

**MORPHOLOGY OF JUVENILE INSTARS OF *GYMNODAMAEUS ADPRESSUS*
AND *ALEURODAMAEUS SETOSUS*
(ACARI: ORIBATIDA: GYMNODAMAEOIDEA)**

S. G. Ermilov¹, N. A. Ryabinin², A. A. Khaustov³

¹Nizhniy Novgorod Referral Center of the Federal service for Veterinary and Phytosanitary Inspection, Nizhniy Novgorod 603107, Russia; e-mail: ermilovacari@yandex.ru

²Institute of Water and Ecological Problems, Russian Academy of Sciences, Khabarovsk 680000, Russia

³Nikita Botanical Gardens — National Scientific Center, Yalta, Crimea 98648, Ukraine

ABSTRACT: The morphology of all juvenile instars of the oribatid mites *Gymnodamaeus adpressus* (Aoki and Fujikawa, 1971) and *Aleurodamaeus setosus* (Berlese, 1883) is described and illustrated. Juvenile instars of *Gymnodamaeus adpressus* differ from those of *G. bicostatus* by the length of exobothridial and gastronotic setae in larva; by the length of exobothridial and gastronotic setae, number of gastronotic and scalpal setae, absence of protonymphal setae of segment AD and deutonymphal setae of segment AN in nymphs. Juvenile instars of *Aleurodamaeus setosus* differ from those of *A. africanus* by the length of gastronotic setae *da* in larva; by the length of prodorsal setae, body size, number of genital setae in nymphs.

KEY WORDS: oribatid mites, *Gymnodamaeidea*, *Gymnodamaeus*, *Aleurodamaeus*, morphology, juvenile instars

INTRODUCTION

The oribatid mite superfamily *Gymnodamaeidae* comprises six genera that collectively include more than 60 species (Subías 2004, online version 2009). However, juvenile instars have been studied in only a small number of species (Grandjean 1928, 1953; Bayartogtokh and Schatz 2009; Ermilov and Lochynska 2010; Ermilov et al. 2010).

The purpose of the present work is to describe and illustrate the morphology of juvenile instars of two *Gymnodamaeidae* mites: *Gymnodamaeus adpressus* (Aoki and Fujikawa, 1971) (*Gymnodamaeidae*) and *Aleurodamaeus setosus* (Berlese, 1883) (*Aleurodamaeidae*). Adults of these species were described or otherwise documented by several other authors (in particular, Bulanova-Zachvatkina 1967, 1975; Pérez-Iñigo 1970; Aoki and Fujikawa 1971), but their juveniles have not been treated in the literature.

Gymnodamaeus adpressus is distributed in the eastern Palearctic and northeastern India. While *Gymnodamaeus* Kulczynski, 1902 comprises more than 20 species, juvenile instars have been described only by Ermilov and Lochynska (2010), for *Gymnodamaeus bicostatus* (Koch, 1835). *Aleurodamaeus setosus* is distributed in the meridional Palearctic. *Aleurodamaeus* Grandjean, 1954 comprises six species, but juvenile instars have been described only by Ermilov et al. (2010), for *Aleurodamaeus africanus* Mahunka, 1984.

MATERIAL AND METHODS

Specimens of *Gymnodamaeus adpressus* were collected by N.A. Ryabinin in Russia, Far East, near Sagdy-Silikanka river, 47°18' N, 136°29' E from soil of mixed forest (birches, cedars, lindens forming the canopy), 28 August 2009. The

material included: 9 larvae, 2 protonymphs, 9 deutonymphs, 1 tritonymph and 7 adults. Specimens of *Aleurodamaeus setosus* were collected by A.A. Khaustov in the Ukraine, Crimea, “Cape Martyan” Nature Reserve, from soil under juniper, 1 February 2010. The material included: 2 larvae, 3 protonymphs, 7 deutonymphs, 7 tritonymphs and 8 adults.

The illustrated specimens were permanently mounted and studied on flat microscope slides. Body length was measured in lateral view, from the tip of the rostrum to the posterior edge of the gastronotic region. Body width refers to the maximum width of gastronotic region in dorsal aspect. Length of body setae was measured in lateral aspect. All body measurements are presented in micrometers.

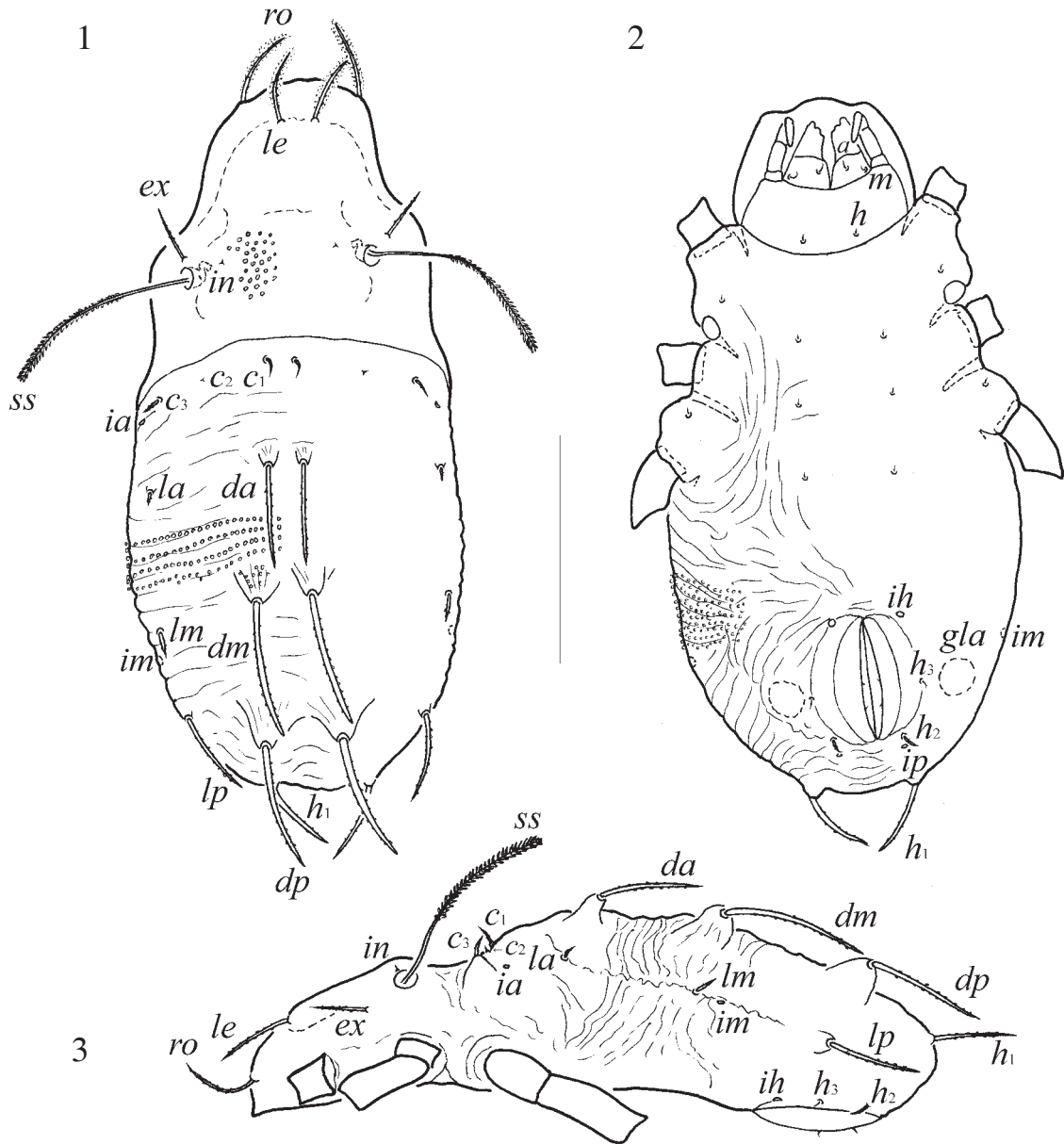
Formulae of leg setation are given according to the sequence trochanter-femur-genu-tibia-tarsus (famulus included). Formulae of leg solenidia are given according to the sequence genu-tibia-tarsus.

RESULTS

Morphology of juvenile instars of *Gymnodamaeus adpressus* (Aoki and Fujikawa, 1971)

Dimensions. Total length of: larva 289 (282–298, n=7), protonymph 381 (365–398, n=2), deutonymph 441 (415–464, n=5), tritonymph 581 (n=1). Total width of: larva 155 (149–166, n=6), protonymph 199 (n=2), deutonymph 225 (199–249; n=7), tritonymph 315 (n=1). Body of juveniles longer than wide, approximately by 1.8–1.9.

Integument. General body cuticle weakly sclerotized, colorless to yellowish. Legs and gnathosoma more sclerotized. Cuticle of prodorsum



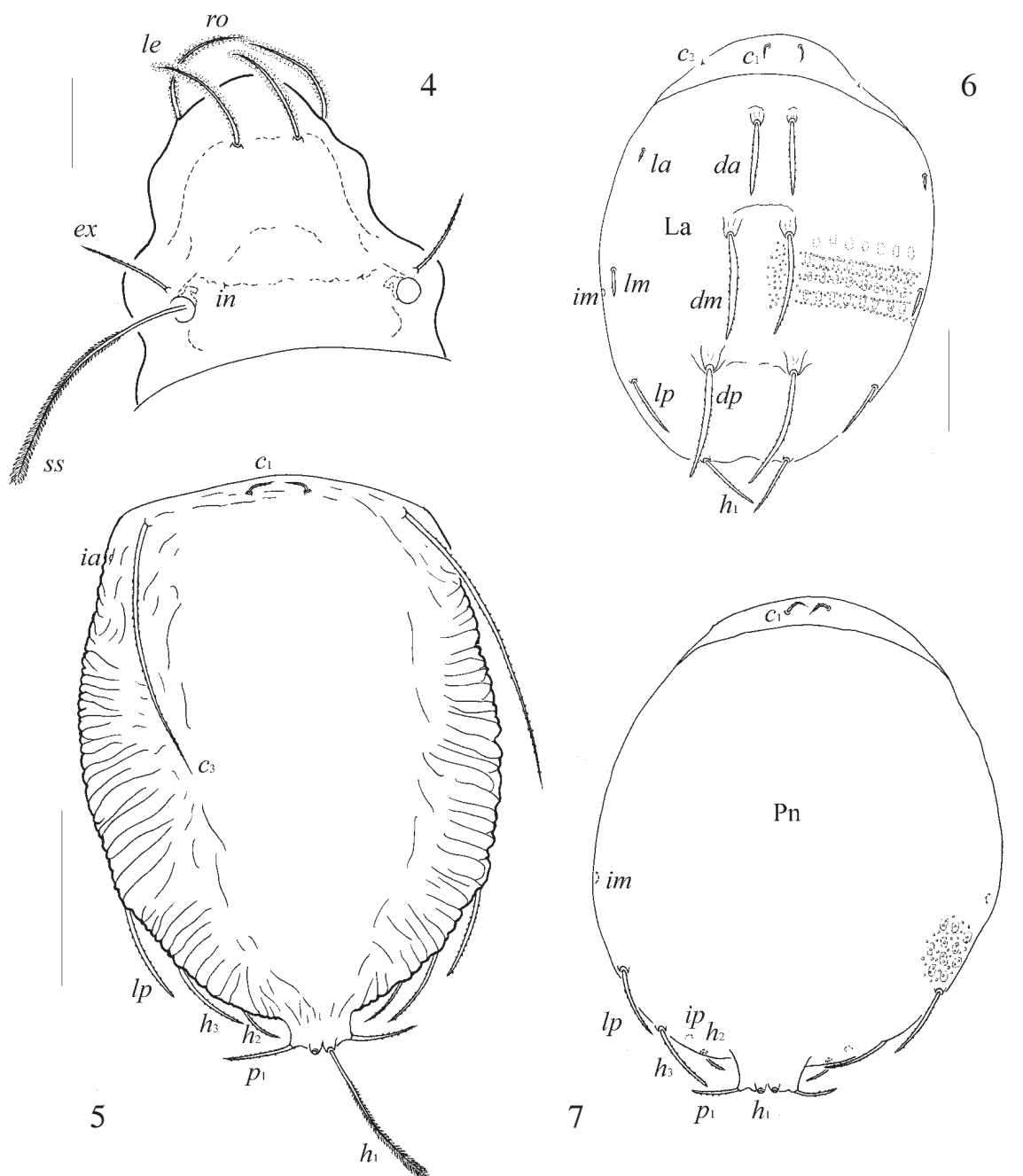
Figs. 1–3. *Gymnodamaeus adpressus*, larva: 1 — dorsal view, legs removed; 2 — ventral view, legs partly removed; 3 — lateral view, legs partly removed, gnathosoma removed. Scale bars 100 μ m.

smooth, cuticle of gastronomic and ventral region folded. Granular cerotegument covers body and legs in all juvenile instars; granules hemispherical, small (diameter up to 4 μ m in prodorsum and gastronomic region; up to 2 μ m in epimeral and anogenital regions, and legs). Body setae with or without filamentous cerotegument.

Prodorsum (Figs. 1, 3, 7). Relatively short, about half length of gastronomic region in lateral view. Rostrum widely rounded in dorsal view. Rostral (*ro*), lamellar (*le*) and exobothridial (*ex*) setae setiform, thickened, barbed, set on small tubercles. Interlamellar setae (*in*) very short, smooth. Sensilli longest setae on prodorsum, slightly dilating to tip, barbed. Comparison of prodorsal setae measurements of juvenile instars given in Table 1.

ing to tip, barbed. Comparison of prodorsal setae measurements of juvenile instars given in Table 1.

Gastronomic region (Figs. 1, 3, 8–10). Larval gastronomic region rounded posteriorly, nymphal gastronomic region with lobe-shaped caudal ledge. Larva with 12 pairs of gastronomic setae, only 10 pairs visible from dorsal view. Setae *da*, *dm* and *dp* longer, thick and barbed, sometimes slightly dilated in middle region, located on strong apophyses. Relative length of larval setae: $dm \approx dp > da \geq lp \geq h_1 >$ others (setae c_2 and h_3 shortest). Nymphs with nine pairs of gastronomic setae, c_2 absent. Setae h_1 and p_1 located on caudal ledge. Setae h_1 long, slightly dilating to tip, barbed; other setae setiform, thick-

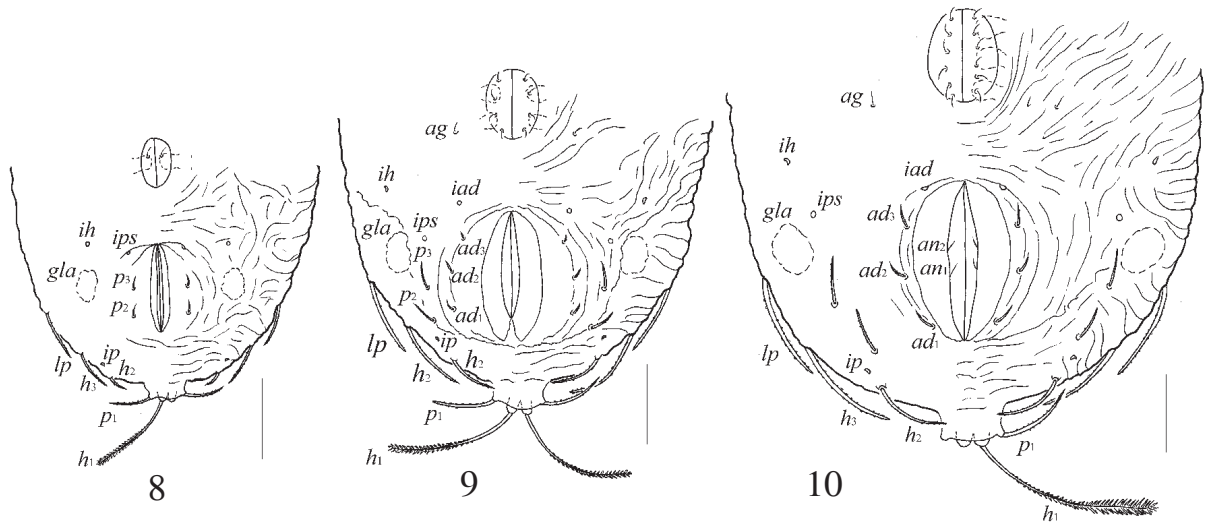


Figs. 4–7. *Gymnodamaeus adpressus*: 4 — prodorsum of deutonymph, dorsal view; 5 — notogaster of deutonymph, dorsal view, larval scalp and legs removed; 6 — larval (La) scalp; 7 — protonymphal (Pn) scalp. Scale bars (4, 6) 50 μm , (5, 7) 100 μm .

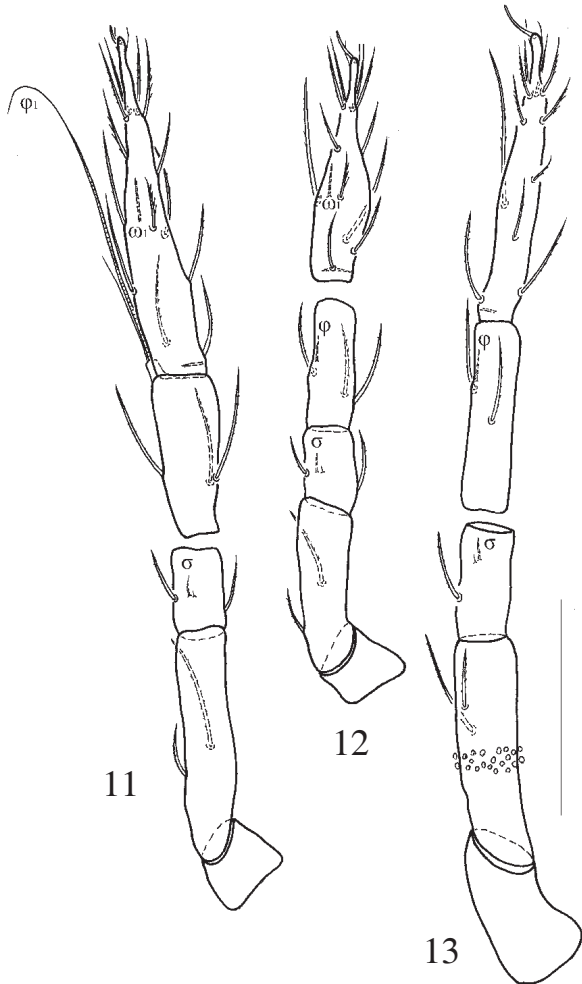
Table 1. Comparison of prodorsal setae measurements (in μm) of *Gymnodamaeus adpressus* during ontogeny

Character	Larva	Protonymph	Deutonymph	Tritonymph
	n=4	n=2	n=4	n=1
Length of rostral setae	31 (28–32)	55 (53–57)	71 (69–73)	86
Length of lamellar setae	30 (28–32)	51 (49–53)	67 (65–69)	82
Length of interlamellar setae	2	2	2	2
Length of sensilli	93 (86–98)	129 (127–131)	151 (147–155)	180
Length of exobothridial setae	26 (24–28)	38 (36–41)	57 (53–61)	73

ened, barbed. Relative length of nymphal setae: $c_3 > im$ located in normal ontogenetic pattern. Scaples $h_1 > others$ (setae c_1, p_2 and p_3 shortest). Cupules ia , with reticular ornamentation. Larval scaples with



Figs. 8–10. *Gymnodamaeus adpressus*, anogenital region of juveniles: 8 — protonymph; 9 — deutonymph; 10 — tritonymph. Scale bars 50 μ m.



Figs. 11–13. *Gymnodamaeus adpressus*, legs I–III of larva, respectively. Scale bar 50 μ m.

nine pairs of setae; nymphal scalps with six pairs of setae (h_1 vestigial, represented only by alveoli).

Anogenital region (Figs. 2, 11–13). Ontogenetic genital, aggenital, adanal, anal formulae,

larva to tritonymph, 0–1–4–6, 0–0–1–1, 0–0–3–3, 0–0–0–2 respectively. All setae setiform, slightly barbed (adanal) or smooth (others). Larva with two pairs of minute pseudanal setae. Cupules *ih*, *ips*, *iad*, *ip* and small opisthosomal gland opening (*gla*) appearing in normal ontogenetic pattern.

Epimeral region (Fig. 2). Setal formulae for epimeres: larva 3–1–2 (third setae of the first epimere form protective scales over Claparède's organ); protonymph 3–1–2–1; deutonymph 3–1–2 (or 3)–2, tritonymph 3–1–3–3. Epimeral setae rather short, setiform, thin, smooth. Setae *Ic* (in deutonymph) and *Ic*, *3c*, *4c* (in tritonymph) longer than others.

Gnathosoma. Typical of Gymnodamaeioidea. Subcapitulum wider than long; mentum considerably wider than long. Hypostomal setae short, setiform, slightly barbed; *a* and *m* with similar length (or *a* slightly longer), longer than *h*. Lateral lips with 2 pairs setiform, barbed adoral setae. Palp setal formulae: larva 0–1–1–3–9+1 ω ; nymphs 0–2–1–3–9+1 ω . Cheliceral setae long, setiform, barbed; *cha* longer than *chb*.

Legs (Figs. 11–13). Typical of Gymnodamaeioidea. Long, thin. Setal formulae: larva: I (0–2–3–4–16) [1–1–1], II (0–2–3–3–13) [1–1–1], III (0–2–2–2–13) [1–1–0]; protonymph: I (0–4–3–4–16) [1–1–2], II (0–4–3–3–13) [1–1–1], III (0–2–2–2–13) [1–1–0], IV (0–0–0–0–7) [0–0–0]; deutonymph: I (1–5–4–5–16) [1–2–2], II (1–5–4–4–13) [1–1–2], III (1–3–3–4–13) [1–1–0], IV (1–2–2–2–12) [0–1–0]; tritonymph: I (1–5–4–5–18) [1–2–2], II (1–5–4–4–15) [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

Table 2. Development of leg setation of *Gymnodamaeus adpressus**

	Trochanter	Femur	Genu	Tibia	Tarsus
Leg I					
Larva	–	d, bv''	$d, (l), \sigma$	$(l), v', d\phi_1$	$(ft), (tc), (p), (u), (a), s, (pv), (pl), e (sunken), \omega_1$
Protonymph	–	(l)	–	–	ω_2
Deutonymph	v'	v''	v'	v'', ϕ_2	–
Tritonymph	–	–	–	–	(it)
Leg II					
Larva	–	d, bv''	$d, (l), \sigma$	d, l', v', ϕ	$(ft), (tc), (p), (u), (a), s, (pv), \omega_1$
Protonymph	–	(l)	–	–	–
Deutonymph	v'	v''	v'	l''	ω_2
Tritonymph	–	–	–	–	(it)
Leg III					
Larva	–	d, ev'	d, l', σ	d, v', ϕ	$(ft), (tc), (p), (u), (a), s, (pv)$
Protonymph	–	–	–	–	–
Deutonymph	v'	l'	v'	l', v''	–
Tritonymph	l'	–	–	–	(it)
Leg IV					
Protonymph	–	–	–	–	$ft'', (p), (u), (pv)$
Deutonymph	–	d, ev'	d, v'	d, v', ϕ	$(tc), (a), s$
Tritonymph	v'	–	l'	l', v''	–

*Roman letters refer to normal setae, Greek letters refer to solenidia; e — famulus; $d\phi$ — solenidion 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.

2. Setae setiform, most well barbed. Setae p short, smooth, located closer to claw than setae u and tc . Famulus sunken. Tibia I with dorsal apophysis, bearing long flagellate solenidion ϕ_1 and short coupled seta d . Others solenidia rod-shaped, without coupled seta d . Larval genua with minute seta d and well developed solenidion; nymphal genua with seta d longer than solenidion.

Morphology of juvenile instars of *Aleurodamaeus setosus* (Berlese, 1883)

Dimensions. Total length of: larva 273 (265–282, $n=2$), protonymph 340 (332–348, $n=2$), deutonymph 439 (431–448, $n=4$), tritonymph 502 (481–531, $n=4$). Total width of: larva 140 (132–149, $n=2$), protonymph 190 (182–199, $n=2$), deutonymph 240 (232–249, $n=4$), tritonymph 286 (265–315, $n=4$). Body of juveniles approximately 1.7–1.9 times longer than wide.

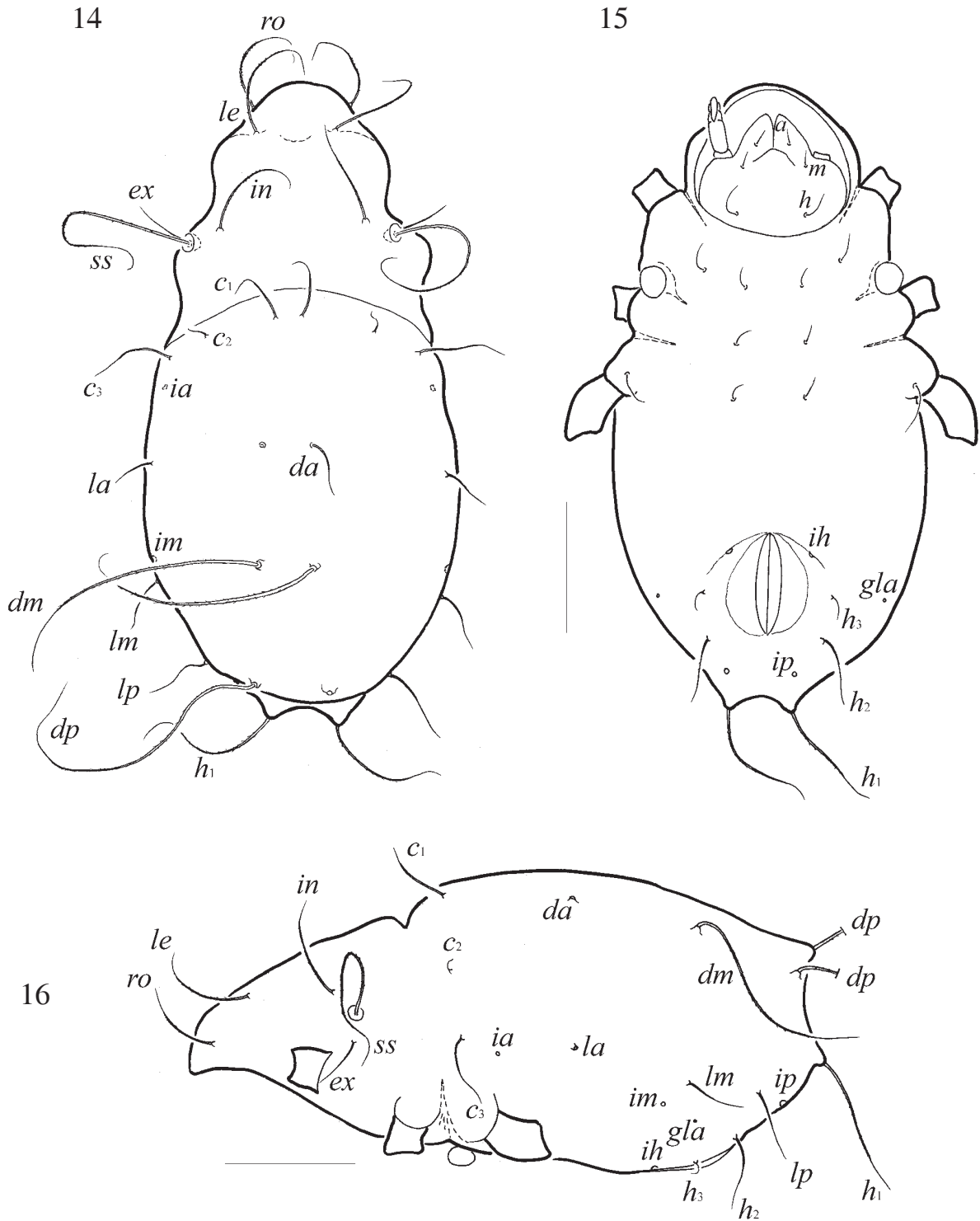
Integument. General body cuticle weakly sclerotized, colourless. Legs and gnathosoma more sclerotized. Cuticle of body smooth. Filamentous cerotegument covers body and legs in all juvenile instars. Body setae with or without cerotegument.

Prodorsum (Figs. 14, 16, 17). Relatively short, about half length of gastronotic region in lat-

eral view. Rostrum widely rounded in dorsal view. Rostral, lamellar, interlamellar (in larva) and exo-bothridial setae setiform, with flagellate tips, barbed, set on small tubercles. Interlamellar setae (in nymphs) short, strong, smooth. Sensilli setiform, with long flagellate tips, barbed, longest setae on prodorsum. Length of prodorsal setae in larva: $ss > ro \approx le \approx in > ex$; in nymphs: $ss > ro \approx le > ex > in$. Comparison of prodorsal setae measurements of juvenile instars given in Table 3.

Gastronotic region (Figs. 14, 16, 18–20). Larval gastronotic region rounded posteriorly, nymphal gastronotic region with lobe-shaped caudal ledge. Larva and nymphs with 12 pairs of gastronotic setae. Setae often broken or absent (only alveoli present). Setae dark-coloured, barbed, with flagellate tips, set on apophyses or tubercles. Relative length of larval setae: $dm \approx dp > h_3 > others$. Relative length of nymphal setae: $h_1 > p_1 > others$. Cupules ia, im located in normal ontogenetic pattern. Scalps with reticular ornamentation. Larval scalps with nine pairs of setae; nymphal scalps with 10 pairs of setae.

Anogenital region (Figs. 15, 21–23). Ontogenetic genital, aggenital, adanal, anal formulae, larva to tritonymph, 0–1–4–6, 0–0–1–1, 0–0–2–2, 0–0–0–2 respectively. All setae setiform, with



Figs 14–16. *Aleurodamaeus setosus*, larva: 14 — dorsal view, legs removed; 15 — ventral view, legs partly removed; 16 — lateral view, legs partly removed, gnathosoma removed. Scale bars 50 μ m.

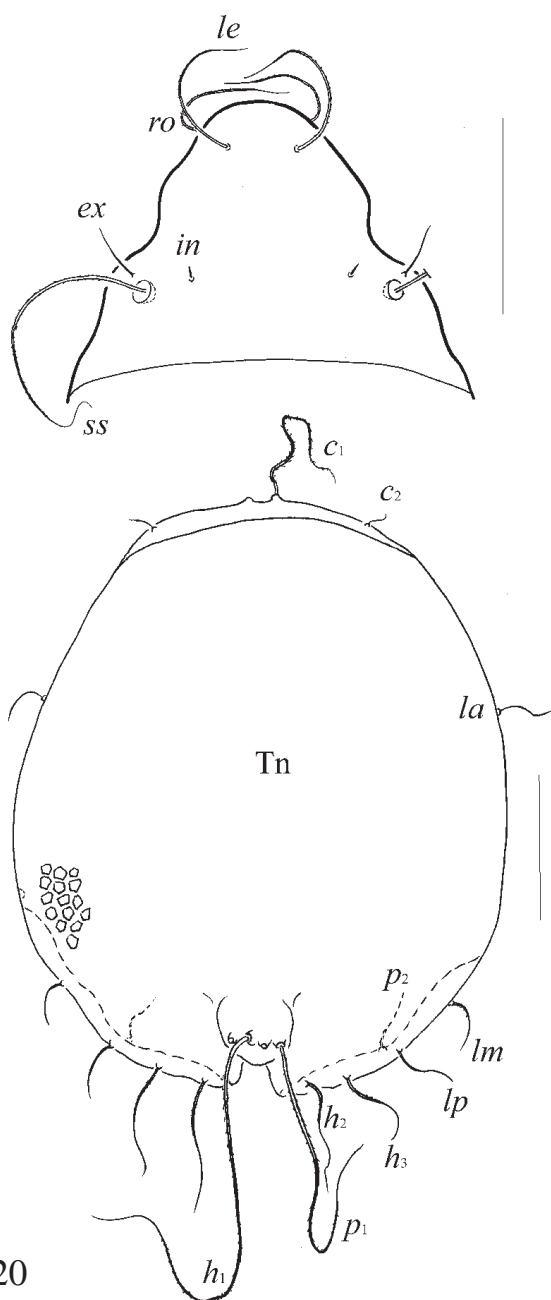
small flagellate tips (except anal setae), barbed. Cupules *ih*, *ips*, *iad*, *ip* and small opisthosomal gland opening (*gla*) appearing in normal ontogenetic pattern.

Epimeral region (Fig. 15). Setal formulae for epimeres: larva 3–1–2 (third setae of the first epimere form protective scales over Claparède's organ); protonymph 3–1–2–1; deutonymph 3–1–

3–2, tritonymph 3–1–3–3. Epimeral setae long, thin, with small flagellate tips, barbed.

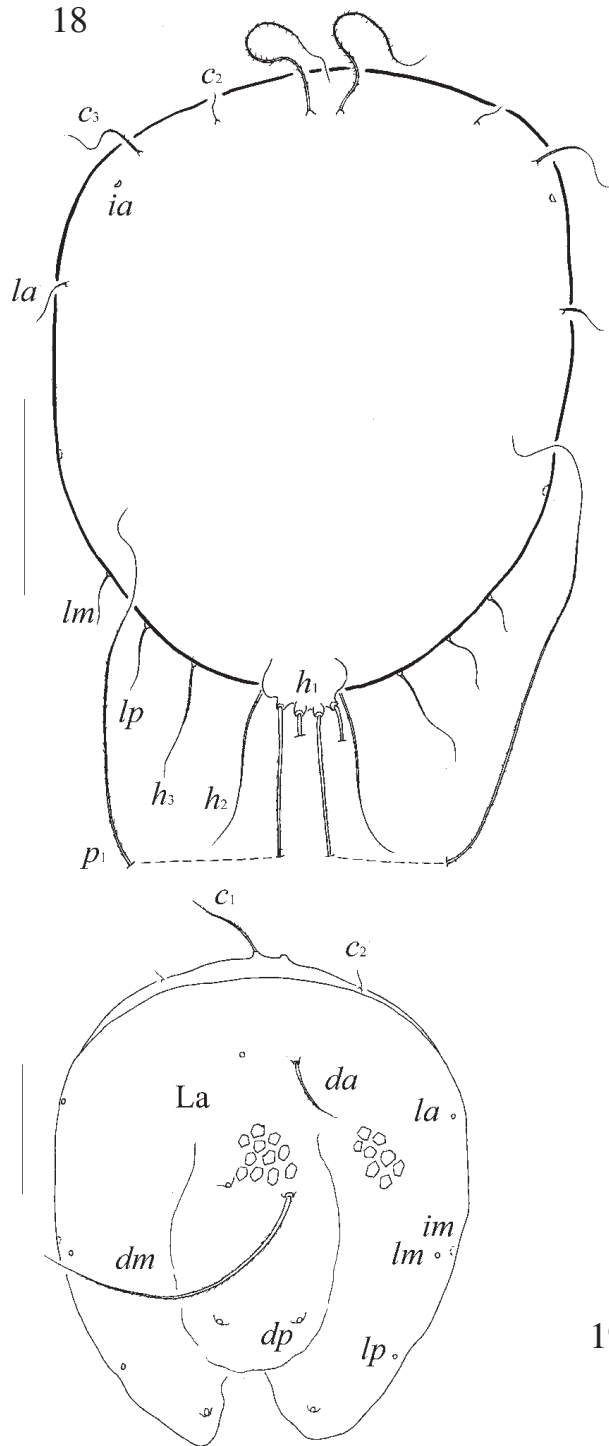
Gnathosoma. Typical of *Gymnodamaeioidea*. Subcapitulum wider than long; mentum considerably wider than long. Hypostomal setae *m* and *a* similar in length, setiform, barbed; setae *h* longer, setiform, barbed, with small flagellate tips. Lateral lips with 2 pairs of setiform, barbed adoral setae.

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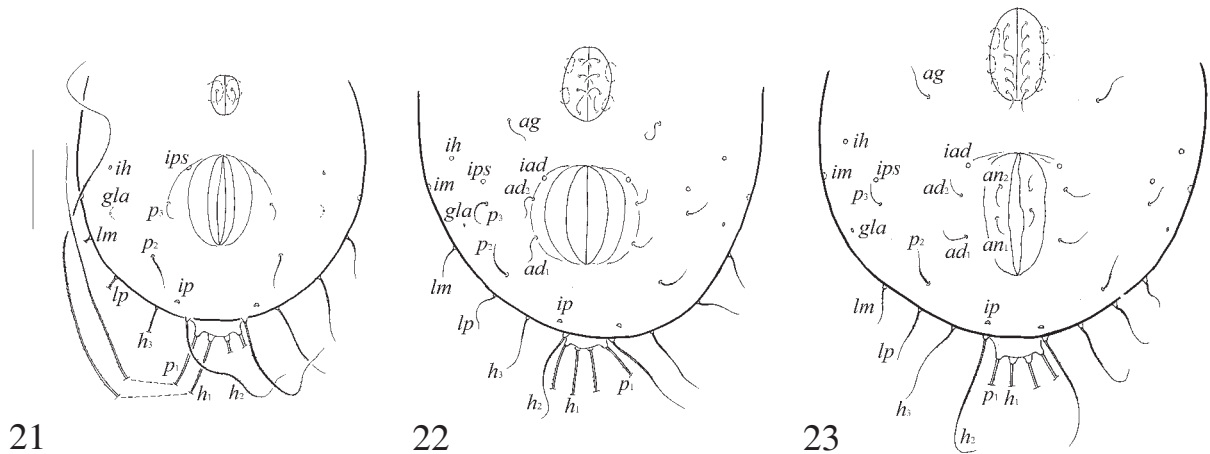
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Figs 17–20. *Aleurodamaeus setosus*: 17 — prodorsum of deutonymph, dorsal view; 18 — notogaster of deutonymph, dorsal view, larval scalp and legs removed; 19 — larval (La) scalp; 20 — tritonymphal (Tn) scalp. Scale bars (17, 18, 20) 100 μ m, (19) 50 μ m.

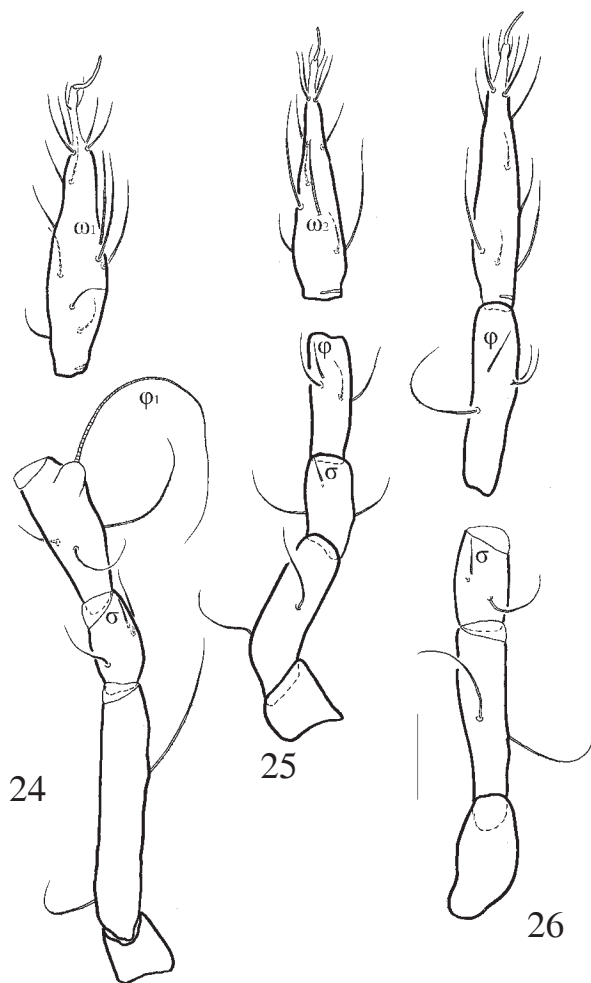
Palp setal formulae: larva 0–1–1–3–9+1 ω ; nymphs 0–2–1–3–9+1 ω . Cheliceral setae long, setiform, barbed; *cha* longer than *chb*.

Legs (Figs. 24–26). Typical of Gymnodamaeidae. Long, thin. Setal formulae: larva: I (0–2–3–4–16) [1–1–1], II (0–2–3–3–13) [1–1–1], III (0–2–2–3–13) [1–1–0]; protonymph: I (0–4–3–4–16) [1–1–2], II (0–4–3–3–13) [1–1–1], III (0–3–

2–3–13) [1–1–0], IV (0–0–0–0–7) [0–0–0]; deutonymph: I (1–5–4–5–16) [1–2–2], II (1–5–4–4–13) [1–1–2], III (2–3–3–4–13) [1–1–0], IV (1–2–2–3–12) [0–1–0]; tritonymph: I (1–5–4–5–18) [1–2–2], II (1–5–4–5–15) [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 4. All setae (except for thin, smooth *p*) setiform,



Figs. 21–23. *Aleurodamaeus setosus*, anogenital region of juveniles: 21 — protonymph; 22 — deutonymph; 23 — tritonymph. Scale bars (21) 50 μ m, (22, 23) 100 μ m.



Figs. 24–26. *Aleurodamaeus setosus*, legs I–III of larva, respectively. Scale bar 20 μ m.

barbed. Famulus minute, emergent in all instars. Tibia I with dorsal apophysis, bearing long flagellate solenidion ϕ_1 and short coupled seta d (seta often absent). Other solenidia rod-shaped, without coupled seta d . Larval genua with minute seta d and well developed solenidion; nymphal genua with seta d longer than solenidion.

Comparison. With these new data, comparisons can be made with other species in the respective gymnodamaeoid genera. Analyses of juvenile instars of Gymnodamaeioidea (Ermilov et al. 2010) can be expanded. Juvenile instars of *Gymnodamaeus adpressus* differ noticeably from those of *Gymnodamaeus bicostatus* (see Ermilov and Lochynska 2010) by several characters.

Larva:

- exobothridial setae long (little shorter than lamellar setae; longer than lm) in *G. adpressus*; short in *G. bicostatus* (shorter in several lengths than lamellar setae; not longer than lm);
- gastronomic setae da , dm , dp inserted on apophyses in *G. adpressus*; only dm and dp on apophyses in *G. bicostatus*;
- gastronomic setae da long (little shorter than dm and dp) in *G. adpressus*; minute in (obviously shorter than dm and dp) *G. bicostatus*.

Nymphs:

- exobothridial setae long (little shorter than lamellar setae; similar in length with lm) in *G. adpressus*; short (shorter in several lengths than lamellar setae; shorter than lm) in *G. bicostatus*;
- nine pairs of gastronomic setae (c_2 absent) in *G. adpressus*; ten pairs (c_2 present) in *G. bicostatus*;
- gastronomic setae c_3 very long (approximately half of length gastronomic region) in *G. adpressus*; minute in *G. bicostatus*;
- gastronomic setae h_1 long (approximately as rostral setae), slightly dilated to tip in *G. adpressus*; minute and thin in *G. bicostatus*;
- nymphal scalps with six pairs of setae in *G. adpressus*; with seven pairs in *G. bicostatus*;
- protonymphal setae of segment AD and deutonymphal setae of segment AN absent in *G. adpressus*; present, though very short, in *G. bicostatus*.

Table 3. Comparison of prodorsal setae measurements (in μm) of *Aleurodamaeus setosus* during ontogeny

Character	Larva	Protonymph	Deutonymph	Tritonymph
	n=2	n=2	n=4	n=4
Length of rostral setae	43 (41–45)	55 (53–57)	65 (61–69)	75 (69–77)
Length of lamellar setae	53 (49–57)	59 (57–61)	69 (65–73)	80 (77–86)
Length of interlamellar setae	45 (41–49)	8	8	8
Length of sensilli	100 (94–106)	116 (110–123)	136 (131–143)	163 (155–168)
Length of exobothridial setae	30 (28–32)	36 (32–41)	41 (36–45)	45 (41–49)

Table 4. Development of leg setation of *Aleurodamaeus setosus**

	Trochanter	Femur	Genu	Tibia	Tarsus
Leg I					
Larva	–	d, bv''	$d, (l), \sigma$	$(l), v', d\phi_1$	$(ft), (tc), (p), (u), (a), s, (pv), (pl), e$ (emergent), ω_1
Protonymph	–	(l)	–	–	ω_2
Deutonymph	v'	v''	v'	v'', ϕ_2	–
Tritonymph	–	–	–	–	(it)
Leg II					
Larva	–	d, bv''	$d, (l), \sigma$	d, l', v', ϕ	$(ft), (tc), (p), (u), (a), s, (pv), \omega_1$
Protonymph	–	(l)	–	–	–
Deutonymph	v'	v''	v'	l''	ω_2
Tritonymph	–	–	–	v''	(it)
Leg III					
Larva	–	d, ev'	d, l', σ	d, l', v', ϕ	$(ft), (tc), (p), (u), (a), s, (pv)$
Protonymph	v'	l'	–	–	–
Deutonymph	l'	–	v'	v''	–
Tritonymph	–	–	–	–	(it)
Leg IV					
Protonymph	–	–	–	–	$ft'', (p), (u), (pv)$
Deutonymph	v'	d, ev'	d, l', v'	d, l', v', ϕ	$(tc), (a), s$
Tritonymph	–	–	–	v''	–

*See Table 2 for explanation.

Juvenile instars of *Aleurodamaeus setosus* are very similar in structure (cuticle, morphology of body setae, body setal formulae) with those of *Aleurodamaeus africanus* (see Ermilov et al. 2010). However, there are several differences.

Larva:

— setae da short (approximately as c_1) in *A. setosus*; long (obviously longer than c_1) in *A. africanus*.

Nymphs:

— tritonymphal genital plates with six pairs of setae in *A. setosus*; with seven pairs in *A. africanus*;
 — mean body length of deutonymph and tritonymph respectively 439 and 502 in *A. setosus*; 470 and 614 in *A. africanus*;
 — mean body width of deutonymph and tritonymph respectively 240 and 286 in *A. setosus*; 265 and 348 in *A. africanus*;

— mean lengths of prodorsal setae in protonymph, deutonymph and tritonymph, respectively: in *A. setosus* ro 55–65–75, le 59–69–80, in 8–8–8, ss 116–136–163, ex 36–41–45; in *A. africanus*: ro 67–77–90, le 69–79–90, in 8–13–15, ss 135–153–174, ex 39–45–53.

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