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# Morphology of larval stages of *Arrenurus albator* (O. F. MÜLLER, 1776), *A. fimbriatus* KOENIKE, 1885, and *A. bruzelli* KOENIKE, 1885 (Acari: Hydrachnidia)

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ABSTRACT. Larvae of *A. fimbriatus* and *A. bruzelli* are described for the first time and larva of *A. albator* is redescribed. The description of the larval *A. albator* is compared to that given by STECHMANN (1977) and particular attention is paid to the characters differing among the three species.

Key words: acarology, morphology, Hydrachnidia, *Arrenurus*, larvae

## INTRODUCTION

Currently the interest in the larval stages of water mites has increased because of the possibility of investigating relations between them and their hosts. A basic aim of such studies is to describe the morphology of larvae of individual species since the larvae of the genus *Arrenurus* Duges are known to a particularly insufficient degree. Inadequate descriptions can be found in the works of KOENIKE (1908), LUNDBLAD (1927, 1930), MÜNCHBERG (1936), and SPARING (1959). In recent years such studies were conducted by STECHMANN (1977), CICHOCKA (1980), VAJNŠTEJN (1980), BÖTTGER & MARTIN (2003). The decidedly the most detailed drawings and descriptions were given by IMAMURA & MITCHELL (1967), VAJNŠTEJN (1980), SMITH (1990), and ZAWAL (in print a, b, c).

The aim of this paper was to described for the first time morfology of larvae of *A. fimbriatus* and *A. bruzelli* and rediscribed morfology of larva of *A. albator* with particular attention paid to diversifying traits, and also to compare *A. albator* with earlier descriptions elaborated by STECHMANN (1977).

## MATERIALS AND METHODS

The descriptions are based on larvae hatched from eggs laid by females caught in the field. Until egg laying, each female was kept in a separate 100 $cm^3$ container filled with 20-24°C water and subsequently fixed in Wilson's liquid. The eggs were kept, until hatching, under identical conditions. The larvae, 48 h post hatch, were mounted by embedding them in the F'our liquid; the 48 h period was necessary for the larvae to become fully sclerotised.

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 notation follows that of SMITH & COOK (1991) and ZAWAL (in print a).

The meristic characters are reported with their ranges, mean values, and standard deviations. The leg segments were measured from their distal margins.

## RESULTS

### *Arrenurus albator* (O. F. MÜLLER, 1776)

*Hydrachna albator* O. F. MÜLLER, 1776: 189. male;
*Hydrachna obscura* O. F. MÜLLER, 1776: 190. female;
*Arrenurus albator* (O. F. MÜLLER); DUGÉS, 1834.

Shape of the dorsal plate is elliptical distinctly narrowing in the posterior part. Anterior-lateral incisions are fairly big with nearly straight angles, and reach to about 1/5 of the plate length and 1/3 of its width. The Lpl seta tripartite, the remaining setae on the dorsal plate are fairly thin and smooth (Fig. 2).

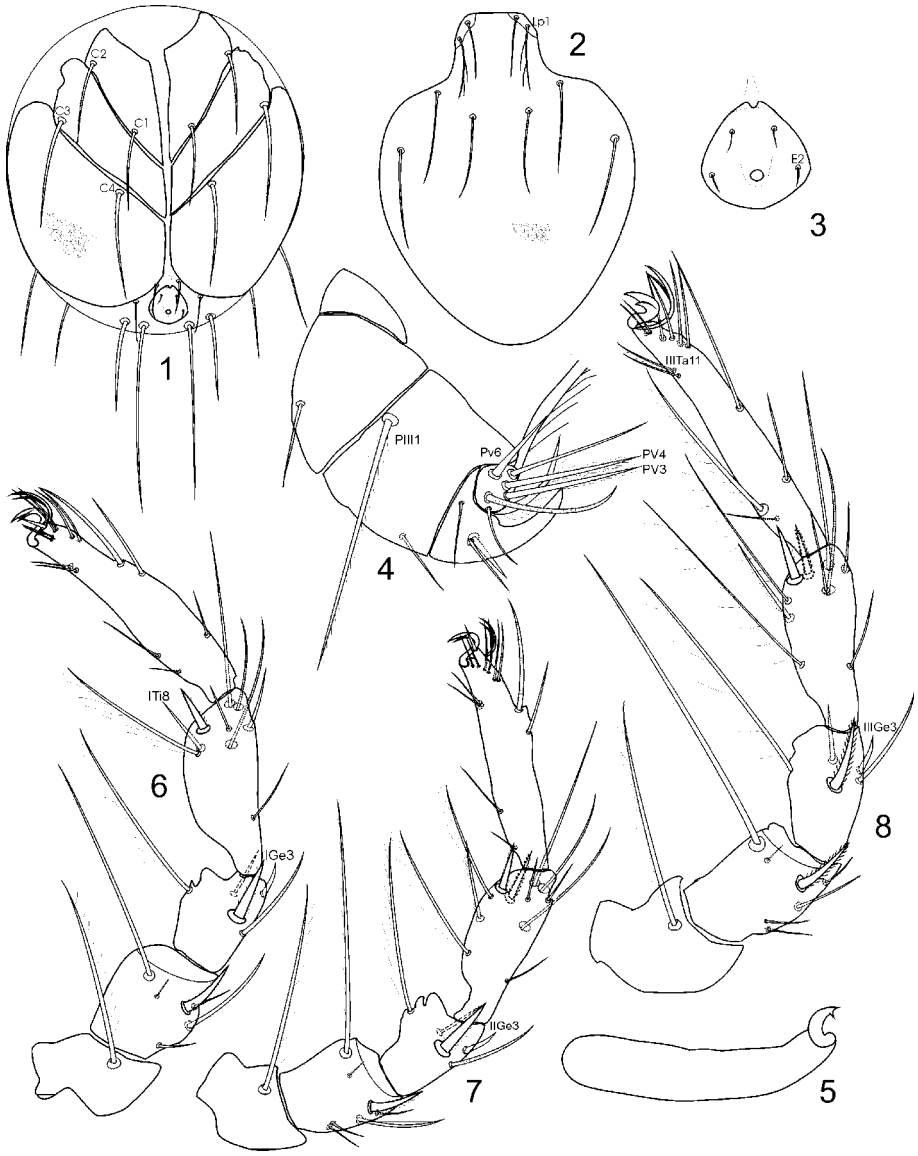
The shortest lateral margins are found on epimeres of pair II, followed by epimeres of pair III and the longest epimeres of pair I (Fig. 1). The ratios of epimeres I, II and III are 2/1/1.2 respectively (Table 1). The C3 and C4 setae are feathered on one side, and C1 and C2 on both sides (Fig. 1).

The anal plate is rhomboidal, width and length are almost equal, with a small hollow in the front part. The anal aperture lies distintly below the middle of the shield and at the same level as E2 setae (Fig. 3, Table 1).

The shape and size of pedipalps resemble those in other *Arrenurus* species. The PIII1 seta is feathered on both sides, the PV3 and PV4 setae are feathered on both sides from about 1/3 of their length, and PV5 seta is fairly thick and long (Fig. 4).

The first segment of chelicerae has the form of an elongated and curved cylinder with margins parallel to each other (Fig. 5).

The proportions of segments are more or less the same on each limb. The decidedly shortest trochanter constitutes about 2/3 of the femur and genu which are of the same length; the tibia is 1.5 times longer and the tarsus 2.5 times longer (Table 2). The ITi8 seta is fairly thin, the IGe3, IIGe3 and IIIGe3 setae are fairly thick, and the IIITa11 seta is feathered on one side (Figs 6- 8).

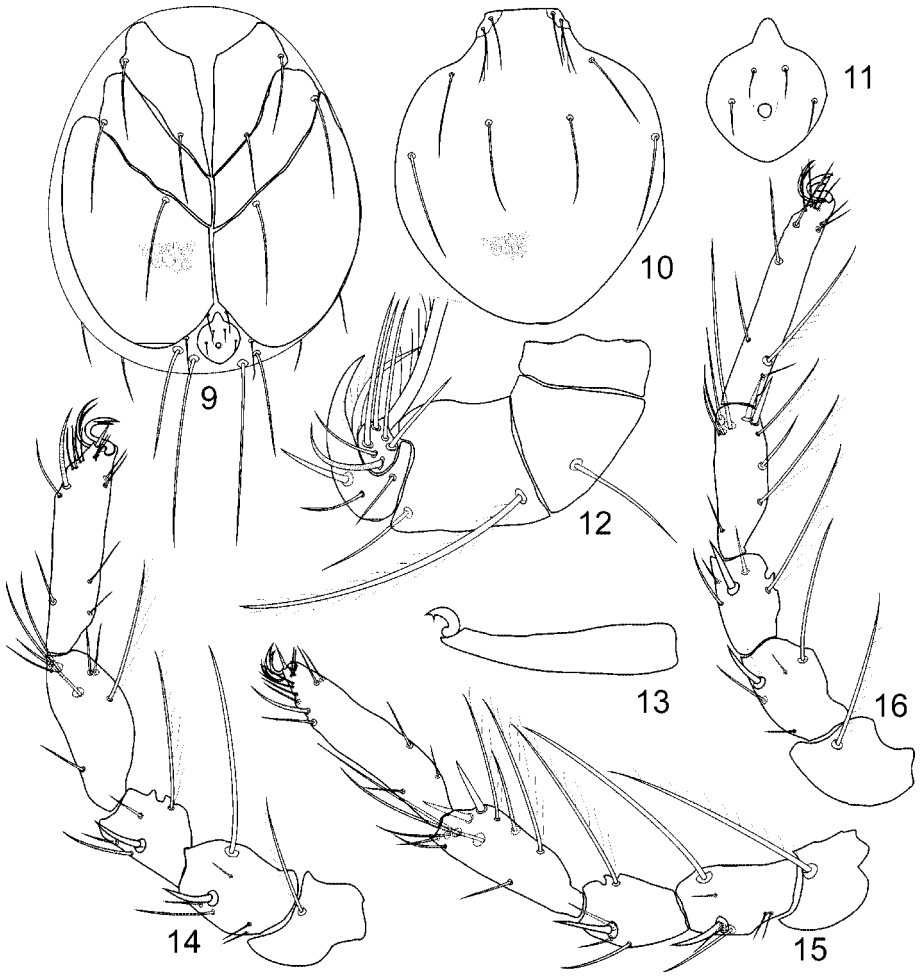



1-8. Morphology of the larva of *Arrenurus albator*: 1 - ventral side, 2 - dorsal side, 3 - anal plate, 4 - pedipalp, 5 - chelicera, 6 - leg I, 7 - leg II, 8 - leg III (explanation in text)

## *Arrenurus fimbriatus* KOENIKE, 1885

*Arrenurus fimbriatus* KOENIKE, 1885: 220

The dorsal plate is elliptical with the widest part in the mid-length. Anterior-lateral incisions are fairly small, with slightly obtuse angles, and reach to about 1/4 of the plate width and 1/6 of its length. The Lpl seta is tripartite, the remaining setae smooth (Fig. 10).




9-16. Morphology of the larva of *Arrenurus fimbriatus*: 9 - ventral side, 10 - dorsal side, 11 - anal plate, 12 - pedipalp, 13 - chelicera, 14 - leg I, 15 - leg II, 16 - leg III (explanation in text)

Ratios beetwen epimeres I/II/III are 2.4/1/1.5 respectively (Table 1). The C2, C3 and C4 setae are feathered on one side, the C1 are smooth (Fig. 9).

The anal plate is oval-shaped with a characteristic process in the front part, its width slightly exceeds its length. The anal aperture lies slightly below the middle of the shield and slightly below E2 setae (Fig. 11, Table 1).

The shape of pedipalps resembles those in other *Arrenurus* species. The PIII1 seta is feathered on both sides. The PV6 seta is longer than in other *Arrenurus* species (Fig. 12).

The first segment of chelicerae has the form of an elongated cylinder with slightly narrower posterior part (Fig. 13).

The proportions of segments are more or less the same as those in other *Arrenurus* species, but shorter (Table 2). The number of setae found on each segment and the number of solenoids is like in other *Arrenurus* species. The ITi7 and ITi8 setae are fairly thin (Figs 14-16).

### *Arrenurus bruzelli* KOENIKE, 1885

*Arrenurus bruzelli* KOENIKE, 1885: 221

The dorsal plate is oval-shaped with the widest part in 1/3 of its length distinctly narrowing in the posterior part. Anterior margin is almost straight and posterior margin is pointed. Anterior-lateral incisions reach to about 1/4 of the plate width and 1/5 of its length. Their angles are slightly obtuse. The Lpl seta is tripartite, the Lp2 and Mh1 setae are thick and feathered on both sides, the remaining setae are fairly thin and smooth (Fig. 18).

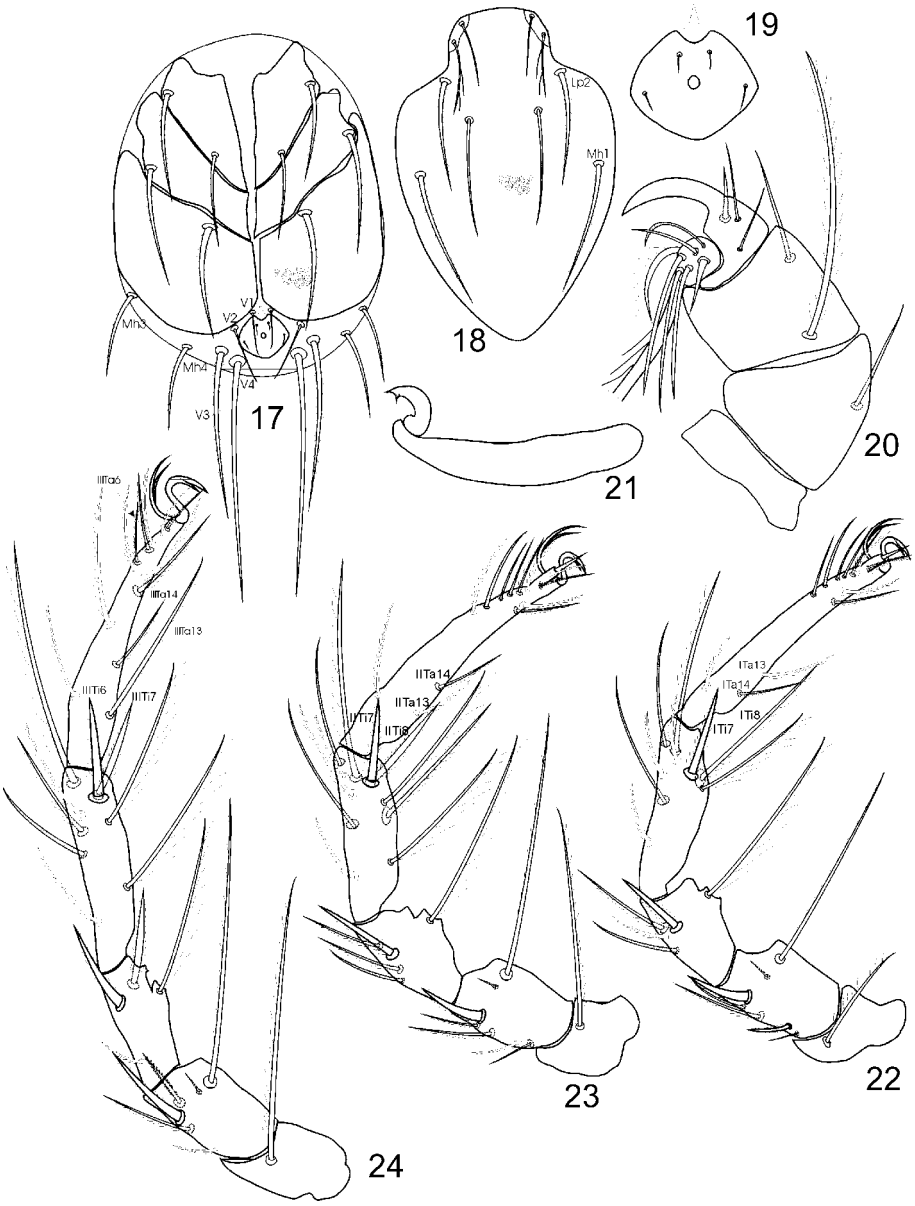
Ratios beetwen epimeres I/II/III are 2.3/1/1.3 respectively (Table 1). All seatae on epimeres are feathered on both sides as well as setae V3. The Lh2 and Lh4 setae are feathered on one side while the V1, V2, V4 setae are smooth (Fig. 17).

The anal plate is rhomboidal, its width exceeds its length in 1/1.3 ratio. The anal aperture lies almost in the middle of the shield and slightly over E2 setae (Fig. 19, Table 1).

Pedipalps are typical of *Arrenurus* species. The PIII1 seta is feathered on both sides (Fig. 20).

The first segment of chelicerae has the form of an elongated cylinder with slightly narrower posterior part, both margins are slightly curved (Fig. 21).

The proportions of segments are more or less the same on each limb. The decidedly shortest trochanter constitutes about 2/3 of the femur and genu which are of the same length; the tibia is 1.5 times longer and the tarsus 2.5 times longer (Table 2). Tarsi all of legs are distinctly narrowing in posterior part. Almost all setae on legs are feathered, the ITi8 seta is very long, the ITi7, IITi7, IITi8, IIITi6 and IIITi7 setae are long as well. The tarsus of III pair of the legs shows one seta more (IIITa8) (Figs 22-24), like in *A. perforatus* (ZAWAL in press b). The ITa13, IITa13 and IIITa13 setae are nearer anterior end of tarsi than the ITa14, IITa14 and IIITa14 setae (Figs 22-24).




17-24. Morphology of the larva of *Arrenurus bruzelli*: 17 - ventral side, 18 - dorsal side, 19 - anal plate, 20 - pedipalp, 21 - chelicera, 22 - leg I, 23 - leg II, 24 - leg III (explanation in text)

## DISCUSSION

The larval *Arrenurus albator* was described by STECHMANN (1977). However, his drawings and descriptions provide little detail and are illegible, and there is no description of any pedipalp. It is only the drawing of the dorsal plate that is sufficiently legible and similar to that shown in this paper; however, it does not show the actual tripartity of the Lp1 seta (Fig. 2). Body dimensions, as reported in this paper and by STECHMANN (1977), are basically in agreement. The only difference is that in the distance between the Mp2-Mh1 setae which was calculated by STECHMANN (1977) rather than directly measured (Table 1).

Among the larvae of the three species described, that of *A. bruzelli* is the largest. The other two are similar in size, although the *A. albator* larva is slightly larger (Table 1).

Larvae of the three species described differ in the shape of the dorsal plate. The plate of *A. bruzelli* is distinctly narrower (with the widest part in the 1/3 of its length), and the Lp2 and Mh1 setae are thick and feathered on both sides (Fig. 17). Dorsal plates of both *A. albator* and *A. fimbriatus* are wider than the dorsal plate of *A. bruzelli*, with the widest part in mid-length, while the Lp1 and Mh1 setae are thin and smooth. Anterior-lateral incisions in *A. albator* are distinctly larger than those in *A. fimbriatus* (Figs 2, 10).

The longest lateral margin is found on epimeres of pair I, followed by epimers of pair III and finally by epimeres of pair II in the larvae of all the three species; however, *A. bruzelli* has the longest epimeres, and much greater differences in proportions are observed in *A. albator* (Table 1). Among the species described, the epimere setae in *A. bruzelli* are the thickest and feathered on both sides. Additionally, the Lh4, V3 and V4 setae are feathered as well (Fig. 17). The *A. fimbriatus* setae are the thinnest; those on C2, C3 and C4 are feathered on one side, and those on C1 are smooth (Fig. 9). All the setae on epimeres in *A. albator* are feathered on one side, and their thickness is intermediate between those of *A. fimbriatus* and *A. bruzelli.* The differences in the arrangement of the secondary setae on epimeres are not a reliable character as those setae are difficult to detect.

Distinct differences appear between the size and shape of anal plates, particularly in the situation of the anal aperture and E2 setae (Table 1, Figs 3, 11, 19). The anal aperture in *A. bruzelli* lies almost in the middle of the shield and slightly above the E2 setae (Fig. 19, Table 1). In the other two species, it lies below the middle of the shield, but in *A. albator* it lies at the same level as the E2 setae, while it lies below the E2 setae in *A. fimbriatus* (Figs 3, 11).

Pedipalps of the three species are very similar, the only differences is in the arrangement of secondary setae on PV4 and PV5 in *A. albator* (Fig. 4).

The size and shape of legs in *A. albator* and *A. fimbriatus* are very similar (tarsi in *A. fimbriatus* are slightly shorter) (Table 2). There are some differences in the arrangement of setae: the ITi8seta in *A. fimbriatus* is smooth and distinctly thinner than that in *A. albator*; the IFe4, IGe2, ITi8, IIFe4, IIGe2, IITi7, IITi8, IIIFe3, IIIGe2, IIITi6, IIITi7 setae in *A. albator* are feathered on both sides, while

Table 2. Dimensisons (in μm) of individual body parts

| | *A. albator* | | | *A. fimbriatus* | | | *A. bruzelli* | | | *A. albator* STECHMANN |
|---|---|---|---|---|---|---|---|---|---|---|
| | range | mean | standard deviation | range | mean | standard deviation | range | mean | standard deviation | range |
| length | 196-216 | 206.0 | 5.89 | 180-194 | 187.2 | 3.68 | 212-228 | 220.6 | 5.50 | - |
| width | 156-196 | 175.6 | 12.57 | 156-172 | 163.4 | 4.90 | 170-194 | 183.8 | 7.91 | - |
| dorsal plate length | 192-208 | 199.2 | 4.83 | 174-188 | 182.4 | 3.63 | 202-214 | 208.4 | 4.09 | 194-206 |
| dorsal plate width | 144-172 | 157.0 | 9.35 | 140-152 | 145.6 | 3.63 | 146-158 | 151.6 | 3.37 | 143-153 |
| pair I epimere length | 62-67 | 65.0 | 1.25 | 59-66 | 61.8 | 2.00 | 78-81 | 79.8 | 1.00 | 60-65 |
| pair II epimere length | 30-34 | 31.4 | 1.13 | 23-29 | 26.5 | 1.79 | 34-37 | 35.2 | 1.13 | 27-32 |
| pair III epimere length | 34-37 | 36.2 | 1.05 | 37-42 | 39.4 | 1.45 | 44-46 | 45.0 | 0.83 | 33-40 |
| distances: Mp1-Mp1 | 30-33 | 31.5 | 0.77 | 31-36 | 33.4 | 1.51 | 46-50 | 48.5 | 1.32 | 30-37 |
| Lp1-Lp1 | 38-43 | 40.3 | 1.32 | 40-45 | 42.8 | 1.32 | 59-62 | 60.2 | 0.66 | 39-46 |
| Lp2-Lp2 | 74-82 | 77.2 | 2.39 | 69-72 | 70.2 | 0.91 | 80-84 | 82.2 | 1.36 | 75-81 |
| Mp2-Mp2 | 36-39 | 36.8 | 1.07 | 38-43 | 39.9 | 1.53 | 46-50 | 48.2 | 1.41 | 37-39 |
| Mh1-Mp2 | 46-50 | 47.9 | 1.53 | 43-50 | 47.1 | 2.63 | 33-36 | 34.6 | 1.05 | 44-48* |
| Mp1-Lp1 | 7-10 | 8.3 | 0.77 | 5-8 | 6.4 | 0.92 | 9-13 | 10.9 | 1.32 | - |
| Mp1-Lp2 | 38-42 | 39.1 | 1.10 | 28-34 | 31.6 | 1.97 | 36-38 | 36.4 | 0.68 | - |
| Mp1-Mp2 | 59-64 | 61.2 | 1.47 | 56-61 | 58.7 | 1.26 | 62-66 | 64.0 | 1.07 | 55-65 |
| Mp2-Mh1 | 12-16 | 14.2 | 1.41 | 13-18 | 15.8 | 1.80 | 32-38 | 35.5 | 1.97 | 26-28** |
| distance between C1 and pair I epimere margin | 15-19 | 17.0 | 1.20 | 14-18 | 15.5 | 0.94 | 20-22 | 20.8 | 0.84 | 16-19 |
| distance between C4 and pair III epimere margin | 26-31 | 28.3 | 1.69 | 21-24 | 22.1 | 0.94 | 30-35 | 32.6 | 1.55 | - |
| anal plate length | 24-26 | 24.6 | 0.98 | 24-30 | 28.2 | 2.17 | 25-28 | 26.6 | 1.24 | - |
| anal plate width | 24-27 | 25.0 | 1.12 | 25-31 | 28.9 | 2.08 | 33-37 | 35.0 | 1.51 | - |
| distance between anal pore and anal plate posterior margin | 8-10 | 9.1 | 0.77 | 8-11 | 9.9 | 1.08 | 11-14 | 11.8 | 0.85 | - |
| distance between E1 setae and anal plate anterior margin | 4-8 | 6.6 | 1.18 | 4-8 | 6.9 | 1.42 | 4-6 | 5.7 | 0.88 | - |
| distance between E2 setae and distal margin of anal plate | 8-10 | 9.0 | 0.63 | 10-13 | 12.2 | 1.05 | 9-10 | 9.5 | 0.59 | - |
| PI length | 8-10 | 8.6 | 0.74 | 7-8 | 8.0 | 0.53 | 14-16 | 15.4 | 0.66 | - |
| PII length | 21-26 | 23.1 | 1.53 | 22-28 | 24.3 | 1.89 | 30-32 | 31.5 | 0.56 | - |
| PIII length | 22-26 | 23.5 | 1.01 | 21-26 | 23.2 | 1.96 | 26-28 | 26.7 | 0.94 | - |
| length of PIV claw | 16-20 | 17.6 | 1.13 | 14-20 | 18.1 | 1.93 | 27-30 | 28.0 | 0.84 | - |
| length of cheliceral segment I | 72-78 | 74.9 | 1.97 | 64-70 | 67.6 | 2.04 | 93-98 | 94.9 | 1.52 | - |
| length of PV 8 seta | 135-142 | 137.0 | 2.74 | 120-136 | 130.6 | 5.07 | 158-165 | 162.1 | 2.07 | - |

*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)

Table 2. Dimensisons (in μm) of leg segments

| | | trochanter | | | femur | | | genu | | | tibia | | | tarsus | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | range | mean | standard deviation | range | mean | standard deviation | range | mean | standard deviation | range | mean | standard deviation | range | mean | standard deviation |
| *A. albator* | I | 19-23 | 20,6 | 1,13 | 30-36 | 32,6 | 1,77 | 30-34 | 31,8 | 1,12 | 43-50 | 45,3 | 2,56 | 66-74 | 69,2 | 2,75 |
| | II | 19-22 | 20,1 | 0,7 | 34-40 | 35,5 | 2,14 | 31-35 | 32,4 | 1,21 | 45-50 | 47,0 | 1,31 | 70-74 | 71,6 | 1,08 |
| | III | 19-24 | 20,5 | 1,42 | 34-38 | 34,9 | 1,42 | 30-36 | 32,1 | 1,53 | 45-51 | 47,7 | 1,65 | 70-75 | 72,4 | 1,32 |
| *A. fimbriatus* | I | 18-22 | 20,6 | 1,55 | 30-35 | 33,0 | 1,36 | 29-34 | 31,4 | 1,25 | 40-46 | 43,0 | 1,45 | 53-58 | 55,2 | 1,60 |
| | II | 18-24 | 20,6 | 1,95 | 30-37 | 32,8 | 2,17 | 29-34 | 31,5 | 1,26 | 39-44 | 41,6 | 1,41 | 53-58 | 54,8 | 1,52 |
| | III | 22-26 | 23,4 | 1,12 | 30-34 | 32,2 | 1,35 | 28-32 | 29,9 | 1,14 | 39-48 | 43,4 | 2,82 | 56-64 | 59,1 | 2,51 |
| *A. bruzelli* | I | 22-28 | 25,3 | 1,86 | 45-50 | 47,1 | 1,58 | 43-47 | 45,2 | 1,37 | 70-78 | 74,1 | 2,33 | 106-112 | 108,4 | 2,14 |
| | II | 26-30 | 27,5 | 1,42 | 46-48 | 46,8 | 0,86 | 44-49 | 46,2 | 1,4 | 70-74 | 72,0 | 0,92 | 103-115 | 108,6 | 4,01 |
| | III | 28-30 | 28,5 | 0,67 | 45-49 | 46,3 | 1,33 | 46-50 | 47,8 | 1,13 | 76-82 | 78,6 | 1,89 | 107-110 | 108,4 | 0,78 |

those in *A. fimbriatus* are smooth (Figs 6-8, 14-16). *A. bruzelli* legs are distinctly larger, and the tarsi distinctly narrower in their posterior parts. The IFe4, IGe2, ITi8, IIFe4, IIGe2, IITi7, IITi8, IIIFe3, IIIGe2, IIITi6, IIITi7 setae are larger than those in the other two species, and the ITa13, IITa13 and IIITa13 setae are nearer to the anterior end of tarsi than are the ITa14, IITa14 and IIITa14 setae. The tarsus of pair III of the legs shows one seta more (IIITa6) (Fig. 24), like in *A. perforatus* (ZAWAL in press b). A common feature of the three species is that the IGe5, ITi9, IIGe5, IITi9, IITi11, IIIGe5, IIITi8, and IIITi10 setae bear characteristically long secondary setae, spaced widely apart. Similar, long secondary setae are seen on the setae in *A. bartonensis* Cook, *A. birgei* Marshall, *A. neobirgei* Cook, *A. rotundus* Marschall, *A. cuspidator*, *A. maculator*, *A. sinuator*, *A. bifidicodulus*, *A. perforatus*, *A. globator*, and *A. tubulator* (SMITH 1990, ZAWAL in press a, b, c), therefore this feature is probably common to all the species of the genus *Arrenurus*.

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