

MORPHOLOGY OF ADULT AND NYMPHAL INSTARS OF *GUSTAVIA LONGISETA* (ACARI: ORIBATIDA: GUSTAVIIDAE)

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ABSTRACT. The oribatid mite, *Gustavia longiseta* Mahunka, 1984 (Gustaviidae) is redescribed in details, on the basis of specimens from Ethiopia. Nymphal instars of this species are described and illustrated for the first time.

KEY WORDS: Oribatida, supplementary description, morphology, juvenile instars, ontogeny, *Gustavia longiseta*, Ethiopian region

INTRODUCTION

Gustavia Kramer, 1879 (Acari: Oribatida: Gustaviidae) comprises 16 species that are collectively distributed in the Holarctic and Palearctic regions (Subías 2004, online version 2012).

The species *Gustavia longiseta* was described by Mahunka (1984) from Tanzania. The original description of this species was based on the study of a single specimen (holotype) and was very incomplete. In the course of faunistic research on Ethiopian oribatids (Ermilov *et al.* 2012) we found several specimens (adult and nymphal instars) of *G. longiseta*. Our main objective is to provide a supplementary description account of its morphology and ontogeny. At present, the morphology of juvenile instars is known in detail for only one *Gustavia* species, *G. microcephala* (Nicolet, 1855) (Ermilov 2010).

MATERIALS AND METHODS

Material. Specimens of *Gustavia longiseta* were collected at the following locality: 6°38' N, 39°43' E, 1883 m a.s.l., Bale Mountains National Park, Harena Forest (woody species, in particular, *Hagenia abissinica* forming the canopy), in soil, 23.11.2009, coll. L.B. Rybalov. The field-collected material included: 23 adults, two protonymphs, four deutonymphs, four tritonymphs.

Methods of study. All specimens were mounted in lactic acid on temporary cavity slides for measurement and illustration. All body measurements are presented in micrometers (µm). Body length was measured in lateral view, from the tip of the rostrum to the posterior edge of the gastronotum. Notogastral width refers to the maximum width in dorsal aspect. Lengths of body setae were measured in lateral aspect. Formulae for

leg setation are given in parentheses according to the sequence trochanter–femur–genu–tibia–tarsus (famulus included). Formulae for leg solenidia are given in square brackets according to the sequence genu–tibia–tarsus.

General terminology used in this paper mostly follows that summarized by Norton and Behan-Pelletier (2009).

RESULTS

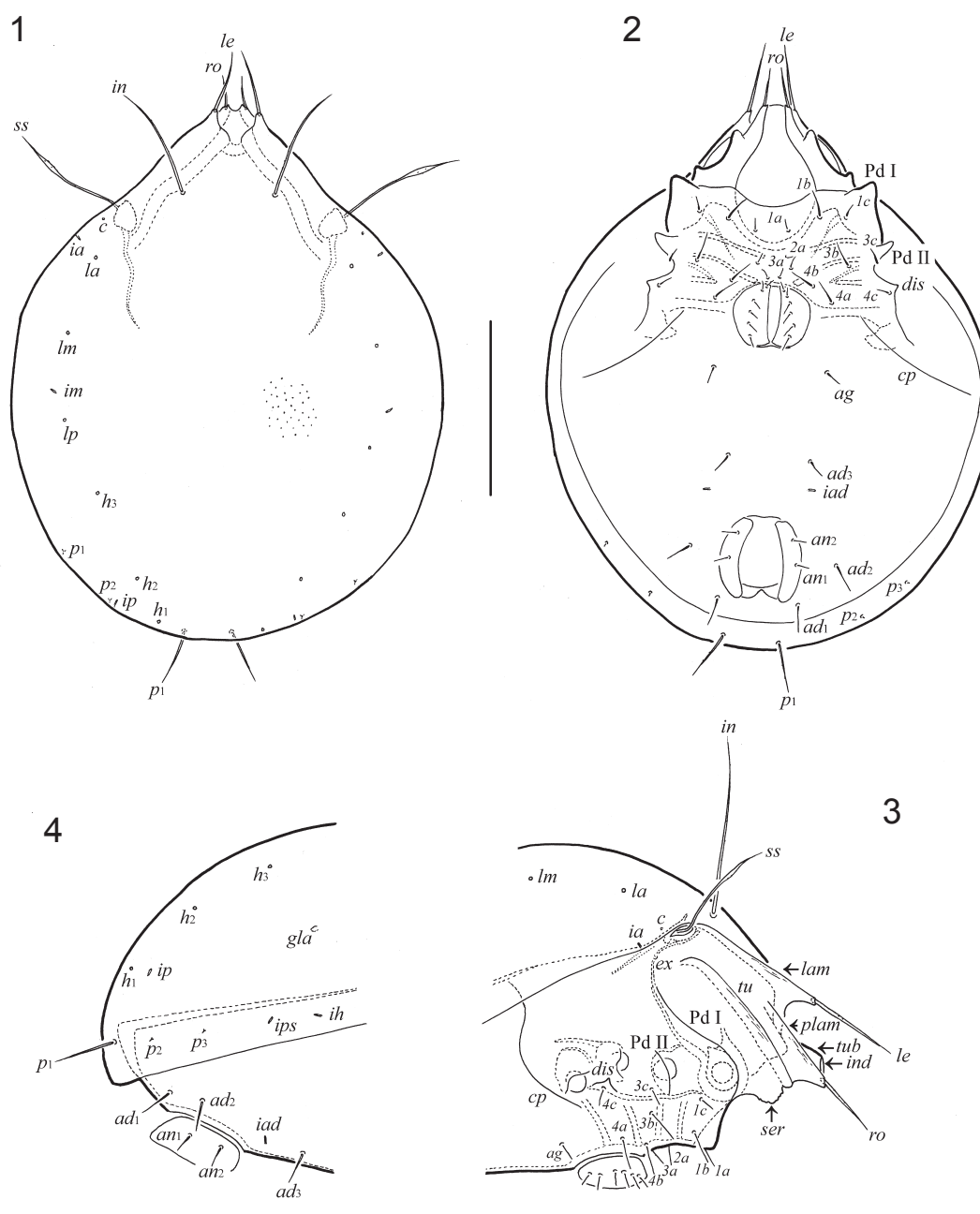
Supplementary description of adult *Gustavia longiseta* Mahunka, 1984

Figs 1–18

Dimensions. Body size: body length 597–664 (mean 629; n=11); notogaster width 464–514 (mean 482; n=11).

Integument. Body color light to medium brown. Body surface smooth. Cerotegument covering notogaster microgranular; granules small, poorly visible (diameter up to 2). Surface of lamellae, prolamellae and tatoria with striae.

Prodorsum (Figs 1, 3, 6–9). Rostrum with deep indentation (*ind*; clearly visible in dorso-anterior view of mite). It near base of indentation as a triangular tubercle (*tub*; visible in lateral view of mite). Prolamellae (*plam*) with minute cusps, truncate or with one small tooth, bearing setiform, slightly barbed rostral setae (*ro*, 61–77). Distal part of prolamellae located lateral to rostral indentation. Lamellae (*lam*) about half length of prodorsum, slightly converging. Lamellar cusps distinct, separated from lamellae, truncate or with small tooth, bearing setiform, slightly barbed lamellar setae (*le*, 94–114). Translamella absent. Interlamellar setae (*in*, 172–192) longest prodorsal setae, about equal prodorsum in length, setiform, slightly



Figs 1–4. *Gustavia longiseta*, adult: 1 — dorsal view; 2 — ventral view, legs and gnathosoma not shown; 3 — lateral view of prodorsum and partial notogaster; 4 — lateral view of posterior part of notogaster. Scale bars 200 μ m (1, 2), 100 μ m (3, 4).

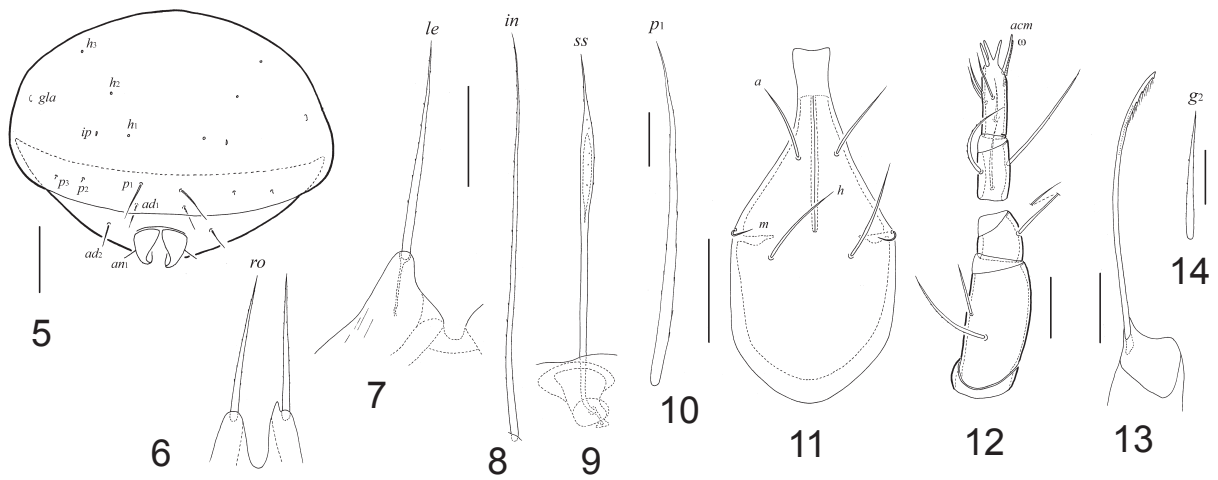
barbed. Sensilli (*ss*, 131–147) elongate spindle-form, with long stalk and well developed head and flagellate tip, barbed in medio-distal part. Exobothridial setae (*ex*, 4–8) setiform, thin, smooth. Tutoria (*tu*) long. Wide serrate (*ser*) ledge present on each side of prodorsum.

Notogaster (Figs 1, 2, 4, 5, 10). Seven pairs of notogastral alveoli and three pairs of notogastral setae present. Alveoli of setae *c* vestigial, poorly visible; alveoli of setae *la*, *lm*, *lp*, *h*₁, *h*₂, *h*₃ developed normally. Setae *p*₁ longest setae on notogaster (57–73), setiform, slightly barbed; setae

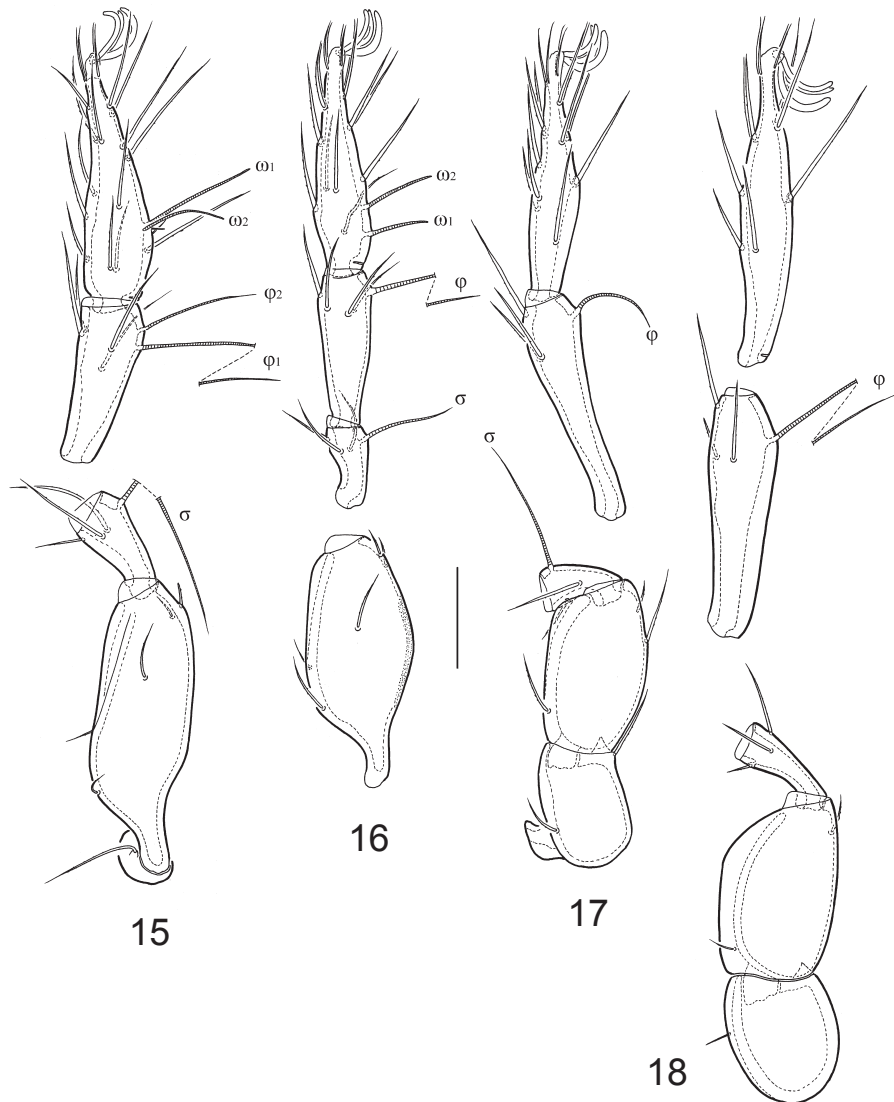
*p*₂ and *p*₃ short (4–6), thin, smooth. Lyrifissures *ia*, *im*, *ip*, *ih* and *ips* short, distinct. Opisthotal gland openings (*gla*) present, but often poorly visible. Pedotecta I, II (Pd I, Pd II), triangular discidia (*dis*) and circumpedal carinae (*cp*) well developed, morphology typical for genus. Notogastral posterior tectum well developed.

Gnathosoma (Figs 11–13). Morphology typical for genus (Grandjean 1957; Norton and Behan-Pelletier 2009; Ermilov 2010). Subcapitulum “suctorial”, overall longer than wide (164–168 \times 77–86). Subcapitular setae *h* (49–65), *m* (16–20)

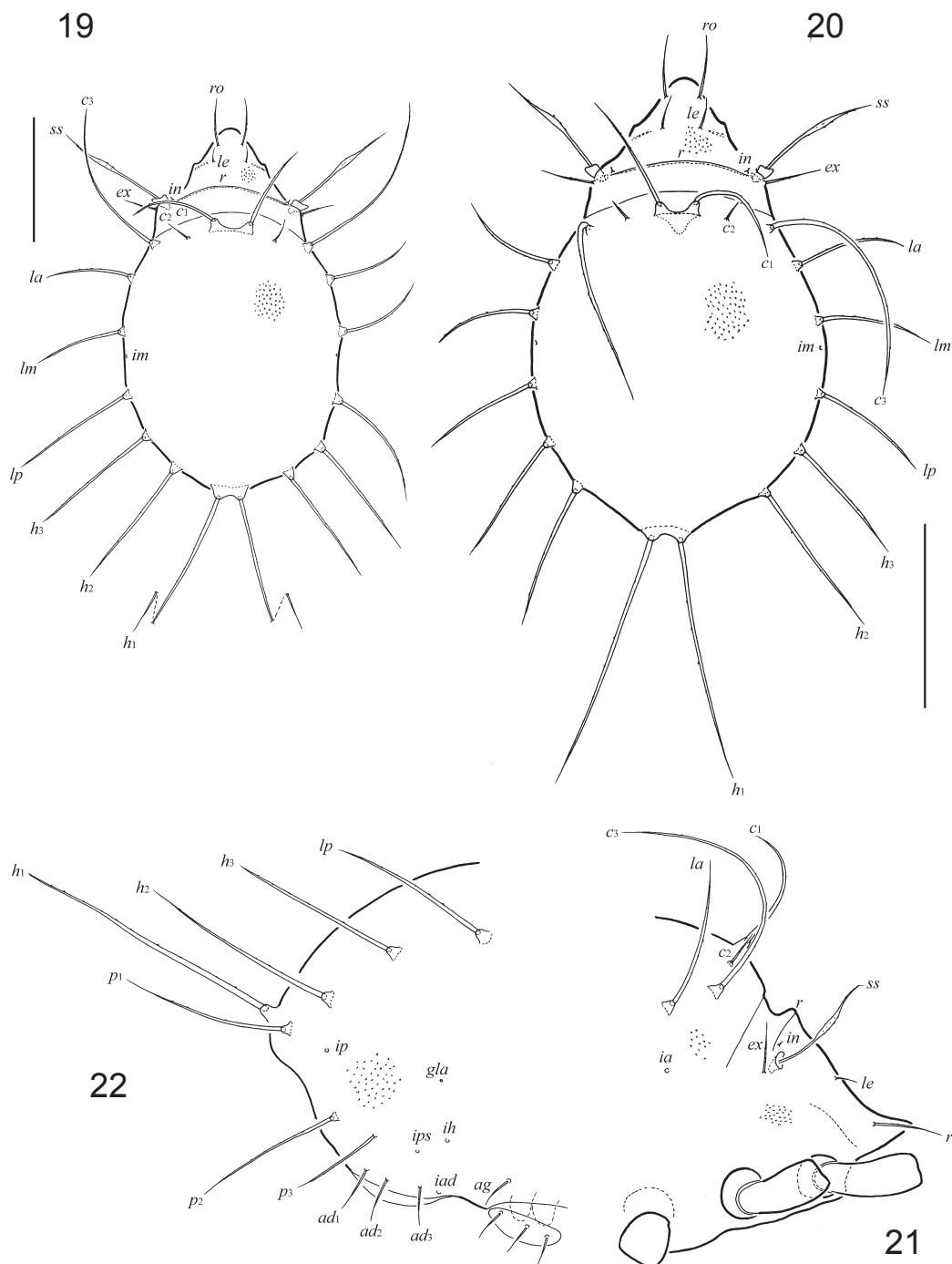
Morphology of adult and nymphal instars of *Gustavia longiseta*



Figs 5–14. *Gustavia longiseta*, adult: 5 — posterior view of notogaster; 6 — rostral setae; 7 — lamellar seta; 8 — interlamellar seta; 9 — sensillus; 10 — notogastral seta p_1 ; 11 — subcapitulum; 12 — palp; 13 — chelicera; 14 — genital seta g_2 . Scale bars 100 μm (5), 50 μm (6–9, 11, 13), 10 μm (10, 14), 20 μm (12).



Figs 15–18. *Gustavia longiseta*, legs of adult: 15 — leg I, left, antiaxial view; 16 — leg II, without trochanter, left, antiaxial view; 17 — leg III, right, antiaxial view; 18 — leg III, right, antiaxial view. Scale bar 50 μm .



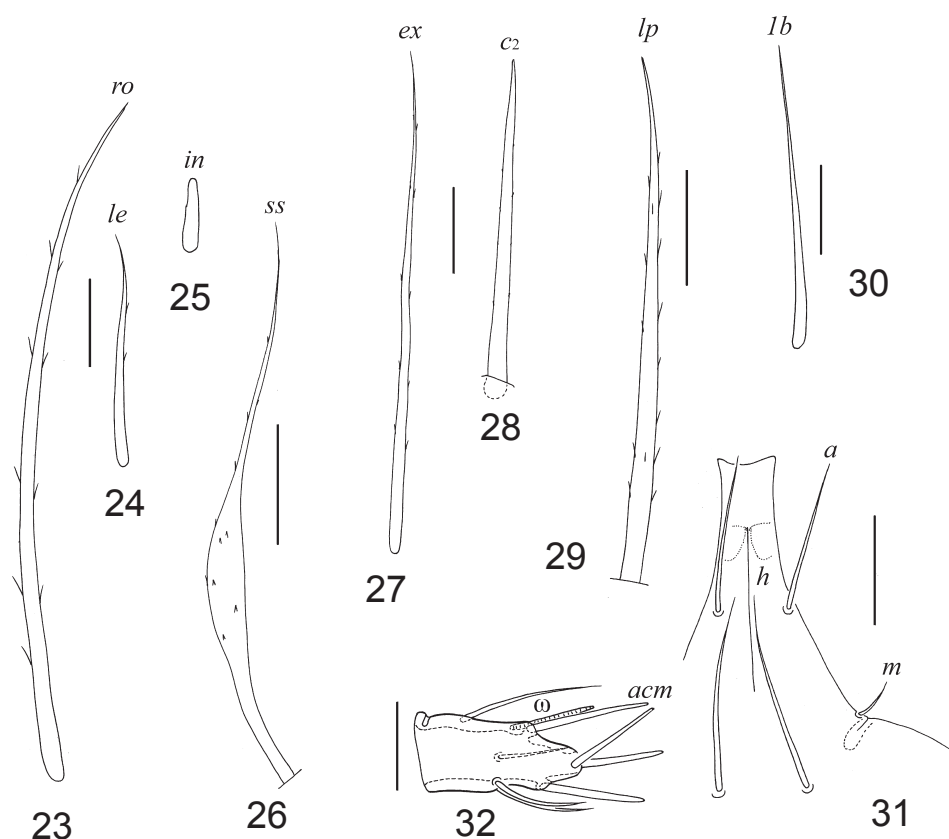
Figs 19–22. *Gustavia longiseta*, juvenile instars: 19 — protonymph, dorsal view; 20 — tritonymph, dorsal view; 21 — deutonymph, lateral view of prodorsum and partially gastronomic region, legs IV, gnathosoma and epimeral setae not shown, only basal parts of leg I–III shown; 22 — deutonymph, lateral view of posterior part of gastronotum. Scale bars 100 μm (19, 21, 22), 200 μm (20).

and *a* (41–45) setiform, smooth. Palps (length 110–131) with setation: 0–2–1–3–8(+ ω). Palpal eupathidium *acm* and solenidion attached in double horn. Chelicerae very long (192–217), styli-form; distal part with 3 larger teeth and more thin, small multiple cilia.

Epimeral region (Figs 2, 3). Epimeral borders IV often poorly developed, straight, connected

to lateral sides of genital aperture. Epimeral setae setiform, slightly barbed, differs in length: *1a*, *1c*, *2a*, *3a*, *3c*, *4c* 20–36; *1b*, *3b*, *4a*, *4b* 41–61.

Anogenital region (Figs 2, 4, 5, 14). Six pairs of genital (20–24), one pair of aggenital (*ag*, 28–32), two pairs of anal (*an*₁, *an*₂, 20–28) and three pairs of adanal (*ad*₁–*ad*₃, 32–49) setae present; all setiform, slightly barbed. Lyrifissures *iad* in preanal



Figs 23–32. *Gustavia longiseta*, deutonymph (24–26, 28–32) and tritonymph (23, 27): 23 — rostral setae; 24 — lamellar seta; 25 — interlamellar seta; 26 — medio-distal part of sensillus; 27 — exobothridial setae; 28 — notogastral seta c_2 ; 29 — medio-distal part of notogastral seta lp ; 30 — epimeral seta lb ; 31 — medio-distal part of subcapitulum; 32 — palptarsus. Scale bars 10 μm (23–25, 27, 28, 30, 32), 20 μm (26, 29, 31).

position, transversely oriented, often poorly visible.

Legs (Figs 15–18). Median claw only slightly thicker than lateral claws. Trochanters and femora III, IV with ventral ridges and dorsal porose areas (very poorly visible). Trochanters III and IV with dorso-distal tooth. Formulae of leg setation and solenidia: I (1–5–3–4–20) [1–2–2], II (1–5–3–4–16) [1–1–2], III (2–3–2–3–15) [1–1–0], IV (1–2–3–3–12) [0–1–0]; homology of setae and solenidia indicated in Table 1. Setae setiform, mostly slightly barbed. Famulus setiform, straight, blunt-ended. Solenidia setiform, mostly blunt-ended.

Description of nymphs *Gustavia longiseta* Mahunka, 1984

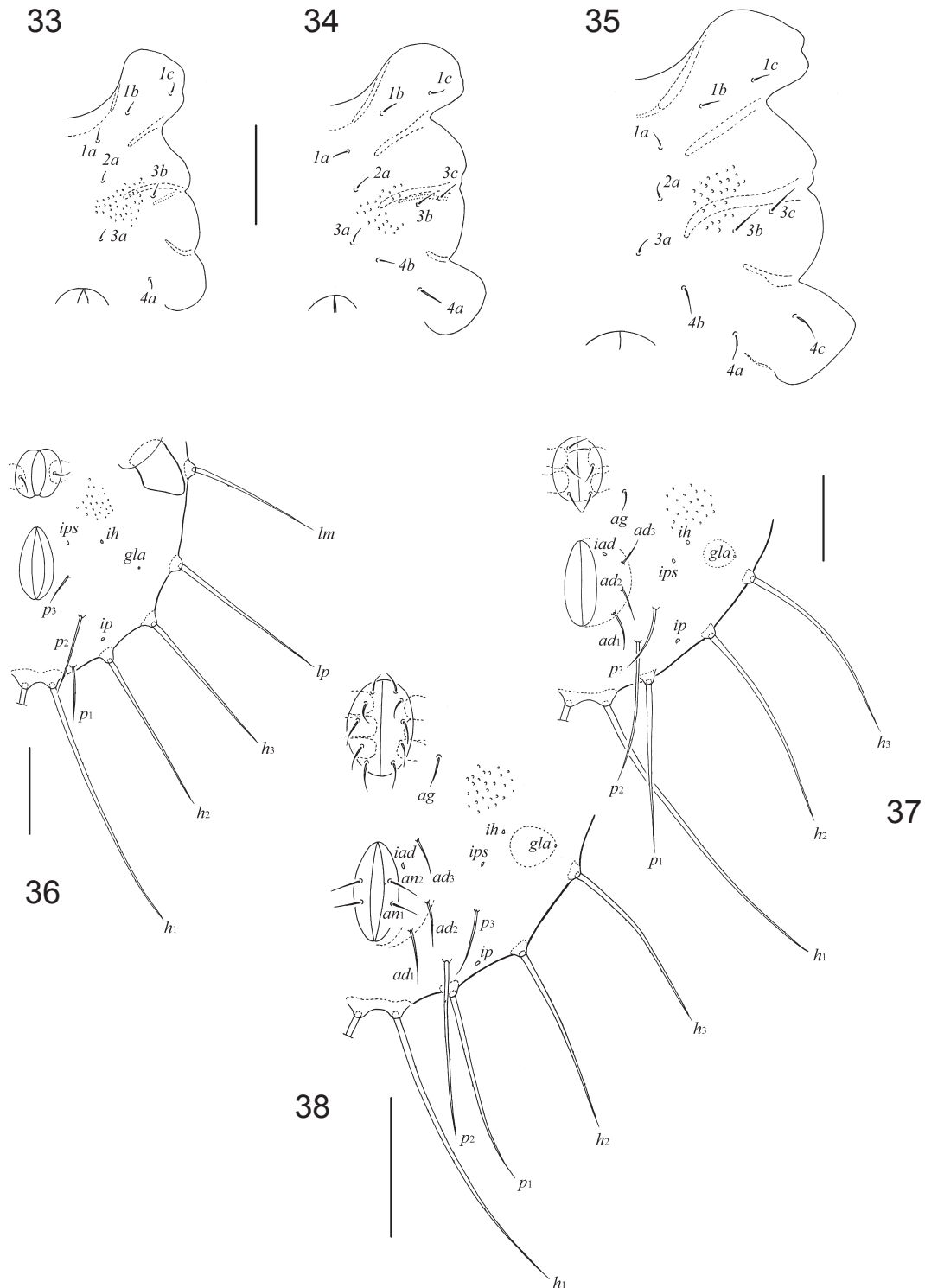
Figs 19–44

Dimensions. Body length: protonymph 298 (n=2), deutonymph 365–381 (mean 369; n=4), tritonymph 481–498 (mean 494; n=4). Gastronotum width: protonymph 182 (n=2), deutonymph 215–232 (mean 2284; n=4), tritonymph 298–315 (mean 306; n=4).

Integument. Body cuticle light brown. Microgranular cerotegument covers body and legs in all instars; granules small, spherical (diameter up to 4).

Prodorsum (Figs 19–21, 23–27). Relatively short, about half-length of gastronotic region in lateral view. Rostrum narrowly rounded. Distinct transverse ridge (r) present between bothridia. Rostral setae slightly thickened, setiform, barbed, inserted on tubercles. Lamellar setae shorter and thinner than latter, with sparse small barbs, inserted on small tubercles. Interlamellar setae minute, spiniform, blunt-ended, smooth, set near transverse ridge. Exobothridial setae setiform, barbed, inserted on tubercles. Sensilli elongate spindle-form, with well developed head and long flagellate tip, slightly barbed. Comparison of prodorsal setae measurements of juvenile instars given in Table 2.

Gastronotic region (Figs 19, 20, 22, 28, 29, 36–38). Covered with typical reticulate exuvial scaps, each with 9 pairs of gastronotic setae (Ermilov 2010). Twelve pairs of gastronotic setae



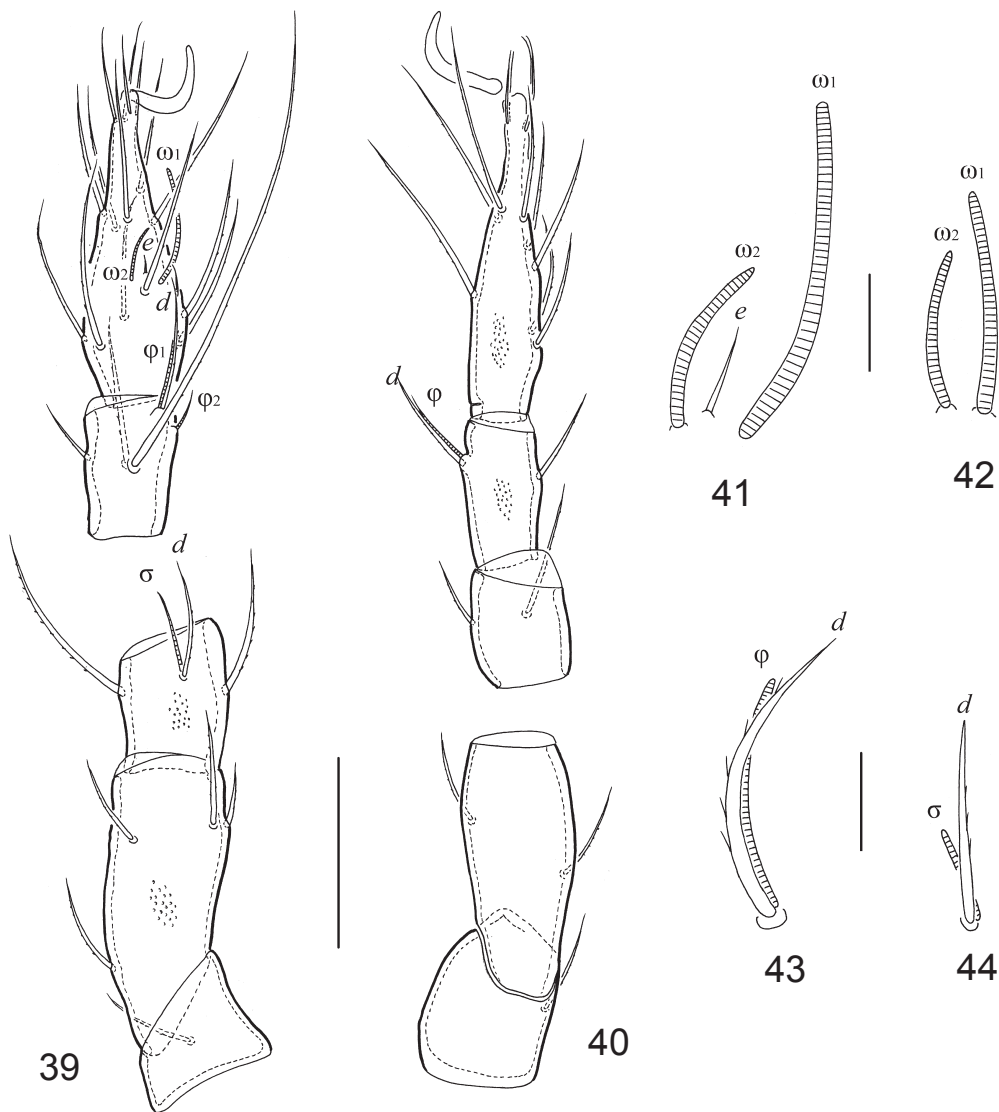
Figs 33–38. *Gustavia longiseta*, left half of epimeral (33–35) and left half of anogenital (36–38) regions of nymphs: 33, 36 — protonymph; 34, 37 — deutonymph; 35, 38 — tritonymph. Scale bars 50 μ m (33–37), 100 μ m (38).

present, lacking dorsocentral setae. Apophyses of setal pair c_1 united on single medial sclerite, same with pair h_1 . All setae setiform, barbed. Setae c_3 and h_1 longest, c_2 shortest on dorsal side. Cupules ia , im , ip well visible.

Gnathosoma (Figs 31, 32). Similar to adult (see above) (see Ermilov 2010): subcapitulum “suctorial”; hypostomal setae h little longer than

a , and considerable than m ; palpal setation 0–2–1–3–8(+ ω); palpal eupathidium acm and solenidium ω attached in double horn; chelicerae styliform.

Epimeral region (Figs 33–35). Setal formulae for epimeres: protonymph 3–1–2–1; deutonymph 3–1–3(2)–2; tritonymph 3–1–3–3. Setae setiform, slightly barbed. Median setae slightly shorter than others.



Figs 39–44. *Gustavia longiseta*, legs, setae and solenidia of deutonymph: 39 — leg I, left, dorsal view; 40 — leg IV, right, paraxial view; 41 — solenidia and famulus on tarsus of leg I, dorsal view; 42 — solenidia on tarsus of leg II, dorsal view; 43 — solenidion and seta *d* on tibia of leg II, dorsal view; 44 — solenidion and seta *d* on genu of leg II, dorsal view. Scale bars 50 μ m (39, 40), 10 μ m (41–44).

Anogenital region (Figs 36–38). Ontogenetic formulae (protonymph to tritonymph, respectively): genital 1–3–5, aggenital 0–1–1, adanal 0–3–3, anal 0–0–2. All setae setiform, smooth. Cupules *ih*, *ips*, *iad* appearing in normal ontogenetic pattern. Opisthonotal gland opening small, poorly visible.

Legs (Figs 39–44). Formulae of leg setation and solenidia: protonymph I (0–2–3–4–16) [1–1–2], II (0–2–3–3–13) [1–1–1], III (1–2–2–2–13) [1–1–0], IV (0–0–0–0–7) [0–0–0]; deutonymph I (1–4–3–4–16) [1–2–2], II (1–4–3–4–13) [1–1–2], III (2–3–2–3–13) [1–1–0], IV (1–2–2–2–12) [0–1–0]; tritonymph: I (1–4–4–5–18) [1–2–2], II (1–4–4–5–15) [1–1–2], III (2–3–3–4–15) [1–1–0],

IV (1–2–3–4–12) [0–1–0]; homology of setae and solenidia indicated in Table 1. Setae setiform, mostly slightly barbed. Famulus setiform. Solenidia setiform, blunt-ended. Tibia I–IV and genua I–III with coupled seta *d* and solenidion on dorsal side.

REMARKS

Adult instar. Our adult specimens fit well with the original description and illustrations of Mahunka (1984), but there are slight morphometrical differences. interlamellar and epimeral setae are somewhat longer (versus shorter in Ethiopian specimens), notogastral setae *p*₂ and *p*₃ represented by alveoli (versus represented by short setae in

Table 1.
Development of leg setation of *Gustavia longiseta* during ontogeny. Larva unknown; most setae of protonymph probably formed in larval instar (see Ermilov 2010)

	Trochanter	Femur	Genu	Tibia	Tarsus
Leg I					
Protonymph	–	d, bv''	$d\sigma, (l)$	$d\varphi_1, (l), v'$	$(ft), (tc), (p), (u), (a), s, (pv), (pl), e, \omega_1 \omega_2$
Deutonymph	v'	(l)	–	φ_2	–
Tritonymph	–	–	v'	v''	(it)
Adult	–	v''	$-d$	$-d$	v', l''
Leg II					
Protonymph	–	d, bv''	$d\sigma, (l)$	$d\varphi, (l), v'$	$(ft), (tc), (p), (u), (a), s, (pv), \omega_1$
Deutonymph	v'	(l)	–	l''	ω_2
Tritonymph	–	–	v'	v''	(it)
Adult	–	v''	$-d$	$-d$	l''
Leg III					
Protonymph	v'	d, ev'	$d\sigma, l'$	$d\varphi, v'$	$(ft), (tc), (p), (u), (a), s, (pv)$
Deutonymph	l'	l'	–	l'	–
Tritonymph	–	–	v'	v''	(it)
Adult	–	–	$-d$	$-d$	–
Leg IV					
Protonymph	–	–	–	–	$ft'', (p), (u), (pv)$
Deutonymph	v'	d, ev'	d, l'	$d\varphi, v'$	$(tc), (a), s$
Tritonymph	–	–	v'	l', v''	–
Adult	–	–	–	$-d$	–

Roman letters refer to normal setae (e — famulus), Greek letters refer to solenidia, $d\sigma$ and $d\varphi$ — solenidia and seta coupled. One apostrophe (') marks setae on anterior and double apostrophe (") setae on posterior side of the given leg segment. Parentheses refer to a pair of setae. Setae are listed only for the instar in which they first appear.

Table 2.
Comparison of prodorsal setae measurements (in μm) of nymphal *Gustavia longiseta*

Character	Protonymph	Deutonymph	Tritonymph
	n*=2	n=4	n=4
Length of rostral seta	36–41	49–65	61–86
Length of lamellar seta	12–16	16–24	28–32
Length of interlamellar seta	2–4	4–8	4–8
Length of sensillus	90–110	106–135	131–143
Length of exobothridial seta	20–32	32–57	53–73

*Number of studied specimens

Ethiopian specimens). We believe these differences represent intraspecific (perhaps geographical) variability.

Nymphal instars. Nymphs of *G. longiseta* and *G. microcephala* (see Ermilov 2010) are similar in general appearance: body form; microgranular cerotegument on body and legs; spindle-form sensilli; rostral, lamellar and exobothridial setae setiform ($ro > ex > le$); interlamellar setae short, spiniform; gastronotic region covered with reticulate exuvial scalp(s); gastronotic region with 12

pairs of setae (dorsocentral setae absent); dorsal gastronotic setae long, excepting short c_2 (c_3 and h_1 longest); apophyses of setal pairs c_1 and h_1 each united on single medial sclerite; paraproctal setae absent in proto- and deutonymphal instars; subcapitulum “suctorial”; palpal setation 0–2–1–3–8(+ ω); palpal eupathidium *acm* and solenidion attached in double horn; chelicerae styliform; setal formulae for epimeres: protonymph 3–1–2–1, deutonymph 3–1–3(2)–2, tritonymph 3–1–3–3; setal ontogenetic formulae for anogenital region:

genital 1–3–5, aggenital 0–1–1, adanal 0–3–3, anal 0–0–2; development of leg setation and Solenidia (see Table 1); all tibia and genua I–III of legs with coupled setae *d* and solenidion.

This high level of similarity suggests that *Gustavia* can be included among those genera in which species are difficult to distinguish based on juvenile characteristics alone. Nymphs of *G. longiseta* can be distinguished from those of *G. microcephala* only by the length of notogastral setae *p* (protonymph: p_2 less than twice as long as p_1 versus p_2 more than twice as long as p_1 in *G. microcephala*; deuto- and tritonymph: p_2 not longer than p_1 versus p_2 longer than p_1 in *G. microcephala*).

ACKNOWLEDGEMENTS

We cordially thank Prof. Dr. Roy A. Norton (State University of New York, College of Environmental Science and Forestry, Syracuse, USA) for many valuable suggestions.

The work was performed within the framework of the Joint Russian-Ethiopian Biological Expedition financially supported by the Russian Academy of Sciences. We are grateful to our Project Coordinators Dr. Andrey Darkov and Ato Girma Yosef for management of the Expedition. We thank Dr. Kemal Ali, director of the Ambo Plant Protection Research Centre, EIAR, for supporting field studies and organizing laboratory operations.

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