoma length 457, width 295. Gnathosoma: length including palps 62, width at base 85. Prodorsal shield as in male, length along midline 65, width at posterior margin 123. Setae *si* spiculiform, 70–72 long. Distance between bases of prodorsal setae: *vi:vi* 19, *si:si* 26, *se:se* 79. Length of hysterosoma 300. Hysteronotal shield: anterior margin at level of trochanters III, posterior end with pair of incisions extending beyond level of setae *h1*; surface with weakly expressed bow-shaped striae in anterior part and with longitudinal striae in posterior part; greatest length 225, width at anterior margin 170. Setae *c1* and cupules *ia* off hysteronotal shield. Subhumeral setae *c3* slightly shorter than half of hysterosoma width. Macrosetae *se*, *cp* with filiform apical part. Hysteronotal setae: *c2* spiculiform, 51 long; *e2* setiform, 40 long; *f2* setiform, 8 long. Distance between dorsal setal rows: *c2:d2* 115, *d2:e2* 114, *e2:h3* 63. Cupules *im* and *ip* clearly visible. Bases of trochanters III, IV not flanked by sclerotized bands. Epigynium thick, bow-shaped, not extending to setae *c1*; length 57, width 77. Distance between ventral setal rows: *3a:3b* 37, *3b:g* 29. Setae *4a* posterior to setae *g* by 4–12. Anterior pair of genital papillae approximately at level of setae *4a*. Ventral surface of genua I–IV not inflated. Setae *cG* of genu II setiform, about 3 times longer than segment, 85–90 long. Length of tarsi: I 43, II 61, III 74, IV 85.

***Proaposolenidia elanoides* Mironov and Proctor, sp. nov.**

(Figs. 4, 5)

Type material

Holotype (male, UASM 80502): UNITED STATES OF AMERICA: Florida, 4.vi.2005, G. Zimmermann, *ex* live swallow-tailed kite, *Elanoides forficatus* (Linnaeus) (Accipitridae),

bird identification No. STKI F0506 HY. **Paratype:** COLOMBIA: 1 female paratype, *ex* museum skin of female *E. forficatus*, Valle del Cauca, collected 30.vii.1969, J.I. Borrero and G. Cataño, Universidad del Valle: Mus. Cat. No. 1280. Holotype and paratype UASM.

Etymology

The specific epithet derives from the generic name of the host and is a noun in apposition.

Diagnosis

The following characters of *P. elanoides* differentiate it from *P. accipitris*. In both sexes: setae *cG* of genu I spiculiform, about 1.5 times longer than segment, hysteronotal shield with clear reticulate pattern, idiosomal macrosetae *se*, *cp* thick along entire length, without filiform apical part; genua of all legs, particularly legs I, II, with strong inflation on ventral side; trochanters III, IV flanked by narrow sclerotized band. In males, prodorsal shield extending beyond row of scapular setae, hysteronotal shield encompasses bases of setae *c1* and cupules *ia*. In females, hysteronotal shield with convex anterior margin, cupules *im* and *ip* not visible.

Description

Male (holotype). Idiosoma length 394, idiosoma width 283. Gnathosoma: length 48, width 65. Prodorsal shield: extended beyond row of scapular setae *se*, *si*, lateral parts completely fused with heavily sclerotized ball-shaped bases of epimerites I, II forming entire shield covering prodorsum; length along midline 92; areas of ball-shaped bases of epimerites I, II with wavy striation. Setae *si* spiculiform, 56 long. Distance between bases of prodorsal setae: *vi:vi* 28, *si:si* 40, *se:se* 88. Length of hysterosoma 255. Hysteronotal shield: anterior margin strongly convex, extending to level of sejugal furrow, greatest length 283, width at anterior margin 225; surface with distinct reticulate pattern. Setae *c1* and cupules *ia* on hysteronotal shield. Subhumeral setae *c3* long setiform, length nearly one third of hysterosoma width. Macrosetae *se*, *cp* thick along all their length. Hysteronotal setae: *c2* spiculiform, 45 long; *e2* spiculiform, 45 long; *f2* narrowly lanceolate, 40 long; *h1* spiculiform, 48 long. Terminal cleft with large rounded ledge, total length 66, greatest width of posterior part 93. Terminal membrane short, with rounded posterior end, 12–14 long. Bases of trochanters III, IV flanked by narrow sclerotized bands connecting bases of respective epimerites. Genital apparatus

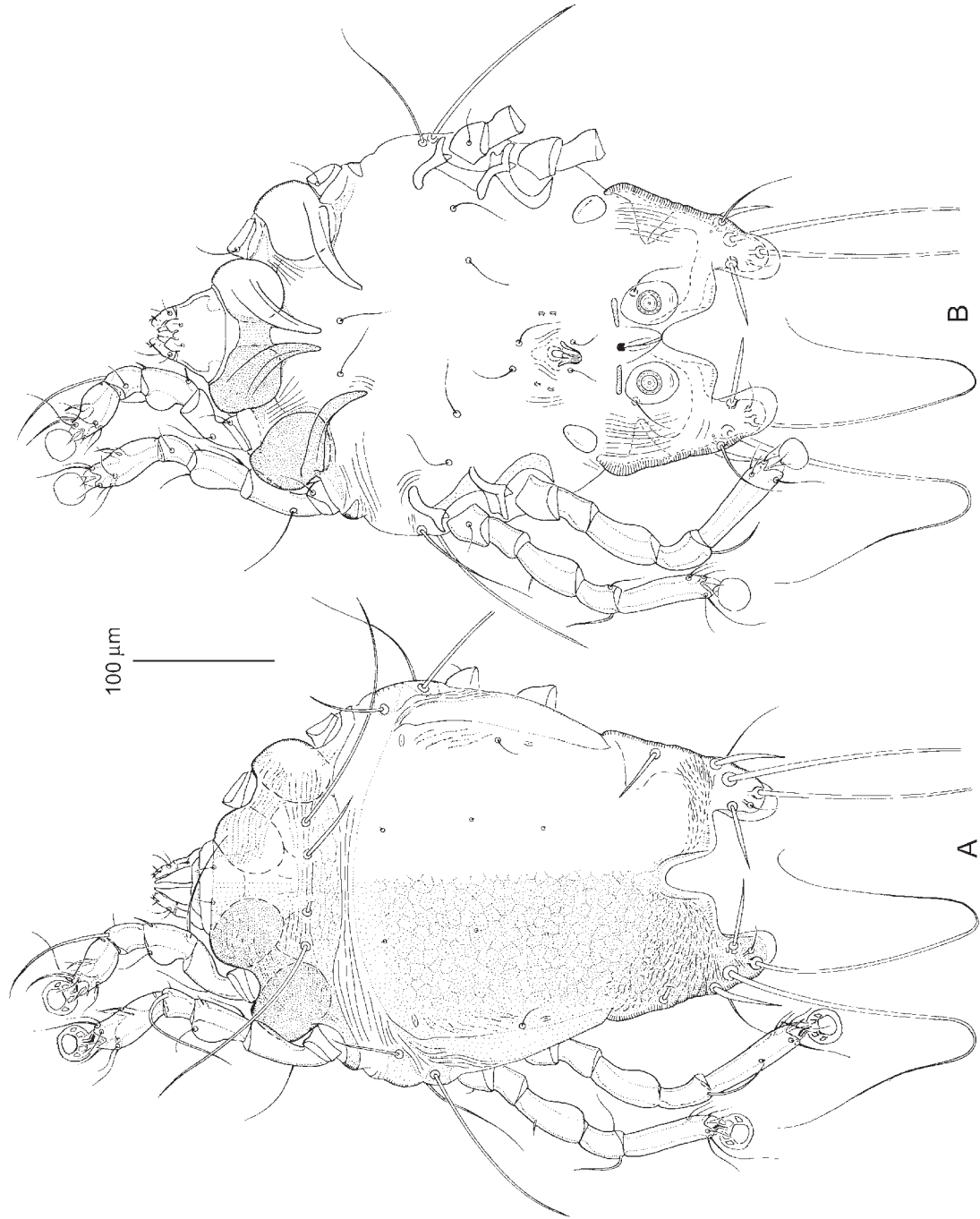
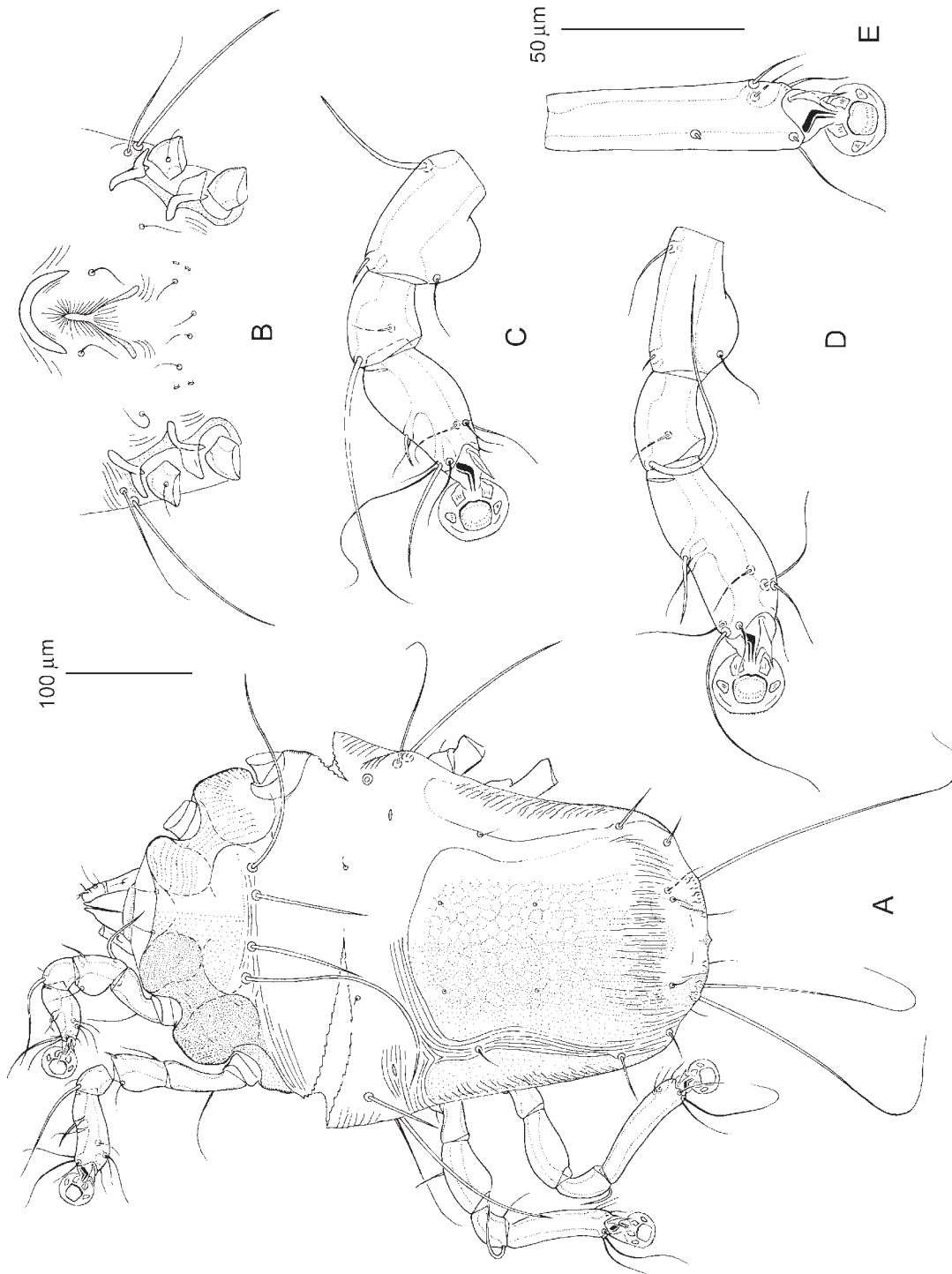


Fig. 4. *Proprosolenidia elanooides*, male: A, dorsal view; B, ventral view.

Fig. 5. *Proaposolenidia elanoides*: A, dorsal view of female; B, oviporus region of female; C, tarsus, tibia, and genu I of male; D, tarsus, tibia, and genu II of male; E, tarsus IV of male.



situated at level of trochanters IV, 18×17 . Setae *g* at level of anterior margin of trochanters IV. Genital papillae at level of genital apparatus. Distance between ventral setal rows: *3b:3a* 9, *3a:g* 34, *g:4a* 37. Adanal apodemes triangular in form, situated at level of anal suckers; egg-shaped sclerites situated anterior to adanal apodemes. Adanal shields as small transverse sclerites. Diameter of anal suckers 16. Ventral surface of genua I, II strongly inflated, those of genua III, IV inflated to a lesser extent. Setae *cG* of genu I spiculiform, 1.5 times longer than segment, 36 long. Length of tarsi: I 39, II 49, III 65, IV 71. Modified seta *d* approximately at midlength of tarsus IV.

Female (paratype). Idiosoma length from anterior end to lobar apices 451, idiosoma width 295. Gnathosoma: 56×75 . Prodorsal shield: not extending beyond row of scapular setae *se*, *si*; lateral parts completely fused with heavily sclerotized ball-shaped bases of epimerites I, II as in male; length along midline 74; areas of ball-shaped bases with wavy striation. Scapular setae *si* spiculiform, 86 long. Distance between bases of prodorsal setae: *vi:vi* 32, *si:si* 43, *se:se* 90. Length of hysterosoma 300. Hysteronotal shield: anterior end extending to level of trochanters III, anterior margin convex, posterior end with incision extending beyond level of setae *h1*; surface with well-expressed reticulate pattern in anterior $2/3$, greatest length 242, width at anterior margin 158. Setae *c1* and cupules *ia* off hysteronotal shield. Subhumeral setae *c3* long, setiform, length nearly one third of hysterosoma width. Macrosetae *se*, *cp* thick along all their length. Hysteronotal setae: *c2* spiculiform, 62 long; *e2* and *f2* thin spiculiform, 39 and 26 long, respectively. Distance between dorsal setal rows: *c2:d2* 88, *d2:e2* 117, *e2:h3* 65. Bases of trochanters III, IV flanked by sclerotized bands as in male. Epigynium thick semicircular, not extending to setae *c1*, 39×70 . Distance between ventral setal rows: *3a:3b* 32, *3b-g* 52. Setae *4a* posterior to setae *g* by 9–15. Anterior pair of genital papillae at level of setae *4a*. Ventral surface of genua I–IV inflated as in male. Setae *cG* of genu I spiculiform, 49 long, nearly 1.5 times longer than segment. Length of tarsi: I 49, II, 58, III 79, IV 94.

Genus *Aposolenidia* Gaud and Atyeo, 1975

Diagnosis

Aposolenidia differs from other gabuciniid genera by the following features: in both sexes, bases of epimerites I, II modified as inflated, heavily sclerotized ball-shaped structures;

homolateral inflations of epimerites I, II connected by heavily sclerotized dorsolateral bridges; bases of epimerites I connected to each other by ventral transverse bridge, solenidion $\sigma 1$ absent on genua I–III; in males, genital setae *g* anterior to genital papillae; in females, setae *4a* and genital papillae close to level of setae *g*, situated between levels of trochanters III and IV. Table 1 summarizes the similarities and differences between *Aposolenidia* and all other genera of gabuciniid mites.

Remark

Up to now the genus *Aposolenidia* has included only a single species, *Aposolenidia anomogonima* Gaud and Atyeo, described from the Ovambo sparrowhawk, *Accipiter ovampensis* Gurney (Accipitridae), in South Africa and the dark chanting goshawk, *Melierax metabates* Heuglin, in Cameroon (Gaud and Atyeo 1975). Here we describe another *Aposolenidia* species from an accipitrid host in Colombia, which represents the first record of this genus in the New World.

Aposolenidia striata Mironov, Proctor, and Barreto, sp. nov.

(Figs. 6, 7)

Type material

Holotype (male, UASM 80503): COLOMBIA: 16.xi.2005, M. Barreto and M. E. Burbano, ex male museum specimen of the pearl kite, *Gampsonyx swainsonii* (Accipitridae), Valle del Cauca, La Unión, vereda El Vergel, hacienda Tesorito, collected 14.iv.1983, C. Murillo, Universidad del Valle: Mus. Cat. No. 4938. **Paratypes**: COLOMBIA: 3 male and 9 female paratypes, same data as holotype. Holotype, 1 male and 5 female paratypes UASM, 1 male, 3 female paratypes ZISP, 1 male, 1 female paratypes UVS.

Etymology

The specific epithet refers to the transverse striations on the hysteronotal shield in males (*striatus* [Latin], “furrowed”).

Diagnosis

Differs from *Aposolenidia anomogonima* in the following features: in both sexes the prodorsal shield does not extend beyond the row of scapular setae (extends beyond in *A. anomogonima*), dorsal seta pairs *c1*, *d1*, *e1*

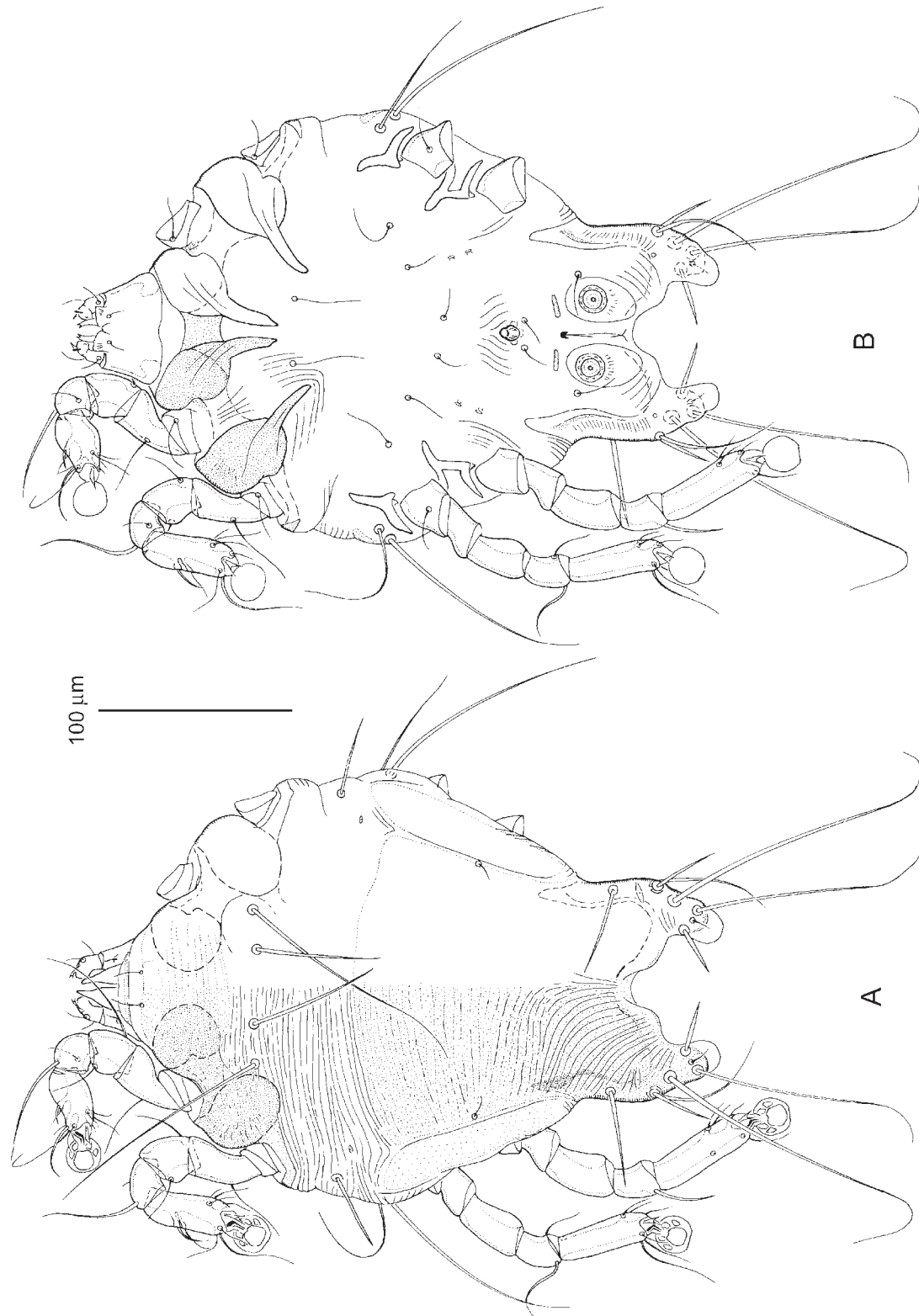
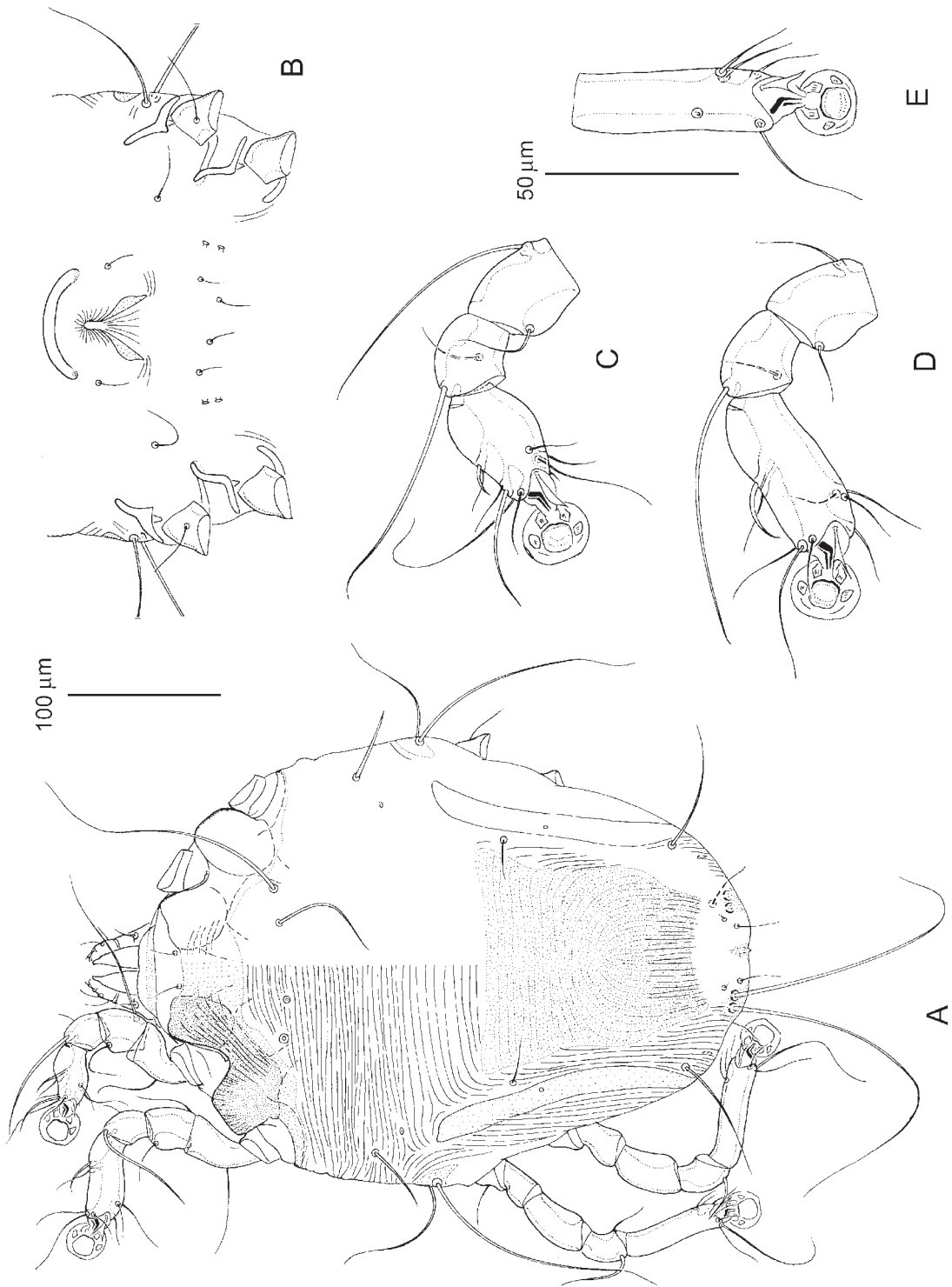


Fig. 6. *Aposolenidia striata*, male: A, dorsal view; B, ventral view.

Fig. 7. *Aposolenidia striata*: A, dorsal view of female; B, oviporus region of female; C, tarsus, tibia, and genu I of male; D, tarsus, tibia, and genu II of male; E, tarsus IV of male.



absent (present in *A. anomogonima*); in males, hysteronotal shield with transverse striation and convex anterior margin (without striation and with straight margin in *A. anomogonima*); in females, anterior margin of hysteronotal shield concave (slightly convex in *A. anomogonima*).

Description

Male (holotype, measurements for 3 paratypes in parentheses). Idiosoma length 295 (290–304), idiosoma width 224 (205–240). Gnathosoma: 46 (43–46) × 56 (52–62). Prodorsal shield: lateral parts completely fused with heavily sclerotized ball-shaped bases of epimerites I, lateral margins indistinct, posterior end not extending to row of scapular setae *se*, *si*; length of the shield along midline 44 (40–43); surface with poorly expressed wavy striation. Scapular setae *si* spiculiform, 70 (70–75) long. Distance between bases of prodorsal setae: *vi:vi* 14, *si:si* 43, *se:se* 77. Length of hysterosoma 205 (205–225). Hysteronotal shield: anterior margin convex, not extending to level of sejugal furrow, greatest length 186 (174–186), width at anterior margin excluding lateral bands 160 (140–190); surface with transverse wavy striae on anterior part and with oblique striae on lobar part. Lateral bands clearly separated from the main body of hysteronotal shield. Cupules *ia* off hysteronotal shield. Subhumeral setae *c3* long setiform, length nearly one third of hysterosoma width. Setae *c1*, *d1*, *e1* absent. Hysteronotal setae: *c2* spiculiform 36 (33–43) long; *e2* spiculiform, 46 (48–52) long; *f2* spiculiform, 36 (38–43) long; *h1* narrowly lanceolate, 30 (27–32) long. Terminal cleft with poorly demarcated ledge on lateral margins, total length of the cleft 34 (30–35), width of posterior part 54 (52–58). Terminal membrane short, with rounded posterior end, 14 (12–18) long. Bases of trochanters III, IV not flanked by sclerotized bands. Genital apparatus small, with ball-like sheath of aedeagus, 9 (8–9) × 7 (7–9), situated at level of trochanters IV. Setae *g* at level of posterior margin of trochanters III. Genital papillae between levels of trochanters III and IV, slightly posterior to level of setae *g* and as distant from each other as setae *3a–3a*. Distance between ventral setal rows: *3b:3a* 10 (7–16), *3a:g* 23 (20–26), *g:4a* 46 (36–46). Anterior ends of adanal apodemes extend almost to level of setae *4a*. Adanal shields as small transverse sclerites. Diameter of anal suckers 15 (14–15). Ventral wall of genua I–IV noticeably thickened. Seta *cG* of genua I long setiform, about 2.5 times longer than segment, 70 (64–75) long.

Length of tarsi: I 32 (29–34), II 44 (44–49), III 50 (48–52), IV 54 (52–56). Modified seta *d* of tarsus IV closer to apical part of the segment than to basal part.

Female (9 paratypes). Idiosoma length 372–397, idiosoma width 266–303. Gnathosoma: 54–57 × 68–72. Prodorsal shield: as in male but shorter and without striae, length along midline 26–34. Scapular setae *si* 75–80 long. Distance between bases of prodorsal setae: *vi:vi* 16–24, *si:si* 47–55, *se:se* 95–100. Length of hysterosoma 267–310. Hysteronotal shield: anterior end extends to level of trochanters III, anterior margin slightly concave, posterior end narrowed and not extending to level of setae *h1*, surface with well-expressed longitudinal striations in posterior quarter, greatest length 140–146, width at anterior margin 143–154. Lateral hysteronotal bands extend to level of humeral setae *cp*. Cupules *ia* off hysteronotal shield. Subhumeral setae *c3* long, setiform, length nearly one third of hysterosoma width. Setae *c1*, *d1*, *e1* absent. Hysteronotal setae: *c2* spiculiform, 48–57; *e2* long, setiform, 95–115; *f2* setiform 24–34. Distance between dorsal setal rows: *c2:d2* 92–103, *d2:e2* 102–110, *e2:h3* 37–51. Bases of trochanters III, IV not flanked by sclerotized bands. Epigynium thick, bow-shaped, not extending to level of setae *c1*, 21–25 × 66–83. Distance between ventral setal rows: *3a:3b* 30–35, *3b-g* 28–47. Setae *4a* posterior to level of setae *g* by 6–18. Anterior pair of genital papillae at level of setae *g*. Ventral wall of genua I–IV thickened as in male. Seta *cG* of genua I setiform, nearly 3 times longer than segment, 80–90 long. Length of tarsi: I 38–46, II, 52–58, III 58–64, IV 63–70.

Genus *Metagabucinia* Mironov and Proctor, gen. nov.

Type species: *Metagabucinia caracarae* Mironov and Proctor, **sp. nov.**

Etymology

The name is a combination of *Gabucinia*, the type genus of the family Gabuciniidae, and *meta* (Greek; “after”); feminine.

Diagnosis

Metagabucinia differs from other genera of the family by the following features: in both sexes, bases of epimerites I, II modified as inflated, heavily sclerotized ball-shaped structures; homolateral inflated structures of epimerites I, II

connected by sclerotized dorsolateral bridges; bases of epimerites I not connected to each other by transverse bridge, solenidion $\sigma 1$ present on genera I–II and absent on genera III; in males, genital setae *g* and anterior pair of genital papillae approximately at same transverse level; in females, setae *4a* and genital papillae close to level of genital setae *g*, situated between levels of trochanters III and IV. As there is currently only a single species in this genus, the generic diagnosis also serves for diagnosing the type species. Table 1 summarizes the similarities and differences between *Metagabucinia* and all other genera of gabuciniid mites.

Description

Both sexes. Two vertical setae *vi* present, closer to each other than distance between internal scapular setae *si*. Dorsal setae of idiosoma simple, not branched. Scapular setae *si* setiform, closer to respective homolateral setae *se* than to midline. Subhumeral setae *c3* short, setiform, much shorter than idiosoma width. Setae *c2* short, spiculiform. Hysteronotal gland openings *gl* indistinct. Bases of epimerites I, II modified as inflated, heavily sclerotized ball-shaped structures; homolateral inflated structures of epimerites I, II connected by dorsolateral bridges; inflations of epimerites I not connected by transverse ventral bridge. Lateral parts of prodorsal shield fused with inflations of epimerites I and dorsolateral bridges. Tarsus I about twice length of palps, tarsus II over than twice length of palps; dorsal wall of these segments greatly thickened, dorsobasal part of tarsus I noticeably inflated. Solenidion $\sigma 1$ present on genera I, II and absent on genus III, seta *cG* of genu I spiculiform, not longer than total length of tibia and genu of this leg.

Male. Opisthosomal lobes well developed, terminal cleft with poorly expressed ledge on inner margins of lobes; interlobar membrane absent, terminal membranes present. Setae *e2* setiform, setae *f2*, *h1* spiculiform. Hysteronotal shield entire, lobar parts not separated from main body of shield. Supranal concavity not expressed. Corolla of anal suckers with indentations. Adanal apodemes present, extending from lateral margins of opisthosoma. Anterior pair of genital papillae and genital setae *g* approximately at same transverse level.

Female. Lateral sclerotized bands of hysteronotal shield clearly separated from main part of shield. Epigynium thick, semicircular, situated anterior to level of humeral shields;

posterior tips not extending to level of setae *3a*. Setae *4a* and genital papillae situated between levels of trochanters III and IV. Hysteronotal shield extends to posterior margin of opisthosoma, posterior end with pair of incisions. Setae *e2*, *f2* setiform.

The genus includes 1 species.

Metagabucinia caracarae Mironov and Proctor, sp. nov.

(Figs. 8, 9)

Type material

Holotype (male, UASM 80504): COLOMBIA: 16.xi.2005, M. Barreto and M.E. Burbano, *ex* male museum specimen of a red-throated caracara, *Ibycter americanus* (Boddaert) (Falconidae), Valle del Cauca, Buenaventura, Bahía Málaga, collected 5.vii.1969, J.I. Borrero and G. Cataño, Universidad del Valle Mus. Cat. No. 1350. **Paratypes**: COLOMBIA: 1 male and 2 female paratypes, same data as holotype. Holotype, 1 female paratype, UASM, 1 male, 1 female paratypes, UVS.

Etymology

The specific epithet derives from *Caracara*, which is both the alternative generic name for the avian host and the common name for these birds; it is a noun in the genitive case.

Description

Male (holotype, measurements for 1 paratype in parentheses). Idiosoma length 320 (306), idiosoma width 227 (230). Gnathosoma: 57 (54) × 74 (72). Prodorsal shield: split at level of scapular setae into two pieces; lateral parts of anterior fragments fused with heavily sclerotized ball-shaped inflations of epimerites I; posterior fragment a transverse sclerite with convex posterior margin; total length of shield along midline 75 (72); surface uniformly punctured. Scapular setae *si* short setiform, 14 (13) long. Distance between bases of prodorsal setae: *vi:vi* 20 (21), *si:si* 46 (51), *se:se* 68 (74). Length of hysterosoma 205 (205–225). Hysteronotal shield: anterior margin slightly convex, not extending to level of sejugal furrow, greatest length 224 (222), width at anterior margin excluding lateral bands 193 (202); surface with numerous ovate lacunae in anterior two thirds and with oblique striae at base of opisthosomal lobes. Lateral bands separated from the main body of hysteronotal shield by narrow groove. Cupules *ia* on hysteronotal

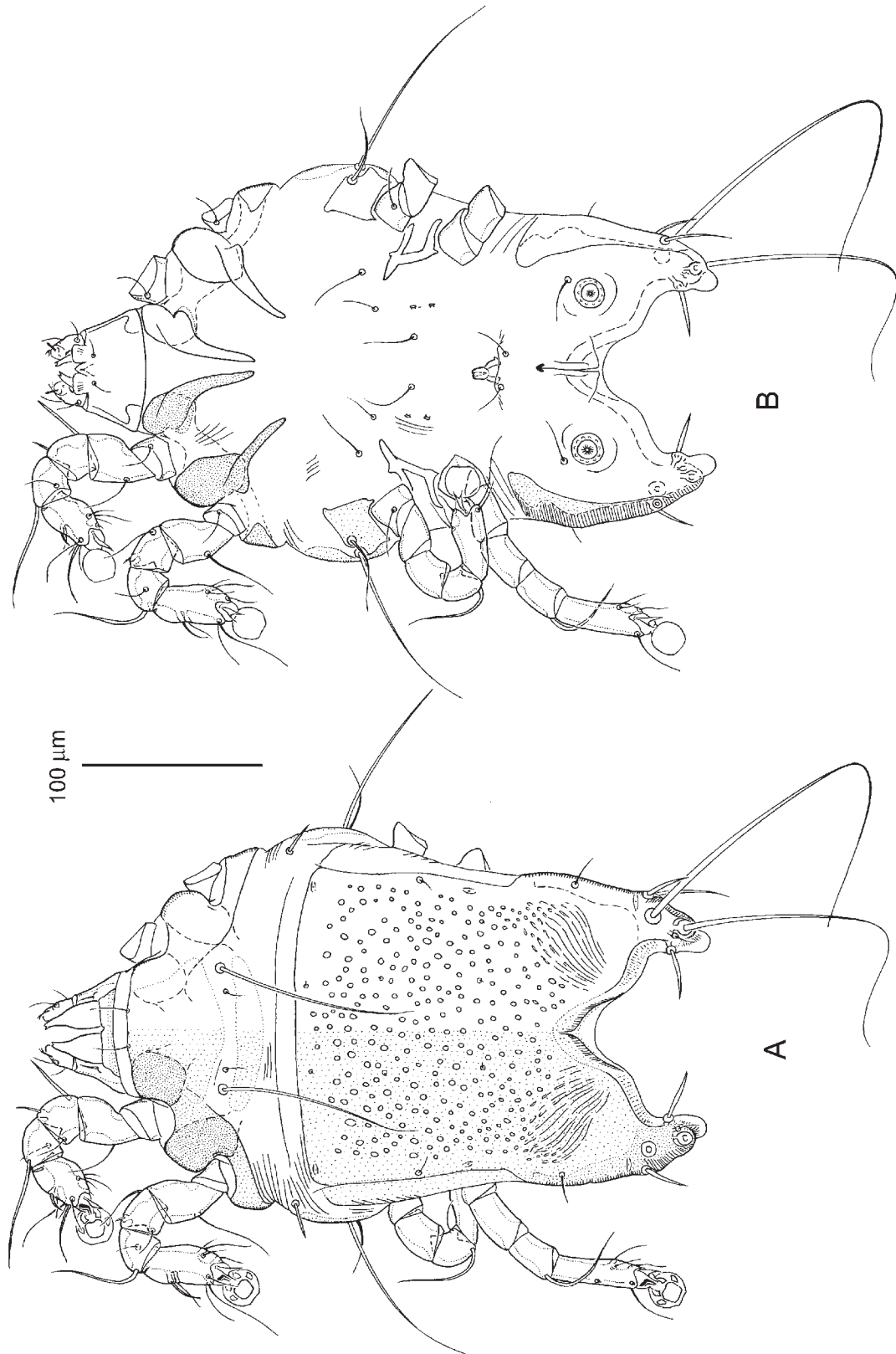
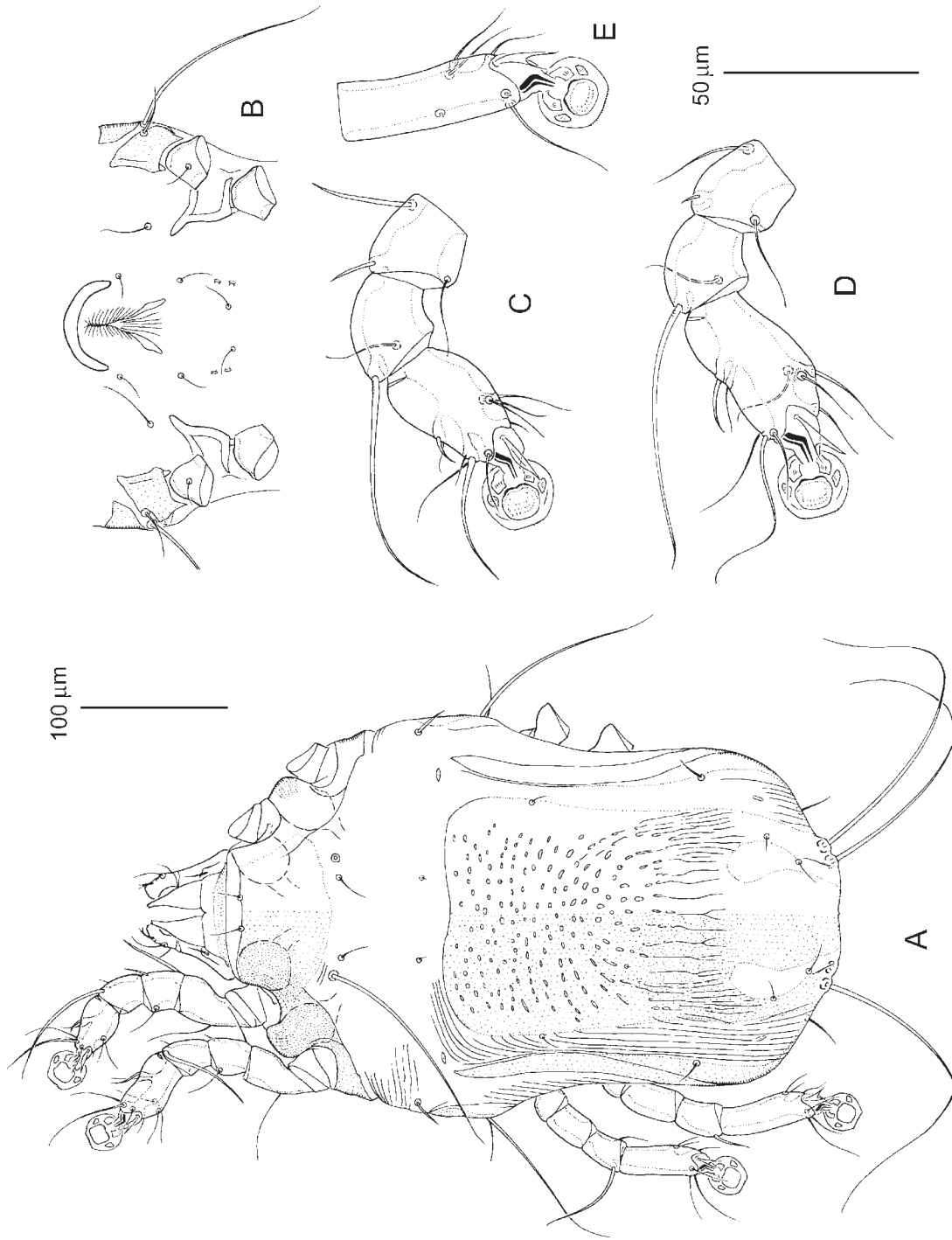


Fig. 8. *Metagabucinia caracarae*, male: A, dorsal view; B, ventral view.

Fig. 9. *Metagabucinia caracarae*: A, dorsal view of female; B, oviporus region of female; C, tarsus, tibia, and genu I of male; D, tarsus, tibia, and genu II of male; E, tarsus IV of male.



shield, setae *c2* off this shield, cupules *im* present. Subhumeral setae *c3* short, setiform, less than one quarter of hysterosoma width. Hysteronotal setae: *c2* spiculiform, 16 (17) long; *e2* setiform, 17 (15) long; *f2* spiculiform, 23 (24) long; *h1* narrowly lanceolate, 29 (28) long. Total length of cleft 52 (49), width of posterior part 90 (86). Terminal membrane short, with rounded posterior end, 8 (10) long. Bases of trochanters III, IV not flanked by sclerotized bands. Genital apparatus situated at level of posterior margins of trochanters IV, 17 × 15. Setae *g* between levels of trochanters III and IV. Anterior pair of genital papillae at level of setae *g*. Distance between ventral setal rows: *3b:3a* 9 (7), *3a:g* 23 (22), *g:4a* 50 (52). Anterior ends of adanal apodemes almost extending to level of setae *4a*. Adanal shields absent. Diameter of anal suckers 18 (17). Seta *cG* of genua I spiculiform, nearly 1.5 times longer than segment, 28 (26) long. Length of tarsi: I 34 (33), II 40 (38), III 43 (44), IV 48 (49). Modified seta *d* of tarsus IV approximately at midlength of segment.

Female (2 paratypes). Idiosoma length 415–417, idiosoma width 264–277. Gnathosoma: 63–71 × 78–86. Prodorsal shield: posterior end not extending to scapular setae, posterior margin convex, lateral margins fused with heavily sclerotized ball-shaped bases of epimerites I; length along midline 62–70; surface uniformly punctured. Scapular setae *si* setiform, 10–14 long. Distance between bases of prodorsal setae: *vi:vi* 20–22, *si:si* 54–57, *se:se* 77–82. Length of hysterosoma 310–315. Hysteronotal shield: anterior end extends to level of humeral setae *cp*, anterior margin slightly concave, posterior end with pair of narrow incisions extending beyond level of setae *h1*; surface with transverse rows of ovate lacunae in anterior part and with sparse longitudinal striae in middle part, greatest length 265–268, width at anterior margin 187–195. Lateral hysteronotal bands extended anterior to level of humeral setae *cp*. Setae *c2* and cupules *ia* off hysteronotal shield; cupules *ip* present, cupules *im* indistinct. Subhumeral setae *c3* long setiform, less than one quarter of hysterosoma width. Hysteronotal setae: *c2* spiculiform, short, 10–14 long, *e2* setiform, short, 14–16, *f2* setiform, 16–20. Distance between dorsal setal rows: *c2:d2* 75–85, *d2:e2* 108–114, *e2:h3* 80–85. Epigynium semi-circular, thick, tips not extending to level of setae *3a*, 30–34 × 61–66. Distance between ventral setal rows: *3a:3b* 23–25, *3b-g* 28 15. Setae *4a* posterior to level of genital setae *g* by 20–

34. Anterior pair of genital papillae approximately at level of setae *g*. Seta *cG* of genua I spiculiform, nearly 1.5 times longer than segment, 32–34 long. Length of tarsi: I 36–38, II 46–48, III 50–52, IV 63–66.

Discussion

The three gabuciniid genera discussed above (*Aposolenidia*, *Metagabucinia*, and *Proaposenidia*) appear to constitute a morphologically well-defined “*Aposolenidia* group” within the family Gabuciniidae (see Table 1). Although their status as a clade awaits a full phylogenetic study, these genera share a number of rare character states: heavily sclerotized ball-shaped inflations of basal part of epimerites I and II; a dorsolateral bridge connecting basal inflations of epimerites I and II on each side of the prodorsum; a strongly thickened dorsal wall of tarsi I and II; and an inflated dorsobasal part of tarsus I that is noticeably different in shape from that of tarsus II. We note that an unusual species, *Hieracolicus ostodus* Gaud, described from the African cuckoo-hawk, *Aviceda cuculoides* Swainson (Accipitridae), likely also belongs to the *Aposolenidia* genus group. Gaud (1983) pointed out in his description of *H. ostodus* that the sclerotized ball-like bases of epimerites I, II and the loss of solenidion σ 1 on genua III differentiate this species from other known representatives of *Hieracolicus* Gaud and Atyeo, and stressed that this species could represent a separate genus.

Although rarely expressed within the Gabuciniidae (Table 1), ball-like basal inflations of the propodosomal epimerites (in one or both pairs) have arisen independently in several taxa of pterolichoid feather mites, particularly the Freyaninae and Michaeliinae (Freyanidae) and the *Protolichus* Mégnin and Trouessart and *Psittophagus* Gaud and Atyeo genus groups (Pterolichidae), and the genera *Kramerella* Trouessart (Kramerellidae), *Nearedecarus* Gaud and Atyeo (Pterolichidae), and *Spilolichus* Gaud and Mouchet (Falculiferidae). The function of these inflated structures is not well understood, but they clearly strengthen the coxosternal skeleton of the propodosomal tagma. The similarity in morphology implies that these unrelated mite taxa have evolved similar modes of attachment to or locomotion within the plumage of their hosts.

Regarding known host associations of members of the *Aposolenidia* genus group, they are currently

restricted to falconiforms and are distributed on these hosts in both the Old and the New World. Because of our methods of collecting, the location of these mites in the plumage of their hosts is not known; however, these relatively broad-bodied mites probably partition plumage microhabitats with representatives of the elongate-bodied gabuciniid genera that inhabit the ventral sides of falconiform flight feathers: *Aetacarus* Gaud and Atyeo, *Hieracolichus*, and *Ramogabucinia* Gaud and Atyeo. There are records of these long-bodied genera from most hosts of the *Aposolenidia* group. *Proaposolenidia accipitris* and *A. anomogonima* occur on birds of the genus *Accipiter*, which are common hosts of mites of the genera *Aetacarus* and *Hieracolichus* (Gaud and Atyeo 1975; Gaud 1983). *Proaposolenidia elanoides* and *Aetacarus elanoides* Proctor and Zimmerman (Proctor *et al.* 2006) are known from the swallow-tailed kite, *Elanoides forficatus*. *Aetacarus avicedae* Gaud and the aberrant *Hieracolichus ostodus*, probably also a member of the *Aposolenidia* genus group, are recorded by Gaud (1983) from *Aviceda cuculoides*. We found *Metagabucinia caracarae* on the red-throated caracara, *Ibycter americanus*, together with an as yet undescribed *Hieracolichus* species. Only the pearl kite, *Gampsonyx swansonii*, the host of *Aposolenidia striata*, currently lacks records of any representatives of long-bodied gabuciniids. Given that one of the principal modes of diversification of feather mites is cospeciation along with their hosts (Gaud and Atyeo 1980, 1982; Dabert and Mironov 1999), and taking into consideration the coexistence of gabuciniids of two morphologically quite different groups of genera on a number of falconiform hosts, we suggest that mites of the *Aposolenidia* genus group probably originated on the common ancestor of falconiforms and diversified along with representatives of the better explored long-bodied gabuciniid genera (*Aetacarus*, *Cathartacarus* Mironov and Galloway, *Hieracolichus*, and *Ramogabucinia*). This scenario and other historical hypotheses await both phylogenetic testing and further exploration of the world's gabuciniid fauna.

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