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Morphology of juvenile stages of *Metabelbella tichonravovi*
BULANOVA-ZACHVATKINA, 1967 with a redescription of the adult
(Acari: Oribatida: Damaeidae)

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ABSTRACT. The morphology of juvenile stages of the oribatid mite *Metabelbella tichonravovi* BULANOVA-ZACHVATKINA, 1967 is described and illustrated. Juvenile stages of this species are most similar in appearance (cuticle, cerotegument, morphology of setae, body setal formulas) to juvenile stages of *Metabelba*. The comparative analysis of juveniles of *Metabelbella tichonravovi*, *Metabelba papillipes* (NICOLET, 1855) and *Metabelba glabriseta* MAHUNKA, 1982 is given. The morphology of adult *Metabelbella tichonravovi* is redescribed and illustrated.

Key words: acarology, morphology, oribatid mite, Damaeidae, *Metabelbella tichonravovi*, redescription, juvenile stages.

INTRODUCTION

The oribatid mite of the Damaeidae family (Acari, Oribatida) comprises 12 genera and more than 250 species (SUBÍAS 2004, online version 2009). However, juvenile stages have been described only for several species (sometimes briefly or not all ontogenetic stages are presented in papers). By now we have the most comprehensive knowledge of juvenile stages in two genera: *Damaeus* and *Epidamaeus* (BULANOVA-ZACHVATKINA 1957, NORTON 1978, 1979, MORAZA et al. 1990, ENAMI 1992, ERMILOV and LOCHYNSKA 2009).

Metabelbella BULANOVA-ZACHVATKINA, 1967 comprises 10 species that distributed in the Palearctic region. The studied species *Metabelbella tichonravovi* BULANOVA-ZACHVATKINA, 1967 has been recorded only in Crimea (Ukraine) and Sochi (Russia) so far (BULANOVA-ZACHVATKINA 1967, KRIVOLUTSKIY et al. 1995). The morphology of the

holotype was poorly described by BULANOVA-ZACHVATKINA (1967). She presented a list of distinctive morphological features of this species in keys only and illustrated the notogaster dorsally (BULANOVA-ZACHVATKINA 1967, 1975). The morphology of juvenile stages of *Metabelbella* has not been studied so far.

The purpose of the present work is to describe and illustrate the morphology of all juvenile stages of *Metabelbella tichonravovi*. This is the first comprehensive ontogeny examination of *Metabelbella*. Moreover, authors present detailed and illustrative morphology of the adult.

MATERIAL AND METHODS

Adults and juvenile stages of *Metabelbella tichonravovi* were collected by A.A. Khaustov in the Ukraine, Crimea, "Cape Martyan" Nature Reserve, soil under oak *Quercus pubescens*, 22 January 2010. The field-collected material included: 89 juveniles (5 larvae, 16 protonymphs, 21 deutonymphs, 47 tritonymphs) and 9 adults.

The illustrated juvenile stages were permanently mounted and studied on flat microscope slides. The illustrated adults were studied in lactic acid, mounted on temporary cavity slides for the duration of the study. All body measurements are presented in micrometers. Body length was measured in lateral view, from the tip of the rostrum to the posterior edge of the gastronomic region. Body width refers to the maximum width of gastronomic region in dorsal aspect. Length of body setae was measured in lateral aspect. Some specimens were dissected for detailed studies. Formulae for leg setation are given in round brackets 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.

The morphological terminology used below is mostly that developed over many years by GRANDJEAN (e.g. 1952, 1960; see also NORTON 1978).

RESULTS

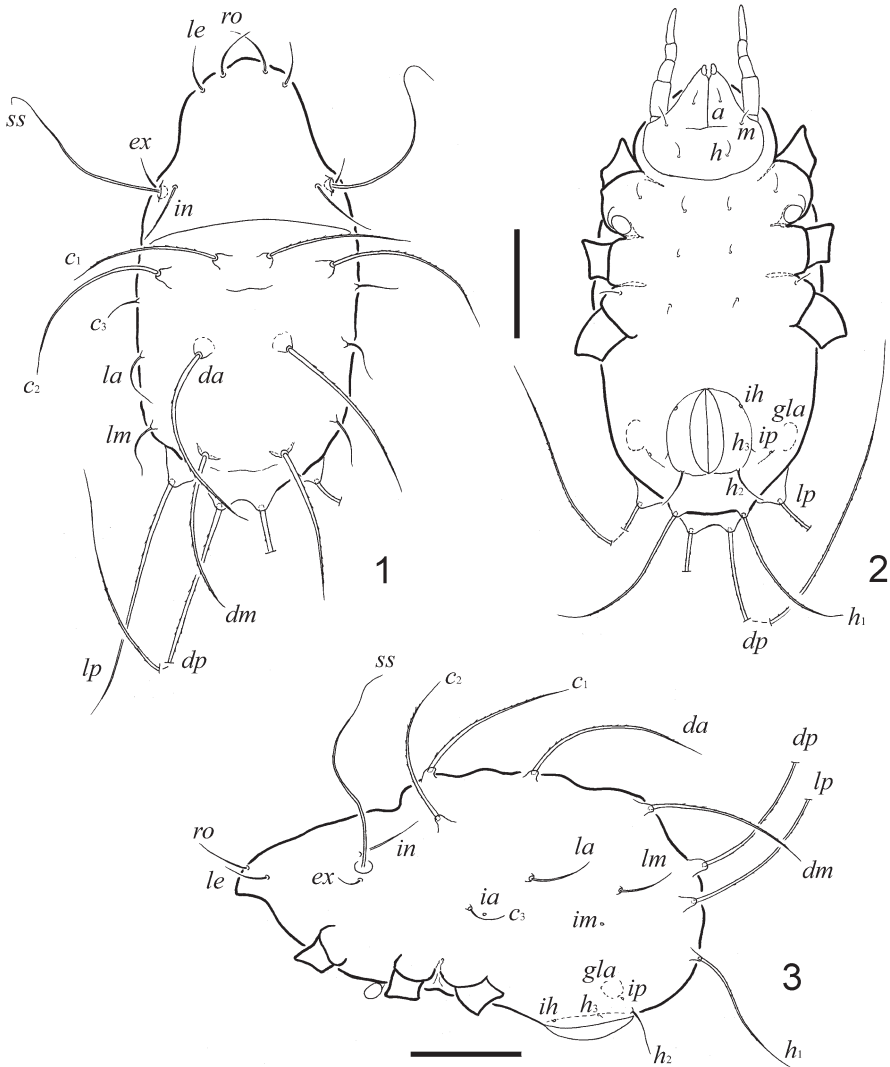
Description of juvenile stages:

Dimensions. Total length of (four specimens): larva 199-215 (mean 211), protonymph 265-282 (mean 269), deutonymph 365-415 (mean 385), tritonymph 448-481 (mean 472). Total width of (four specimens): larva 99-116 (mean 103), protonymph 116-132 (mean 124), deutonymph 199-215 (mean 207), tritonymph 215-249 (mean 232). Body of all stages approximately two times longer than wide.

Integument. Body cuticle colourless to pale yellow. Legs, gnathosoma, apophyses of some setae, gastronomic cornicles more sclerotized, light brown. Cuticle smooth. Granular and filamentous cerotegument covers body and legs in all juveniles. Granules are very small, spherical (up to 2 μm in larva and protonymph; up to 4 μm in deuto- and tritonymph). Body setae with filamentous cerotegument.

Prodorsum (Figs. 1, 3, 11). Relatively short, about half-length of gastronomic region in lateral view. Rostrum rounded. All prodorsal setae darkened, set on small

apophyses. Larval rostral (*ro*) and lamellar (*le*) setae located on edge of rostrum in larva; *le* becomes more posteriorly placed in nymphs. Prodorsal setae similar in length (or *ro* slightly longer), setiform, barbed. Larval interlamellar setae (*in*) long, with small flagellate tips, barbed; nymphal setae *in* short, strong, smooth, with blunt and slightly swollen tips. Exobothridial setae (*ex*) setiform, thin, smooth. Sensilli (*ss*) are the longest setae of prodorsum, with long flagellate tips, smooth. Comparison of prodorsal setae measurements of juvenile instars given in Table 1.



1-3. *Metabelbella tichonravovi*, larva: 1 – dorsal view, legs not shown, 2 – lateral view, legs partly not shown, 3 – ventral view, legs partly not shown, subcapitulum not shown. Scale bar 50 μ m

Gastronotic region (Figs. 1, 3, 7, 8, 12). Rounded or slightly truncate posteriorly in dorsal view. Larva with typical 12 pairs of gastronotic setae; setae dark-coloured, with short or long flagellate tips (except h_2, h_3), barbed (except h_3), set on apophyses. Length of setae: $dp > lp > da > c_2, dm \geq c_1, h_1 > la, lm \geq c_3, h_2 > h_3$. Apophyses of setae dp adjoining.

Scalps with typical 9 pairs of setae and large reticular ornamentation; setae of scalps often broken. Cornicles k long, slightly curled, distally with weakly developed swelling. Distal part of cornicle (approximately 1/3) is longitudinally split, but inconspicuously so, as halves remain in contact. Length of cornicles (n=4): protonymph 26 (24–28), deutonymph 33 (32–36), tritonymph 36 (32–41).

Nymphs with typical 12 pairs of gastronotic setae. Setae dark-coloured, setiform, with short or long flagellate tips, well or scarcely barbed, set on apophyses. Length of setae: $h_1 > c_2 \geq c_1 \geq la, lm, lp, h_3 \geq h_2 > p_1 > c_3, p_2 \geq p_3$. Pair of setae c_1 set on single medial sclerite. Apophyses of setae h_1 adjoining. In ventral view, hysterosoma with slightly bowed sclerotized crest delimiting small sclerotized area with setal pairs h_1 and p_1 . Cupules ia and im typical for Damaeidae.

Anogenital region (Figs. 2, 9, 10, 13, 14). Genital, aggenital, adanal and anal formulas from larva to adult are: 0–1–3–5–6, 0–0–1–1–1, 0–0–3–3–3, 0–0–0–2–2 respectively. All setae are setiform, thin, smooth. Adanal setae ad_1 are slightly longer than ad_2 and ad_3 . Cupules ip, ih, ips, iad and opisthosomal gland opening (gla) distinctly visible, in typical ontogenetic pattern.

Epimeral region (Figs. 2, 13). Epimeral formula: larva 3–1–2 (third setae of I epimere form protective scales over Claparède's organ), protonymph 3–1–2–1, deutonymph 3–1–2–2, tritonymph and adult 3–1–3–3. Setae setiform, smooth.

Gnathosoma. Typical of Damaeidae (NORTON 1978). Subcapitulum is slightly longer than wide. Subcapitular setae (h, m, a) setiform, slightly barbed. Setae m slightly longer than h and a . Lateral lips with two pairs of setiform, barbed adoral setae. Palp

Table 1. Prodorsal setae measurements during ontogeny of *Metabelbella tichonravovi*

Character	Larva, mean (min-max)	Protonymph, mean (min-max)	Deutonymph, mean (min-max)	Tritonymph, mean (min-max)	Adult, mean (min-max)
	4 sps.	4 sps.	4 sps.	4 sps.	4 sps.
Length of rostral setae	34 (32–36)	45 (41–49)	49 (45–53)	62 (61–65)	73 (69–77)
Length of lamellar setae	30 (28–32)	37 (36–41)	49 (45–53)	62 (61–65)	73 (69–77)
Length of interlamellar setae	42 (41–45)	16	19	22 (20–24)	115 (102–123)
Length of sensilli	99 (94–102)	127 (123–131)	181 (164–205)	207 (184–229)	197 (184–205)
Length of exobothridial setae	20	29 (28–32)	39 (36–41)	45 (41–49)	50 (49–53)

setal formulas: larva 0-1-1-3-9+1 ω ; nymphs 0-2-1-3-9+1 ω . Palpal setae barbed (except setae of tarsi). Chelicerae with few blunt teeth on fixed and movable digits. Cheliceral setae setiform, *cha* longer than *chb*, barbed, barbs of *chb* long in middle-distal part.

Legs (Figs. 4-6, Tables 2 and 3). All legs of juveniles are shorter than body. Leg 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 (0-2-3-4-16) [1-1-2], II (0-2-3-3-13) [1-1-1], III (1-2-2-3-13) [1-1-0], IV (0-0-0-0-7) [0-0-0]; deutonymph: I (1-4-4-5-16) [1-2-2], II (1-4-4-4-13) [1-1-2], III (2-3-3-4-13) [1-1-0], IV (1-2-2-3-12) [0-1-0]; trito-

Table 2. Leg measurements during ontogeny of *Metabelbella tichonravovi*

	Larva, mean (min-max)	Protonymph, mean (min-max)	Deutonymph, mean (min-max)	Tritonymph, mean (min-max)	Adult, mean (min-max)
	3 specimens	3 specimens	3 specimens	3 specimens	3 specimens
Leg I	195 (190-202)	237 (231-240)	323 (318-326)	410 (404-413)	467 (453-479)
leg I:body length	0.92	0.88	0.83	0.86	0.81
trochanter I	21 (20-24)	25 (24-28)	41	54 (53-57)	-
femur I	54 (53-57)	68 (65-69)	95 (94-98)	124 (123-127)	184 (176-192)
genu I	20	24	31 (28-32)	42 (41-45)	45 (41-49)
tibia I	31 (28-32)	41	53 (49-57)	68 (65-69)	79 (77-82)
tarsus I	69 (65-73)	79 (77-82)	103 (102-106)	121 (118-123)	159 (155-164)
Leg II	169 (166-170)	198 (190-202)	248 (243-251)	371 (367-375)	380 (376-384)
leg II:body length	0.80	0.73	0.64	0.78	0.66
trochanter II	20	23 (20-24)	33 (32-36)	57	-
femur II	41	53	70 (65-73)	103 (102-106)	136 (131-143)
genu II	20	24	29 (28-32)	41	41
tibia II	29 (28-32)	35 (32-36)	41	58 (57-61)	64 (61-65)
tarsus II	58 (57-61)	64 (61-65)	74 (73-77)	111 (110-114)	139 (135-143)
Leg III	174 (170-178)	210 (210-211)	268 (265-269)	349 (346-350)	462 (448-475)
leg III:body length	0.82	0.78	0.69	0.73	0.80
trochanter III	25 (24-28)	35 (32-36)	46 (41-49)	61	83 (82-86)
femur III	41	46 (45-49)	61	89 (86-90)	103 (98-106)
genu III	20	24	28	33 (32-36)	38 (36-41)
tibia III	29 (28-32)	38 (36-41)	45	61	79 (77-82)
tarsus III	58 (57-61)	68 (65-69)	87 (86-90)	105 (102-106)	159 (155-164)
Leg IV	-	220 (214-224)	316 (313-317)	427 (419-437)	606 (597-613)
leg IV:body length	-	0.81	0.82	0.90	1.06
trochanter IV	-	39 (36-41)	57	80 (77-82)	124 (123-127)
femur IV	-	50 (49-53)	74 (73-77)	98 (94-102)	134 (131-135)
genu IV	-	24	28	38 (36-41)	42 (41-45)
tibia IV	-	29 (28-32)	52 (49-53)	77 (73-82)	114 (110-118)
tarsus IV	-	79 (77-82)	105 (102-106)	134 (131-135)	192 (188-196)

nymph: I (1–6–4–5–18) [1–2–2], II (1–6–4–5–15) [1–1–2], III (4–5–3–4–15) [1–1–0], IV (2–5–3–4–12) [0–1–0]. Most of the setae are slightly barbed (only some of dorsal setae are distinctly barbed); barbs are visible unilaterally as a rule. Tibiae I–III (and IV in deuto-, tritonymphs) and genera I–III with coupled seta *d* and solenidion. Solenidion ϕ_1 flagellate; other solenidia setiform or rod-like. Tibia I with very long solenidion and short seta *d*; tibia IV with long solenidion and slightly shorter seta *d*; tibiae II–III and nymphal genera with seta *d* slightly longer than solenidion; larval genera with minute seta *d* and well developed solenidion. Famulus emergent, short, setiform.

REMARKS

The comparative analysis of juveniles in some genera of Damaeidae are given earlier (ERMILOV and LOCHYNSKA 2009, ERMILOV 2010). Juvenile stages of *Metabelbella tichonravovi* are the most similar in appearance (cuticle, cerotegument, morphology

Table 3. Development of leg setation of *Metabelbella tichonravovi**

	Trochanter	Femur	Genu	Tibia	Tarsus
Leg I					
Larva	–	<i>d, bv''</i>	$\underline{d\sigma}, (l)$	$\underline{d\phi}_1, (l), v'$	<i>(ft), (tc), (p), (u), (a), s, (pv), (pl), e (minute), \omega_1</i>
Protonymph	–	–	–	–	ω_2
Deutonymph	<i>v'</i>	<i>(l₁)</i>	<i>v'</i>	<i>v'', \phi_2</i>	–
Tritonymph	–	<i>(v₁)</i>	–	–	<i>(it)</i>
Adult	–	<i>(l₂), (v₂)</i>	–	<i>d</i> lost	<i>(v)</i>
Leg II					
Larva	–	<i>d, bv''</i>	$\underline{d\sigma}, (l)$	$\underline{d\phi}, l', v'$	<i>(ft), (tc), (p), (u), (a), s, (pv), \omega_1</i>
Protonymph	–	–	–	–	–
Deutonymph	<i>v'</i>	<i>(l₁)</i>	<i>v'</i>	<i>l''</i>	ω_2
Tritonymph	–	<i>(v₁)</i>	–	<i>v''</i>	<i>(it)</i>
Adult	–	<i>(l₂), (v₂)</i>	–	<i>d</i> lost	<i>(v)</i>
Leg III					
Larva	–	<i>d, ev'</i>	$\underline{d\sigma}, l'$	$\underline{d\phi}, l', v'$	<i>(ft), (tc), (p), (u), (a), s, (pv)</i>
Protonymph	<i>v'</i>	–	–	–	–
Deutonymph	<i>l'</i>	<i>l₁'</i>	<i>v'</i>	<i>v''</i>	–
Tritonymph	<i>d, v''</i>	<i>(v₁)</i>	–	–	<i>(it)</i>
Adult	–	<i>l_{1}'', l_{2}', (v₂)}}</i>	<i>v''</i>	<i>l'', d</i> lost	<i>(v)</i>
Leg IV					
Protonymph	–	–	–	–	<i>fi'', (p), (u), (pv)</i>
Deutonymph	<i>v'</i>	<i>d, ev'</i>	<i>d, l'</i>	$\underline{d\phi}, l', v'$	<i>(tc), (a), s</i>
Tritonymph	<i>l'</i>	<i>l_{1}', (v₁)}</i>	<i>v'</i>	<i>v''</i>	–
Adult	<i>d</i>	<i>l_{1}'', l_{2}', (v₂)}}</i>	<i>v''</i>	<i>l'', d</i> lost	<i>(v)</i>

*Roman letters refer to normal setae (*e* — famulus), Greek letters refer to solenidia, $\underline{d\sigma}$ and $\underline{d\phi}$ — 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.

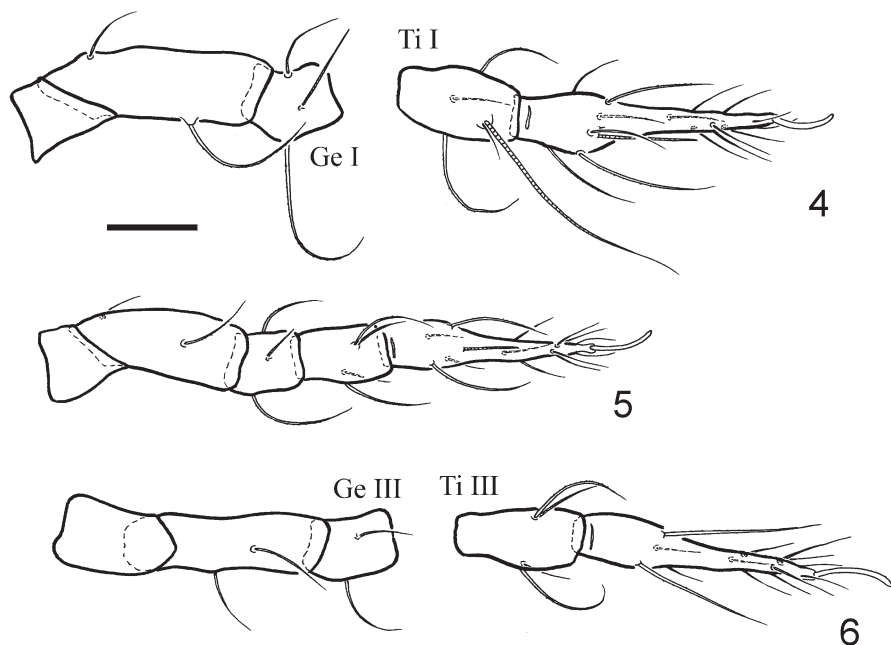
of setae, body setal formulas) to juvenile stages of *Metabelba* GRANDJEAN, 1936. Only juvenile stages of *Metabelba papillipes* (NICOLET, 1855) and *Metabelba glabriseta* MAHUNKA, 1982 are known (ERMILOV 2010, ERMILOV et al. 2010). There are only several differences presented below.

Larvae:

- gastronomic setae dp longest in *M. tichonravovi*; lp longest in *Metabelba*.
- gastronomic setae da longer than dm in *M. tichonravovi* and *M. glabriseta*; da and dm of approximately identical lengths in *M. papillipes*.
- gastronomic setae h_1 and h_2 long in *M. tichonravovi* and *M. glabriseta*, short in *M. papillipes*.

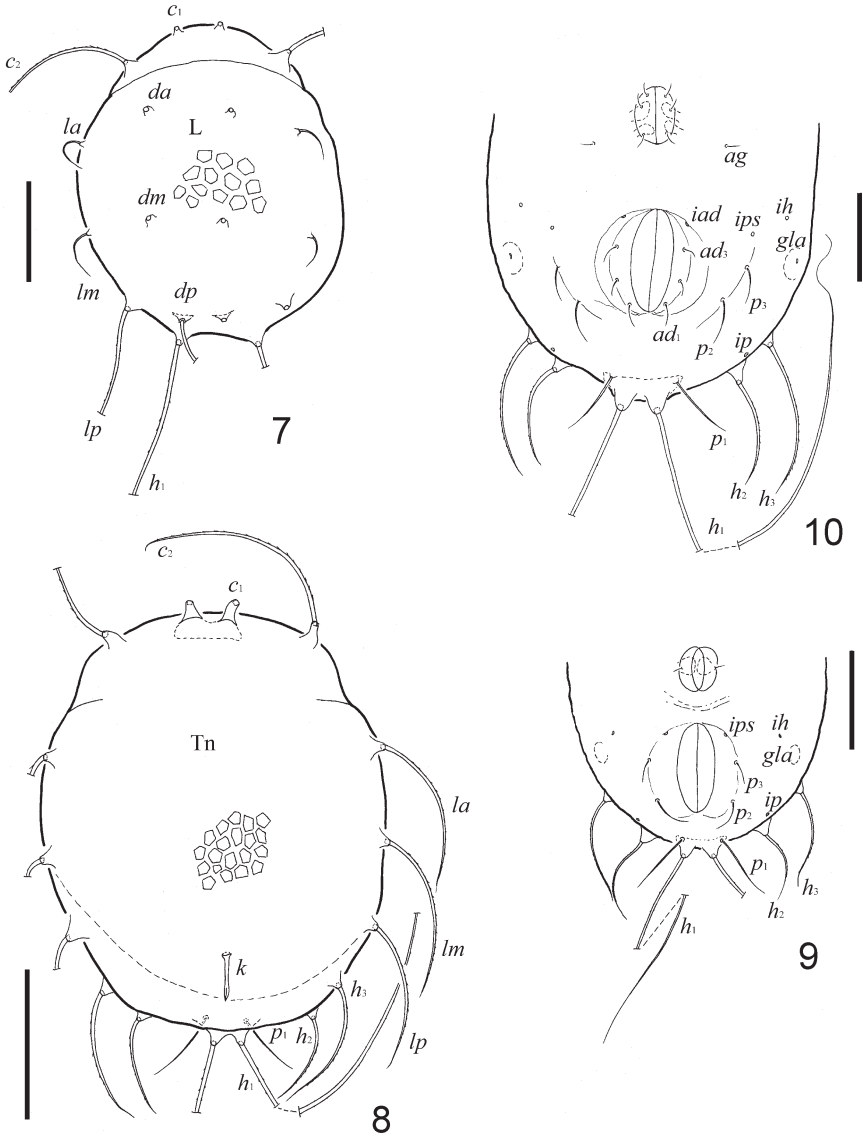
Nymphs:

- protonymphal and deutonymphal gastronomic setae h_2 similar with h_3 in *M. tichonravovi*; h_2 shorter and thinner than h_3 in *Metabelba*.
- cornicles long, slightly curled, distally with weakly developed swelling in *M. tichonravovi* and *M. glabriseta*; helical in *M. papillipes*.
- gastronomic setae h_1 are the longest in *M. tichonravovi* and *M. papillipes*; similar in length setae c_1, c_2, h_1 the longest in *M. glabriseta*.
- dorsal gastronomic setae distinctly barbed in *M. tichonravovi* and *M. glabriseta*; only c_1, c_2 with numerous barbs (other setae with rare barbs) in *M. papillipes*.



4-6. *Metabelbella tichonravovi*, larva: 4 – leg I, left, dorsal view, 5 – leg II, left, dorsal view, 6 – leg III, left, dorsal view; Ti, Ge – tibiae, genua, accordingly. Scale bar 20 μm

– subcapitular setae slightly barbed, setae *m* longer than *a* and *h* in *M. tichonravovi* and *M. glabriseta*; all setae smooth and similar in length in *M. papillipes*;
 – setae *d*, *v*'' of trochanters III and setae *v*₁' of femora IV appear in tritonymphs of *M. tichonravovi* and *M. papillipes*; in *M. glabriseta* – in adult stage.

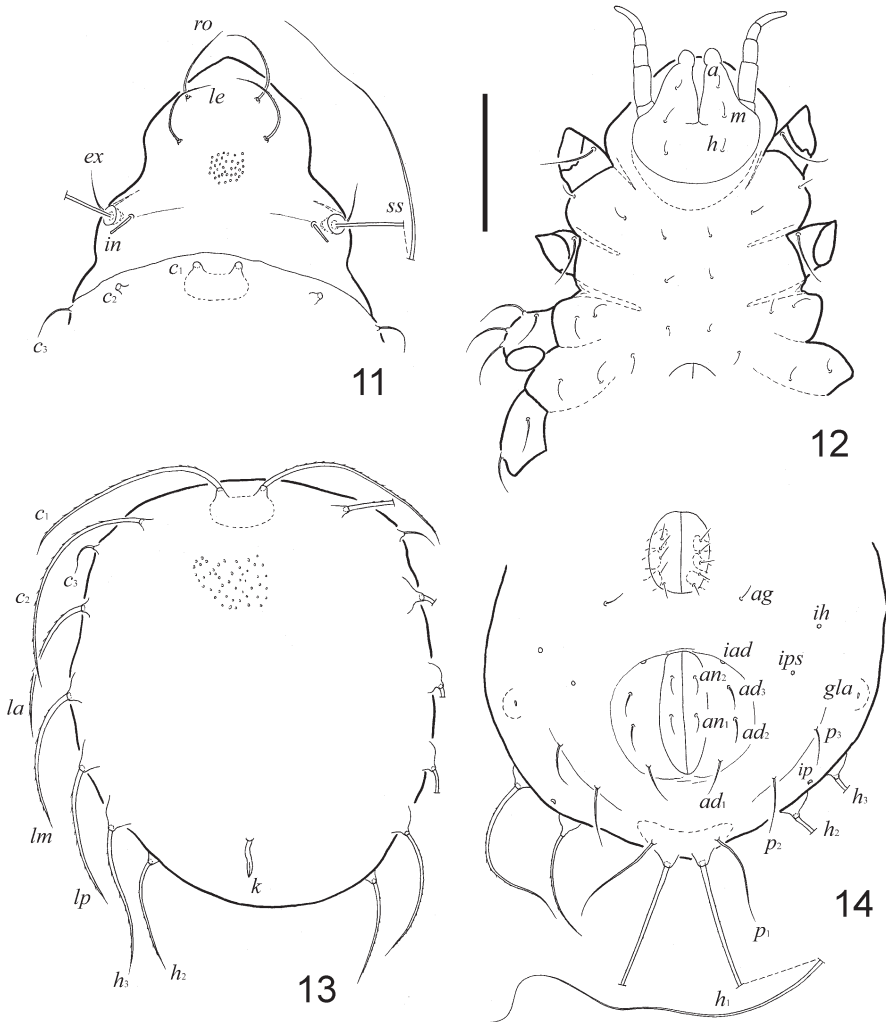


7-10. *Metabellia tichonravovi*, juveniles: 7 – larval (L) scalp, 8 – tritonymphal (Tn) scalp, 9 – anogenital region of protonymph; 8 – anogenital region of deutonymph. Scale bar 50 μ m (7, 9, 10), 100 μ m (8)

Redescription of adult:

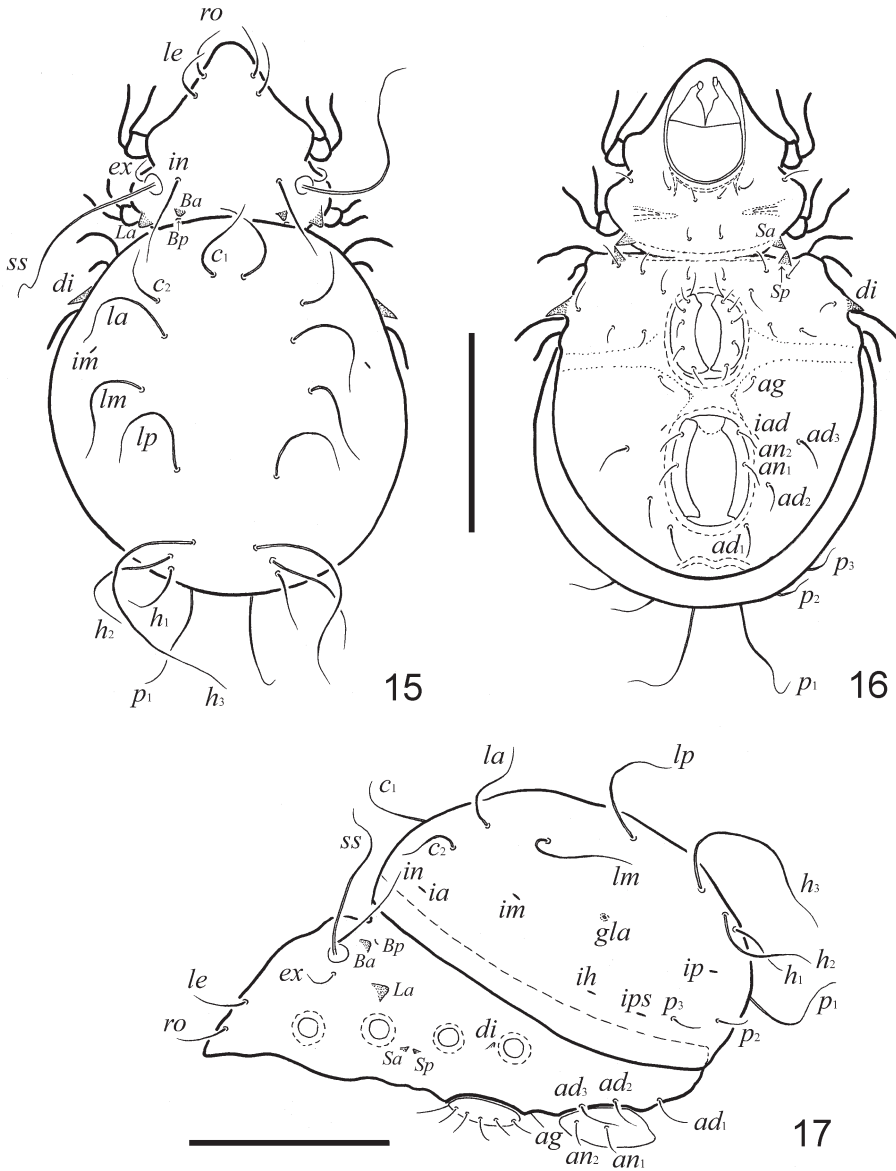
DIAGNOSIS

With character states of *Metabelbella* as summarized by BULANOVA-ZACHVATKINA (1957b, 1962, 1967, 1975), BALOGH and BALOGH (1992), MIKO (2006). *Metabelbella tichonravovi* is characteristic by the size of body, 547-581 × 332-348; tubercles *Ba* and *La* well developed, triangular, blunt-ended; tubercles *Bp* very weakly developed; rostral, lamellar (both 69–77) and interlamellar (102–123) setae setiform, barbed;



11-14. *Metabelbella tichonravovi*, tritonymph: 11 – prodorsum, dorsal view, 12 – gastronomic region, dorsal view, scalps removed, 13 – epimeral region, 13 – anogenital region. Scale bar 100 µm

sensilli 184–205, flagellate, smooth; notogastral setae long, flagellate, smooth (except short, setiform setae p_2 and p_3); parastigmatic tubercles Sa and Sp equal sizes, triangular, pointed; discidium well developed, triangular.



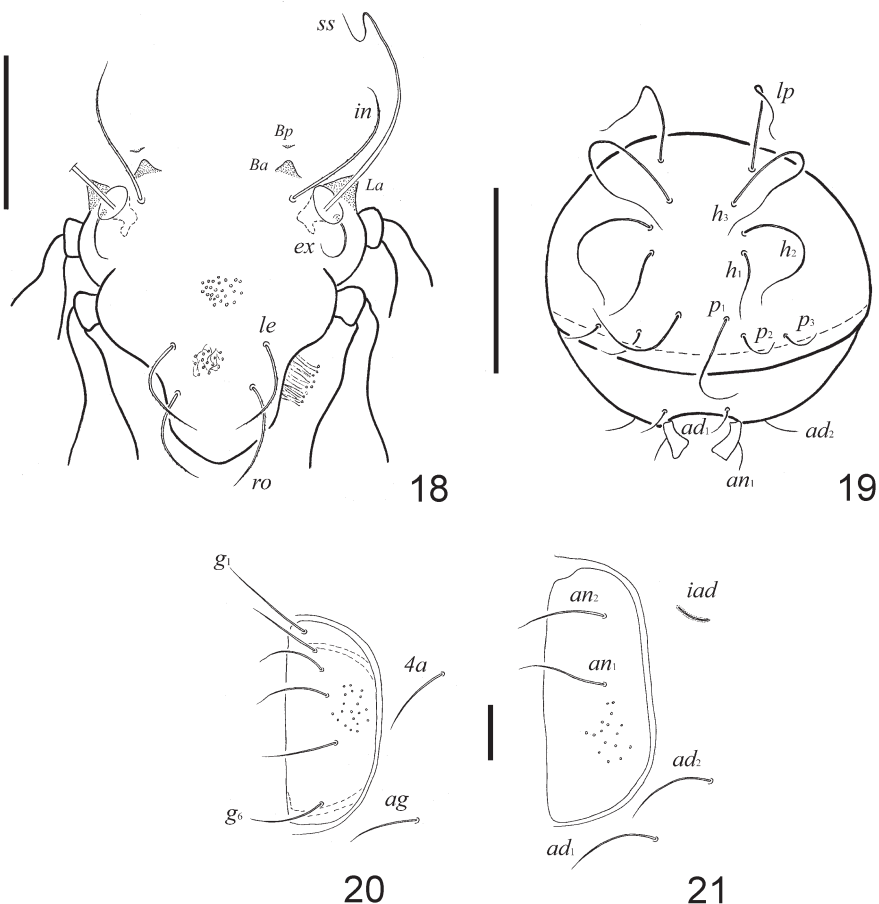
15-17. *Metabelbella tichonravovi*, adult: 15 – dorsal view, legs partly not shown, 16 – ventral view, legs partly not shown, 17 – lateral view, legs and gnathosoma not shown. Scale bar 200 μ m

DESCRIPTION

Dimensions. Body length 547-581 (mean 571; nine specimens), body width 332-348 (340; nine specimens). Body 1.7 times longer than wide.

Integument. Body color yellowish brown to brown. Surface of body and leg segments with granular and filamentous cerotegument. Granules are small, spherical (up to 4 μm). Setae of prodorsum with cerotegument; setae of notogaster with or without cerotegument.

Prodorsum (Figs. 15, 17, 18). Rostrum conical, rounded in dorsal view. Prodorsal tubercles *Ba* and *La* well developed, triangular, blunt-ended; *La* larger than *Ba*. Tubercles *Bp* very weakly developed (as sclerotized line or very small hillock). Rostral, lamellar (both 69-77) and interlamellar (102-123) setae setiform, barbed. Sensilli 184-

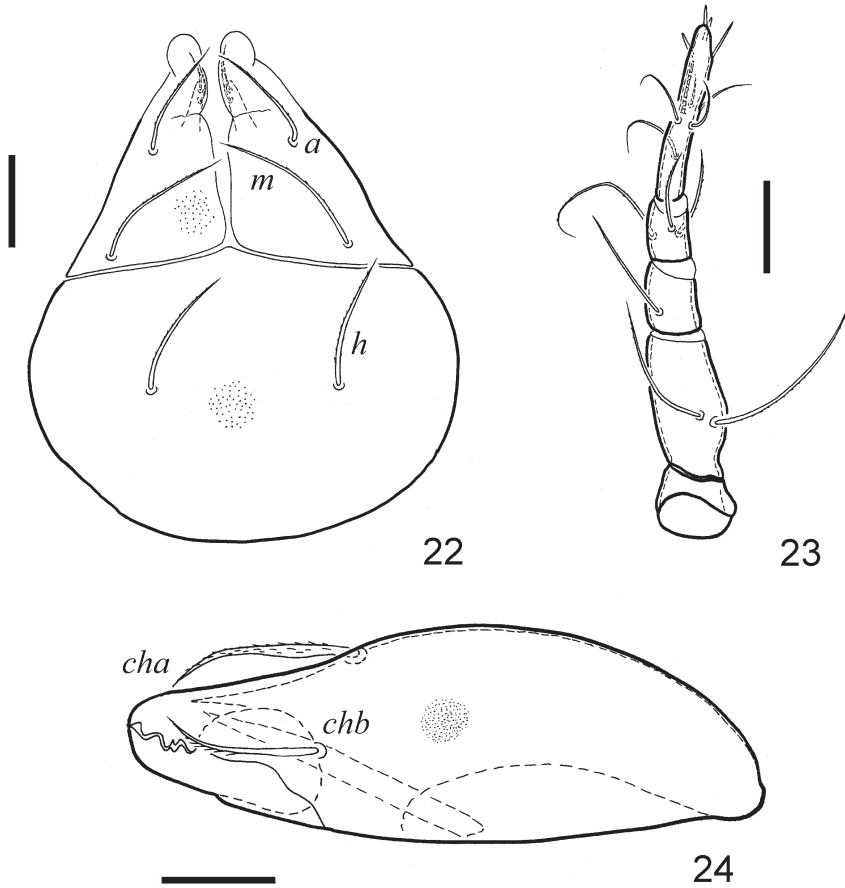


18-21. *Metabelbella tichonravovi*, adult: 18 – prodorsum, dorso-anterior view, legs partly not shown, 19 – posterior view, legs not shown, 20 – genital plate, left, aggenital seta and epimeral seta *4a*, 21 – anal plate, left, adanal setae *ad₁* and *ad₂*, lyryfissure *iad*. Scale bar (18) 100 μm , Scale bar (19) 200 μm , scale bar (20, 21) 20 μm

205, flagellate, smooth. Exobothridial setae 49-53, setiform, smooth. Bothridia well developed, funnel-shaped, with large opening, directed posterolaterad.

Notogaster (Figs. 15, 17, 19). Notogastral setae long, flagellate, smooth (except short, setiform setae p_2 and p_3). Setae h_3 longest. Distance between setae: c_1-c_1 24-28, c_2-c_2 147-155, $la-la$ 127-135, $lm-lm$ 176-188, $lp-lp$ 98-106, h_3-h_3 61-65, h_2-h_2 94-98, h_1-h_1 98-102, p_1-p_1 49-57, c_1-c_2 61-65, c_2-la 41-45, c_1-la 73-82, $la-lm$ 61, $lm-lp$ 86-94, $lp-h_3$ 77-86, h_3-h_2 36-45, h_2-h_1 24-28, h_1-p_1 53-57. Lyrifissures ia , im , ih , ips , ip and latero-opisthosomal glands opening (gla) well visible.

Anogenital region (Fig. 16, 20, 21). Setation typical for Damaeidae (GRANDJEAN 1960 NORTON 1978): 2 pairs of anal setae (32-41), 3 pairs of adanal setae (41-49), 6 pairs of genital setae (28-36, anterior pair longer 36-41), 1 pair of aggenital setae (28-32). All setae setiform, thin, smooth. Adanal lyrifissures (iad) well visible.

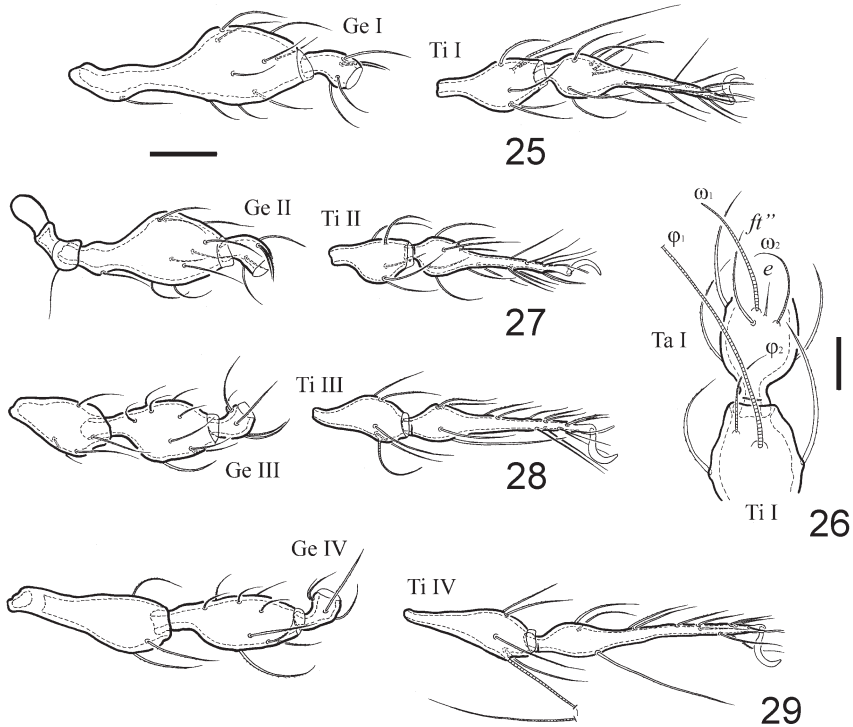


22-24. *Metabelbella tichonravovi*, adult: 22 – subcapitulum, 23 – palp, 24 – chelicera. Scale bar 20 μ m

Epimeral region (Fig. 16). Parastigmatic tubercles *Sa* and *Sp* equal sizes, triangular, pointed. Discidium (*di*) well developed, triangular. Epimeral setal formula (I-IV epimere): 3-1-3-4. Epimeral setae 20-36, setiform, thin, smooth.

Gnathosoma (Figs. 22-24). Typical of Damaeidae (NORTON 1978). Subcapitulum longer than wide (114-118 × 90-98). Hypostomal setae *a*, *m*, *h* setiform, barbed; *h* and *a* equal length (28-32), little shorter than *m* (36-41). Lateral lips with 2 pairs setiform, slightly barbed of adoral setae (12-16). Palps 110-118; with setation 0-2-1-3-9(+1 ω). All setae (except on tarsus) barbed. Chelicerae 110-114, with few blunt and point teeth on fixed and movable digits. Cheliceral setae long, setiform (*cha* thickened basally), barbed (barbs of *chb* long in middle-distal part); *cha* (36) longer than *chb* (28-32).

Legs (Figs. 25-29, Tables 2 and 3). Legs I-III shorter than body length, legs IV longer than body length. Leg formulas: I (1-10-4-4-20) [1-2-2], II (1-10-4-4-17) [1-1-2], III (4-9-4-4-17) [1-1-0], IV (3-9-4-4-14) [0-1-0]. Setae setiform; most setae barbed. Famulus well developed, setiform, pointed. Solenidion ϕ_1 on tibia I very long, with flagellate tip; other solenidia shorter, setiform or rod-like. Genua I-III with seta *d* slightly longer than solenidion.



25-29. *Metabelbella tichonravovi*, adult: 25 - leg I, without trochanter, left, paraxial view, 26 - partly tarsus and tibia of leg I, right, dorsal view, 27 - leg II, right, antiaxial view, 28 - leg III, right, antiaxial view, 29 - leg IV, right, antiaxial view; Ta, Ti, Ge - tibiae, genua, accordingly. Scale bar 50 μ m

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