

## MORPHOLOGY OF JUVENILE STAGES OF *GUSTAVIA MICROCEPHALA* (ACARI, ORIBATIDA, GUSTAVIIDAE)

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**ABSTRACT:** The morphology of juvenile stages of the oribatid mite *Gustavia microcephala* is described and illustrated. In most aspects all juvenile instars are similar: body broadly oval, with microgranular cerotegument; with distinct continuous ridge between bothridia; sensilli elongate spindle-shaped, with noticeable swelling and flagellate tip. Nymphs are characterized by having very small interlamellar setae. The gastronotal region of nymphs carries reticulate exuvial scalps. Setal formulas of body (larva to tritonymph): genital (0–1–3–5), aggenital (0–0–1–1), anal (0–0–0–2), adanal (0–0–3–3), gastronotic (12–12–12–12) and epimeral (3–1–2, 3–1–2–1, 3–1–2–2, 3–1–3–3). Chelicerae styliform in all instars.

**KEY WORDS:** *Gustavia microcephala* (Nicolet, 1855), Gustaviidae, morphology, juvenile stages, ontogeny, development, oribatid mite

### INTRODUCTION

The oribatid mite family Gustaviidae (Acari, Oribatida) includes 1 genus (*Gustavia* Kramer, 1879) with 13 species. Collectively, the family is distributed in the Holarctic and Ethiopian regions (Subías 2004). The morphology of juvenile stages in this family has not yet been described in detail, although Grandjean (1953) listed several characters of juveniles as representing the family Gustaviidae.

The purpose of the present work is to describe and illustrate the morphology of all juvenile stages of *Gustavia microcephala* (Nicolet, 1855). It is the first such complete treatment for any member of Gustaviidae. Adults of this species were redescribed by Abd-el-Hamid (1965) and illustrated by several other authors (Pérez-Iñigo 1970; Weigmann 2006). *Gustavia microcephala* is distributed in the Palearctic, China and Mexico, and is the unique representative of *Gustavia* known in the Central European part of Russia, from where the studied material was collected.

### MATERIALS AND METHODS

The available material included 21 juveniles of *Gustavia microcephala*: 4 larvae, 8 protonymphs, 4 deutonymphs, 5 tritonymphs. All were collected by myself in the Nizhniy Novgorod Region, Volodarskiy District (European part of Russia) during the spring and summer of 2008–2009. Juveniles were not numerous in samples and were collected only in one biotope (in soil near marsh, geographical coordinates: 56°12'N, 43°21'E).

The illustrated specimens were permanently mounted and studied on flat microscope slides.

All body measurements are presented in micrometers.

### RESULTS

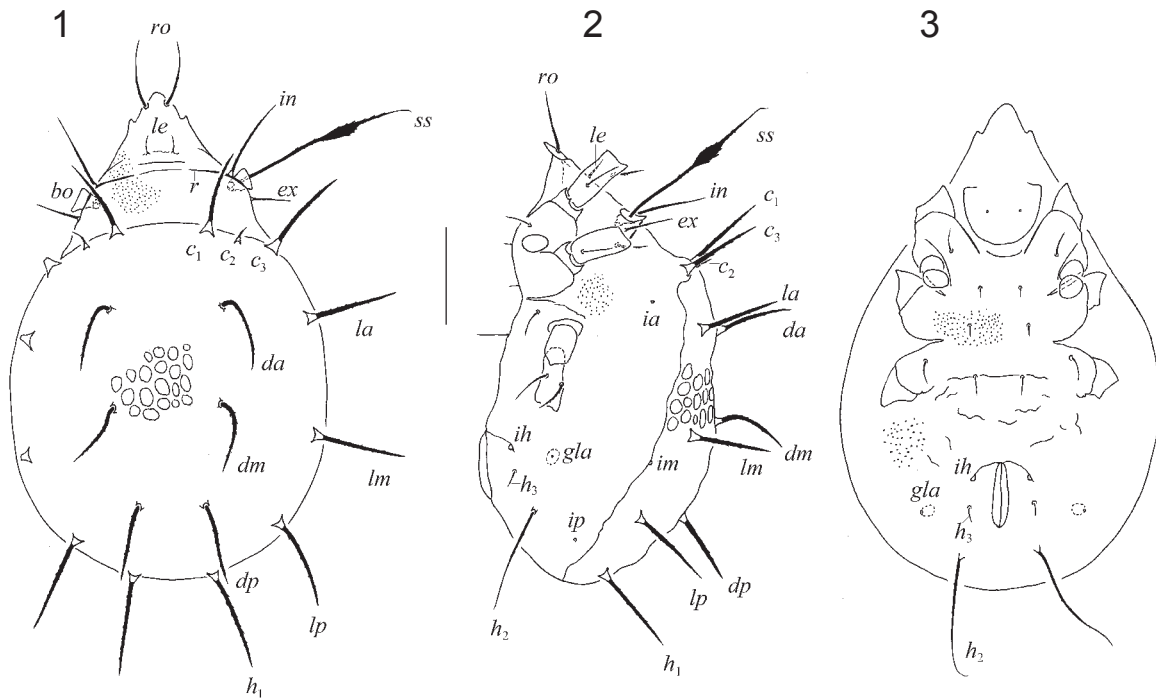
**Dimensions.** Total length of: larva 232–249 (mean 240), protonymph 249–315 (mean 281), deutonymph 365–382 (mean 377), tritonymph 481–547 (mean 501). Total width of: larva 166–182 (mean 170), protonymph 182–215 (mean 201), deutonymph 249–265 (mean 261), tritonymph 332–381 (mean 368). Body of all juveniles longer than wide, approximately by 1.4.

**Integument.** General body cuticle weakly sclerotized. Cuticle of larva colourless to light brown, that of nymphs light brown. Legs, gnathosoma, apophyses of gastronotic setae more sclerotized, brown. Cerotegument covers body and legs in all stages. Cerotegument microgranular; granules very small (diameter often less 1, maximum – 2) Body setae always without cerotegument.

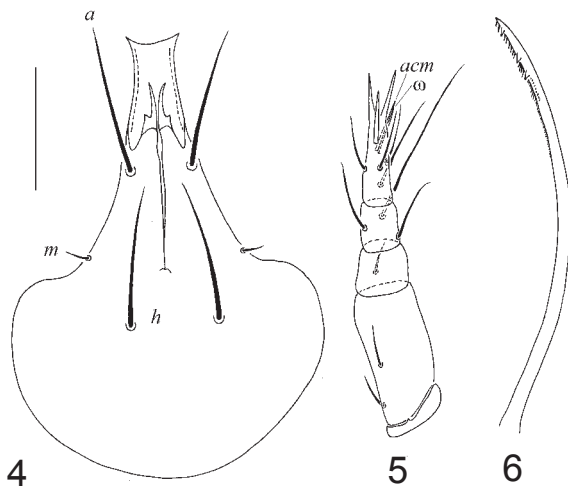
**Prodorsum** (Figs. 1, 2, 10, 11, 14). Relatively short, about half-length of gastronotic region in lateral view. Triangular form in dorsal view, rostrum narrowly rounded. Larva with distinct transverse ridge (*r*) between bothridia, discontinuous in medial part. Nymphs with distinct continual ridge between bothridia. Cuticle with rare distinct folds in lateral parts of prodorsum.

Setae *ro*, *ex* and *in* (in larva) setiform, with several very small barbs, set on small apophyses. Setae *le* shorter, thinner, with 1–2 very small barbs. Nymphal setae *in* very short, slightly thickened, spiniform, set on small apophyses; apophyses set on transverse ridge. Sensilli (*ss*) and bothridia (*bo*) well developed in all stages. Sensilli elongate spindle-form, with well developed swelling and long flagellate tips, barbed. Bothridia funnel-shaped, with large opening.

Comparison of prodorsal setae measurements of juvenile stages given in Table 1.



Figs 1–3. *Gustavia microcephala*, larva: 1 — dorsal view, legs removed; 2 — lateral view, legs partly removed; 3 — ventral view, legs and subcapitulum partly removed. Scale bar 50  $\mu\text{m}$ .



Figs. 4–6. *Gustavia microcephala*, larva: 4 — subcapitulum; 5 — palp; 6 — chelicera. Scale bar 20  $\mu\text{m}$ .

**Gastronotic region** (Figs. 1, 2, 10, 11, 14). Broadly oval. Rounded posteriorly. Cuticle of larva with conspicuous region of large reticular ornamentation having distinct borders; that of nymphs with only weakly visible reticular ornamentation. Gastronotic region of nymphs covered with reticulate exuvial scalps (Fig. 15), each with 9 pairs of gastronotic setae. Cupules *ia*, *im*, *ip* well visible in all stages.

Larva with 12 pairs of gastronotic setae, all barbed, set on separate apophyses. Setae (except  $c_2$ ,  $h_2$ ,  $h_3$ ) long, straight or weakly curved. Dorsocentral setae (*da*, *dm*, *dp*) slightly shorter than lateral setae.

Setae  $h_2$  also long, but with flagellate tips. Setae  $c_2$  and  $h_3$  much shorter.

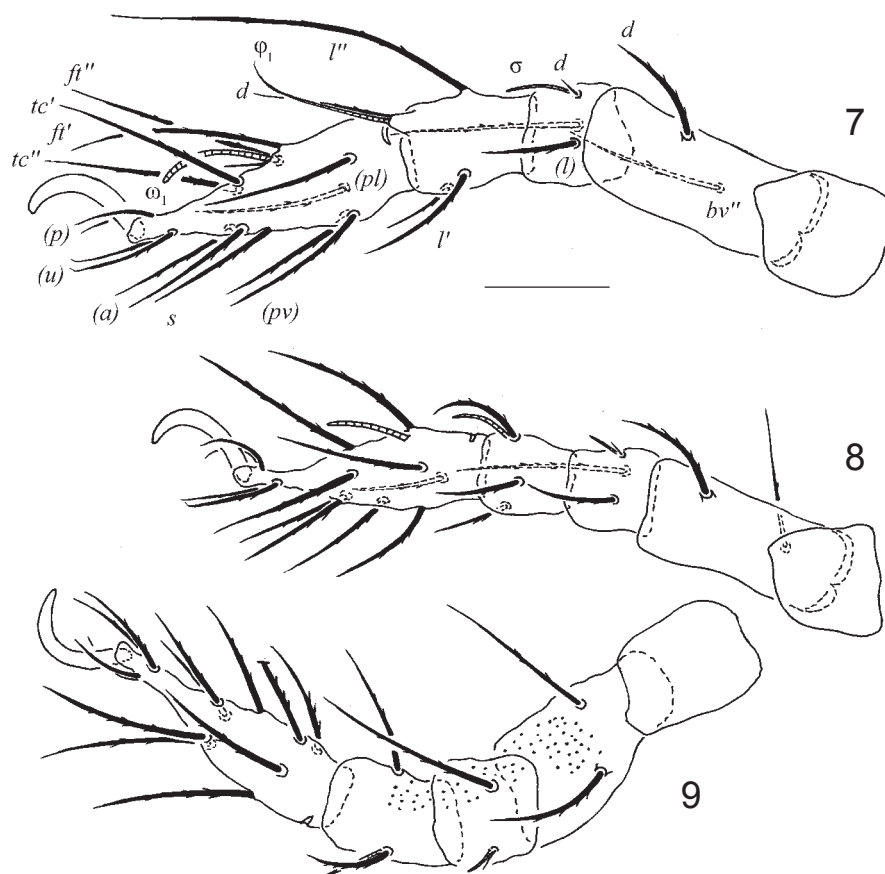
Nymphs with 12 pairs of gastronotic setae, lacking *da*, *dm*, *dp*. Apophyses of setal pair  $c_1$  united on single medial sclerite, same with pair  $h_1$ . Most setae of nymphs similar in structure to those of larva (except  $c_3$ ,  $h_1$ ,  $h_2$ ,  $h_3$ ). Setae  $c_3$  longest, with flagellate tips. Setae  $h_1$  long, but shorter than  $c_3$ . Setae  $h_2$ ,  $h_3$  long, setiform, barbed. Setae  $p_2$  long, with small flagellate tips; setae  $p_1$  shorter, straight; setae  $p_1$  shortest.

**Anogenital region** (Figs. 1, 12, 13, 16). Ontogenetic genital, aggenital, adanal, anal formulas, larva to tritonymph, 0–1–3–5, 0–0–1–1, 0–0–3–3, 0–0–0–2 respectively. All setae setiform, smooth. Cupules *ih*, *ips*, *iad* and small opisthosomal gland opening (*gla*) well visible, appearing in normal ontogenetic pattern (Figs. 3, 12, 13).

**Epimeral region** (Figs. 3). Setal formulas for epimeres: larva: 3–1–2 (third setae of the first epimeres ( $1c$ ) forms protective scale over Claparède's organ); protonymph: 3–1–2–1; deutonymph: 3–1–2–2, tritonymph: 3–1–3–3. Epimeral setae short, setiform, smooth.

**Gnathosoma** (Figs. 4–6). Subcapitulum “suctorial” (Grandjean 1957), characterized by a fusion of mentum and genae, and the modification of ruttella to form a tube through which the chelicera move (see also Fig. 15.12F of Norton and Behan-Pelletier 2009). Subcapitulum overall longer than

## Morphology of juvenile stages of *Gustavia*



Figs. 7–9. *Gustavia microcephala*, larva: legs I–III, respectively. Scale bar 20  $\mu$ m.

Table 1

Comparison of prodorsal setae measurements of *Gustavia microcephala* during ontogeny

Character	Larva	Protonymph	Deutonymph	Tritonymph
Length of rostral setae	36–41	41–49	57–69	73–82
Length of lamellar setae	12	16–24	28–32	32–41
Length of interlamellar setae	49–53	2–4	4–6	6–8
Length of sensilli	90–98	106–123	135–147	151–164
Length of exobothridial setae	28–32	36–49	53–61	61–65

Table 2

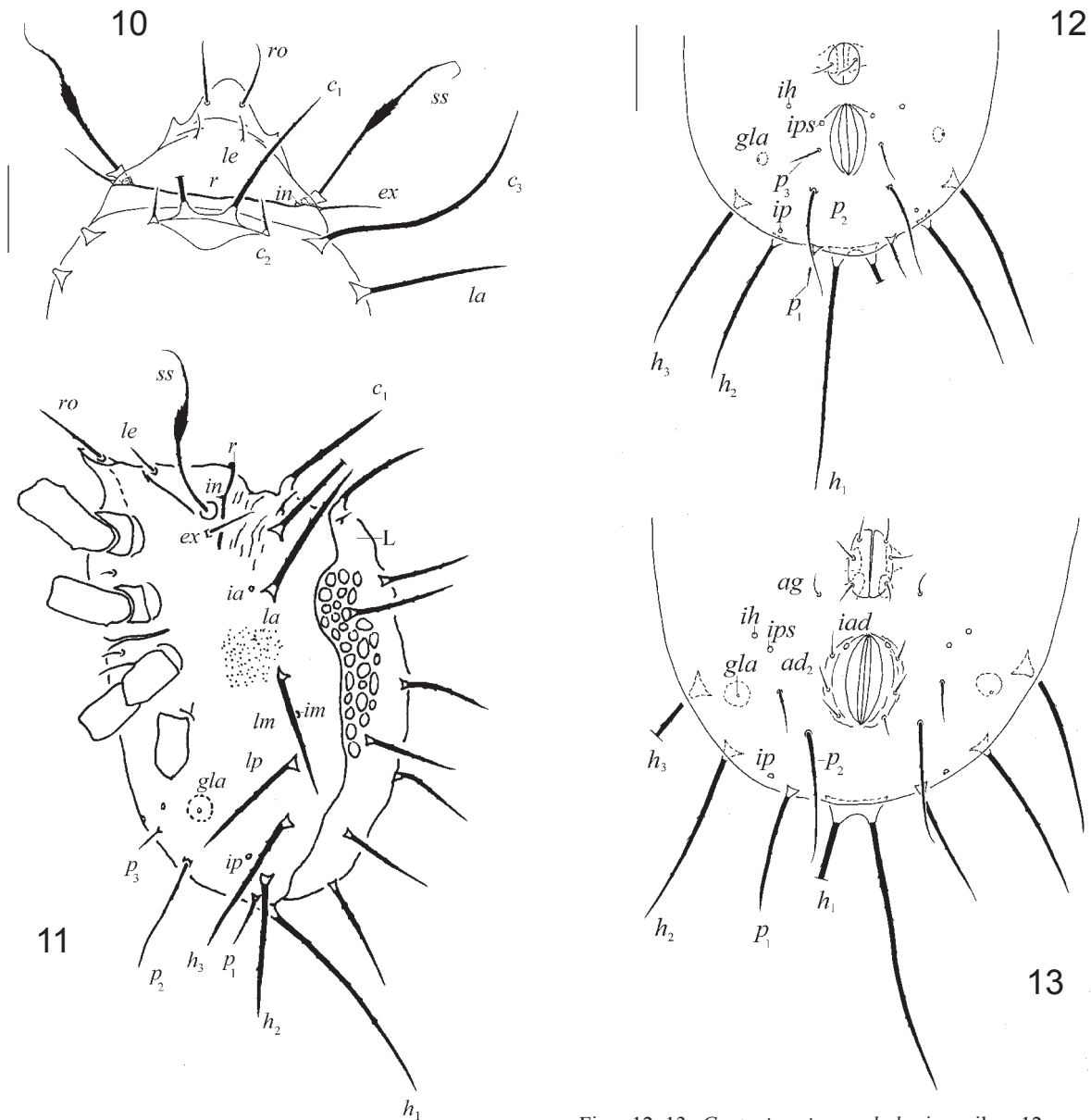
Size changes in the gnathosoma of *Gustavia microcephala* during ontogeny

Character	Larva	Protonymph	Deutonymph	Tritonymph
Length of subcapitulum	53–61	61–73	69–82	82–94
Width of subcapitulum	41–49	49–61	65–77	73–86
Length of palps	53–61	61–69	69–77	86–94
Length of chelicerae	69–73	77–98	114–123	143–151

wide, mentum wider than long. Hypostomal setae *a* and *h* long, setiform, smooth; setae *m* shorter. Palps slender, with 5 segments. Palpal setation similar for all juvenile stages: 0–2–1–3–8(+1 $\omega$ ). Palpal eupathidium *acm* and solenidion  $\omega$  attached in double horn. Palpal setae smooth. Chelicerae very long, styliform; distal part with 3 large teeth and

more thin, small multiple teeth and cilia. Ontogeny of size changes in the gnathosoma of *Gustavia microcephala* given in Table 2.

**Legs** (Figs. 7–9, 17–20) Tarsi with 1 simple claw. Most setae long, barbed. Tibia I–IV and genua I–III with coupled seta *d* and solenidion on dorsal side. On tibia I seta *l''* very long, with flag-



Figs. 10–11. *Gustavia microcephala*, protonymph: 10 — pro-dorsum and gastronic anterior margin, legs removed; 11 — lateral view (with larval (L) exuvial scalp), legs partly removed. Scale bars 50  $\mu$ m (10), 100  $\mu$ m (11).

Figs. 12–13. *Gustavia microcephala*, juveniles: 12 — anogenital region of protonymph, legs removed; 13 — anogenital region of deutonymph, legs removed. Scale bar 50  $\mu$ m.

ellate tip. Ontogeny of leg setae and solenidia given in Tables 3 and 4.

**DISCUSSION**

Grandjean (1953) listed several characters of juveniles as representing the family Gustaviidae and its single genus, *Gustavia*: paraproctal atrichosity present in larva, proto- and deutonymph; genital formula of nymphs 1–3–5; nymphal tibia and genua I–III of legs with coupled setae *d* and solenidion; palpal eupathidium *acm* and solenidion attached in double horn; larval femur of palp with 2 setae; chelicerae styliform. The juvenile stages of *Gustavia microcephala* are consistent in all these

characters. In fact, the species studied by Grandjean may have been *G. microcephala*, but this was not mentioned. Unfortunately, juveniles are not known for any of the other species of Gustaviidae, so generalizations about them cannot be made.

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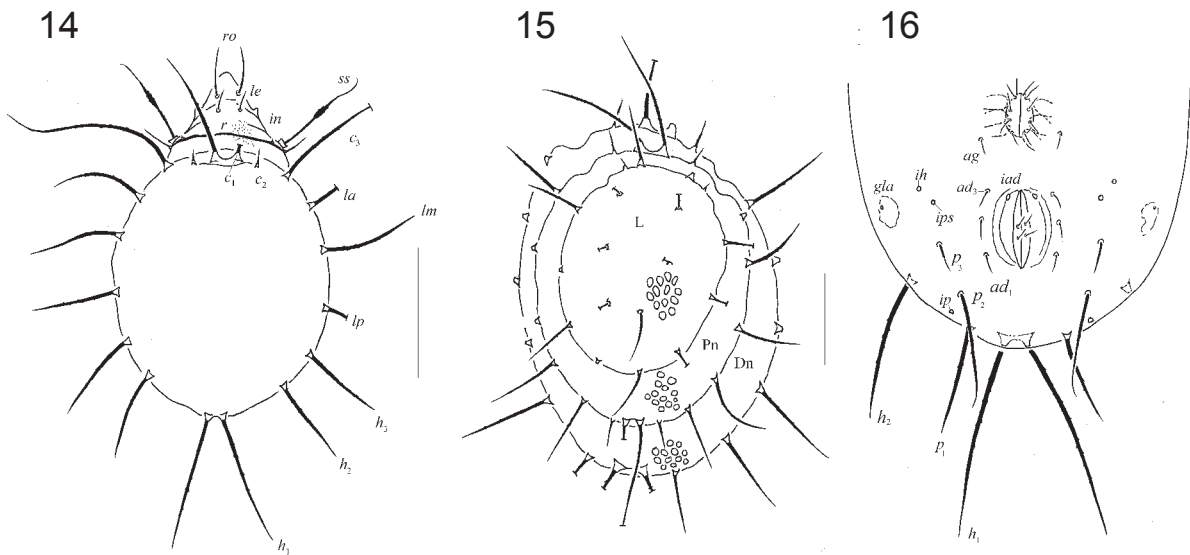
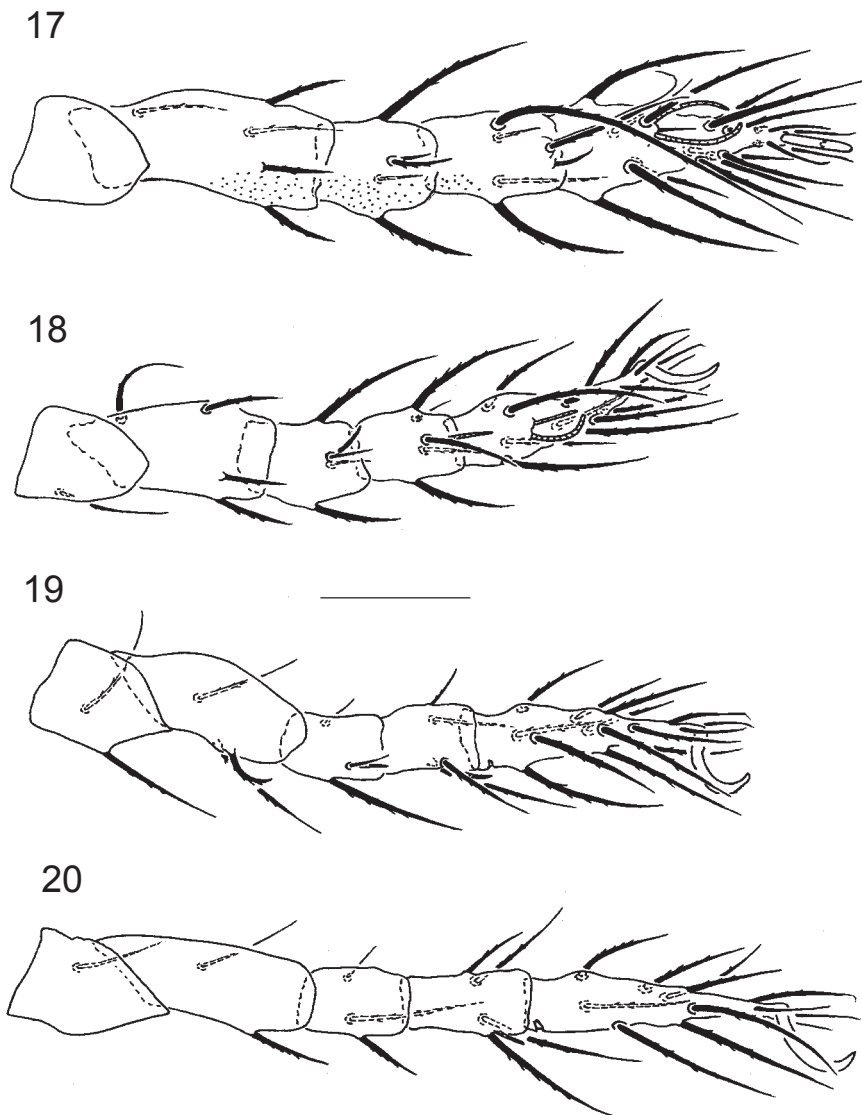


Fig. 14–16. *Gustavia microcephala*, tritonymph: 14 — dorsal view, legs removed; 15 — larval (L), proto- (Pn) and deutonymphal (Dn) exuvial scalps; 16 — anogenital region, legs removed. Scale bars 200  $\mu\text{m}$  (14), 100  $\mu\text{m}$  (15, 16).



Figs. 17–20. *Gustavia microcephala*, tritonymph: legs I–IV, respectively. Scale bar 50  $\mu\text{m}$ .

Table 3  
Development of legs formulas of *Gustavia microcephala* during ontogeny\*

	Formula of setae	Formula of solenidia
Leg I		
Larva	0-2-3-4-16	1-1-1
Protonymph	0-2-3-4-16	1-1-2
Deutonymph	1-4-3-4-16	1-2-2
Tritonymph	1-5-4-5-18	1-2-2
Leg II		
Larva	0-2-3-3-13	1-1-1
Protonymph	0-2-3-3-13	1-1-1
Deutonymph	1-4-3-4-13	1-1-2
Tritonymph	1-4-4-5-15	1-1-2
Leg III		
Larva	0-2-2-2-13	1-1-0
Protonymph	1-2-2-2-13	1-1-0
Deutonymph	2-3-2-3-13	1-1-0
Tritonymph	2-3-3-4-15	1-1-0
Leg IV		
Protonymph	0-0-0-0-7	0-0-0
Deutonymph	1-2-2-2-12	0-1-0
Tritonymph	1-2-3-4-12	0-1-0

\*Famulus included

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Table 4  
Development of legs setation of *Gustavia microcephala* during ontogeny\*

	Trochanter	Femur	Genu	Tibia	Tarsus
Leg I					
Larva	–	<i>d, bv''</i>	<i>dσ, (l)</i>	<i>dφ<sub>1</sub>, (l), v'</i>	<i>(ft), (tc), (p), (u), (a), s, (pv), (pl), e, ω<sub>1</sub></i>
Protonymph	–	–	–	–	<i>ω<sub>2</sub></i>
Deutonymph	<i>v'</i>	<i>(l)</i>	–	<i>φ<sub>2</sub></i>	–
Tritonymph	–	<i>v''</i>	<i>v'</i>	<i>v''</i>	<i>(it)</i>
Leg II					
Larva	–	<i>d, bv''</i>	<i>dσ, (l)</i>	<i>dφ, l', v'</i>	<i>(ft), (tc), (p), (u), (a), s, (pv), ω<sub>1</sub></i>
Protonymph	–	–	–	–	–
Deutonymph	<i>v'</i>	<i>(l)</i>	–	<i>l''</i>	<i>ω<sub>2</sub></i>
Tritonymph	–	–	<i>v'</i>	<i>v''</i>	<i>(it)</i>
Leg III					
Larva	–	<i>d, ev'</i>	<i>dσ, l'</i>	<i>dφ, v'</i>	<i>(ft), (tc), (p), (u), (a), s, (pv)</i>
Protonymph	<i>v'</i>	–	–	–	–
Deutonymph	<i>l'</i>	<i>l'</i>	–	<i>l'</i>	–
Tritonymph	–	–	<i>v'</i>	<i>v''</i>	<i>(it)</i>
Leg IV					
Protonymph	–	–	–	–	<i>ft'', (p), (u), (pv)</i>
Deutonymph	<i>v'</i>	<i>d, ev'</i>	<i>d, l'</i>	<i>dφ, v'</i>	<i>(tc), (a), s</i>
Tritonymph	–	–	<i>v'</i>	<i>l', v''</i>	–

\*Roman letters refer to normal setae, Greek letters refer to solenidia, *e* — famulus, *dσ* and *dφ* — 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 stage in which they first appear.