

Review of External Morphology of Chirorhynchobiidae (Acari: Sarcoptoidea) with Description of a New Species

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ABSTRACT Two species of Chirorhynchobiidae, *Chirorhynchobia glossophaga* sp. n. and *Chirorhynchobia matsoni* Yunker, 1970 are described and redescribed, respectively. The male of *C. glossophaga* and the tritonymph of *C. matsoni* are the first to be described in the family. The mites are ectoparasites living on the wing membrane of phyllostomid bats *Glossophaga soricina* (Pallas) from Peru and *Anoura geoffroyi* Gray from several localities. Females of the new species differ from those of *C. matsoni* by the shorter idiosoma (length 439–450 versus 497–562 in *C. matsoni*), by the dorsal position of setae 4a (terminal in *C. matsoni*), and by the narrower posterior projections of the propodonal shield (width 6 versus 17). Although the morphology of Chirorhynchobiidae is strongly regressive, homologies of the leg and idiosomal setae in these mites with those of other Astigmata are established. The combination of absence of famulus ϵ and solenidia σ I-II and presence of solenidia ω I-II and ω 3I in these mites is shared with the Rhyncoptidae–Sarcoptidae clade, suggesting a possible relationship with those groups.

KEY WORDS acari, Chirorhynchobiidae, morphology, ectoparasites, phyllostomid bats

The family Chirorhynchobiidae was established by Fain (1967) for a single species *Chirorhynchobia urodermae* Fain, 1967. It was described based on a single female collected from *Uroderma bilobatum* Peters, 1866 (Chiroptera: Phyllostomidae: Stenodermatinae) in Panama; this specimen was attached to the membranous wing margin of its host by means of the greatly enlarged gnathosoma (Fain 1967, 1968). Yunker (1970) added a second species, *Chirorhynchobia matsoni* Yunker, 1970 collected from *Anoura geoffroyi* Gray, 1838 (Phyllostomidae: Glossophaginae) in Venezuela. This species was described from seven females, six of them attached to the wing margin. Yunker (1970) also provided an emended diagnosis of Chirorhynchobiidae. Palacios-Vargas (1980) reported a single female of *C. matsoni* from *A. geoffroyi* from Mexico.

In this study, we describe a new species of this family, *Chirorhynchobia glossophaga* sp. n., from *Glossophaga soricina* Pallas, 1766 (Phyllostomidae: Glossophaginae) from Peru, including the first description of the male in the family, and we redescribe *C. matsoni* from females and describe the tritonymph for the first time. Homologies of the leg and idiosomal setae in

these mites with other Astigmata are established for the first time. To document the synapomorphies of Chirorhynchobiidae and its assumed relationships with other Sarcoptoidea, we compared our observations on this family with data on external morphology of mites belonging to other currently recognized sarcoptoid families.

Materials and Methods

Mite specimens were collected by B.M.O.C. and H.K. from ethanol-preserved bats *A. geoffroyi* and *Glossophaga soricina* housed in the Museum of Zoology, University of Michigan, Ann Arbor, MI, and the Field Museum of Natural History, Chicago, IL. We also examined 30 specimens of *Uroderma bilobatum* (15 from Panama and 15 from Peru) but did not re-collect specimens of *C. urodermae*.

In the descriptions below, idiosomal chaetotaxy follows Griffiths et al. (1990) with modifications of Norton (1998) for coxal setae. The leg chaetotaxy follows Grandjean (1939). Names of hosts follow Simmons (2005).

Specimen depositories and reference numbers are cited using the following abbreviations: BMOC #, B.M. OConnor reference number; FMNH, Field Museum of Natural History, Chicago, IL; HK #, Hans Klompen reference number; OSAL, The Acarology Laboratory, The Ohio State University, Columbus, OH; UMMZ, Museum of Zoology, University of Michigan, Ann Arbor, MI; and ZISP, Zoological In-

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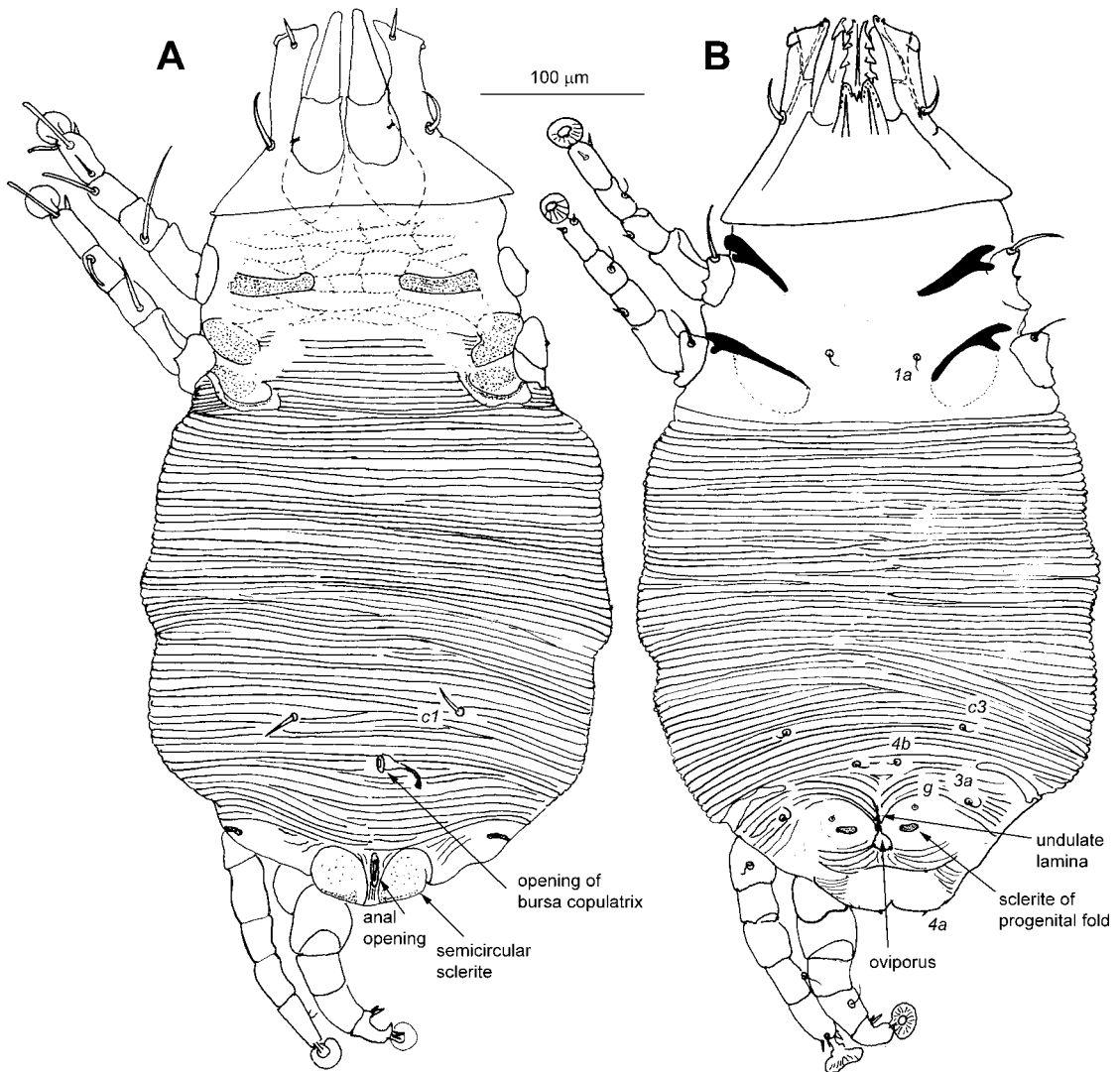


Fig. 1. *C. matsoni* Yunker, 1970, female. (A) Dorsal view. (B) Ventral view.

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Results

Chirorhynchobia matsoni Yunker, 1970 (Figs. 1-3 and 6A)

Chirorhynchobia matsoni Yunker 1970: 151, Figs. 1-4; Palacios-Vargas 1980: 27.

Redescription. Female (15 specimens; Figs. 1 and 2, and 6A). Body elongated, length including gnathosoma 495-560, width 260-315. Gnathosoma 120-150 long, 170-195 wide in basal part. Palps 80-90 long. Lengths of palpal setae: *db* and *v* \approx 23, *da* \approx 20, eupathidia *euI* and *euII* 1-2 long, solenidion ω \approx 1 long. Idiosomal length 380-435, length/width ratio 1.4-1.5:1.

Propodonal shield \approx 70 long, partially covered by an indistinct reticular pattern. Posterior projections of propodonal shield widened in median part, width \approx 17. Distance *c1-c1* \approx 95. Setae *4a* inserted terminally. Setae *g* 1-2 long, indistinct. Tarsi III and IV 35-36 and 26-27 long, respectively. Tarsi IV curved, but not angularly bent. Genua III and IV without spurs. Setae *baI* situated basally. Setae *pRI* slightly thickened, *pRII*, *sRIII*, *kTIII-IV*, *baI* filiform, *cGI-II* saber-like, *mGI-II*, *eI-III*, *fl-III*, *sI-III*, *wIII-IV*, and *rIII-IV*—all short spine-like. Lengths of setae and solenidia given in Table 1.

Female Tritonymph (One Specimen, Fig. 3). Gnathosoma broken. Idiosomal length 205, width 160; length/width ratio 1.3:1. Propodonal shield 50 long, partially covered by short transverse striations. Posterior margin of propodonal shield without projections. Distance *c1-c1* 70. Lateral projections of idio-

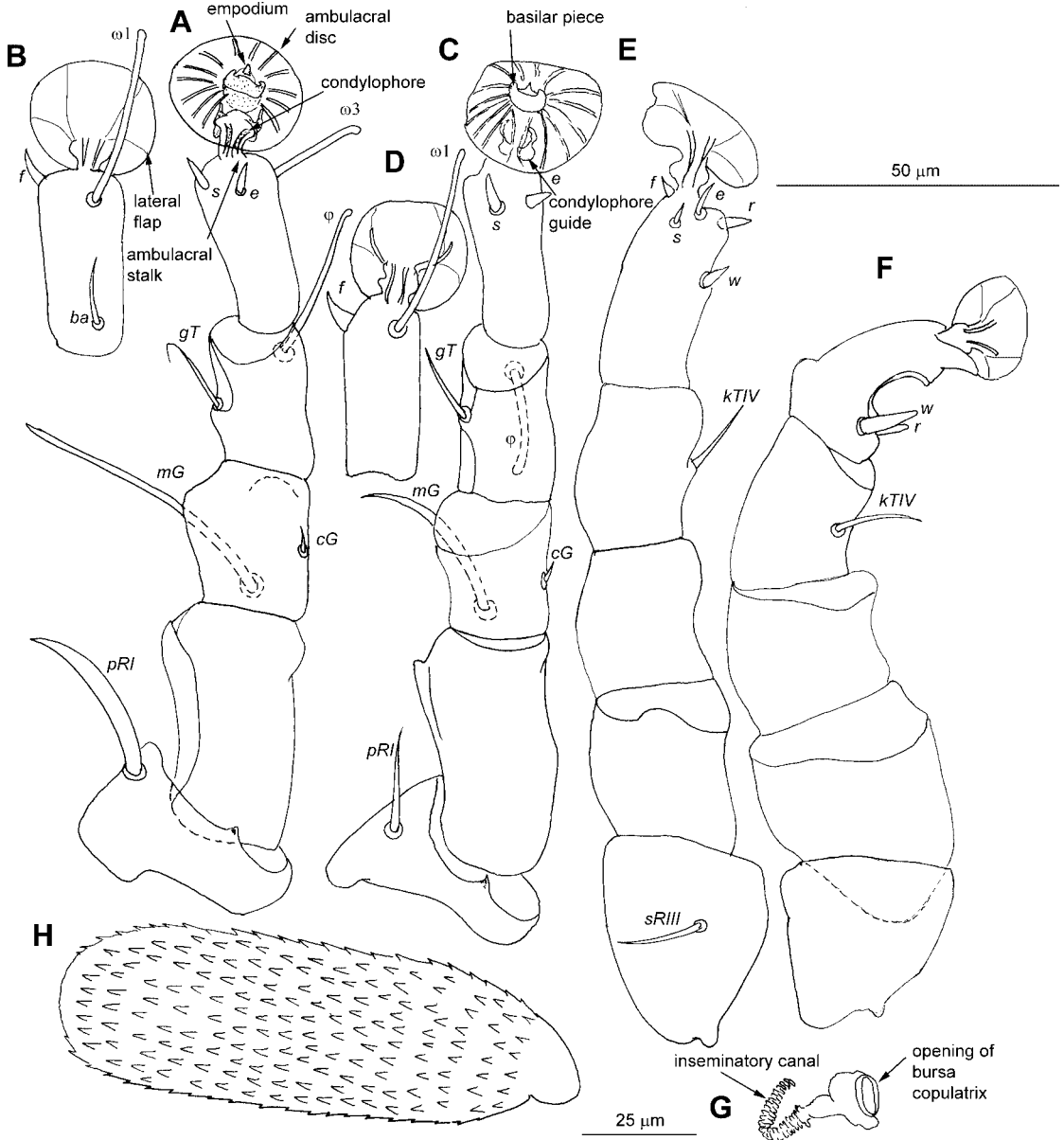


Fig. 2. *C. matsoni* Yunker, 1970, details of female. (A) Leg I in ventral view. (B) Tarsus I in dorsal view. (C) Leg II in ventral view. (D) Tarsus II in dorsal view. (E) Leg III in ventral view. (F) Leg IV in ventral view. (G) Bursa copulatrix. (H) Egg. Scale bars = 100 μ m (A-G) and 25 μ m (H).

soma 22 long and at most 17 wide, situated posterior to coxal fields II. Bursa copulatrix present. Tarsi III and IV 26 and 22 long, respectively. Tarsi IV straight. Genua III and IV without spurs. Setae *baI* situated basally. Leg setae as in female. Length of setae and solenidia: *cI* and *gTI* 10, *c3*, *sRIII* 6, *mGI*, *wIV*, and *ω3I* 4, *1a*, *3a*, and *gTII* 8, *4a*, *g*, and *4b* microsetae, *pRI-II* and *kTIII* 7, *mGII* 3, *cGI* 44, *cGII* 29, *kTIV* 5, *baI* 11, *rIV* 3, *ωII* 18, *ωIII* 22, *φI* 16, and *φII* 11.

Male, Protonymph, and Larva. Unknown.

Material Examined. One female (BMOG 81-0302-004) ex *Anoura geoffroyi* (UMMZ 108650), MEXICO:

Chiapas, 1.6 km. S. Tuxtla Gutierrez, 16° 43' 17" N, 93° 07' 07" W, 722 m, 31-VII-1958, Hooper et al.; 2 females (BMOG 81-0302-005) ex *A. geoffroyi* (UMMZ 108651), same data; 5 females (BMOG 81-0302-006) ex *A. geoffroyi* (UMMZ 108643), same data; 3 females (BMOG 81-0302-007) ex *A. geoffroyi* (UMMZ 108657), same data; 1 female (BMOG 81-0302-008) ex *A. geoffroyi* (UMMZ 108656), same data; 1 female (BMOG 81-0302-009/10) ex *A. geoffroyi* (UMMZ 108659/108642), same data; three females (BMOG 81-0302-011) ex *A. geoffroyi* (UMMZ 108652), same data; 5 females (BMOG 81-0302-012) ex *A. geoffroyi* (UMMZ 108654),

Table 1. Measurements of females of *C. glossophaga* sp.n. and *C. matsoni* Yunker, 1970

Character	Range (mean \pm SD) (μm) ^a	
	<i>C. glossophaga</i> (N = 4)	<i>C. matsoni</i> (N = 15)
Body length	439–450 (447 \pm 7)	497–562 (541 \pm 21)
Body width	269–322 (293 \pm 27)	263–316 (286 \pm 16)
Gnathosomal length	111–122 (116 \pm 6)	122–149 (133 \pm 10)
Gnathosomal width (basally)	147–158 (153 \pm 6)	171–193 (181 \pm 9)
Palpal length	60–67 (64 \pm 4)	78–91 (85 \pm 6)
Idiosomal length	304–333 (320 \pm 12)	380–433 (415 \pm 18)
<i>cl</i>	18–19 (18 \pm 1)	17–22 (20 \pm 2, n = 9)
<i>c3</i>	4–5 (5 \pm 0)	6–7 (7 \pm 0)
<i>Ia</i>	8–10 (9 \pm 1)	12–14 (13 \pm 1)
<i>3a</i>	7–9 (8 \pm 1)	10–12 (11 \pm 1)
<i>g</i>	3–4 (4 \pm 0)	1–2 (2 \pm 0)
<i>4a</i>	5–6 (6 \pm 1)	3–4 (4 \pm 0)
<i>4b</i>	4–5 (5 \pm 0)	3–4 (4 \pm 0)
Tarsus III, length	26–28 (27 \pm 1)	35–36 (35 \pm 0)
Tarsus IV, length	25–26 (26 \pm 1)	26–27 (27 \pm 0)
<i>pRI</i>	22–25 (23 \pm 1)	26–31 (28 \pm 2)
<i>pRII</i>	13–15 (15 \pm 1)	16–18 (17 \pm 1)
<i>sRIII</i>	9–11 (9 \pm 1)	13–14 (14 \pm 1)
<i>mGI</i>	4–5 (5 \pm 0)	2–3 (3 \pm 0)
<i>mGII</i>	4–5 (5 \pm 0)	2–3 (3 \pm 0)
<i>cGI</i>	44–53 (49 \pm 5)	48–53 (51 \pm 3)
<i>cGII</i>	26–33 (30 \pm 3)	26–32 (30 \pm 3)
<i>gTI</i>	13–14 (13 \pm 0)	14–18 (16 \pm 2)
<i>gTII</i>	11–11 (11 \pm 1)	13–15 (14 \pm 1)
<i>kTIII</i>	12–15 (13 \pm 1)	17–18 (17 \pm 1)
<i>kTIV</i>	10–11 (11 \pm 1)	13–16 (14 \pm 2)
<i>baI</i>	11–12 (11 \pm 0)	11–13 (12 \pm 1)
<i>wIV</i>	9–10 (9 \pm 1)	12–13 (13 \pm 1)
<i>rIV</i>	6–7 (6 \pm 0)	7–9 (8 \pm 1)
<i>oI I</i>	26–27 (27 \pm 0)	29–31 (30 \pm 1)
<i>oI II</i>	28–30 (29 \pm 1)	26–33 (30 \pm 3)
<i>o3 I</i>	14–15 (15 \pm 1)	16–18 (17 \pm 1)
ϕ I	23–26 (24 \pm 2)	26–31 (28 \pm 2)
ϕ II	17–19 (18 \pm 1)	18–22 (20 \pm 2)

^a All values are rounded to whole numbers.

same data; 2 females and 1 female tritonymph (BMOC 01-0101-068) ex *A. geoffroyi* (FMNH 169837), PERU: Cuzco Department, Paucartambo, Suecia, km 138.5 on Cuzco-Shintuya Hwy., 13° 10' 53" S, 71° 56' 87" W, 1,920 m, 17-IX-1999, S. Solari (SS 1864). Voucher specimens are in FMNH, OSAL, UMMZ, and ZISP.

***Chirorhynchobia glossophaga* n. sp.**
(Figs. 4–7)

Description. Female (holotype, Figs. 4 and 5, and 6B and C).

Body, including gnathosoma, 440 long (measurements of paratypes in Table 1), 270 wide. Gnathosoma 110 long, 147 wide in basal part. Palps 60 long. Lengths of palpal setae: *db* 26, *vb* 23, and *da* 15, eupathidia *euI* and *euII* 1–2 long, solenidion $\omega \approx 1$ long. Idiosoma 325 long, idiosomal length/width ratio 1.2:1. Propodonal shield 50 long, partially covered by indistinct reticular pattern. Posterior projections of propodonal shield represented by narrow bands, ≈ 6 wide. Distance *cl-cl* 80. Setae *4a* inserted dorsally. Setae *g* 4 long, distinct. Tarsi III and IV 28 and 26 long, respectively. Tarsi IV curved, but not angularly bent. Genua III and IV with-

out spurs. Setae *baI* situated basally. Shape of leg setae as in *C. matsoni*. Length of setae and solenidia: *cl* broken (≈ 18 in three paratypes), *c3* 5, *Ia* and *3a* 8, *4a* 6, *4b* 4, *pRI* broken (≈ 23 in three paratypes), *pRII* 13, *sRIII* 9, *mGI* and *II* 4, *cGI* broken (≈ 49 in three paratypes), *cGII* 29, *gTI* 13, *gTII* 11, *kTIII* 12, *kTIV* 10, *baI* 11, *wIV* 9, *rIV* 6, *oII* 27, *oIII* 30, *o3I* 14, ϕ I 23, and ϕ II 19.

Male (Paratype, Fig. 7). Body, including gnathosoma, 265 long, 135 wide. Gnathosoma 80 long, 100 wide in basal part. Palps 50 long. Lengths of palpal setae: *db* 20, *vb* 17, and *da* 10, eupathidia *euI* and *euII* 1–2, solenidion $\omega \approx 1$. Idiosoma 180 long; length/width ratio 1.3:1. Propodonal shield 30 long, its pattern indistinct. Posterior projections of propodonal shield slightly widened in median parts, ≈ 6 wide. Distance *cl-cl* 50. Setae *4a* inserted dorsally. Setae *4b* and *g* absent. Aedeagus 25 long. Tarsi III and IV 20 and 25 long, respectively. Tarsi IV straight. Genua III and IV without spurs. Tarsi and tibiae IV with short basal spur dorsally. Setae *baI* situated basally. Shape and number of setae on legs I and II same as in female, but setae *cGI* and *II* filiform. All setae of tarsi III and IV filiform, setae *sIII* and *fIII* absent, solenidion ϕ IV and spine-like setae *eIV* present. Length of setae and solenidia: *cl* 13, *c3*, *kTIV*, *wIV*, and ϕ IV 5, *Ia*, *3a*, *4a*, and *mGI-II* 4, *pRI* and ϕ II 18, *pRII*, *sRIII*, and *kTIII* 11, *cGI-II* 3, *cGI* 42, *cGII* and *o3I* 14, *gTI-II* 10, *baI* 9, *rIV* 3, *oII* 21, *oIII* 28, and ϕ I 22.

Immature Instars. Unknown.

Type Material. HOLOTYPE female (HK 84-0615-002) ex *Glossophaga soricina* (UMMZ 160897), PERU: Cuzco Department, Rio Urubamba, Kiteni, approx. 12° 20' S, 72° 50' W, 650 m, 29-V-1984, P. Myers; PARATYPES: 3 females and 1 male, same data.

Holotype and paratypes in UMMZ.

Etymology. The species name is derived from the generic name of the host and is a noun in apposition.

Remarks. Females of this new species differ from *C. urodermae* by the absence of the dorsal spurs on genua III and IV in females. According to the original description of *C. urodermae* (Fain 1968), palpal eupathidium *euII*, setae *db*, *cl*, and *c3*, and the sclerites of the progenital folds are absent in females of this species. Following Yunker (1970): 153, we think that these structures were overlooked by Fain (1968) due to the poor condition of the holotype and only specimen of this species collected to date.

The new species differs from *C. matsoni* by the following characters. In *C. glossophaga* sp. n., the idiosomal length is 439–450, the ratio of idiosomal length/width is $\approx 1.2:1$, the posterior projections of the propodonal shield are represented by the narrow bands, ≈ 6 wide (Fig. 6B), setae *g* are distinct, ≈ 4 long, setae *4a* inserted dorsally. In *C. matsoni*, the idiosomal length is 497–562, the ratio of the idiosomal length/width is 1.4–1.5:1, the posterior projections of the propodonal shield are expanded medially, ≈ 17 wide (Fig. 6A), setae *g* are indistinct, 1–2 long, setae *4a* inserted terminally.

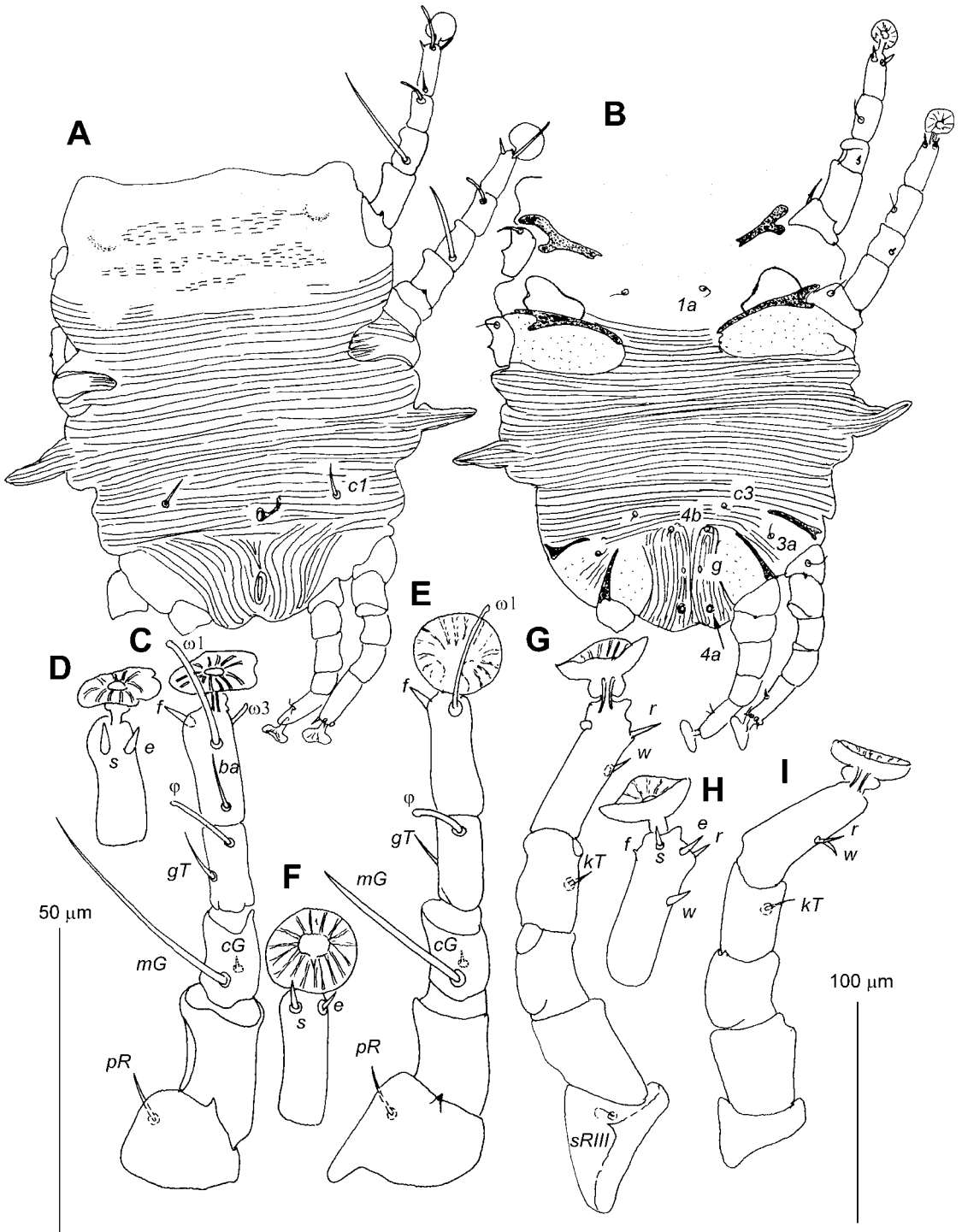


Fig. 3. *C. matsoni* Yunker, 1970, female tritonymph. (A) Idiosoma in dorsal view. (B) Same in ventral view. (C) Leg I in dorsal view. (D) Tarsus I in ventral view. (E) Tarsus II in dorsal view. (F) Tarsus II in ventral view. (G) Leg II in dorsal view. (H) Tarsus III in ventral view. (I) Leg IV in dorsal view. Scale bars = 100 μm (A and B) and 50 μm (C-I).

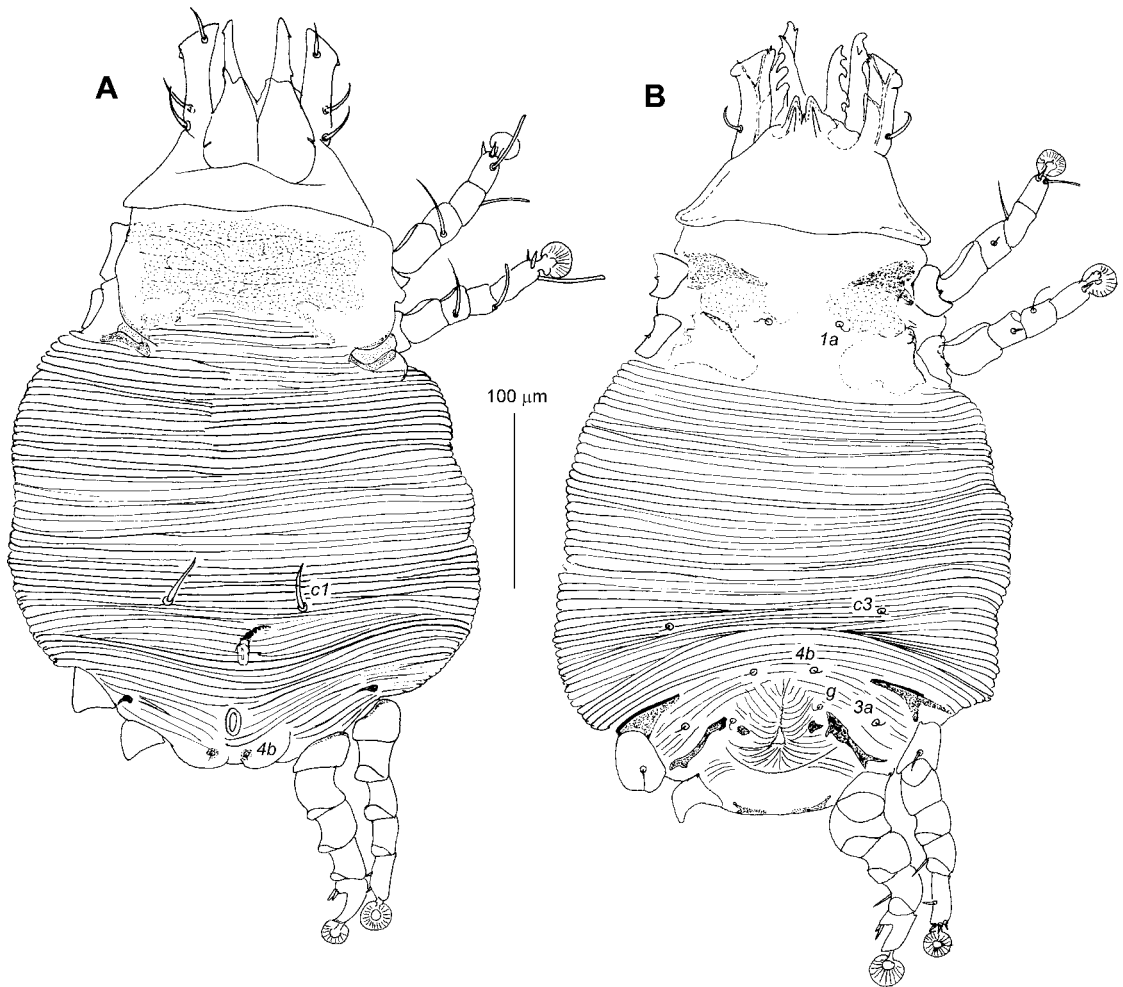


Fig. 4. *C. glossophaga* sp. n., female. (A) Dorsal view. (B) Ventral view.

Observations on External Morphology of Chirorhynchobiidae

Gnathosoma. The gnathosoma of chirorhynchobiids shows strong modifications for attachment to the host skin, modifications that are superficially similar to those of Ixodida (Figs. 6C and 7C). The palps are distinct, slightly longer than the subcapitulum and well sclerotized. The palpal podomeres are completely fused to each other and to the subcapitulum. The palps bear basally two distinct setae, *db* and *v*. The apical part of palps has a short triangular ventro-antiaxial projection, and bears dorsally seta *da*, and ventrally two short proximal eupathidia (*euI-II*), and a minute antiaxial solenidion (ω). The fixed digit of the chelicera has four distinct teeth, the second and third teeth are situated at almost the same level. The movable digit bears four distinct teeth of complicated shape (Fig. 6C) and the dorsal membranous projection situated posterior to these teeth. The paraxial cheliceral hood, the antiaxial apophysis, the cheliceral spur, and the seta-like apoph-

ysis, normally present in Astigmata, are not visible. The subcapitulum is almost trapezoid in outline. A pair of supracoxal setae (*elc. p.*) is present at the palpal bases; ventral subcapitular setae are absent. The hyposome is strongly reduced; the rutella are distinctly developed, tongue-like, with marginal denticles in the anterior parts.

Idiosoma. The idiosoma is dorsoventrally flattened (Fig. 1). The supracoxal setae *scx* are absent and the openings of the supracoxal and the opisthonotal glands were not observed. The lateral remnants of the sejugal furrow are visible immediately posterior to coxal fields II. The dorsal surface of the idiosoma bears a transverse propodosomal shield. The posterior margin of this shield has a pair of projections. The idiosomal venter of chirorhynchobiids bears a transverse sternal plate. The coxal apodemes are short, $\approx 1/3-1/4$ of idiosomal width, and their distal ends are free. Coxal fields are sclerotized, but fields III and IV bear only a narrow sclerotized band. The idiosomal cuticle has distinct

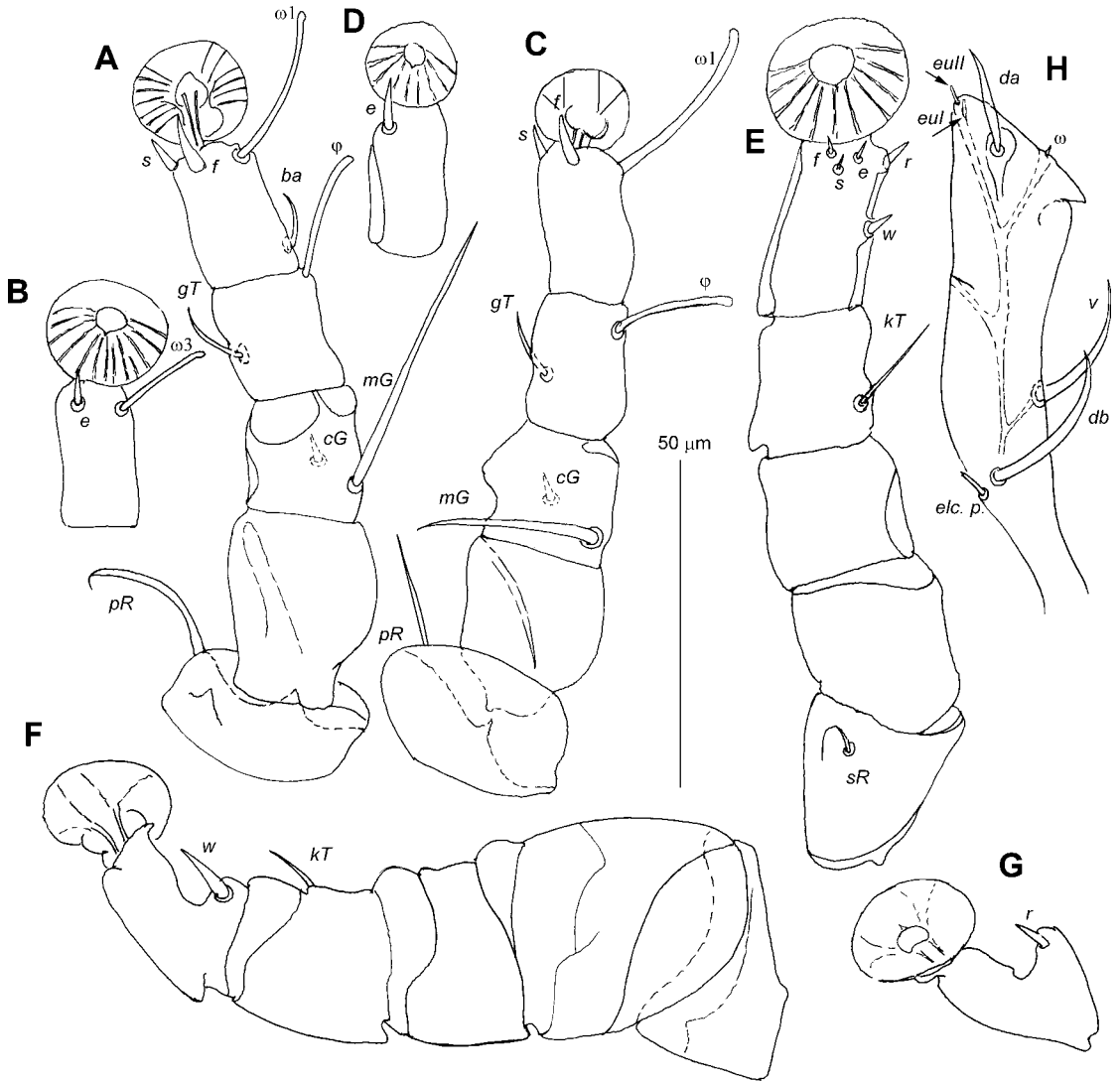


Fig. 5. *C. glossophaga* sp. n., details of female. (A) Leg I in dorsal view. (B) Tarsus I in ventral view. (C) Leg II in dorsal view. (D) Tarsus II in ventral view. (E) Leg III in ventral view. (F) Leg IV in ventral view. (G) Tarsus IV in dorsal view. (H) Palp in dorsal view.

transverse striations. The legs are inserted laterally. The space between coxal fields I-II and III-IV is greatly enlarged. The opisthosoma is strongly reduced, and legs IV are situated almost at the posterior end of the idiosoma. A pair of semicircular sclerites (Fig. 1A) is situated on the posterior end of the female opisthosoma. The idiosomal setation of the family is strongly reduced and includes in females only setae: *c1*, *c3*, *1a*, *3a*, *4a*, *4b*, and *g*; in males setae *g* and *4b* are absent and setae *4a* are displaced dorsally. All setae are setiform, and setae *c1* are thickened. The opening of the female bursa copulatrix is situated dorsally and connected to the unsclerotized spermatheca via an annulated inseminatory canal (Figs. 1A and 2G). The anal opening is situated dorsally, posterior to the opening of the

bursa copulatrix. The oviporus is situated ventrally between the levels of legs III and IV. The undulate lamina of the oviporus is naked, the genital papillae, the progenital and posterogynal folds, present in most other sarcoptoid mites, seem absent, but a pair of small sclerites of the progenital folds is still present. The male genital organ is situated ventrally between the levels of coxal fields III and IV (Fig. 7B and E). The genital papillae and the progenital sclerites are absent. The basal part of the aedeagus is enclosed within the genital capsule and this capsule is connected via a short intermediate sclerite with the distinctly developed postdorsal apodeme (Fig. 7C).

Legs. The legs of chirorhynchobiids consist of five articulating segments and a pretarsus consisting of

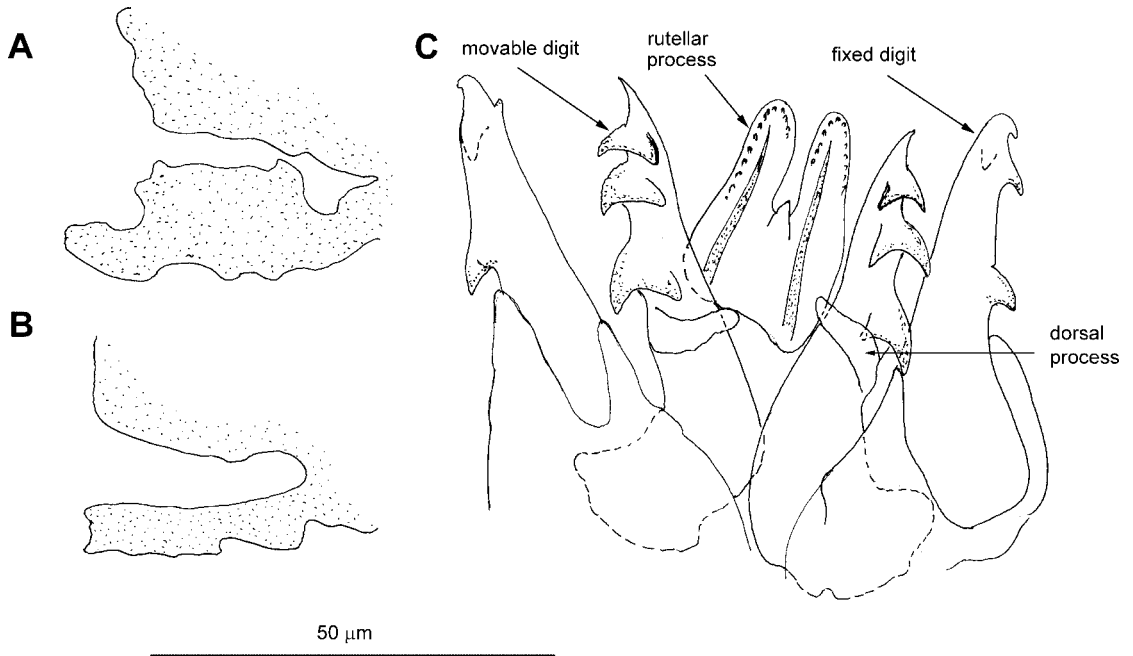


Fig. 6. *Chirorhynchobia* spp., details of females. (A) *C. matsoni*, posterior projections of propodeal shield. (B) Same of *C. glossophaga*. (C) Gnathosoma of *C. glossophaga* in dorsal view.

an ambulacral stalk and ambulacral disc (Fig. 2). Tarsi IV of females are distinctly curved; in males these tarsi are straight. In *C. urodermae* genua III and IV bear a retrorse spur dorsally. In males of *C. glossophaga* tarsus, tibia, and genu IV each bear a short, basal, retrorse spur dorsally. The ambulacral disc is attached to a relatively short ambulacral stalk. The condylophores within the ambulacral stalk are straight. The ambulacral discs are flattened dorso-ventrally, and their ventral surfaces are strongly costated. The basilar piece of the ambulacral disc is very large. The modified empodium (=central sclerite) is fused with the basilar piece. The unguiform sclerites are probably present but completely fused to the basal piece. A condylophore guide is present. The distal end of the ambulacral disc bears two lateral flaps, each supported internally by a fan-shaped structure. The leg setation in Chirorhynchobiidae is slightly different in females and males. In females, legs I-IV bear the following setae and solenidia: *pRI-II*, *sRIII*, *cGI-II*, *mGI-II*, *gTI-II*, *kTIII-IV*, *φI-II*, *sI-III*, *?ba* [or *d*]I, *eI-III*, *fI-III*, *ωIII-IV*, *rIII-IV*, *ωII-II*, and *ω3I*. Solenidia *ωII-II* are situated in the apical part of the respective tarsi. All setae are filiform or spine-like (see species descriptions). In males setae *fIII* and *sIII* are absent, *eIV* and *φIV* are present.

Life Cycle. The females of chirorhynchobiids are probably oviparous. The chorion of the egg is completely covered with short denticles (Fig. 2H). To date the only immature stage known for Chirorhynchobiidae is a single specimen of female tritonymph missing its gnathosoma. In this specimen, the leg and

idiosomal setation is the same as in females, the bursa copulatrix is present, the idiosoma bears a pair of distinct lateral projections behind legs II, and tarsi IV are straight.

Discussion

Chirorhynchobiids are characterized by several distinct autapomorphies. The subcapitulum has a very characteristic trapezoid shape, and although the palps are very large, their podomeres are fused to each other, a gnathosomal structure that is unique within Sarcoptoidea. All propodeal setae and most dorsal hysterosomal setae are lost, only setae *c1* and *c3* remain. Even the endoparasitic Sarcoptoidea (Gastronyssidae, Lemurnyssidae, and Pneumocoptidae), which lack most dorsal setae, retain setae *se*. The opisthosoma is strongly reduced, almost absent, and its setation is completely lost. In nymphs of the genus *Crinicaster* (Myocoptidae), the opisthosoma is strongly reduced, but it is still recognizable and bears setae. The distance between coxal fields I-II and III-IV is greatly enlarged. The oviporus is situated close to the posterior margin of the body, and the anal opening is dorsally situated. These characters are connected with the strong opisthosomal reduction. The dorsal position of the anal orifice is known for many Sarcoptidae; however, in all these cases the oviporus is situated far from the posterior idiosomal margin and the opisthosoma is distinctly developed and bears setae. The tarsal setation of Chirorhynchobiidae is distinct from all other Sarcoptoidea by the absence of setae *dI-IV*, *ra I-II*, and *walI-II*. The setation of tarsi IV in

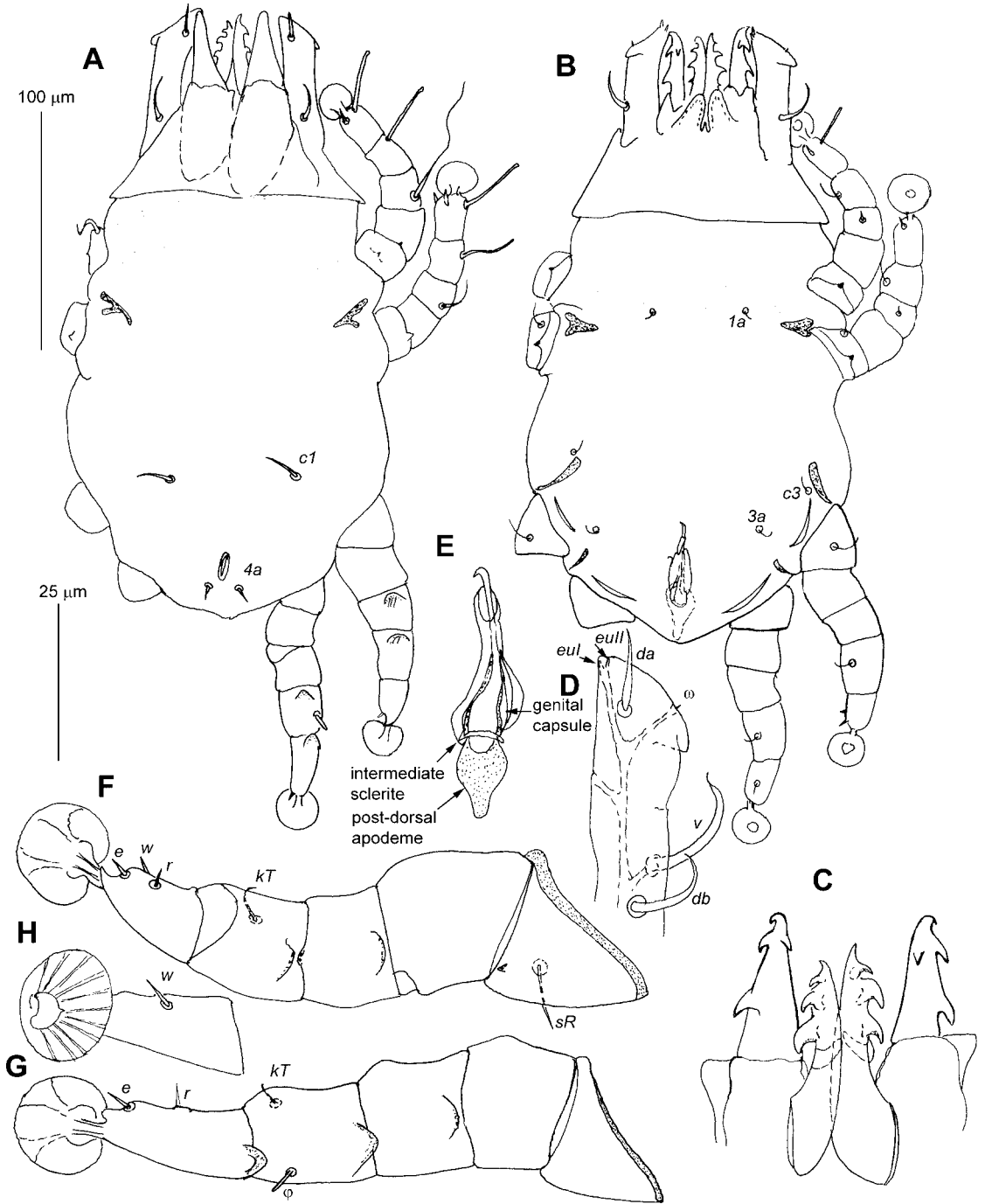


Fig. 7. *C. glossophaga* sp. n., male. (A) Body in dorsal view. (B) Same in ventral view. (C) Chelicerae in ventral view. (D) Palp in dorsal view. (E) Aedeagus. (F) Leg III in dorsal view. (G) Leg IV in dorsal view. (H) Tarsus IV in ventral view. Scale bars = 100 µm (A and B) and 25 µm (C–H).

Chirorhynchobiidae is incomplete, with the absence of setae *dIV*, *eIV*, and *fIV* in females, and *dIV* and *fIV* in the males. These setae are absent in some other Sarcoptoidea, but always in mites whose tarsal segments are strongly shortened, in chirorhynchobiids the tarsi are normally developed.

The strong morphological modifications of chirorhynchobiids make assessment of their phylogenetic relationships with other sarcoptoid families difficult. The simultaneous absence of famulus ϵ and solenidia σ I-II and presence of solenidia ω II-II and ω 3I is shared with the Rhyncoptidae–Sarcoptidae clade (Klompen

1992, 1993). In all representatives of this clade, the famulus is absent, whereas in all other sarcoptoids, including the endoparasitic families, this famulus is always present. Solenidion ω 3I is present in all Sarcoptidae and some Rhyncoptidae. Solenidia σ I-II are absent in all Rhyncoptidae, whereas many Sarcoptidae, retain σ I, but lack σ II.

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