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Morphology of the larval stages of *Arrenurus affinis* Koenike, 1887, *A. neumani* Piersig, 1895, and *A. vietsi* Koenike, 1911 (Acari: Hydrachnidia)

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Abstract. *Arrenurus affinis* and *A. neumani* are well-defined and separate species. On the other hand, *A. vietsi* is known from females only and the basic difference between the species and *A. neumani* involves the shape of the genital alae. The larva of *Arrenurus affinis* is redescribed and the larvae of *A. neumani* and *A. vietsi* are described for the first time. The present paper is aimed at describing the larvae of the three species, to highlight the characters that allow us to differentiate between them. There are no clear-cut differences in larval morphologies of *A. affinis*, *A. neumani* and *A. vietsi*, what renders differentiation between the larvae of the three species impossible.

Key words: acarology, taxonomy, morphology, Parasitengona, water mites, *Arrenurus affinis* group, larvae.

INTRODUCTION

A. affinis and *A. neumani* are well-defined species which differ clearly in the morphology of the males, although distinguishing between the females is not particularly difficult either. On the other hand, *A. vietsi* is known from its females only and the basic difference between the species and *A. neumani* involves the shape of the genital alae. The absence of a known male, a great similarity of the female to that of *A. neumani*, and the extreme scarcity of *A. vietsi* suggest that the differences observed may be an expression of the individual variability of *A. neumani*. Analysis of larval morphology could address the question of the validity of the species.

In recent years studies about larval morphology of *Arrenurus* have been conducted by Prasad & Cook (1972), Stechmann (1977), Smith I.M. (1978), Vainstein (1980),

Tuzovskij (1987), Smith B.P. (1990), Martin (2000), Smith & Cook (2001), Böttger & Martin (2003) and Zawal (2006a, b, c, d, e). Vajnštein (1980) described *Arrenurus affinis* larva.

MATERIALS AND METHODS

The descriptions are based on larvae hatched from eggs laid by females caught in the field. The females were identified with Viets's (1936) key, and in the case of *A. affinis,* the Smit & Duursema (1993) paper was used, and finally in the case of *A. neumani,* Smit's (1996) paper was used. Figure 1 shows the appearance of ventral side of the three species. Before egg laying, each female was kept in a separate 100 cm^3 container filled with water and held at 20-24 ^oC and subsequently fixed in Wilson's liquid (Zawal 2006e). The eggs were maintained until hatching, under similar conditions. The larvae, 48 h post hatch, were mounted in Hoyer's medium; the 48 h period being necessary for the larvae to became fully sclerotised.

The larval morphology of *A. affinis* is redescribed, and *A. neumani* and *A. vietsi* are described (figures and descriptions) based on larvae hatched from eggs laid by a single female of each species. The females of *A. affinis* and *A. neumani* were caught in the field together with their males. The mounts (*A. affinis*: Nos 989 – female, 989a - larva; *A. neumani*: Nos 936 – female, 936a - larva; *A. vietsi*: Nos 637 – female, 637a - larva) are stored at the Department of Invertebrate Zoology and Limnology, University of Szczecin, 71-415 Szczecin, Wąska 13.

Larval body parts were measured on the progeny of one female of *A. vietsi*, and 10 females of *A. affinis* and *A. neumani*.

Drawings were prepared with a drawing attachment to a Nikon ECLIPSE80i microscope. It is difficult to adequately show the arrangement of the secondary setae as they are frequently barely visible. Therefore some of the setae drawn and described as smooth could, in reality, be pectinate. The seta names are those used by Prasad and Cook (1972) with a modification, involving placing before the leg seta symbol, a Roman numeral denoting the leg pair in question (Zawal 2006a), which greatly facilitates comparisons between the larvae of the different species. The metric characters are reported with their ranges, mean values, and standard deviations. The leg segments were measured from their distal margins. In this paper the following abbreviations are used: Cp – coxal plate, Exp – excretory pore, Expp – excretory pore plate.

RESULTS

Arrenurus affinis Koenike, 1887

Arrenurus rufescens Croneberg, 1899.

Dorsal plate shield-shaped, widest in middle of its length, distinctly narrowing in posterior part, with almost straight anterior and rounded posterior margin. Antero-lateral indents deep with obtuse angle, reaching to about one-fifth length of dorsal, and

Table 1. Dimensions (in µm) of individual body parts

	A. affinis (n=10)			*A. neumani* (n=10)			*A. vietsi* (n=6)		
	range	mean	stand. dev.	range	mean	stand. dev.	range	mean	stand. dev.
length	230-244	236.6	4.12	236-244	240.2	2.39	224-240	232.3	5.57
width	184-196	190.0	3.53	178-184	182.0	2.11	166-190	180.0	8.94
dorsal plate length	224-236	229.4	3,27	230-240	235.4	3.27	210-240	228.0	10.51
dorsal plate width	172-184	176.8	3.43	170-174	172.4	1.58	152-174	167.3	8.26
CpI medial margin length	77-78	77.1	0.41	72-78	75.5	1.56	66-76	72.5	3.67
CpII medial margin length	32-34	32.7	0.70	32-36	34.4	1.36	29-34	32.0	1.82
CpIII medial margin length	44-48	45.8	1.13	40-42	41.4	0.98	42-44	42.4	1.01
distance: Mp1-Mp1	62-65	63.4	0.83	62-66	64.1	1.10	50-59	56.1	3.09
distance: Lp1-Lp1	70-74	71.5	1.14	70-74	72.2	1.12	60-68	64.1	2.74
distance: Lp2-Lp2	100-104	102.0	1.26	94-100	97.0	1.68	90-98	93.7	2.97
distance: Mp2-Mp2	58-63	59.8	1.50	56-60	57.8	1.51	51-57	53.5	1.99
distance: Mh1-Mp2	45-47	45.9	0.94	42-46	44.3	1.01	43-46	44.0	1.01
distance: Mp1-Lp1	8-11	10.0	1.02	9-12	10.2	0.92	10-14	10.9	1.87
distance: Mp1-Lp2	43-48	44.4	1.52	34-45	39.9	2.71	38-47	43.1	3.48
distance: Mp1-Mp2	74-80	75.6	1.82	76-80	78.3	1.43	71-84	76.9	4.59
distance: Mp2-Mh1	22-28	24.7	1.75	22-24	22.4	1.00	19-22	20.1	1.18
distance between C1 and CpI median margin	22-23	22.8	0.42	18-21	19.0	0.98	20-22	20.5	0.65
distance between C4 and CpIII median margin	38-39	38.3	0.70	33-36	34.6	1.18	32-35	33.2	1.21
distance between C1 and C2	38-42	39.8	1.30	45-48	46.2	1.25	41-46	43.1	1.99
excretory pore plate length	24-27	25.8	0.91	26-28	27.0	0.66	22-26	24.8	1.43
excretory pore plate width	30-33	31.5	0.77	30-32	31.0	0.74	30-33	31.6	1.10
distance between Exp and Expp posterior margin	12-14	12.7	0.70	12-15	13.6	1.13	14-15	14.3	0.60
distance between E1 setae and Expp anterior margin	4-6	4.64	0.74	4-6	4.56	0.54	2-5	3.87	0.79
distance between E2 setae and Expp posterior margin	10-11	10.2	0.51	10-12	11.2	0.65	10-11	10.5	0.79
PI length	13-14	13.8	0.54	14-15	14.1	0.56	12-14	12.8	1.01
PII length	36-38	36.5	0.67	36-38	36.8	0.75	33-38	35.1	1.99
PIII length	32-34	32.6	0.74	30-34	31.8	1.12	31-33	32.1	0.60
length of PIV claw	25-26	25.2	0.42	24-25	24.3	0.41	22-28	23.7	2.24
length of cheliceral segment I	104-106	104.8	0.65	98-104	101.3	1.69	87-103	99.6	6.61
length of PV 8 seta	154-158	156.3	1.14	132-170	157.4	9.89	134-153	147.9	6.85

*Stechmann (1977) reported the Mh1-Mh1distance; the value given here was obtained by calculating [(Mh1-Mh1) - (Mp2-Mp2)]/2

** Stechmann (1977) reported the Mp1-Mh1 distance; the value given here was obtained by calculating (Mp1-Mh1) - (Mp1-Mp2)

one-quarter of its width. Lp1 seta is tripartite, Lp2 and Mh1 setae are pectinate and thicker than others, remaining dorsal plate setae relatively thin and smooth. Mp1-Mp1 distance longer than Mp2-Mp2 (Table 1, Fig. 2).

CpII median margin is the shortest. Ratio of CpI/CpII/CpIII median margins is 2.4/1/1.4, respectively. All setae on coxal plates and V3 setae bipectinate. C1-CpI median margin reaching about 2/3 C4-CpIII median margin. C1-C2 distance small (Table 1, Fig. 2).

Excretory pore plate pentagonal-shaped, its width clearly greater than length. Excretory pore situated in middle of shield and slightly anterior to E2 setae (Table 1, Fig. 2).

Pepidalps typical for *Arrenurus* species. PIII1 seta bipectinate, and PV7 seta large (Fig. 2).

First segment of chelicerae elongated, slightly narrowed cylinder, with one margin clearly bent and other one almost straight (Fig. 2).

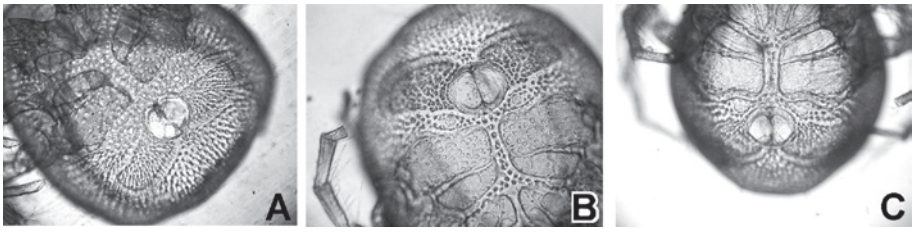
Proportions between segments of each leg more or less identical. Trochanter is clearly the shortest segment, reaching about half of femur, genu a little shorter than femur; tibia and tarsus 1.5 and 2 times longer, respectively (Table 2). ITi7 seta is thin and long. ITa13, IITa13 long and pectinate. IFe1, IFe3, IIFe1, IIFe3, IIIFe1, IIIFe3, ITa7, ITa8, ITa9, ITa10, ITa12, IITi10, IITa7, IITa8, IITa9, IITa10, IITa12, IIITa7, IIITa8, IIITa9, IIITa11, IIITa12 and IIITa13 setae pectinate, and IIITi10 bipectinate (Fig. 2).

Arrenurus neumani Piersig, 1895

The larvae of the *A. neumani* and the *A. affinis* are morphologically identical, very small differences are present in metric characters: length of CpIII median margin,

Table 2. Dimensions (in μm) of leg segments

		trochanter			femur			genu			tibia			tarsus		
		range	mean	stand. dev.	range	mean	stand. dev.	range	mean	stand. dev.	range	mean	stand. dev.	range	mean	stand. dev.
A. affinis (n=10)	I	22-26	23.6	1.21	45-46	46.1	0.56	41-44	42.1	1.01	62-65	62.9	1.08	83-89	86.8	1.57
	II	28-32	29.9	1.20	47-50	48.9	1.10	43-46	44.6	0.93	66-68	67.2	0.75	94-98	96.3	1.37
	III	34-36	35.0	0.63	48-50	48.9	1.03	46-48	47.1	0.83	66-68	66.7	1.01	98-101	99.0	1.05
A. neumani (n=10)	I	22-26	23.1	1.58	43-52	46.6	2.56	40-46	43.4	1.69	58-64	61.0	1.64	84-86	84.8	1.00
	II	26-28	27.0	0.91	46-50	48.0	1.00	42-46	44.5	1.37	64-65	64.2	0.39	93-96	94.7	1.20
	III	30-32	31.2	1.00	46-49	47.8	0.67	44-46	45.6	1.00	64-66	65.3	0.56	98-102	100.3	1.26
A. vietsi (n=6)	I	20-26	23.1	2.34	42-48	44.9	2.11	37-40	38.8	1.41	54-60	57.1	2.36	80-86	84.1	2.11
	II	24-28	26.0	1.81	42-50	45.3	2.51	39-46	40.9	2.74	56-63	60.7	2.55	85-96	89.6	5.13
	III	28-36	32.3	3.02	43-46	44.0	1.24	42-44	43.1	0.94	60-62	60.8	0.88	88-98	94.8	3.74



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1. Ventral sides of females: (A) *Arrenurus affinis*, (B) *A. neumani*, (C) *A. vietsi*; 2. Morphology of the larva of *Arrenurus affinis*: (A) ventral side, (B) dorsal plate, (C) excretory pore plate, (D) pedipalp, (E) chelicera, (F) leg I, (G) leg II, (H) leg III

Lp2-Lp2 distance, C4-CpIII median margin distance, C1-C2 distance and length of trochanter and tibia II and III leg (Tables 1 and 2, Fig. 3), but they are not diagnostic.

Arrenurus vietsi Koenike, 1911

The larva of the *Arrenurus vietsi* is morphologically almost identical to the larva of the *A. affinis*. Certain small differences in the shape of dorsal plate and in the distan-

3. Morphology of the larva of *Arrenurus neumani*: (A) ventral side, (B) dorsal plate, (C) excretory pore plate, (D) pedipalp, (E) chelicera, (F) leg I, (G) leg II, (H) leg III

4. Morphology of the larva of *Arrenurus vietsi*: (A) ventral side, (B) dorsal plate, (C) excretory pore plate, (D) pedipalp, (E) chelicera, (F) leg I, (G) leg II, (H) leg III

ces between the setae on the dorsal plate (Mp1-Mp1, Lp1-Lp1, Lp2-Lp2, Mp2-Mp2, Mp2-Mh1) are seen in *A. vietsi* (Table 1, Fig. 4). Sizes of individual leg segments in *A. vietsi* are somewhat smaller than those in the other two species as well (Table 2). However, these characters are very insignificant and for this reason cannot be used as diagnostic characters.

DISCUSSION

The larva of *A. affinis* was first described by VAJNŠTEIN (1980). His description was basically in agreement with that presented in this work. The differences involve the number of pedal setae on the third pair of pedipalps (11 according to VAJNŠTEIN, against 12 in this study), the appearance of the Lp1 seta (uniform according to VAJNŠTEIN, against tripartite in this study), and the non-pennate Lp2, Mh1, C1, C2, C3, C4, V3, PIII1, PV7, ITa7, ITa8, and ITa12 setae in VAJNŠTEIN's study versus pennate here. In addition, the sizes reported by VAJNŠTEIN are slightly smaller than those revealed in this study.

However, the absence of any clear-cut differences in larval morphologies of *A. affinis*, *A. neumani*, and *A. vietsi* renders differentiation between the larvae of the three species impossible. For this reason, I propose to treat the larvae of these species as those of a collective species *Arrenurus affinis*complex or *Arrenurus affinis*/*neumani*/*vietsi*. For the same reason, analysis of the larval morphology cannot resolve the question whether *A. vietsi* is a valid species or a synonym of *A. neumani*. The lack of differences in larval morphology is not sufficient to synonymise the two species.

The larvae of the species treated in this work resemble those of *A. bicuspidator* BERL. and *A. tetracyphus* PIERS. The shape of Expp is almost identical with that in *A. bicuspidator* BERL.; Dp is very similar as well, except that the deep antero-lateral indents, similar to those in *A. bicuspidator*, are wider, like in *A. tetracyphus*. The character clearly differentiating the larvae of *A. affinis*, *A. neumani* and *A. vietsi* from the larvae of *A. bicuspidator* and *A. tetracyphus* is the appearance of the ITi7 seta, shorter and smoother in the latter species, and the size of ITa14, IITa14 and IIITa14 setae, clearly shorter in *A. affinis*, *A. neumani* and *A. vietsi*, the IIITi10 seta being shorter, thicker, and bipectinate.

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