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Morphology of larval stages of *Arrenurus papillator* (O. F. MÜLLER, 1776), and *A. pustulator* (O. F. MÜLLER, 1776) (Acari: Hydrachnidia)

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ABSTRACT. Larvae of *A. papillator* and *A. pustulator* are described for the first time. They differ from the other *Arrenurus* species mainly in chelicerae and shape of dorsal plate. The characters for differentiation of the two species are mainly: shape of excretory pore plate, size of PV7 seta and size of the IIITa11 and IIITa12 setae.

Key words: acarology, morphology, Hydrachidia, *Arrenurus papillator*, *A. pustulator*, larvae

INTRODUCTION

The possibility of investigating relations between larval stages of water mites and their hosts increases interest in their morphology. Some inadequate descriptions of the larvae of the genus *Arrenurus* DUGES can be found in the works of KRENDOWSKIJ (1878), LUNDBLAD (1927), MÜNCHBERG (1936, 1937, 1963) and VIETS (1936). The decidedly most detailed drawings and descriptions were given by IMAMURA & MITCHELL (1967), PRASAD & COOK (1972), STECHMANN (1977), VAINŠTAIN (1980), TUZOVSKIJ (1987), SMITH I. M. (1978), SMITH B. P. (1990), SMITH & COOK (1991), BÖTTGER & MARTIN (2003) and ZAWAL (2006a, b, c, d). The aim of this paper was to described morphology of larvae of *A. papillator* and *A. pustulator* with a particular consideration of diagnostic characters.

MATERIALS AND METHODS

The descriptions are based on larvae reared from eggs laid by females caught in the field. Until egg laying, each female was kept in a separate 100 cm³ container filled

with 20-24°C water and subsequently fixed in Wilson's liquid. The eggs were kept, until hatching, under similar conditions. 48 h after hatch, the larvae were mounted by embedding in the Hoyers medium; the 48 h period was necessary for the larvae to become fully sclerotised.

Descriptions of larval morphologies of *A. papillator* and *A. pustulator* are based on larvae reared from eggs laid by a single female of each species, the females having been caught in species-specific habitats (a mid-meadow pool near Sikorki, Nowogard district, Poland among sedges in the case of *A. papillator* collected on 29 May 2005; and a dystrophic lake near Głędy, Olsztyn district, Poland above the mud bottom in the case of *A. pustulator* collected on 19 May 2004). The slides (*A. papillator*: Nos 517 – the female, 517a – the larva, *A. pustulator*: Nos 28E – the female, 28Ea – the larva) are stored at the Department of Invertebrate Zoology and Limnology, University of Szczecin, 71-415 Szczecin, ul. Wąska 13.

Larval body parts were measured on the progeny of two females of *A. papillator* and one female of *A. pustulator*.

Drawings were prepared with a drawing attachment to a Nikon ECLIPSE80i microscope, all the details being carefully traced. It is very difficult to adequately render the arrangement of the secondary setae as they are frequently hardly visible. For this reason, those setae bearing secondary ones were drawn as they were spotted, at least in one mount. Consequently, all the setae drawn appear to bear secondary setae, as they in fact do. On the other hand, the lack of secondary setae on smooth primary ones could have been caused by overlooking them on a mounted specimen.

The seta nomenclature follows that of PRASAD & COOK (1972) and ZAWAL (2006b).

The metric characters are reported with their ranges, mean values, and standard deviations. Leg segments were measured along their distal margins. In this paper the following abbreviations are used: Cp – coxal plate, Exp – excretory pore, Expp – excretory pore plate.

RESULTS

Arrenurus papillator (O. F. MÜLLER, 1776)

Hydrachna papillator O. F. MÜLLER, 1776

Trombidium papillator FABRICIUS, 1793

Atax papillator FABRICIUS, 1805

Arrenurus papillator (O. F. MÜLLER); DUGÈS, 1834

Hydrarachna abstergens GISTEL, 1850

Anurania alegans NEUMAN, 1880

Dorsal plate egg-shaped, widest at mid-length, anterior and posterior margins rounded. Anterior-lateral indents very big with much obtuse angles, reaching about one-third length of the plate and one-third of its width. Lpl setae are tripartite, remaining ones are fairly thin and smooth (Fig. 2).



1-8. Morphology of the larva of *Arrenurus papillator*: 1 – dorsal plate, 2 – ventral side, 3 – excretory pore plate, 4 – pedipalp, 5 – chelicera, 6 – leg I, 7 – leg II, 8 – leg III

Median margins of CpIII are the shortest, CpII are only a little longer, and CpI more than twice longer. Ratio of CpI/CpII/CpIII is 2.2/1.2/1 respectively (Table 1). All setae on coxal plates smooth. Distance between C1 and CpI median margin is a little longer than 2/3 of distance between C4 and CpIII median margin. Distance between C1 and C2 is fairly small (Table 1, Fig. 1).

Excretory pore plate is pentagonal with upper angles weakly marked, therefore Expp shape is similar to rhombus. Excretory pore is situated more or less in middle of plate and above E2 setae (Table 1, Fig. 3).

Pedipalps resembling those of other *Arrenurus* species. PV7 seta very large (Fig. 4).

Chelicerae big with first segment short and thick (Fig. 5).

Proportions of segments more or less the same on each limb. The decidedly shortest trochanter constitutes about 2/3 of femur, genu a little shorter than femur, tibia 1.3 times longer and the tarsus 1.7 times longer (Table 2). Tarsi all of legs (especially third pair) fairly thick. The number of setae on legs typical for larvae of *Arrenurus* species, but on tarsus of third pair of legs there are IIITa8 seta which are lacking in a number of *Arrenurus* species larvae. IGe5, ITi9, IIGe5, IITi9, IITi11, IIIGe5, IIITi9 and IIITi10 setae bear characteristic long secondary setae, spaced widely apart. ITr1, IITr1, IIITr1, IFe7, IIFe7 and IIIFe7 setae smooth. IITi10 and IIITi10 setae smooth and situated near distal parts of tibia, IIITa13 seta smooth (Fig. 6, 7, 8).

***Arrenurus pustulator* (O. F. MÜLLER, 1776)**

Hydrachna pustulator O. F. MÜLLER, 1776

Trombidium pustulator FABRICIUS, 1793

Atax pustulator FABRICIUS, 1805

Arrenurus pustulator (O. F. MÜLLER); DUGÉS, 1834

Dorsal plate egg-shaped, anterior and posterior margins rounded. Anterior-lateral indents are fairly big with obtuse angles, reaching about one-quarter of the length of plate and one-quarter of its width. Lpl setae tripartite and remaining ones fairly thin and smooth (Fig. 10).

Median margins of the CpIII a little longer than CpII, and CpI almost three times longer. Ratio of CpI/CpII/CpIII is 2.7/1/1.1. respectively (Table 1). All setae on coxal plates smooth. Distance between C1 and CpI median margin a little longer than 2/3 of distance between C4 and CpIII median margin. Distance between C1 and C2 fairly long (Table 1, Fig. 9).

Excretory pore plate is pentagonal, its width slightly exceeds its length. The excretory pore is situated posterior to midlength of plate and posterior to E2 setae (Table 1, Fig. 11).

Pedipalps are typical for *Arrenurus* species. PV6 seta fairly thick, and PV3, PV4 and PV5 setae are fairly thin (Fig. 12).

Chelicerae big, its first segment thick (Fig. 13).

Proportions of segments more or less the same on each limb. Decidedly shortest trochanter constitutes about 2/3 of femur, genu a little shorter than femur, tibia 1.4 times longer and tarsus 1.8 times longer (Table 2). Tarsi of all legs (especially third



9-16. Morphology of the larva of *Arrenurus pustulator*: 9 – dorsal plate, 10 – ventral side, 11 – excretory pore plate, 12 – pedipalp, 13 – chelicera, 14 – leg I, 15 – leg II, 16 – leg III

pair) fairly thick. Number of setae on legs the same as in former species, IIITa8 setae present. ITr1, IITr1, IIITr1, IFe7, IIFe7 and IIIFe7 setae pectinate. IITi10 and IIITi10 setae pectinate, fairly long, near distal end of tibia. IIITa13 pectinate and IIITa11 and IIITa12 pectinate and very large (Fig. 14, 15, 16).

DISCUSSION

The larval *Arrenurus papillator* was described by LUNDBLAD (1927) and MÜNCHBERG (1936), and *A. pustulator* by LUNDBLAD (1927) and VIETS (1936), however the descriptions were less detailed and inadequate for identification.

The described species have fairly wide dorsal plates with much rounded anterior and posterior margins, similar to the ones in *A. fimbriatus* (ZAWAL 2006a), but they have the antero-lateral indents a little deeper. The antero-lateral indents are slightly deeper in *A. papillator* than in *A. pustulator*, and *A. pustulator* has thicker setae on dorsal plate (Fig. 2, 10).

Table 2. Dimensions (µm) of leg segments of *Arrenurus papillator* [*A. pa*] and *A. pustulator* [*A. pu*] (N=10)

		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.
<i>A. pa.</i>	I	17-19	18.3	0.59	27-30	28.2	1.06	24-26	25.4	0.93	36-37	36.5	0.53	46-50	48.1	1.51
	II	19-21	19.9	0.72	29-31	29.7	0.59	26-27	26.5	0.53	39-41	40.3	0.96	50-56	51.2	1.67
	III	19-26	23.0	1.74	29-31	29.8	0.86	26-28	27.2	0.38	36-40	38.3	1.11	50-53	51.7	0.77
<i>A. pu.</i>	I	22-23	22.4	0.41	33-37	35.0	1.17	30-34	32.0	1.16	47-49	47.6	0.71	62-64	63.1	0.72
	II	23-27	24.8	1.23	37-40	38.7	0.99	34-36	35.0	0.71	51-52	51.3	0.32	65-70	66.7	1.34
	III	28-29	28.1	0.41	37-41	39.0	0.94	32-36	33.1	1.15	50-51	50.9	0.29	66-70	68.0	1.13

Larvae of the two species described differ in the ratio of coxal plates median margins length: the CpIII in *A. papillator* is the shortest while in *A. pustulator* the shortest one is CpII (Table 1, Fig. 1, 9). Both species have long CpIII median margin, in which they are similar to *A. sinuator* (STECHMANN 1977, ZAWAL 2006c).

The excretory pore plates in the both species are pentagonal as in *A. maculator* and *A. cuspidator* (ZAWAL 2006b), while the Expp of *A. papillator* is rhomboidal. There are differences in location of excretory pores in relation to the middle of the plate and the E2 setae (Table 1, Fig. 3, 11).

The pedipalps of the two species are very similar. The only differences are the size of the PV7 seta (in *A. papillator* the PV7 seta is very large which differs the species from all other *Arrenurus* species), and the size of the PV5 seta (thin and long in *A. papillator* and thick and short in *A. pustulator*) (Fig. 4, 12).

The chelicerae are bigger in comparison with larvae of other *Arrenurus* species with the first segment thick, and the segment is slightly longer in *A. pustulator* than in *A. papillator* (Fig. 5, 13).

The tarsi of third pair of legs are fairly thicker, like in *A. cuspidifer* (ZAWAL 2006d), and there are the IIITa8 seta like in *A. bruzelli* (ZAWAL 2006a) (Fig. 8, 16). Large size of the IIITa11 and IIITa12 setae in *A. pustulator* (Fig. 16) is its characteristic feature, and the large secondary setae differ the species from the other larvae of *Arrenurus*.

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Table 1. Dimensions (µm) of individual body parts of larvae of *Arrenurus papillator* and *A. pustulator* (N=10).

	<i>A. papillator</i>			<i>A. pustulator</i>		
	range	mean	standard deviation	range	mean	standard deviation
length	174-191	178.5	4.85	183-206	200.7	6.62
width	143-153	147.3	3.45	162-168	164.9	1.45
dorsal plate length	165-176	170.1	3.10	176-198	192.3	6.20
dorsal plate width	132-140	135.4	3.01	150-161	153.0	3.61
CpI medial margin length	51-53	52.4	0.76	62-66	64.1	1.13
CpII medial margin length	25-29	27.2	1.31	23-25	23.9	0.56
CpIII medial margin length	22-24	23.3	0.72	24-28	25.9	1.04
distances: Mp1-Mp1	67-71	68.9	1.17	47-49	48.0	0.63
Lp1-Lp1	77-79	78.2	0.69	52-57	54.2	1.37
Lp2-Lp2	88-94	90.8	1.94	79-93	87.2	3.67
Mp2-Mp2	49-53	51.4	1.24	39-43	41.3	1.13
Mh1-Mp2	40-41	40.7	0.50	45-48	46.1	1.04
Mp1-Lp1	4-7	5.6	0.76	6-8	6.7	0.60
Mp1-Lp2	26-31	28.8	1.50	36-41	39.2	1.63
Mp1-Mp2	46-51	47.7	1.58	54-58	56.8	1.34
Mp2-Mh1	21-28	24.5	2.09	34-38	36.2	1.05
distance between C1 and CpI	15-16	15.5	0.50	15-16	15.4	0.50
distance between C4 and CpIII	19-23	22.1	1.42	22-24	23.3	0.64
distance between C1 and C2	34-40	36.1	1.69	42-46	45.1	1.22
excretory pore plate length	22-25	23.6	0.85	20-23	20.9	1.09
excretory pore plate width	26-31	28.4	1.55	25-26	25.4	0.65
distance between Exp and Expp posterior margin	10-12	11.3	0.85	8-11	8.8	1.11
distance between E1 setae and Expp anterior margin	5-7	5.8	0.58	3-4	3.4	0.31
distance between E2 setae and Expp posterior margin	10-12	11.0	0.75	8-13	10.1	1.20
PI length	7-10	8.6	0.89	10-13	11.6	0.85
PII length	24-25	24.5	0.53	30-33	31.4	1.20
PIII length	26-27	26.9	0.41	26-28	27.2	0.50
length of PIV claw	17-20	18.9	1.07	19-22	20.2	0.76
length of cheliceral segment I	58-63	60.6	1.39	82-85	83.6	0.89
length of PV 8 seta	91-103	98.5	3.39	91-97	93.4	1.50