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NEW RECORDS OF THE WATER MITE *ARRENURUS* FROM AUSTRALIA, WITH DESCRIPTION OF THREE NEW SPECIES AND ONE NEW SUBSPECIES (ACARI: HYDRACHNIDIA: ARRENURIDAE)

HARRY SMIT

Smit, H. 2002 5 31: New records of the water mite *Arrenurus* from Australia, with the description of three new species and one new subspecies (Acari: Hydrachnidia: Arrenuridae). *Memoirs of the Queensland Museum* **48**(1): 221-232. Brisbane. ISSN 0079-8835.

From northern Australia are described *Arrenurus kimberleyensis*, *A. yorkensis*, *A. recticaudatus* and *A. rostratus mutilus*. Descriptions are provided for a number of females not described before, or described erroneously. *Arrenurus degeneratus*, described as a subspecies of *A. rostratus*, has been raised to a full species. *A. liberatus* Walter and *A. pulcher* Walter are reported new for Australia. Range extensions within Australia are given for a number of species. ❐ *Hydrachnidia, water mites, Arrenurus, Australia, new species.*

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Of the cosmopolitan water mite genus *Arrenurus* 41 species have been reported from Australia (Harvey, 1998; Smit, 1999). Material dealt with herein come from northern Western Australia and northern Queensland. A number of unidentified females and species not previously reported from Australia in the Viets collection (Senckenberg Museum, Frankfurt a/Main, Germany) have been examined. Most are from northern Australia, a small part comes from New South Wales. In this paper three new species and one new subspecies are described. Descriptions are provided for a number of females not described before, or described erroneously. Finally, two species are reported new for Australia, and a number of range extensions are given for species already known from Australia. The subgenus *Brevicaudaturus* will be treated in a separate paper.

MATERIAL AND METHODS

Unless stated otherwise, all material has been collected by the author. All non-type material has been deposited in the Zoological Museum of the University of Amsterdam.

The following abbreviations are used: A1 and A2 pre- and post-antennal glandularia, Cx2-4 coxoglandularia 2-4, D1-4 dorsoglandularia 1-4; L1-4 lateroglandularia 1-4; V2 ventroglandularia 2; PI-PV palp segments 1-5; IV-leg-4-6 fourth-sixth segments of fourth leg; WAM Western Australian Museum, Perth; QM Queensland Museum, Brisbane; ZMAN Zoological Museum of the University of Amsterdam, Amsterdam, SMF Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt am Main. For the description of the glandularia Jin & Wiles (1996) and Wiles (1997) are followed. All measurements are in µm, measurements of leg and palp segments are of the dorsal margins. Measurements of paratypes in the description of new species are given in brackets.

SYSTEMATICS

Arrenurus (Arrenurus) acutipetiolatus Smit, 1999

Arrenurus (Arrenurus) acutipetiolatus Smit, 1999: 225.

MATERIAL. *New South Wales*. ♂, Farmersdam near Gloucester, 19 March 1976, coll. B.V. Timms (slide SMF6196. ♀, pond at Redhead via Newcastle, 12 October 1979, coll. B.V. Timms (slide SMF7376).

REMARKS. Kurt Viets erroneously identified this material as *A. spinifer* Walter or a subspecies of it. However, the shape of the dorsal shield and cauda of *A. spinifer* differs significantly from *A. acutipetiolatus*.

DISTRIBUTION. TAS, VIC and NSW.

Arrenurus (Arrenurus) balladoniensis Halík, 1940

Arrenurus balladoniensis Halík, 1940: 283.
Arrenurus quadripapillatus Lundblad, 1941: 120.
Arrenurus (Arrenurus) balladoniensis Halík: Halík, 1941: 113; Lundblad, 1947: 74; Cook, 1986: 305; Smit, 1992: 106, 1997: 233; Harvey, 1998: 144.

MATERIAL. *Western Australia*. 1 ♀, Taylor's Lagoon, east of Broome, 14 October 1998. 6 ♂, 13 ♀, Lake Eda, east of Broome, 30 October 1998.

DISTRIBUTION. WA, NT, QLD and VIC.

Arrenurus (Arrenurus) bifurcatus Smit, 1999

Arrenurus (Arrenurus) bifurcatus Smit, 1999: 229.
Arrenurus (Arrenurus) mantonensis Smit (err., non George, 1903): Smit, 1997: 239; Harvey, 1998.

MATERIAL. *Western Australia.* 4 ♀, pool downstream of Manning Gorge, at campground, the Kimberley, 12 September 1998. 4 ♀, Jackeroo's Waterhole, El Questro Station, the Kimberley, 15 September 1998. 2 ♀, Lake Kununurra, 10 km SE of Kununurra, 19 September 1998. ♂, 5 ♀, Spillway Creek near Lake Argyle, 20 September 1998. 6 ♀, Arthur Creek, at crossing with Great Northern Highway, the Kimberley, 23 September 1998.

DESCRIPTION. Some additional measurements and characters are: Males. Body 863-899 long, 641-676 wide, yellowish brown. Females. Body 761-887 long, 705-786 wide. Dorsal shield 664-721 long and 502-551 wide.

DISTRIBUTION. NT and WA.

Arrenurus (Arrenurus) kimberleyensis sp. nov. (Fig. 1)

ETYMOLOGY. From the Kimberley.

MATERIAL. HOLOTYPE. ♂, pools upstream of Bell Gorge Falls, the Kimberley, Western Australia, 11 September 1998 (WAMT42590). PARATYPES. 2 ♂, ♀ (WAMT42591), 3♂, ♀ (ZMAN type ACAR. 0001.1-4.), same data as holotype. ♀, pool Lennard River, east side Windjana Gorge, Windjana Gorge National Park, the Kimberley, 10 September 1998 (ZMAN type ACAR. 0002.5.). 2 ♂, ♀, Jackeroo's Waterhole, El Questro Station, the Kimberley, 15 September 1998 (WAM T42592). ♂, 2♀ (ZMAN type ACAR .0003.6-8.), Lily Creek Lagoon, Kununurra, 17 September 1998. ♂ (T42593, WAM), Lake Kununurra, 10 km SE of Kununurra, 19 September 1998.

OTHER MATERIAL. *Western Australia.* ♂ (not sclerotised), ♀, Bell Creek at crossing with Gibb River Road, the Kimberley, 10 September 1998. *Queensland.* ♂ (not sclerotised), Tinaroo Falls Dam at Yungaburra, Qld, 16 September 2000.

DIAGNOSIS. Petiole with a rounded basal piece, on which an arrow-shaped part is inserted; dorsal shield tapering posteriorly. Female with elongate dorsal shield; dorsum with moderate sized humps.

DESCRIPTION. Male. Body 1393 (1073-1393) long and 1126 (1021-1126) wide, green, with concave anterior margin. Dorsal shield 526 (478-535) wide, tapering posteriorly, dorsal furrow incomplete; D1 on large humps (Fig. 1A, C). Cauda well-developed, distinctly set off from anterior body part. Pygal lobes well-developed. Hyaline membrane large, medially pointed (only visible when posterior body part slightly lifted). Petiole consisting of a rounded basal piece, on which dorsally an arrow-shaped part is inserted, which is posteriorly indented. In aberrant male from pools upstream of Bell Gorge Falls, the arrow-shaped part is lacking, and the petiole appears rounded in dorsal view. Genital plates directed perpendicularly to lateral body margin, posterior and anterior margin slightly undulating (Fig. 1B). Lengths of PI-PV: 50, 96, 90, 108, 64. PII with three setae in anteroventral corner (Fig. 1D). Lengths of I-leg-4-6: 219, 203, 259. Lengths of IV-leg-4-6: 336, 198, 243; IV-leg-4 with a spur.

Female. Body 1307 (1552-1618) long, 1146 (1286-1387) wide, with concave anterior margin, truncated posteriorly, with slightly concave posterior margin. Dorsal furrow complete, dorsal shield elongate, 778 (971-993) long, 502 (567-616) wide. D1 and L4 on moderate sized humps (Fig. 1E). Capitular bay V-shaped. Medial margin of fourth coxal plates larger than medial margin of third coxal plates. Medial distance of fourth coxal plates slightly smaller than one genital valve. Gonopore with small, hardly visible chitinised patches. Genital plates large, directed almost perpendicularly to lateral body margin (Fig. 1F); occasionally (young ♀?) lateral part of genital plate slightly enlarged. Lengths PI-PV: 34, 98, 92, 106, 58; palp as in male. Lengths of I-leg-4-6: 211, 186, 198. Lengths of IV-leg-4-6: 227, 243, 227.

REMARKS. The male is distinguished within *Arrenurus* by the shape of its petiole and dorsal shield. The female is close to *A. ensifer* and *A. liliaceus*, the latter species is larger with larger humps (especially L4), a pear-shaped dorsal shield and the posterior body margin is more concave. Differences from *A. ensifer* are not clear, as only one female of this species is known. *A. ensifer* is very similar in body shape, including humps, but has more slender, slightly bowed genital plates. A female from Arthur Creek might belong to the new species, but it is larger (1688 long, 1447 wide), and has larger, slightly bowed genital plates.

Arrenurus (Arrenurus) liberatus Walter, 1929

Arrenurus (Arrenurus) liberatus Walter: 1929b: 263; Daday, 1898a: 97; Daday, 1898b: 106; K. Viets, 1935: 11; K.O. Viets, 1959: 423; Cook, 1967: 225; Lundblad, 1969: 425; Prasad, 1974: 26; Jin & Wiles, 1996: 333; Jin, 1997: 142; Gledhill & Wiles, 1997: 537.

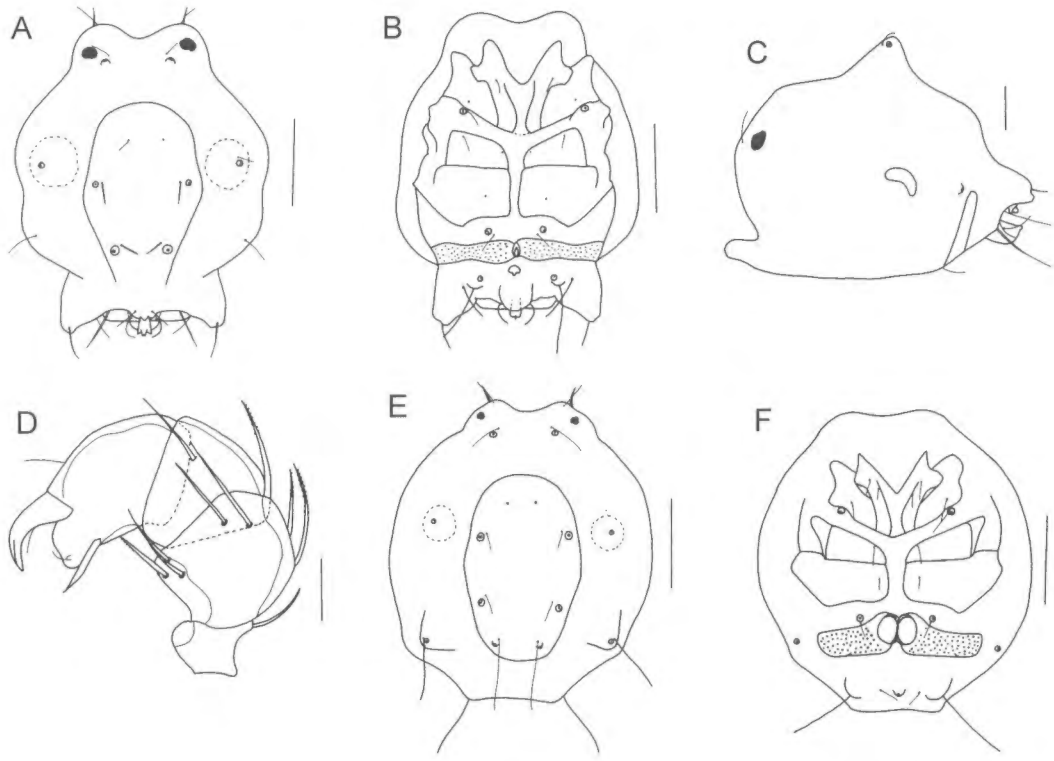

FIG. 1. *Arrenurus kimberleyensis* sp. nov. A-D, holotype ♂; A, dorsal view; B, ventral view; C, lateral view; D, palp. E,F, paratype ♀; E, dorsal view; F, ventral view. Scale bars: A,B,E,F = 400μm; C = 200μm; D = 50μm.

Arrenurus orientalis (part., ♂, err., non Daday, 1898): Daday, 1898a: 97; Daday, 1898b: 107; Piersig & Lohmann, 1901: 92.

MATERIAL. *Queensland*. 1 ♂, Low Lake, Lakefield NP, 5 September 2000.

DISTRIBUTION. China, Burma, Singapore, Sri Lanka, Brunei and Indonesia. It is reported here for the first time for Australia.

Arrenurus (Arrenurus) liliaceus Smit, 1997 (Fig. 2)

Arrenurus (Arrenurus) liliaceus Smit, 1997: 239; Harvey, 1998: 144.

MATERIAL. *Western Australia*. 19 ♂, 19 ♀, Jackeroo's Waterhole, El Questro Station, the Kimberley, 15 September 1998. ♀, Lily Creek Lagoon, Kununurra, 17 September 1998. 12 ♂♂, 3 ♀, Lake Kununurra, 10 km SE of Kununurra, 19 September 1998. 3 ♀, Fitzroy River, S of Fitzroy Crossing, 28 September 1998.

DESCRIPTION. Some additional measurements and characters are:

Male. Body 1467-1779 long, 1065-1206 wide.

Female. Body 1789 (1608-1950) long, 1568 (1427-1598) wide, greenish, occasionally brown, with concave anterior margin. Dorsal furrow complete. Dorsal shield 1045 long, 850 wide, pear-shaped. D1 on large humps, L4 on very large humps (Fig. 2A). Body truncated posteriorly. Medial distance of fourth coxal plates very small. Medial margin of fourth coxal plates much larger than medial distance of third coxal plates. Gonopore 178 long, without chitinous patches. Genital field long, directed more or less perpendicularly to lateral body margin, with an undulating posterior margin (Fig. 2B). Lengths of PI-PV: 51, 128, 98, 150, 98; palp as in male. Lengths of I-leg-4-6: 243, 227, 227. Lengths of IV-leg-4-6: 308, 292, 247.

REMARKS. With more material available, it is clear that the female described by me (Smit, 1997) does not belong to this species, but to an unknown species. The female of *A. liliaceus* is very similar to females of the subgenus *Brevicaudaturus*. However, subgeneric classification

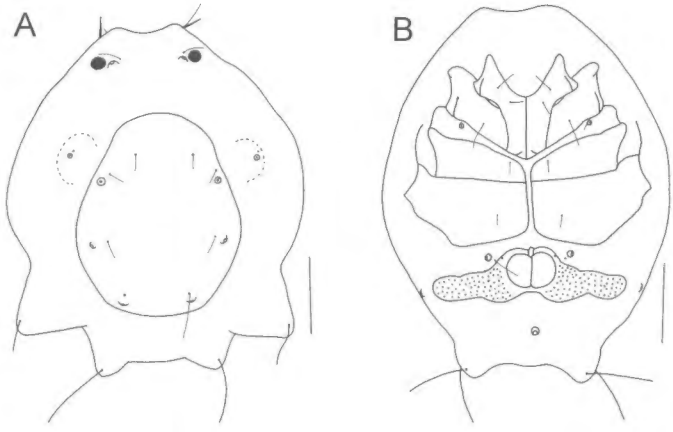

FIG. 2. *Arrenurus liliaceus* Smit, ♀; A, dorsal view; B, ventral view. Scale bars = 400μm.

is based on characters of the males. In young females all the humps are still lacking.

DISTRIBUTION. WA.

Arrenurus (Arrenurus) yorkensis sp. nov. (Fig. 3)

ETYMOLOGY. From Cape York Peninsula.

MATERIAL. HOLOTYPE. ♂, White Lily Lagoon, Lakefield NP, Qld, 4 September 2000 (QMS 55056). PARATYPES. ♂, 4 ♀ (QMS55057), 2 ♂, 4 ♀ (ZMAN type ACAR.0002.1-6.), same data as holotype; ♂, 10 ♀ (ZMAN type ACAR.0002.7-17.), 10 ♀, (QMS55058), Red Lily Lagoon, Lakefield NP, 4 September 2000; ♂, 8 ♀, shallow pool along road to Hanush Waterhole, Lakefield NP, 4 September 2000 (QMS55059).

DESCRIPTION. Male. Body 818 (794-858) long (including petiole), 516 (527-559) wide, greenish-bluish, with straight to slightly concave anterior border. Dorsal shield 332 (340-360) wide, only D4 on small humps; dorsal furrow passing onto sides of body near pygal lobes. Cauda and pygal lobes short (Fig. 3A). Gonopore 40 long. Genital plates large, widened laterally, swollen and visible in dorsal view (Fig. 3B). Near posterior margin of body a key-shaped structure. Hyaline membrane of two lobe-shaped parts. Petiole open dorsally, anterior half chitinised, posterior half more hyaline. In lateral view, hyaline part downturned, and chitinised part upturned (Fig. 3C). Posterior margin of hyaline part indented. On chitinised part, two setae, best seen in lateral view. Lengths of PI-PV: 26, 60, 48, 60, 34. Medial side of PII with two setae near anterior margin (Fig. 3D). Lengths of I-leg-4-6: 114, 112, 130. Lengths of IV-leg-4-6: 206, 84, 98; IV-leg-4 with a very short spur.

Female. Body 737 (680-810) long, 672 (640-717) wide, broad egg-shaped, posterolateral corners absent. Dorsal shield 470 (454-506) wide, dorsal furrow incomplete. Capitular bay wide, U-shaped. Medial distance of fourth coxal plates smaller than width of one genital valve. Medial margin of fourth coxal plates larger than medial margin of third coxal plates. Posterior margin of fourth coxal plates straight, directed slightly oblique or perpendicularly to lateral body margin. Gonopore large, 154 long; genital valves with small, indistinct chitinised parts near central part of gonopore. Genital plates relatively short, about two times as long as wide, narrowed laterally (Fig. 3E). Lengths of PI-PV: 26, 58, 50, 64, 32; palp as in male. Lengths of I-leg-4-6: 106, 102, 110. Lengths of IV-leg-4-6: 140, 134, 112.

REMARKS. The new species belongs to a group which occurs mainly in Asia, e.g. *A. ansatus* Walter, *A. kantakaphorus* Cook, *A. dadayi Cook* and *A. cavipetiolatus* Lundblad. All have a long, complicated petiole.

Arrenurus (Micruracarus) anbangbang Smit, 1997

Arrenurus (Micruracarus) anbangbang Smit, 1997: 246; Harvey, 1998: 144.

MATERIAL. *Arrenurus (Micruracarus) jabiruensis* Smit [part., ♀]. PARATYPES. 4 ♀♀, Lake Jabiru, Northern Territory, 20 July 1994.

OTHER MATERIAL. *Western Australia*. ♀, pool Lennard River, east side Windjana Gorge, Windjana Gorge National Park, the Kimberley, 10 September 1998. ♀, pools upstream of Bell Gorge Falls, the Kimberley, 11 September 1998. ♂, 3 ♀, pools Silent Grove (behind ranger station),the Kimberley, 11 September 1998. 10 ♂, 3 ♀, pool near Adcock Gorge, the Kimberley, 12 September 1998. 16 ♂, 17 ♀, Jack's Waterhole, along Gibb River Road, the Kimberley, 14 September 1998. ♀, pool Amalia Gorge, El Questro Station, the Kimberley, 16 September 1998. ♀, Spillway Creek near Lake Argyle, 20 September 1998. 3 ♂, 4 ♀, Arthur Creek, at crossing with Great Northern Highway, 23 September 1998. ♀, Fitzroy River, S of Fitzroy Crossing, 28 September 1998. *Northern Territory*. ♂, Magela Creek floodplain, Winmurra Billabong, 23 July 1979, coll. R. Tait (slide SMF 7192).

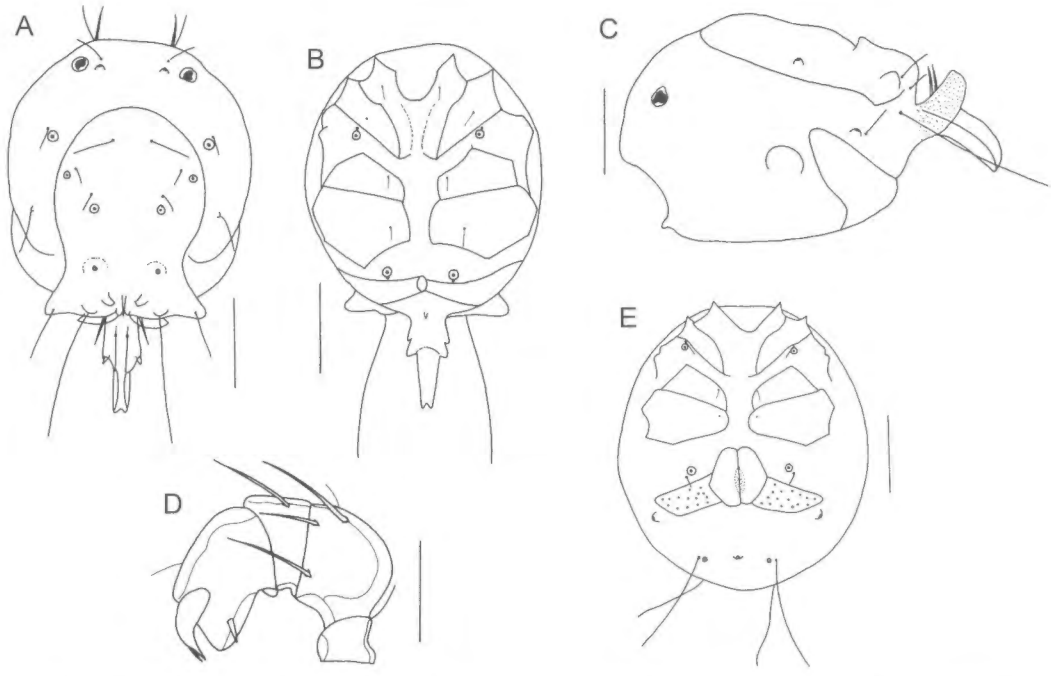

FIG. 3. *Arrenurus yorkensis* sp. nov., holotype ♂: A, dorsal view; B, ventral view; C, lateral view; D, palp. E, *Arrenurus yorkensis* sp. nov., paratype ♀. Scale bars: A,B,C,E = 200μm; D = 50μm.

Queensland. ♂, Lake Emma, Lakefield NP, 3 September 2000. 4 ♂, 5 ♀, Low Lake, Lakefield NP, 5 September 2000. ♂, 3 ♀, swamp 9km E of Musgrave, along road to Lakefield NP, 5 September 2000. ♂, ♀, billabong W of Wenlock River, near crossing with road to Iron RangeNP, 10 September 2000.

REMARKS. Female body shape is variable, many specimens have a more truncated posterior body part compared to specimens in the original description (Smit, 1997). A closer examination of females of *A. jabiruensis* revealed that their palp is similar to that of *A. anbangbang*. Separation of females of *A. anbangbang* and *A. jabiruensis* was based on these two characters. Therefore, females found with males of *A. jabiruensis* must be assigned to *A. anbangbang*.

DISTRIBUTION. NT, WA and QLD.

Arrenurus (Micruracarus) jabiruensis
Smit, 1997
(Fig. 4)

Arrenurus (Micruracarus) jabiruensis Smit, 1997: 249; Harvey, 1998: 144.

MATERIAL. *Northern Territory*. ♀, Magela Creek floodplain, Jabiluka Billabong, 19 January 1979, coll. R. Tait (slide SMF7123). 3 ♀, Magela Creek floodplain, Leichhardt Billabong, 14 May 1979, coll. R. Tait (slides SMF7106, 7107). ♂, ♀, Magela Creek floodplain, Jabiluka Billabong, 16 July 1979, coll. R. Tait (slide SMF7124). ♂, ♀, Magela Creek floodplain, Ja Ja Billabong, 28 September 1979, coll. R. Tait (slides SMF7179, 7181). 2 ♂, 4 ♀, Magela Creek floodplain, Jabiluka Billabong, 1 October 1979, coll. R. Tait (slides SMF7132, 7133, 7137, 7138, 7139). ♀, Magela Creek floodplain, Nankeen Billabong, 4 October 1979, coll. R. Tait (slide SMF7120). 2 ♀, Magela Creek floodplain, Leichhardt Billabong, 19 November 1979, coll. R. Tait (slide SMF7112).

DESCRIPTION. Female. Body 778 (761-810) long, 660 (648-672) wide, bluish, with slightly concave anterior body margin, posteriorly truncated. Dorsal furrow complete, dorsal shield 607 (591-648) long and 486 (486-510) wide. Medial margins of third and fourth coxal plates more or less of equal length. Medial distance of fourth coxal plates slightly less than width of one genital valve. Gonopore 146 long, genital valves with two pairs of rounded chitinous patches. Genital plates twice as long as wide, directing perpendicularly to lateral body margin (Fig. 4). However, genital plates of variable shape, specimens with a more bowed genital plate have been found. Lengths of PI-PV: 27, 60, 40, 74, 36;

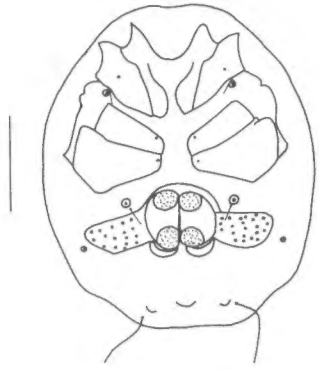

FIG. 4. *Arrenurus jabiruensis* Smit, ♀, dorsal view. Scale bar = 200μm.

PII with three setae on medial side, near anterior margin. Lengths of I-leg-4-6: 108, 122, 100. Lengths of IV-leg-4-6: 156, 150, 132.

REMARKS. Females previously assigned to *A. jabiruensis* are now assigned to *A. anbangbang*. In Viets' collection a number of females found with males of *A. jabiruensis* are here assumed to be females of the species.

The petiole of males consists of a fused ventral and dorsal piece, which sometimes have been loosened as a result of mounting, giving the petiole a quite different appearance. The ventral piece of the petiole has a straight posterior margin, the dorsal piece a slightly concave posterior margin.

DISTRIBUTION. NT.

Arrenurus (Micruracarus) madaraszi Daday, 1898

Arrenurus madaraszi Daday, 1898a: 97, 1898b: 99; Piersig & Lohmann, 1901: 116; Walter, 1929b: 265; Uchida & Miyazaki, 1935: 73; Miyazaki, 1935: 725, 1936a: 1, 1936b: 306; Uchida, 1937: 26; Imamura, 1953a: 259, 1953b: 275; 1953c: 470, 1954: 164, 1956: 25; Mendis & Fernando, 1962: 98; Fernando, 1963: 34; Lundblad, 1969: 402; Prasad, 1974: 26; Fernando, 1990: 271.
Arrenurus (Micruracarus) madaraszi Daday: Viets, 1935: 20; Uchida & Imamura, 1951: 350; Viets, 1959: 423; Imamura, 1961: 57; Jin & Wiles, 1996: 333; Jin, 1997: 146; Cook, 1967: 223; K.O. Viets, 1973: 108; Reisen & Mullen, 1978: 770; Gledhill & Wiles, 1997: 537; Smit, 1999: 233.
Arrenurus geei Marshall, 1921: 172.
Arrenurus kraepelini Koenike, 1906: 132; Viets, 1926: 100.
Arrenurus palembangensis Piersig, 1906: 369; Walter, 1923: 197, 1928: 106; Marshall, 1928: 604; Walter, 1929a: 263.
Arrenurus procursus Viets, 1927: 320; Viets, 1929: 397.

MATERIAL. *Queensland.* ♂, 3 ♀, White Lily Lagoon, Lakefield NP, 4 September 2000. 2 ♂, 5 ♀, shallow pool along road to Hanush Waterhole, Lakefield NP, 4 September 2000. ♂, ♀, Low Lake, Lakefield NP 5 September 2000. ♀, swamp 9km E of Musgrave, along road to Lakefield NP, 5 September 2000. 2 ♂, 2 ♀, Tinaroo Falls Dam at Yungaburra, 16 September 2000.

REMARKS. Both males and females are close to *A. anbangbang*. Its hyaline petiole is for the most part lying free, while the petiole of *A. madaraszi* is fused with the cauda. Moreover, the petiole of *A. madaraszi* has a small knob in the central part. Females are similarly close to each other, but *A. anbangbang* has a truncated posterior body part, and D1 lies on a small tubercle, which is absent in *A. madaraszi*.

DISTRIBUTION. China, Japan, Malaysia, Burma, Singapore, India, Pakistan, Sri Lanka, Indonesia and QLD.

Arrenurus (Micruracarus) pulcher Walter, 1911

Arrenurus pulcher Walter, 1911: 214; Lundblad, 1969: 405.
Arrenurus (Micruracarus) pulcher Walter: Viets, 1959: 424.
Arrenurus (Micruracarus) micropetiolatus (err., non Walter, 1928): Cook, 1967: 223.

MATERIAL. *Queensland.* ♂, 2 ♀, swamp Chili Beach, Iron Range NP 7 September 2000.

REMARKS. Cook (1967) suspected *A. pulcher* and *A. micropetiolatus* Walter to be conspecific. Lundblad (1969) on the contrary, disagreed with this, and assigned Cook's specimen of *A. micropetiolatus* from India to *A. pulcher*.

DISTRIBUTION. Aru Islands (Indonesia), Singapore, India, Burma and QLD.

Arrenurus (Micruracarus) purpureus Smit, 1997

Arrenurus (Micruracarus) purpureus Smit, 1997: 251; Harvey, 1998: 144.

MATERIAL. *Western Australia.* 4 ♀, Cockatoo Creek, at crossing with Great Northern Highway, 8 September 1998. 1 ♂, 2 ♀, Bell Creek at crossing with Gibb River Road, the Kimberley, 10 September 1998. ♂, 2 ♀, pools upstream of Bell Gorge Falls, the Kimberley, 11 September 1998. ♂, 11 ♀, Jack's Waterhole (along Gibb River Road), the Kimberley, 14 September 1998. 4 ♀, Jackeroo's Waterhole, El Questro Station, the Kimberley, 15 September 1998. ♀, pool Valentine Springs, W of Kununurra, 18 September 1998. 7 ♂, 9 ♀, Spillway Creek near Lake Argyle, 20 September 1998. 3 ♂, pools in creek at Old Halls Creek, S of Halls Creek, 26 September 1998. 2 ♂, Fitzroy River, S of Fitzroy Crossing, 28 September 1998. ♂, Taylor's Lagoon, east of Broome, 14 October 1998.

REMARKS. In contrast to the type material (which were all purple), the body of specimens from this study is green or bluish green.

DISTRIBUTION. WA.

Arrenurus (Micruracarus) queenslandicus Smit, 1999

Arrenurus (Micruracarus) queenslandicus Smit, 1999: 231.

MATERIAL. PARATYPES. 3 ♂, 5 ♀, pond north of Normanton, 14 August 1989 (ZMAN).

OTHER MATERIAL. *Queensland.* 3♂, Red Lily Lagoon, Lakefield NP, 4 September 2000. ♂, pool along road to Hanush Waterhole, Lakefield NP, 4 September 2000. ♂, ♀, Hasties Swamp, Hasties Swamp NP, 6 August 1989; same location, 6 ♂, 8 ♀, 16 September 2000. ♂, Tinaroo Falls Dam at Yungaburra, 16 September 2000.

REMARKS. Smit (1999) mentioned as differences between *A. anbangbang* and *A. queenslandicus* the petiole, which should be fused with the cauda in *queenslandicus*, and be free in *anbangbang*. However, this is not correct, as in the latter species the hyaline petiole is also fused. *A. anbangbang* has a cauda consisting of two broad lobes, while in *queenslandicus* these lobes are narrower. Other characters which separate males of *anbangbang* are D1 on small humps, and a large rounded anteroventral corner of PIV. In males of Hasties Swamp (only in 2000) and Tinaroo Falls Dam, the hyaline petiole is only partly fused with the cauda.

DISTRIBUTION. Queensland.

Arrenurus (Micruracarus) recticaudatus sp. nov. (Fig. 5)

ETYMOLOGY. For the rectangular male cauda.

MATERIAL. HOLOTYPE. ♂, Spillway Creek, near Lake Argyle, WA, 20 September 1998 (WAMT42594). PARATYPES. 3♂, 5♀, same data as holotype (WAMT42595). 2 ♀, Jack's Waterhole (along Gibb River Road), the Kimberley, WA, 14 September 1998 (ZMAN type ACAR.0003.1-2.). 2 ♂, 2 ♀, Lake Emma, Lakefield NP, Qld, 3 September 2000 (ZMAN type ACAR.0003.3-7.). OTHER MATERIAL. ♀, Stock Dam, Anakie, Qld, 18 July 1974, coll. B.V. Timms (slide SMF5654). ♀, Lake Kununurra, 10km SE of Kununurra, 19 September 1998.

DIAGNOSIS. Male with a rectangular cauda, posteriorly with a closed cleft, cauda simple. Female with long, widened genital plates and D1, L4 and V2 on humps.

DESCRIPTION. Male. Body 859 (855-859) long, 721 (656-672) wide, brownish green, with concave anterior margin. Dorsal shield complete, rounded, 462 (425-446) long and 397 (365-393) wide. D1 on large humps, D3 on small tubercles. Petiole simple, almost completely fused with cauda, bluntly pointed posteriorly (Fig. 5C). Cauda more or less rectangular, posteriorly with a closed cleft (Fig. 5A). Medial margin of third coxal plates larger than medial margin of fourth coxal plates. Cx 4 on rounded humps, V4 on large pointed humps, which extend beyond posterior body margin. Genital plates extending to lateral body margin, but acetabula hardly visible (Fig. 5B). Lengths of PI-PV: 36, 66, 46, 70, 50; PII with 2-3 setae on medial side (Fig. 5D). Lengths of I-leg-4-6: 160, 174, 202. Lengths of IV-leg-4-6: 200, 168, 188; IV-leg-4 with a short spur.

Female. Body 887 (859-972) long and 798 (737-810) wide. Anterior body margin slightly concave. Dorsal shield complete, pear-shaped (Fig. 5E, but in some females more rectangular), posterior margin concave, 608 (591-660) long and 470 (417-486) wide. D1 and L4 on humps. Medial margin of fourth coxal plates larger than medial margin of third coxal plates. Gonopore 105 long, without chitinous patches. Genital plates long, widened laterally (Fig. 5F). V2 on humps. Lengths of PI-PV: 32, 72, 52, 68, 50; palp as in male. Lengths of I-leg-4-6: 150, 152, 148. Lengths of IV-leg-4-6: 146, 180, 174.

REMARKS. The shape of the cauda and petiole will easily separate the new species from other species. The female is characterised by the shape of the genital plates.

Arrenurus (Megaluracarus) degeneratus Viets, 1984 nov. comb.

Arrenurus(Megaluracarus) rostratus degeneratus K.O. Viets, 1984: 434; Smit, 1997: 246; Harvey, 1998: 144.

MATERIAL. *Western Australia.* ♂, ♀, pool upstream of Bell Gorge Falls,the Kimberley, 11 September 1998. 2 ♂, 2 ♀, Lily Creek Lagoon, Kununurra, 17 September 1998. 31 ♂, 9 ♀, Lake Kununurra, 10km SE of Kununurra, 19 September 1998.

REMARKS. Large differences can be found between *A. rostratus* Daday (and its new subspecies, see below) and *A. degeneratus*. The last species is larger, and both male and female of the two species differ quite strongly in the shape of the body. Moreover, *A. rostratus mutilus* subsp. nov. and *A. degeneratus* have been found at the same location (pool upstream of Bell Gorge Falls), and can therefore not belong to the same species. Therefore, an elevation in rank to species is proposed for *A. degeneratus*.

DISTRIBUTION. NT and WA. Harvey (1997) reported the species from Queensland. I assume that his record refers to Viets (1975) report of *A. rostratus* probably from Queensland. As the material in the Viets collection from

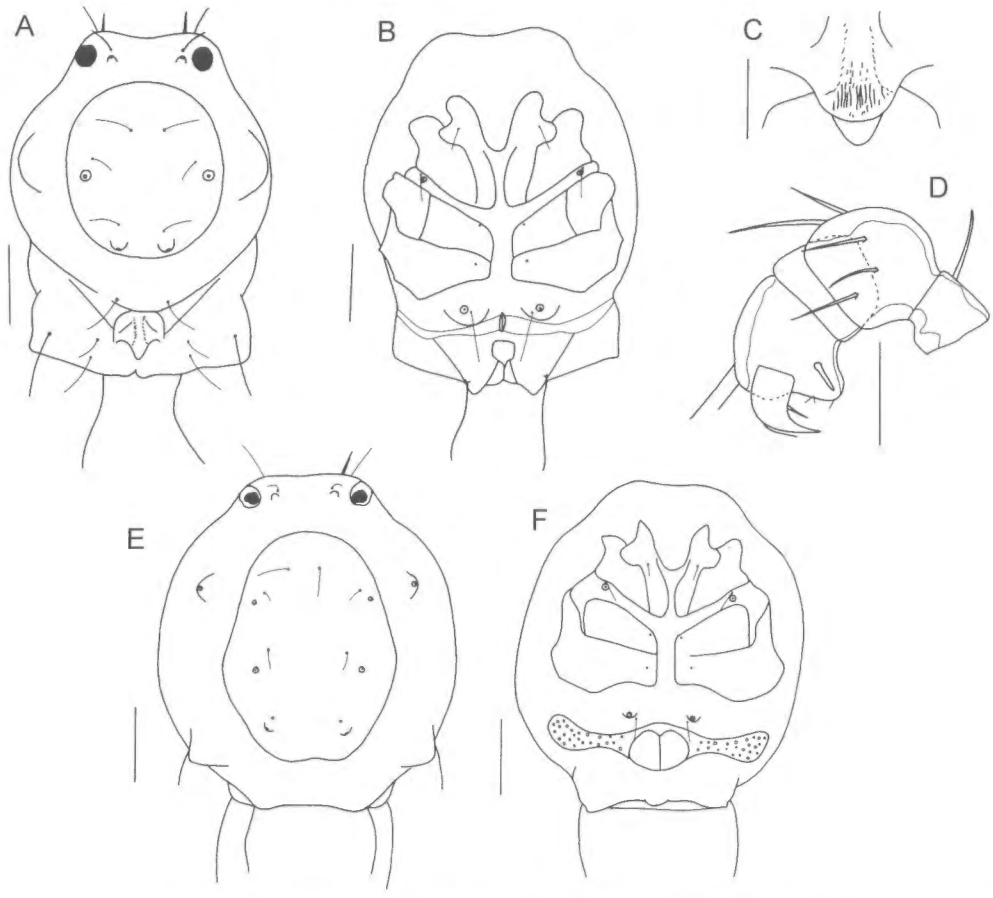

FIG. 5. *Arrenurus recticaudatus* sp. nov., holotype ♂: A, dorsal view; B, ventral view; C, detail of petiole; D, palp. *Arrenurus recticaudatus* sp. nov., paratype ♀; E, dorsal view; F, ventral view. Scale bars: A,B,E,F = 200μm; C,D = 50μm.

Queensland must be assigned to *A. rostratus mutilus*, I consider Harvey's record erroneous.

Arrenurus (Megaluracarus) gilvus Smit, 1997

Arrenurus (Megaluracarus) gilvus Smit, 1997: 242; Harvey 1998: 144.

MATERIAL. *Western Australia.* 1♂, 5♀, pool Amalia Gorge, El Questro Station, 16 September 1998.

REMARKS. Some additional measurements and characters are: Male. Body 964 long, 518 wide. Female. Body 794-891 long, 680-713 wide. Dorsal furrow complete, dorsal shield 527-567 long, 462-502 wide. One aberrant female with much narrower genital plates, otherwise similar.

DISTRIBUTION. NT and WA.

Arrenurus (Megaluracarus) harpagopalpus Walter, 1929

Arrenurus harpagopalpus Walter, 1929a: 252; Viets, 1981: 334; Smit, 1997: 259; Harvey, 1998: 144.

MATERIAL. *Queensland.* 2 ♂, 4 ♀, 1 nymph, shallow pool along road to Hanush Waterhole, Lakefield NP, 4 September 2000. 4 ♂, ♀, 2 nymphs, Low Lake, Lakefield NP, 5 September 2000.

DISTRIBUTION. Indonesia (Java), NT, NSW and QLD.

Arrenurus (Megaluracarus) rostratus mutilus subsp. nov. (Fig. 6)

Arrenurus (Megaluracarus) spec A - Smit, 1992: 107.

ETYMOLOGY. For its truncated body.

MATERIAL. HOLOTYPE. ♀, Jack's Waterhole (along Gibb River Road), the Kimberley, WA, 14 September 1998 (WAMT42596). PARATYPES. 9♂, 13♀ (WAM T42597), 9♂, 14♀ (ZMAN type ACAR.0004.1-23.), same data as holotype. OTHER MATERIAL. *Queensland*. ♂, ♀, Stock Dam, Anakie, 18 July 1974, coll. B.V. Timms (slides SMF5656, 5655). ♀, pond N of Normanton, 14 August 1989. 3♂, 5♀, Lake Emma, Lakefield NP, 3 September 2000. 6♀, Low Lake, Lakefield NP, 5 September 2000. 2♂, ♀, swamp 9 km E of Musgrave, along road to Lakefield NP, 5 September 2000. *Western Australia*. ♂, ♀, Cockatoo Creek at crossing with Great Northern Highway, 8 September 1998. ♂, 2♀, pools upstream of Bell Gorge Falls, the Kimberley, 11 September 1998. ♀, pool downstream of Manning Gorge, at campground, the Kimberley, 12 September 1998. ♂, pool Amalia Gorge, El Questro Station, 16 September 1998. ♂, Fitzroy River, S of Fitzroy Crossing, 28 September 1998. *Northern Territory*. 3 ♀, Roper Valley Station spring, 12 July 1981, coll. B.V. Timms (slides SMF7444, 7445).

DIAGNOSIS. Body of female truncated.

DESCRIPTION. Male. Body 1029 (996-1061) long, 446 (429-454) wide, with a long pointed rostrum. Dorsal furrow complete, dorsal shield almost circular, 275 (275-284) in diameter; occasionally slightly longer than wide. Cauda long, narrow, widest part near posterior (Fig. 6A, B). Posterior part of cauda with a concavity. Gonopore 60 long. Genital plates long, narrow, reaching beyond lateral body margin. Lengths of PI-PV: 22, 54, 38, 62, 34; palp as in female. Lengths of I-leg-4-6: 106, 107, 152. Lengths of IV-leg-4-6: 188, 122, 150; IV-leg-4 without a spur.

Female. Body 875 (818-931) long, 591 (587-688) wide, yellowish-greenish, with a distinct rostrum anteriorly. Dorsal furrow incomplete, dorsal shield 421 (413-498) wide. Body posteriorly truncated, posterior margin straight to slightly concave (Fig. 6C). Shape of truncated posterior body part variable, specimens with a broader truncated part do occur (Fig. 6F) Medial distance of fourth coxal plates slightly smaller than width of one genital valve. Medial margin of fourth coxal plates larger than medial distance of third coxal plates. Gonopore 116 long and without chitinised patches. Genital field short, rounded and sloping posteriorly (Fig. 6D). However, specimens with a straight posterior margin of the genital plate can be found (Fig. 6G) Lengths of PI-PV: 22, 56, 42, 62, 38. PII with two short setae on medial side, PIV stocky (Fig. 6E). Lengths of I-leg-4-6: 112, 102, 136. Lengths of IV-leg-4-6: 150, 130, 136.

REMARKS. The female has a truncated posterior body part. Females of widespread *A. rostratus rostratus* Daday have a rounded posterior body part, which is not truncated. The male is not separable from the nominate form, but as all females collected so far belong to the new subspecies, all males are assigned to the new subspecies as well. Variation in the cauda is similar to that in *A. rostratus rostratus*.

Arrenurus (Megaluracarus) thienemanni Viets, 1984

Arrenurus (Megaluracarus) thienemanni Viets, 1984: 432; Smit 1997: 243; Harvey 1998: 144.

MATERIAL. *Western Australia*. ♀, Fitzroy River, at crossing with Great Northern Highway, S of Derby, 8 September 1998. 10♂, 5♀, pool Lennard Gorge, Windjana Gorge National Park, the Kimberley, 10 September 1998. ♀, pool Lennard River, E side Windjana Gorge, Windjana Gorge National Park, the Kimberley, 10 September 1998. 5♂, 3♀, pool 3 km from Lennard Gorge, the Kimberley, 10 September 1998. 3♂, pool near Adcock Gorge, the Kimberley, 12 September 1998. 3 ♀, pool Manning Gorge Falls, the Kimberley, 13 September 1998. ♀, Jack's Waterhole, the Kimberley, 14 September 1998. 2 ♂, 18 ♀, pool Amalia Gorge, El Questro Station,the Kimberley, 16 September 1998. ♀, Middle Springs, W of Kununurra, 18 September 1998. ♂, ♀, Spillway Creek near Lake Argyle, 20 September 1998. ♂, Arthur Creek, at crossing with Great Northern Highway, the Kimberley, 23 September 1998. 3 ♂, pools in creek at Old Halls Creek, S of Halls Creek, 26 September 1998. 5 ♂, pool W of Tunnel Creek, Tunnel Creek National Park, 30 September 1998.

REMARKS. A character not previously reported is the very short rostrum of the males.

DISTRIBUTION. NT and WA.

Arrenurus (Megaluracarus) vanderpalae Smit, 1992

Arrenurus (Megaluracarus) vanderpalae Smit, 1992: 109, 1997: 246; Harvey, 1998: 144.

MATERIAL. *Western Australia*. 2♂, 3♀, plunge pool Cathedral Gorge, Purnululu NP, 24 September 1998.

DISTRIBUTION. QLD and WA.

Arrenurus (Truncaturus) tasmanicus Lundblad, 1941

Arrenurus (Truncaturus) tasmanicus Lundblad, 1941: 160; Lundblad 1947: 77; Smit, 1992: 110; Harvey, 1998: 144.

MATERIAL. *New South Wales*. 5 ♀, swamp no. 5, Myall Lakes National Park, 13 September 1977, coll. B.V. Timms (SMF6706-6708).

REMARKS. Kurt Viets erroneously identified these specimens as *A. depressus*, a species only

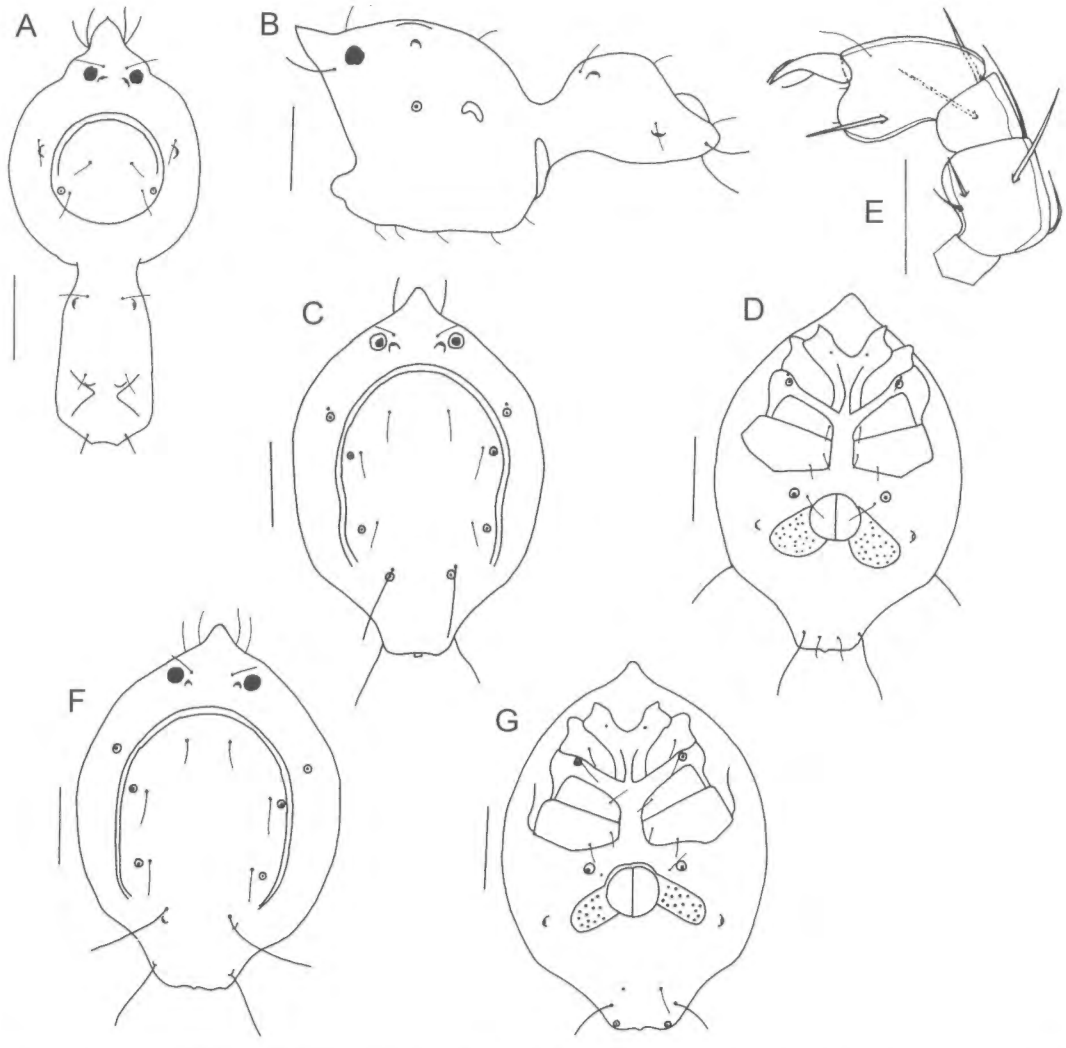

FIG. 6. *Arrenurus rostratus mutilus* subsp. nov., paratype ♂; A, dorsal view; B, lateral view. *Arrenurus rostratus mutilus* subsp. nov., holotype ♀; C, dorsal view; D, ventral view; E, palp. *Arrenurus rostratus mutilus* subsp. nov., paratype ♀; F, dorsal view; G, ventral view. Scale bars: A,B,C,D,F,G = 200μm; E, = 50μm.

known in New Caledonia. However, its genital plates are slightly bowed, while those of the NSW specimens are slightly contracted laterally.

DISTRIBUTION. TAS and NSW.

Arrenurus (Rhinophoracarus) gracilipes Piersig, 1906

Arrenurus (Rhinophoracarus) gracilipes Piersig, 1906: 370; Smit, 1997: 251.
Rhinophoracarus gracilipes (Piersig): Viets, 1935: 2; Lundblad, 1969: 392.

MATERIAL. *Queensland.* 3♂, 14 ♀, White Lily Lagoon, Lakefield NP, 4 September 2000. ♂, 4 ♀, Red Lily Lagoon, Lakefield NP, 4 September 2000. ♂, 4 ♀, pool along road to Hanush Waterhole, Lakefield NP, 4 September 2000. ♂, 2♀, Low Lake, Lakefield NP, 5 September 2000. ♂, swamp 9 km E of Musgrave, along road to Lakefield NP, 5 September 2000. 8 ♀, billabong W of Wenlock River, at crossing with road to Iron RangeNP, 10 September 2000. *Western Australia.* 5 ♀, Cockatoo Creek at crossing with Great Northern Highway, 8 September 1998. 2 ♀, Lily Creek Lagoon, Kununurra, 17 September 2000. ♀, Lake Kununurra, 10km SE of Kununurra, 19 September 1998.

DISTRIBUTION. Burma, India, Indonesia, QLD, WA.

Arrenurus (Dividuracarus) gereckei Smit (Fig. 7)

Arrenurus (Dividuracarus) gereckei Smit, 1997: 255; Harvey, 1998: 144.

MATERIAL. *Western Australia.* 8 ♂, 6 ♀, Arthur Creek, at crossing with Great Northern Highway, 23 September 1998. ♂, plunge pool Frog Hole Gorge, Purnululu NP, 23 September 1998. *New South Wales.* ♀, Lake Hiawatha, 10 August 1975, coll. B.V. Timms (SMF6192). ♂, Lake Hiawatha, 17 March 1977, coll. B.V. Timms (SMF6435). *Northern Territory.* ♂ (not sclerotised), Magela Creek floodplain, Jabiluka Billabong, 19 January 1979, coll. R. Tait (SMF7121). ♀, Magela Creek floodplain, Island Billabong, 21 May 1979, coll. R. Tait (SMF7161). ♀, Magela Creek floodplain, Buffalo Billabong, 22 May 1979, coll. R. Tait (SMF7113). ♂, Magela Creek floodplain, Ja Ja Billabong, 23 May 1979, coll. R. Tait (SMF7171). 3♀, Magela Creek floodplain, Winmurra Billabong, 23 July 1979, coll. R. Tait (SMF 7193-7195). ♂, 2♀, Magela Creek floodplain, Winmurra Billabong, 27 September 1979, coll. R. Tait (SMF7202- 7204). ♂, 3♀, Magela Creek floodplain, Winmurra Billabong, 15 November 1979, coll. R. Tait (SMF7214- 7217).

DESCRIPTION. Male. 996-1105 long, 745-810 wide. Female. Body 1158 (1126-1255) long, 988 (923-1037) wide, greenish, with slightly concave anterior margin, truncated anteriorly and posteriorly. D1 and L4 on small humps. Dorsal furrow complete, dorsal shield 721 long, 664 wide. Medial distance of fourth coxal plates large; fourth coxal plates almost without a medial margin or with a short medial margin. Gonopore extended laterally. Genital plates directed perpendicularly or slightly bowed to lateral body margin, short, about 1,5 times as long as wide (Fig. 7). Lengths of PI-PV: 38, 94, 56, 103, 51; palp as in male. Lengths of I-leg-4-6: 140, 128, 106. Lengths of IV-leg-4-6: 235, 227, 196. Third and fourth legs with numerous swimming setae.

REMARKS. The female which has not been described previously, has an unusual gonopore, with lateral extension not found in any other member of the genus.

DISTRIBUTION. QLD, WA and NSW.

Arrenurus (Dividuracarus) tripartitus Smit, 1997

Arrenurus (Dividuracarus) tripartitus Smit, 1997: 255; Harvey, 1998: 144.

MATERIAL. *Western Australia.* ♀, pool Joffre Gorge, Hamersley Range NP, 13 August 1994.

DISTRIBUTION. QLD and WA.

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LITERATURE CITED

COOK, D.R. 1967. Water mites from India. Memoirs of the American Entomological Institute 9: 1-411.

DADAY, E. VON 1898a. Édesvizi mikroskopi állatok Ceylonból. Matematikai es Természettudomanyi, Értesitö 16: 89-100.

1898b. Mikroskopische Süsswasserthiere aus Ceylon. Természetrajzi Füzetek, Anhangsheft 21: 1-123.

FERNANDO, C.H. 1963. A guide to the freswater fauna of Ceylon. Bulletin of the Fisheries Research Station, Ceylon 16: 29-38.

1990. The freshwater fauna and fisheries of Sri Lanka. A collection of published papers by C.H. Fernando and collaborators (1962-1980), with taxonomic and common name indexes. Suborder Hydracarina, pp. 268-273. (Natural Resources, Energy and Science Authority of Sri Lanka: Colombo).

GLEDHILL, T. & WILES, P.R. 1997. Water-mites (Acari: Hydrachnidia) from Sri Lanka with descriptions of a new genus and two new species. Archiv für Hydrobiologie, Supplement 107: 513-539.

HARVEY, M.S. 1998. The Australian water mites. A guide to families and genera. Monographs on Invertebrate Taxonomy 4. (CSIRO Publishing: Collingwood).

IMAMURA, T. 1953a. Some water-mites from Hiroshima Prefecture. Journal of the Faculty of Science of the Hokkaido University 11: 193-260.

1953b. Some stenophilous water-mites from Hyogo Prefecture. Journal of the Faculty of Science of the Hokkaido University, Zoology 11: 261-276.

1953c. Water-mites from Gifu Prefecture. Journal of the Faculty of Science of the Hokkaido University, Zoology 11: 411-471.

1954. Some stenophilous water-mites from Niigata Prefecture. Journal of Hokkaido Gakugei University, Section B, Supplement 1: 149-164.

1956. Water-mites from lakes Kasumigaura and Kitaura. Bulletin of the Faculty of Liberty and Arts, Ibaraku University 6: 23-26.

1961. Water-mites (Hydrachnellae), mainly in subterranean waters, from the Ryu-Kyu Islands. Acarologia 3: 48-59.

JIN DAOCHAO & WILES, R. 1996. New species of *Arrenurus* Dugès (Acari: Hydrachnidia:

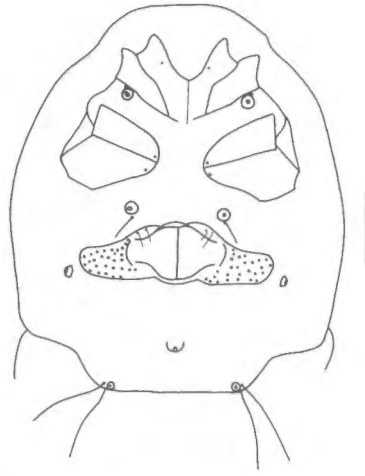

FIG. 7. *Arrenurus gereckei*, Smit, ♀, ventral view. Scale bar = 200μm.

Arrenuridae) from China and first records of watermites from Laos. Acarologia 37: 317-344.

LUNDBLAD, O. 1941. Neue Wassermilben aus Amerika, Afrika, Asien und Australien. Zoologischer Anzeiger 133: 155-160.

1947. Zur Kenntnis Australischer Wassermilben. Arkiv för Zoologie 40A: 1-82.

MARSHALL, R. 1921. New species and collections of Arrhenuri: 1921. Transactions of the American microscopical Society 40: 168-176.

1928. Water mites from China. Transactions of the Wisconsin Academy of Sciences, Arts and Letters 23: 601-609.

MENDIS, A.S. & FERNANDO, C.H. 1962. A guide to the freshwater fauna of Ceylon. Bulletin of the Fisheries Research Station, Ceylon 12: 1-160.

MIYAZAKI, I. 1935. On a water mite parasitic on *Anopheles*. Botany & Zoology, Tokyo 3: 725-729. (in Japanese)

PIERSIG, R. & LOHMANN, H. 1901. Acarina. Hydrachnidae and Halacaridae. Das Tierreich 13: 1-336.

PIERSIG, R. 1906. Über Süßwasser-Acarinen von Hinterindien, Sumatra, Java und den Sandwich-Inseln. (Reise von Dr. Walter Volz.). Zoologische Jahrbücher, Abteilung für Systematik 23: 321-394.

REISEN, W.K. & MULLEN, G.R. 1978. Ecological observations on acarine associates (Acari) of Pakistan mosquitos (Diptera: Culicidae). Environmental Entomology 7: 769-776.

SMIT, H. 1992. Water mites from New South Wales and Queensland, Australia. Tijdschrift voor Entomologie 135: 91-112.

1997. Australian water mites of the genus *Arrenurus*, with the description of 12 new species, from northern and western Australia (Acari: Hydrachnellae: Arrenuridae). Records of the Western Australian Museum 18: 233-261.

1999. New species of the water mite genus *Arrenurus* from eastern Australia (Acari: Hydrachnidia: Arrenuridae). Memoirs of Museum Victoria 57: 225-236.

UCHIDA, T. & MIYAZAKI, I. 1935. Life-history of a water-mite parasitic on *Anopheles*. Proceedings of the Imperial Academy (of Japan) 11: 73-76.

UCHIDA, T. 1937. Water mites from Kyushu. Bulletin of the biogeographical Society 7: 9-29.

UCHIDA, T. & IMAMURA, T. 1951. Some water mites from China. Journal of Science, Hokkaido University, Sapporo, serie VI, Zoology 10: 324-358.

VIETS, K. 1926. Fauna sumatrensis. (Beitrag Nr. 15). Hydracarina. Entomologische Mitteilungen, Berlin 15: 100-102.

1927. Wassermilben von Hinterindien. Zoologischer Anzeiger 73: 315-322.

1929. Watermites from the Malay Peninsula. Journal of the Federated Malay States Museums 14: 397.

1935. Die Wassermilben von Sumatra, Java und Bali nach den Ergebnissen der Deutschen Limnologischen Sunda-Expedition. Archiv für Hydrobiologie, Supplement 14: 1-113.

VIETS, K.O. 1959. Wassermilben (Hydrachnellae) aus dem indo-australischen Faunengebiet. Archiv für Hydrobiologie 55: 415-428.

1973. Results of the Austrian-Ceylonese Hydrobiological Mission 1970 of the 1st Zoological Institute, University of Vienna (Austria) and Department of Zoology, Vidyalankara University of Ceylon, Kelaniya, Ceylon. Part III. Über einige Wassermilben aus Ceylon (Hydrachnellae, Acari). Bulletin of the Fisheries Research Station, Ceylon 23: 101-111.

WALTER, C. 1923. Hydrobiologische Beiträge aus China. Nach Dr. H. Weigolds Material von den Stötznerschen Expeditionen und aus China. Hydracarina. Zugleich ein Beitrag zur Frage der Hautatmung bei *Arrhenurus*-Arten. Internationale Revue der gesamten Hydrobiologie und Hydrographie 11: 193-201.

1928. Zur Kenntnis der Mikrofauna von British Indien. Records of the Indian Museum 30: 57-108.

1929a. Hydracarinen aus Java. Treubia 11: 211-273.

1929b. Revision der von E. von Daday beschriebenen Hydracarinen von Ceylon. Annales Musei Nationalis Hungarici 26: 251-268.

WILES, P.R. 1997. The homology of glands and glandularia in the water mites (Acari: Hydrachnidia). Journal of Natural History 31: 1237-1251.