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The larval chaetotaxy of *Bathyphantes eumenis* (L. KOCH, 1879) and *Trochosa ruricola* (DE GEER, 1778) – a model description (Araneae: Linyphiidae, Lycosidae)

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ABSTRACT. A detailed description including analysis of chaetotactic pattern of larvae of two spiders is given for the first time. *Bathyphantes eumenis* (KOCH, 1879) and *Trochosa ruricola* (DE GEER, 1778) - species belonging to different far-related superfamilies (Araneoidea and Lycosoidea) were chosen for the comparative studies. Nomenclature of setae occurring on the larval integument is proposed. Both species examined showed some chaetotactic complexes to be homologous.

Key words: arachnology, morphology, *Bathyphantes eumenis*, *Trochosa ruricola*, morphology, larva, nomenclature of chaetotaxy

INTRODUCTION

Research on larval stages of spiders focuses on general morphological description and only the level of development of sensory structures, spinnerets and tarsal claws is taken into consideration (HOLM 1940, VACHON 1957, CANARD 1987, DOWNES 1987, CANARD & STOCKMAN 1993, HALLAS 1988, GALIANO & GOLOBOFF 1996).

Some taxonomic studies on immature stages were carried out among Salticidae where the pace of development and the morphology of species belonging to subfamilies Spartaeinae and Lyssomaninae were studied (HALLAS 1988). Another study on larval morphology was carried out among Mygalomorphae (GALIANO & GOLOBOFF 1996). They studied the genus Diplura and stated that the specific leg spination could be the synapomorphic feature for this group. However, all the

above mentioned papers lacked the detailed description of chaetotaxy which might be a crucial character useful in morphological-systematic studies as it was in the case of similar studies carried out among other groups of invertebrate Coleoptera (e.g. NAYROLLES & BETSCH 1993, KILIAN 1998, BOROWIEC & ŚWIĘTOJAŃSKA 2003) and Collembola (POMORSKI 1996).

The only detailed analysis of spiders chaetotactic pattern was provided in the paper describing morphology of the protonymph (sensu VACHON 1957) of *Bathyphantes eumenis* (L. KOCH 1879) (RYBAK and POMORSKI 2003).

Characters occurring in larval stages of spiders are also very interesting when taking into account ontogenetic criterion, which states that ontogeny may recapitulate phylogeny. Such a research on early postembrional stages enables us to get the information on the morphology of today's spiders ancestors.

The present paper is the first presenting the detailed description of spiders larval chaetotaxy. The nomenclature concerning postembrional development is still ambiguous but following the terms proposed by M. VACHON, the stage examined is called larvae (VACHON 1957). It is the first postembrio with completely segmented legs and the first to possess chaetotactic structures on the integument. According to other authors, the stage corresponds to IV instar (GALIANO 1991), Stage D (HOLM 1940), larva (VACHON 1957), préjuvenilé (Ji 1) (CANARD 1987), larva "setose stage" (HALLAS 1988).

The objectives of this study were:

- to provide the first complete description of chaetotactic pattern observed in the larvae of *B. eumenis* and *T. ruricola*;
- to propose a nomenclature of particular setae;
- to create a model of the larval description for future research on spiders larval chaetotaxy.

MATERIAL AND METHODS

As a model two species representing two superfamilies: Araneoidea and Lycosoidea were chosen for the study. Araneoidea belonging to Orbicularia group is considered to be a sister group to RTA Clade (CODDINGTON and LEVI 1991) which comprises superfamily Lycosoidea. The specimens of *T. ruricola* were collected in a mixed forest near the city of Wrocław. The specimens of *B. eumenis* were sampled from deep sandstone crevices in the stone labyrinth "Błędne Skały" Nat. Reserve in the Stołowe Mountains (Sudets), the only locality of the species in Poland. To collect larval stages in question fertilized females or fully formed egg sacs were collected. The cocoons were preserved in incubators and observed every day. The incubators were composed of 3 petri dishes: the smallest one contained eggs and was located on the bottom of a larger one where wet cotton was placed. These two dishes were covered with the third one reversed. Particular attention was paid to providing a high level of humidity and to sterilizing the incubators since the eggs showed sensibility to drought and the presence of fungi.

Once infected by mould, the eggs died immediately. At the appropriate stage of development, the specimens were moved to 75% ethanol, transferred to KOH solution and cleared in distilled water finally. Then the specimens were moved into chloramphenol and mounted in Swan medium. All slides were observed under phase contrast microscope Nikon Eclipse E 600 with a drawing attachment. 56 specimens of *Bathyphantes eumenis* and 64 of *Trochosa ruricola* were examined.

RESULTS

The characters used in the description of larval stages include external morphological structures. The classification of setae and sensilla used here are presented in Fig. 26 and contributes to the classification applied by RYBAK and POMORSKI (2003):

- **S** – long spine broadened at the base and gradually tightening towards the top. Larval spines have smooth sculpture and simple, round chaetopore
- **s** – shortened spine S
- **T** – thin smooth setae, sharply tipped; chaetopor round distinct
- **t** – shortened seta T
- **Ŧ** – usually bluntly tipped setae, smooth; chaetopor not clearly visible
- **ŧ** – shortened setae **Ŧ**
- **$Ŧ_D$** – similar to Ŧ but small denticles on its surface occur in different intensity
- **M** – microsetae, whose length was to small to classify it as any of the above mentioned structure
- **C** – chaetopor like structures
- Liryform organs **(Ly)** and slit sensilla **(Sl)**: mechanoreceptors observed on the larval body, most numerous on the legs. Their function is to register and transmit mechanical stress in the cuticle caused by substrate vibrations, gravity or by the spider's own movements (SEYFART & BARTH 1972)

The presence of the chaetotactic structures occurring on the particular body parts of both species examined is given in Table 1.

Model description of larval morphology is presented in: Table 2 and 3 for *Bathyphantes eumenis*, and in Table 4 and 5 for *Trochosa ruricola.*

DISCUSSION

The study showed difference in chaetotactic pattern between *Bathyphantes eumenis* and *Trochosa ruricola* but some areas of body showed the same setae distribution. The complexes present in both species *B. eumenis* and *T. ruricola* appear to be homologous:

1. Three out of four complexes ($T_{DA,}$ T_{DM} $T_{VAI,}$ T_{VAII}) are present on legs tarsi of both species, implying that these complexes are homologous in both species

examined. Pedipalps of the species possess also homologous complexes ($T_{DA,}$ $T_{VAI,}$ $T_{VAII,}$ T_{VM}).

2. Remaining leg segments (metatarsus, tibia, patella, femur, trochanter, coxa) show differences between chaetoactic complexes of *Bathyphanthes eumenis* and *Trochosa ruricola*, which make it impossible to establish homology among them.

3. *Trochosa ruricola* possesses a constant number of setae on each leg whereas *Bathyphantes eumenis* shows different number of structures on legs I, II, III, IV.

4. Differences were observed in the morphology of chelicerae and maxillae. The poison fang of *Bathyphantes eumenis* is not fully developed and the basal segment lacks any spine. In contrast, the fang of *Trochosa ruricola* was well-developed and chaetotactic complexes ($Ch_{DA,}$ Ch_{VAM}) were observed on the basal segment. Labium of *B. eumenis* has no special structures but single spine situated medially was observed on the maxillae, while larvae of *T. ruricola* possess numerous setae on both maxillae (complexes $Ma_{DS,}$ $Ma_{DP,}$ $Ma_{VS,}$ Ma_{VI}) and labium(two complexes La_{DL} and one complex La_{DM}).

5. Chaetotactic pattern is a constant feature an can be useful in both morphological and phylogenetic studies.

Table 1. Presence of chaetotactic structures on larval body of *Trochosa ruricola* and *Bathyphantes eumenis*

Body part	*T. ruricola*	*B.eumenis*
Chelicerae	+	-
Labium	+	-
Maxillae	+	+
Sternum	-	-
Carapace	-	-
Palp	+	+
Legs	+	+
Abdomen	-	-
Spinnerets	-	-

Table 2. Morphology of *Batyphantes eumenis* larval stage (chelicera, maxilla, labium)

Body parts	
Chelicerae, Ch: (Fig. 1)	Micro-sculpture: small spines; poison fang round, not completely developed **Dorsal**:. No structures **Ventral side**: 2 Sl
Maxillae, (Ma) (Fig. 2)	Micro-sculpture: small spines **Dorsal**: no structures **Ventral**: single spine Ma_{v0}–S type
Labium, La (Fig. 2)	no structures

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Table 3. Morphology of *Bathyphantes eumenis* larval stage (legs nad palps)

Leg segment	
Tarsus, T: Legs I, II (Fig. 7,8) Legs III (Fig. 9) Legs IV (Fig. 10) Palps (Figs 3,4)	Two well-developed claws and a third short process present on all legs. Single claw on palp tarsus **Dorsal**: apical complex T_{DA} ($T_{d1,}$ $T_{d2,}$ T_{d3} - S type), medial complex T $_{DM}$ ($T_{d4,}$ T_{d5} - S type); 1Sl medially. **Ventral**: I apical complex T_{VAI} ($T_{v1,}$ T_{v2} - S type); II apical complex T_{VAII} ($T_{v3,}$ T_{v4} - S type); III apical complex T_{VAIII} complex ($T_{v5,6,7}$ - S type); medial complex T_{VM} ($T_{v8,}$ T_{v9}- S type); **Dorsal**: no changes **Ventral**: T_{VM}: lack T_{v8}. **Dorsal**: no changes **Ventral**: T_{VAI}: lack $T_{v1;}$ T_{VAIII}: lack $T_{v5,6}$ T_{VM}: lack T_{v8} **Dorsal**: apical complex T_{DA} ($T_{d1,}$ $T_{d2,}$ T_{d3} - S type), 1 Sl laterally **Ventral**: I apical complex T_{VAI} ($T_{v1,}$ T_{v2} - S type); II apical complex T_{VAII} ($T_{v3,}$ T_{v4} - S type); medial complex T_{VM} ($T_{v5,}$ T_{v6})
Metatrasus, Me Legs I, II (Fig. 7) LegsIII, IV	 **Dorsal**: distally-medially Me_{d0} - S type; 1Ly centrally near proximal ending **Ventral**: no structures **Dorsal**: lack of Me_{d0}; 1Ly as in III legs **Ventral**: no structures
Tibia, Ti: Legs I, II (Fig. 5) Legs III, IV (Fig. 6) Palp (Fig. 3)	 **Dorsal**: distal spine $Ti_{d1,}$ proximal Ti_{d2} - both of S type; 1Sl laterally **Ventral**: no structures **Dorsal**: lack of Ti_{d2}, 1Sl laterally **Ventral**: no structures **Dorsal**: medially: single $Ti_{d0;}$ retrolateral 1Sl, distal:1Ly **Ventral**: no structures
Patella, Pa: Legs I, II,I II, IV (Fig. 5) Palps (Fig. 3)	 **Dorsal**: 1 Ly laterally **Ventral**: no structures **Dorsal**: 1 Sl laterally **Ventral**: no structures
Femur, Fe: Legs I, II,I II, IV (Fig. 6) Palps (Fig. 3)	 no structures no structures

Table 3. Continuation

Leg segment	
Trochanter, Tr : Legs I, II, III, IV (Fig. 6) Palps (Fig. 3)	**Dorsal**: no structures **Ventral**: 1Sl **Dorsal**: no structures **Ventral**: 1Sl
Coxa, Co: Legs I, II, III, IV (Fig. 6)	**Dorsal**: no structures **Ventral**: central spine Co_{v0} no structures

Table 4. Morphology of *Trochosa ruricola* larval stage (chelicerae, maxillae, labium)

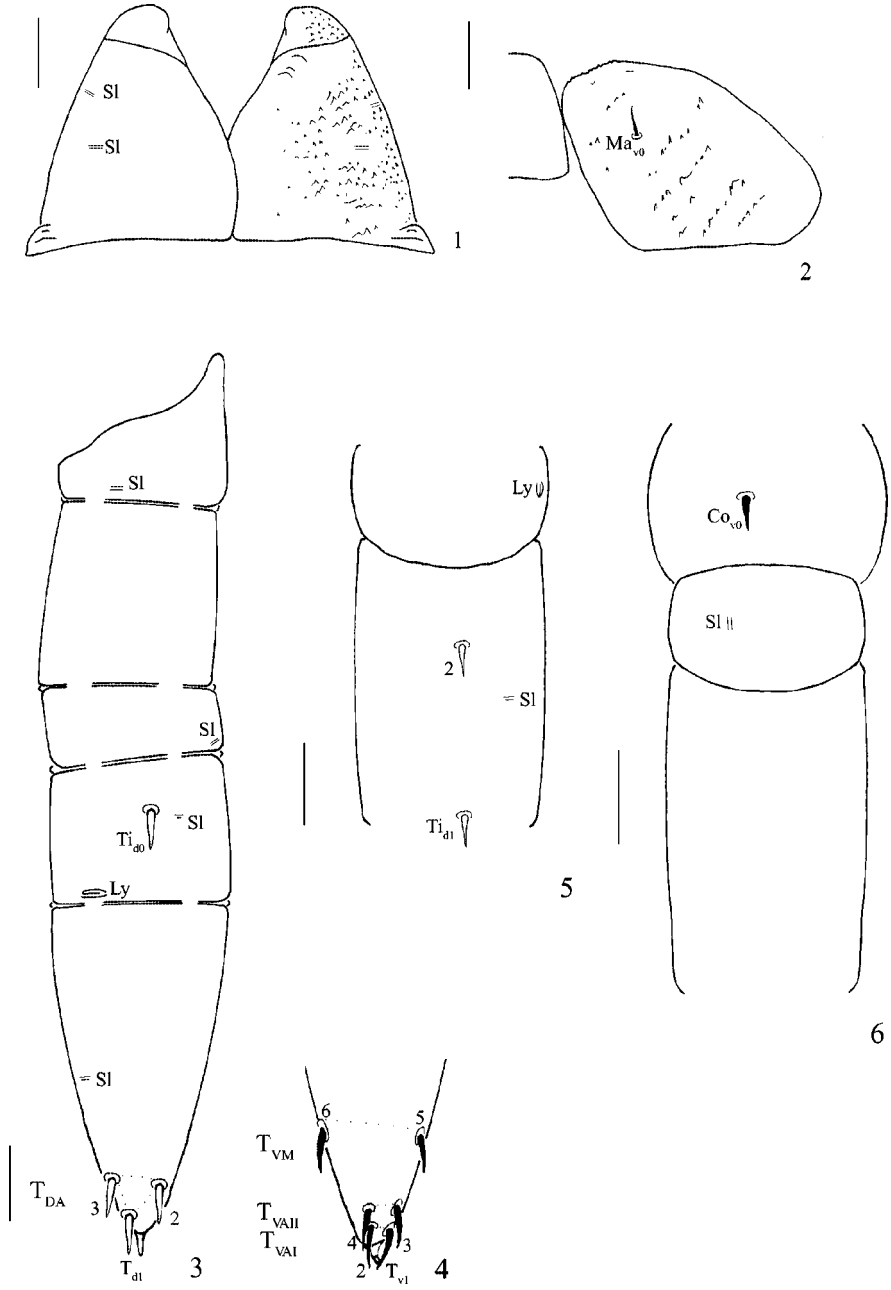
Body parts	
Chelicerae, Ch: (Figs 11-14)	Micro-sculpture: small delicate denticles mainly apically; poison fang well-developed, sharply tipped; 3 cuticular dentes on promarginal edge of chelicerae **Dorsal**: apical complex Ch_{DA} (Ch_{d1}- type T, Ch_{d2}, Ch_{d4}, Ch_{d7} - S type, Ch_{d3}, Ch_{d5}, Ch_{d6} - unstable C/M type), 1Sl laterally in the medial part;. 2 *Sl* in the apical part. They are not as clearly visible as Sl located laterally and so they are marked in italics *Sl* **Ventral**: apically- medial complex Ch_{VAM} (Ch_{v1} - ŧ type,Ch_{v2} - unstable M/ ŧ type, Ch_{v3} - unstable T̶ / T_D type Ch_{v4}- ŧ type); 2 *Sl* in the apical part.
Maxillae, Ma: (Figs 15-16)	Micro-sculpture: massive dentes, especially on the promarginal side; well sclerotized **Dorsal**: cuticular, spatula like appendix Ma_A, superior complex Ma_{DS}: (Ma_{d1}- ŧ type, Ma_{d2}- s type); promarginal complex Ma_{DP} (Mad_3, Ma_{d4} -unstable T̶/ T_D type); some individuals lack one seta within this complex **Ventral**: superior complex Ma_{VS} (Ma_{v1}, Ma_{v2}, - S type, Ma_{v3} - t type); inferior complex Ma_{VI} (Ma_{v4}, Ma_{v5} - unstable M/C type).
Labium, La: (Fig. 15)	**Dorsal**: two lateral complexes La_{DL} (number of unstable 2-3 setae, all of ŧ/ T_D type); one medial complex La_{DM} with changeable number of setae (setae within this complex might be of M/ ŧ/ T_D type)
Abdomen (Fig. 25)	Micro sculpture: wrinkles with rows of small denticles

Table 5. Morphology of *Trochosa ruricola* larval stage (legs and palps)

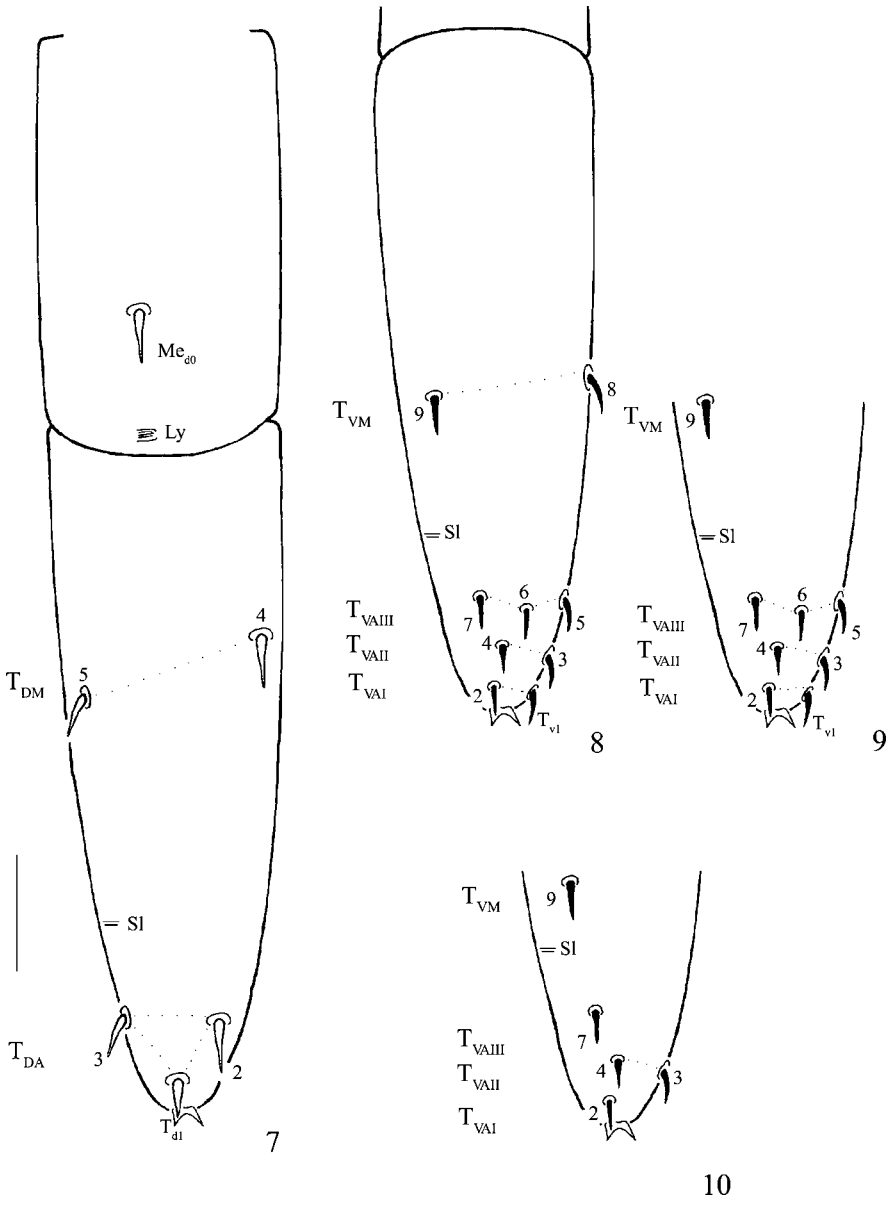
Leg segment	
Tarsus, T:	Two well-developed claws and a third shorter one present on all legs. Single claw on palp tarsus Micro-sculpture: delicate small denticles, mainly apically
Legs I, II (Figs 17-18)	**Dorsal**: apical complex T_{DA} ($T_{d1,}$ $T_{d2,}$ T_{d3} - S type), medial complex T_{DM} ($T_{d4,}$ T_{d5} - S type); 1Sl laterally, 1 T_{d6} of typeC laterally **Ventral**: I apical complex T_{VAI} ($T_{v1,}$ T_{v2} - S type); II apical complex T_{VAII} ($T_{v3,}$ T_{v4}- S type); medial complex T_{VM} ($T_{v5,}$ T_{v7} - S type, T_{v6} - unstable t/M type)
Legs III (Fig. 19)	**Dorsal**: no changes **Ventral**: translocation of $T_{v5, 6, 7}$ in the direction of proximal ending of tarsus
Legs IV (Fig. 20)	**Dorsal**: no changes **Ventral**: further translocation of setae $T_{v7'}$ (complex T_{VM}), transformation of T_{v5*} to t type; remaining setae of the type as in III legs
Palps (Figs 23-24)	**Dorsal**: apical complex T_{DA} ($T_{d1,}$ $T_{d2,}$ T_{d3} - S type), medial complex T_{DM} ($T_{d4,}$ T_{d5} - S type); 1Sl laterally, 11 T_{d6} of type C laterally laterally **Ventral**: I apical complex T_{VAI} ($T_{v1,}$ T_{v2} - S type); II apical complex T_{VAII} ($T_{v3,}$ T_{v4} - S type); I medial complex T_{VMI} ($T_{v5,}$ T_{v6} - S type);
Metatrasus, Me: Legs I, II, III, IV (Fig. 17)	**Dorsal**: distal complex Me_{DD} (Me_{d1} - unstable M/C type, Me_{d2} - t type, Me_{d3} - S type), 1Ly centrally near the distal ending. **Ventral**: no structures
Tibia, Ti:	
Legs I, II (Fig. 21)	**Dorsal**:distal single Ti_{d1}-S type, medial complex Ti_{DM} (Ti_{d2}, Ti_{d3}, Ti_{d4} - unstable type M/C); proximal complex Ti_{DP} (Ti_{d5}- M type, Ti_{d6} - S type) **Ventral**: 1 obscure *Sl* laterally near distal ending
Legs III, IV	**Dorsal**: in proximal complex Ti_{DP} Ti_{d6*} is shortened and transformed to M type **Ventral**: as in legs I, II
Palp (Figs 23-24)	**Dorsa**l: distal complex Ti_{DD} (Ti_{d1} - S type, Ti_{d2} - M type). 1 Sl centrally near the distal ending **Ventral**: no structures
Patella, Pa:	
Legs I, II, III, IV (Fig. 21)	**Dorsa**l: 1Ly laterally **Ventral**: 1 Sl laterally
Palps (Figs 23-24)	**Dorsa**l: 1Ly laterally **Ventral**: 1 Sl laterally

Table 5. Continuation

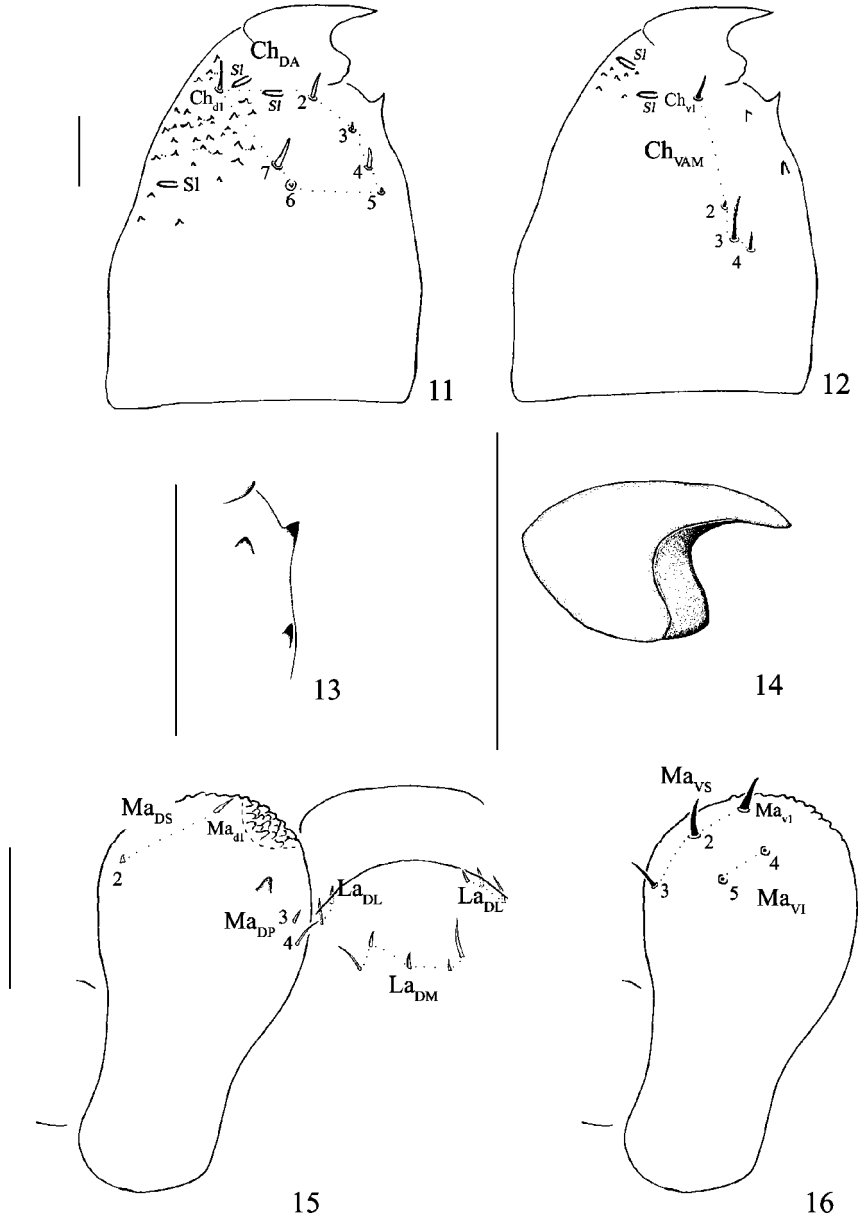
Leg segments	
Femur, Fe: Legs I, II, III, IV (Fig. 22) Palps (Figs 23-24)	**Dorsal**: 2 obscure *Sl*; they might be of unstable character or the sclerotization of that structures is so week that the are not as distinct as those occurring on the remaining leg segments **Ventral**: no structures **Dorsal**: 2 Sl of the same character as in femur of legs **Ventral**: no structures
Trochanter, Tr: Legs I, II, III, IV (Fig. 22) Palps (Figs 23-24)	**Dorsal**: 1Sl centrally **Ventral**: lateral spine Tr_{v0} of t type, 1 Sl centrally **Dorsal**: 1Sl centrally **Ventral**: lateral spine Tr_{v0} - t type , 1 Sl centrally
Coxa, Co: Legs I, II, III, IV (Fig. 22)	**Dorsal**: no structures **Ventral**: medial complex Co_{VM} (Co_{v1} - S type, Co_{v2} - t type)



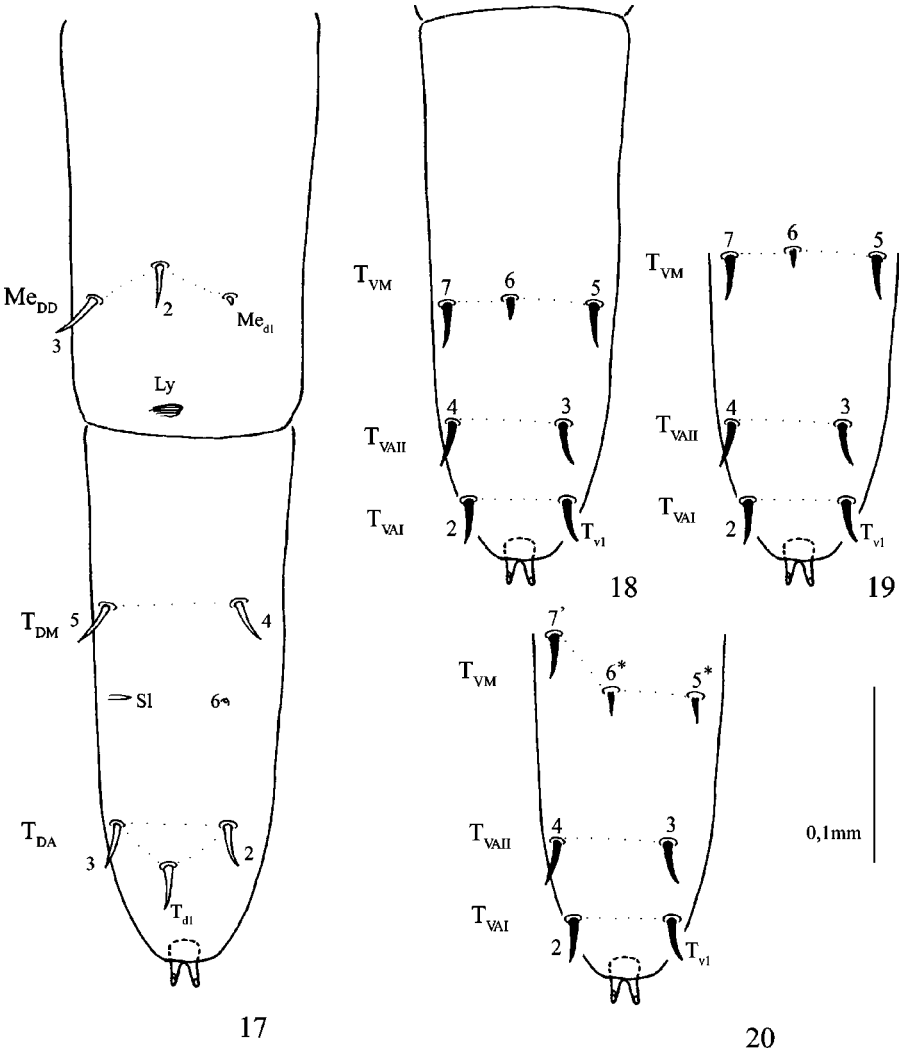
1-6. *Bathyphatntes eumenis*: 1 - chelicerae, 2 - maxillae and labium, 3 - pedipalp, dorsal view, 4 - apical part of tarsus of pedipalp, ventral view, 5 - tibia, patella, dorsal view, 6 - femora, trochanter, coxa, ventral view (scale 20 μm)



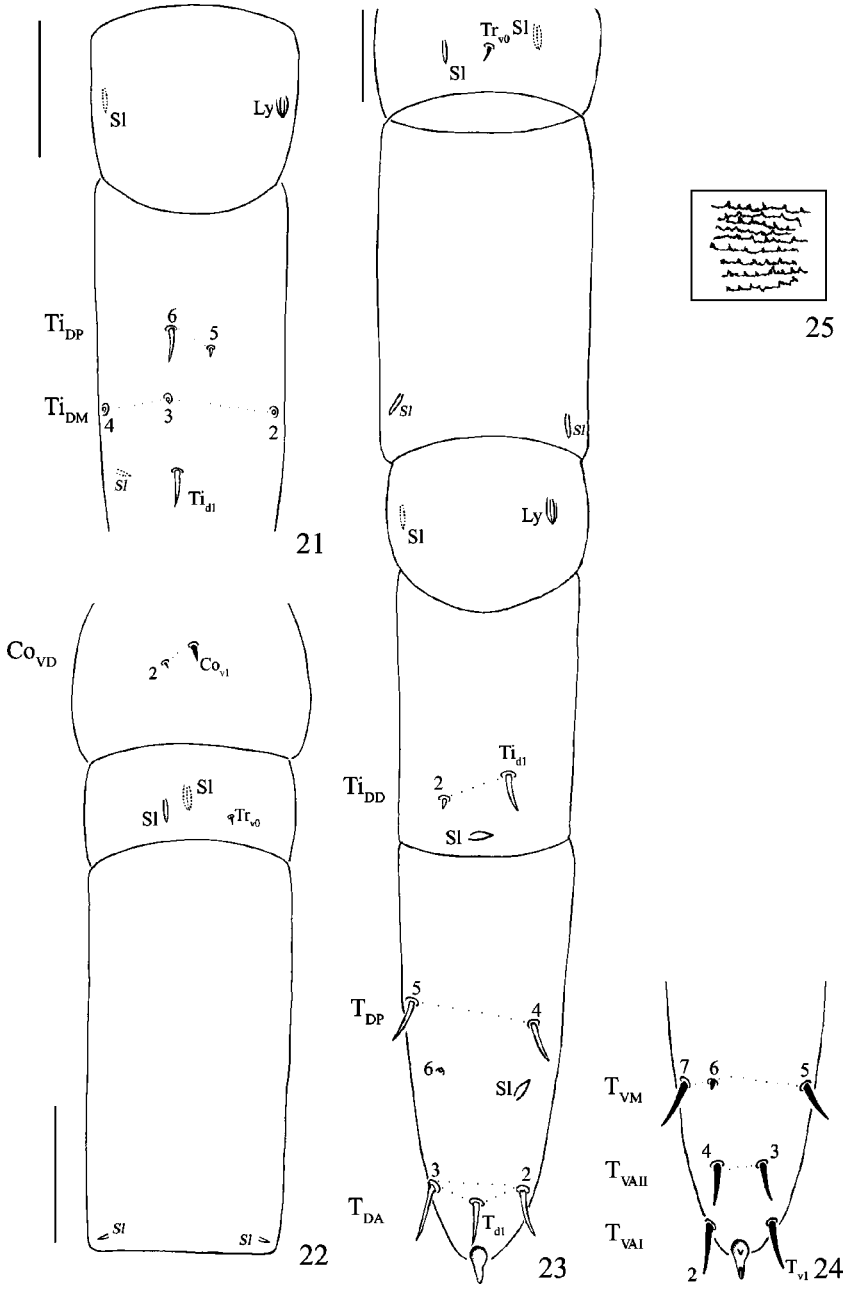
7-10. *Bathyphatntes eumenis*: 7 - tarsus, metatarsus of legs I-IV, dorsal view, 8 - tarsus of legs I, II, ventral view, 9 - apical part of tarsus of leg III, ventral view, 10 - apical part of tarsus of leg IV, ventral view (scale 20 μm)



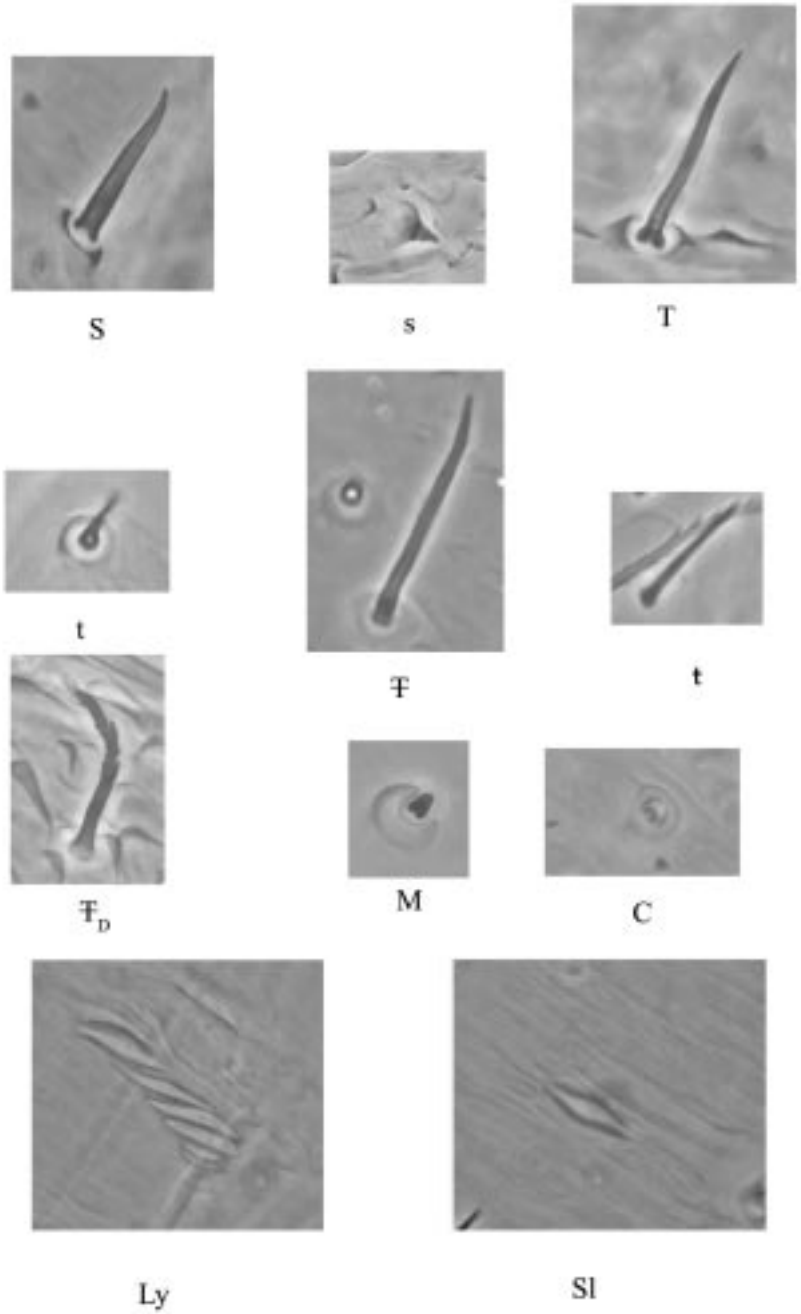
11-16. *Trochosa ruricola*: 11 - chelicerae, dorsal view, 12 - chelicerae, ventral view, 13 - chelicerae, promarginal edge, 14 - chelicerae, fang, 15 - maxillae and labium, dorsal view, 16 - maxillae, ventral view (scale 0.1 mm)



17-20. *Trochosa ruricola*: 17 - tarsus, metatarsus of legs I-IV, dorsal view, 18 - tarsus of legs I, II, ventral view, 19 - apical part of tarsus of leg III, ventral view, 20 - apical part of tarsus of leg IV, ventral view (scale 0.1 mm)



21-25. *Trochosa ruricola*: 21 - tibia, patella, dorsal view, 22 - femora, trochanter, coxa, ventral view, 23 - pedipalp, dorsal and ventral view, 24 - apical part of tarsus of pedipalp, 25 - microsculpture of the abdomen



26. Ventral view of *Bathyphantes eumenis* and *Trochosa ruricola*: morphological structures occurring on the larval body (explanation in the text)