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# A new species of *Arrenurus* (Acari, Parasitengona, Hydrachnidia) found in the crop of a Yellow-billed Teal *Anas flavirostris* in Bolivia

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**Original research**

**ABSTRACT**

New findings of organismal dispersal by other organisms can help explain the distribution of species to remote places. In this work, I describe a male and a female of a new water mite species of the genus *Arrenurus* that were found in the crop of an *Anas flavirostris* duck near Cochabamba, Bolivia. Both specimens were complete; however, it is unknown if they were alive and, thus, potentially viable at the time of collection. This study also represents the first reported finding of water mites in a bird crop.

**Keywords** water mite; *Anas flavirostris*; crop; Bolivia; dispersal; new species
**Zoobank** http://zoobank.org/6A5F717F-CE15-40EA-897B-83853C8EBDD4

## Introduction

Models that aim to explain the distribution of organisms range from absolute dispersion to vicariance, and include those that differentially combine these two extremes (Zink *et al*. 2000). In some cases, the underlying causal mechanisms of dispersion are unknown, leading to a search of the most parsimonious model to explain a given pattern of organismal occurrence. In other cases, the dispersal mechanisms may be known but the actual distribution of the species is not. A common mechanism of organismal dispersal is via birds (for a recent review on waterfowl dispersal, see Van Leeuwen *et al*. 2012). This is potentially the case of two specimens of a new water mite species of the genus *Arrenurus* that were found in the crop of an *Anas flavirostris* duck in Bolivia. The mites, a male and a female, were in perfect condition; however, it is uncertain if they would have been viable.

Of the nearly 1,000 species of *Arrenurus* Dugés that have been described worldwide (Gerecke *et al*. 2016), over 160 are known from South America (Rosso de Ferradas and Fernandez 2005). Of these species, 17 belong to the subgenus *Arrenurus*. Another 26 species may also belong to this subgenus; however, as their descriptions are based only on female specimens, they cannot be assigned to a subgenus rank (Rosso de Ferradas and Fernandez 2005). The two water mite specimens described herein, a male and a female, represent a new species of *Arrenurus* (*Arrenurus*). Moreover, to my knowledge, this study is the first to report the presence of water mites in the crop of a duck.

## Materials and methods

The type material, a male and a female, were found in the crop of a Yellow-billed Teal, *Anas flavirostris*, near Cochabamba (Bolivia). The specimens were fixed in Koenike's fluid (Cook

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1974), and the palps, chelicerae and gnathosoma dissected, oriented and permanently mounted on a slide with glycerin jelly (O. Lundblad's formulation provided by T. Gledhill, Freshwater Biological Association, Ambleside, Cumbria, England), together with the main body. The slides were deposited in the invertebrate collection held at the Museo Nacional de Ciencias Naturales, Madrid (MNCN). Abbreviations: P-I, first segment palp; P-II, second segment palp and so on. I-Leg-3, third segment of the first leg; I-Leg-4, fourth segment of the first leg and so on. All measurements are in µm.

A drawing tube attached to a standard Zeiss compound microscope was used to facilitate drawings. Laser scanning confocal microscopy stacks were acquired with a Leica SPE (for detailed methodology, see Valdecasas and Abad 2010). Image stacks were processed with Fiji/ImageJ and Amira (ver. 5.4.3). The autofluorescence of the mounting medium competed with the natural autofluorescence typically found in arthropod specimens. Therefore, several strategies were used to improve the resolution of the leg setation images: maximum and median projections were both rendered, as was the average of both projections, followed by contrast limited adaptive histogram equalization (CLAHE) and unsharp masking (Malin 1977) plus background subtraction, followed by maximum intensity projection (MIP).

## Results

**Family: Arrenuridae Thor, 1900**

**Genus: *Arrenurus* Dugès, 1834**

**Subgenus: *Arrenurus* Dugès, 1834**

**Type species: *Arrenurus viridis* Dugès, 1834**

***Arrenurus* (*Arrenurus*) *caboti* n. sp. (Figs 1–6)**

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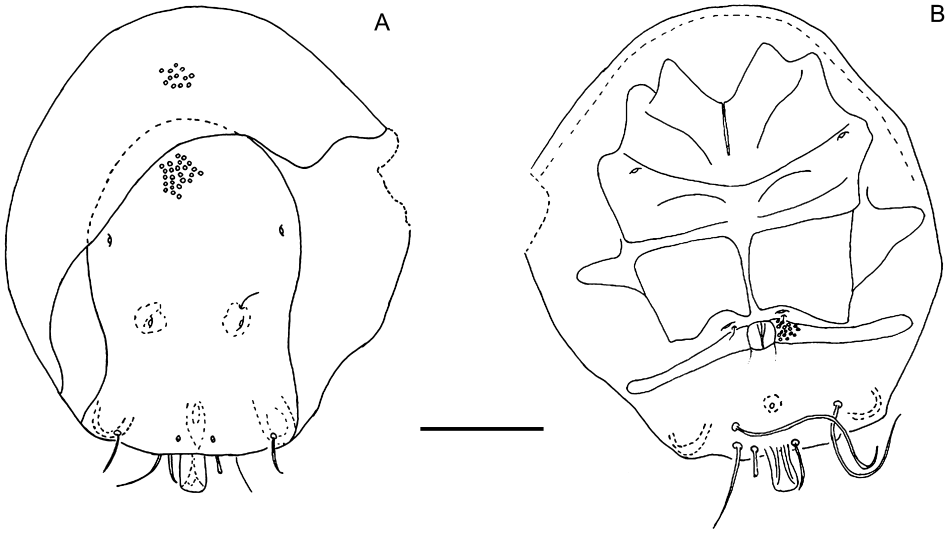


**Figure 1** *Arrenurus caboti* **n. sp.**, holotype male: A) dorsal view; B) ventral view. Scale bar = 300 µm.

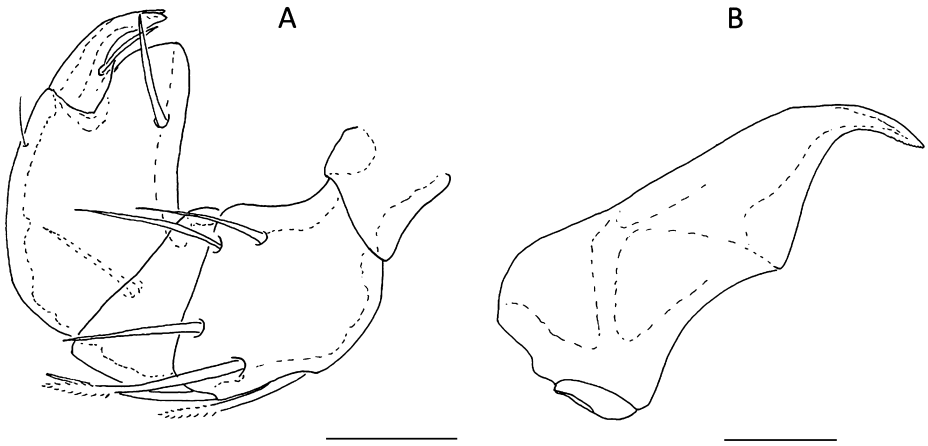


**Figure 2** *Arrenurus caboti* **n. sp.**, holotype male: A) palp; B) chelicera. Scale bar = 50 μm.

## Material examined

Holotype male, Cochabamba, Bolivia, found in the crop of a Yellow-billed Teal, *Anas flavirostris*. 9 January 1983, leg., José Cabot Nieves. Collection number: MNCN 20.02/19390. Paratype, one female, same data as holotype. Collection number: MNCN 20.02/19391.

## Description

**Male** — Colour not registered. Body rounded, anterior end convex between the eyes, cauda absent (Fig. 1). Body, excluding petiole, 991 μm long with a maximum width of 966 μm. Cauda indistinct, with a rectangular petiole without an evident notch nor a hyaline membrane. Petiole 91 μm long, with a maximum width at the tip of 69 μm. Dorsal furrow complete, with two medial and two terminal humps. Pygal lobes absent. Gonopore 59 μm long. Acetabular plates extending laterally.

Dorsal length of the palps: P-I, 42; P-II, 87; P-III, 59; P-IV, 95; P-V, 46. P-II with six setae, three of which are pennate. P-III and P-IV with one setae each. Chelicera total length 203 μm (Fig. 2). Gnathosoma 147 μm long and 114 μm wide. Legs have a complex chaetotaxy (see Table 1 and Figs 3 and 4). Dorsal length of leg segments: I-Leg-3: 125; I-Leg-4: 169; I-Leg-5: 159; I-Leg-6: 169; II-Leg-3: 141; II-Leg-4: 188; III-Leg-5: 194; II-Leg-6: 203; III-Leg-4: 234; III-Leg-5: 226; III-Leg-6: 197; IV-Leg-2: 203; IV-Leg-3: 203; IV-Leg-4: 340; IV-Leg-5: 153; IV-Leg-6: 169.

**Female** — Colour not registered. Body rounded, 1421 μm long with a maximum width of 1290 μm (Fig. 4). Dorsal furrow complete, maximum width 733 μm. Gonopore 172 μm

**Table 1** Approximate number of strong, long setae and swimming setae, respectively, on male leg segments.

| Segment | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| I-Leg | 4/0 | 3/0 | 1/0 | 2/0 | 0/0 |
| II-Leg | 4/0 | 4/0 | 3/4 | 1/0 | 0/16 |
| III-Leg | 7/0 | 5/0 | 5/7 | 3/10 | 0/0 |
| IV-Leg | 0/11 | 8/7+12 | 12/8+12 | 9/6+2 | 0/0 |

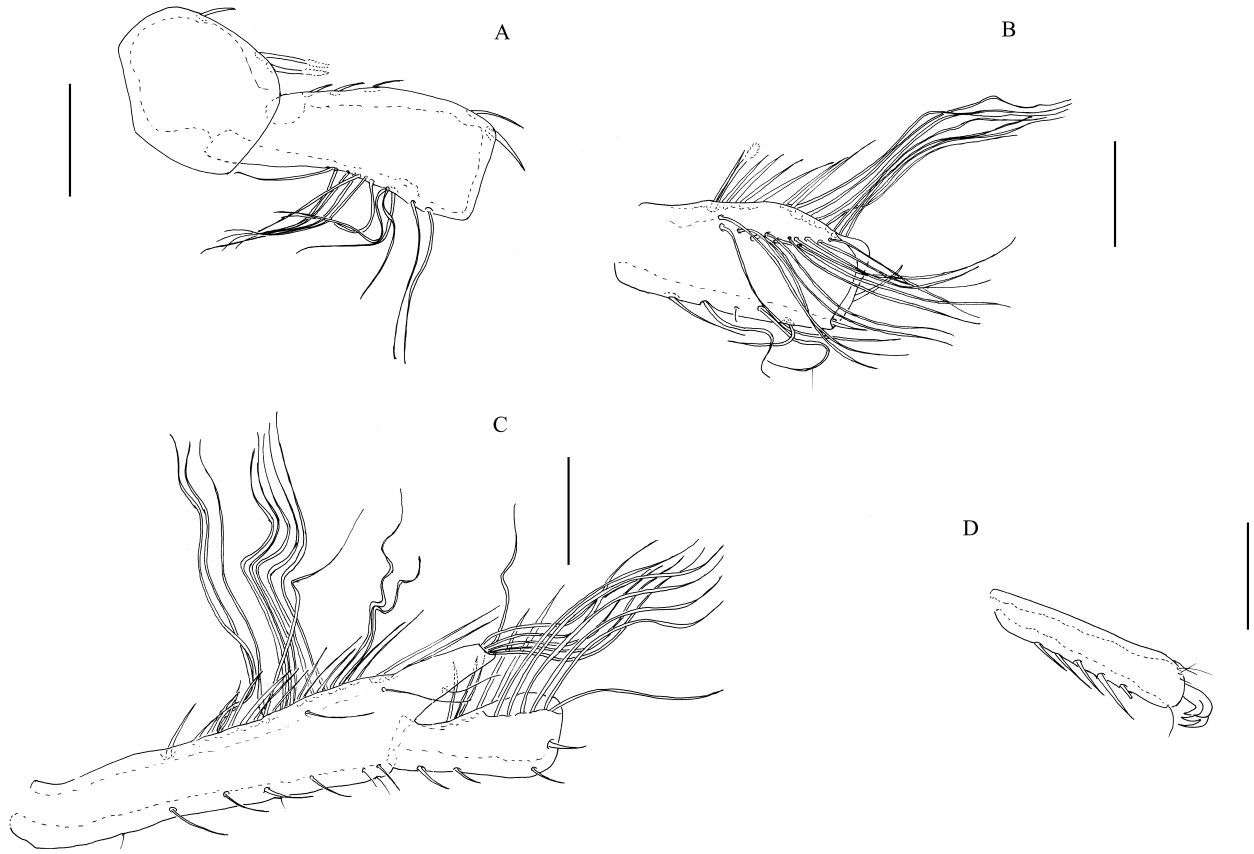


**Figure 3** *Arrenurus caboti* **n. sp.**, holotype male: A) IV-Leg-1-2; B) IV-Leg-3; C) IV-Leg-4-5; D) IV-Leg-6. Scale bar = 100 μm.

long. Dorsal length of the palps: P-I, 46; P-II, 91; P-III, 70; P-IV, 112; P-V, 57. Palp shape similar to the male; P-II with five setae, and P-III with one setae. Cheliceral shape similar to the male, total length 178 μm. Gnathosoma 200 μm long and 153 μm wide. Dorsal length of the IV-Leg segments: IV-Leg-2: 184; IV-Leg-3: 197; IV-Leg-4: 262; IV-Leg-5: 238; IV-Leg-6: 200. Number of swimming setae on the IV-Leg segments: IV-Leg-3: 11; IV-Leg-4: 9+11; IV-Leg-5: 10 (Table 2 and Fig. 6).

### Etymology

The new species is named after José Cabot who gave me the specimens during a stay in Bolivia.

## Discussion

Van Leeuwen *et al.* (2012) provide a review of macroinvertebrate and macrophyte species transported by waterbirds via their faecal droppings, and although crustacean, insect, molluscan and bryozoan species were all recorded, no chelicerates were found. In a more recent study that focuses on the dispersal of wetland plant seeds, Kleyheeg and van Leeuwen (2015) highlight regurgitation as an overlooked dispersal mechanism. Given that this event can happen within a few hours, regurgitated organisms may potentially remain viable. The relevance of this mechanism for the occasional transportation of non-resting stages of invertebrates is unknown. However, as speculative at it may be, De Queiroz (2014) shows that, given sufficient time, almost inconceivable dispersal events can occur.

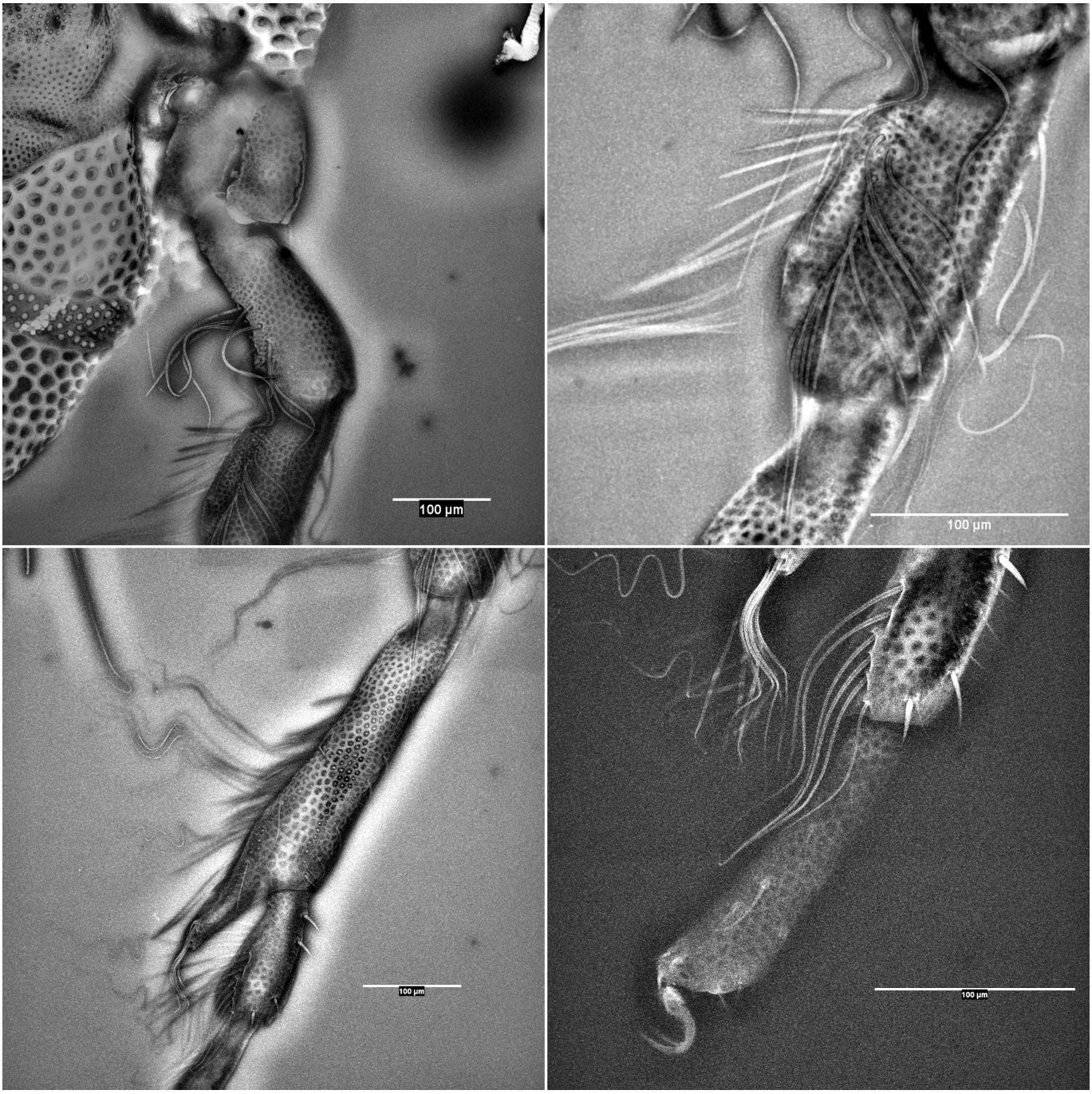


**Figure 4** *Arrenurus caboti* **n. sp.**, holotype male: Laser scanning confocal microscope MIP images after unsharp masking and background subtraction. A) IV-Leg-1-2; B) IV-Leg-3; C) IV-Leg-4-5; D) IV-Leg-6.

According to BirdLife International (2019), the Yellow-billed Teal is 'resident' in the area where it was found. The bodies of the male and female water mite specimens were complete, and the female had no eggs. Whether the specimens were alive at the time of collection is unknown, as their vital activity was not documented. However, one can speculate that they could have possibly passed through the digestive system of the duck intact due to the hard body composition of the species and, if the female had been gravid and the bird's droppings fell into water, she could have hatched offspring. In another possible scenario, they could have been

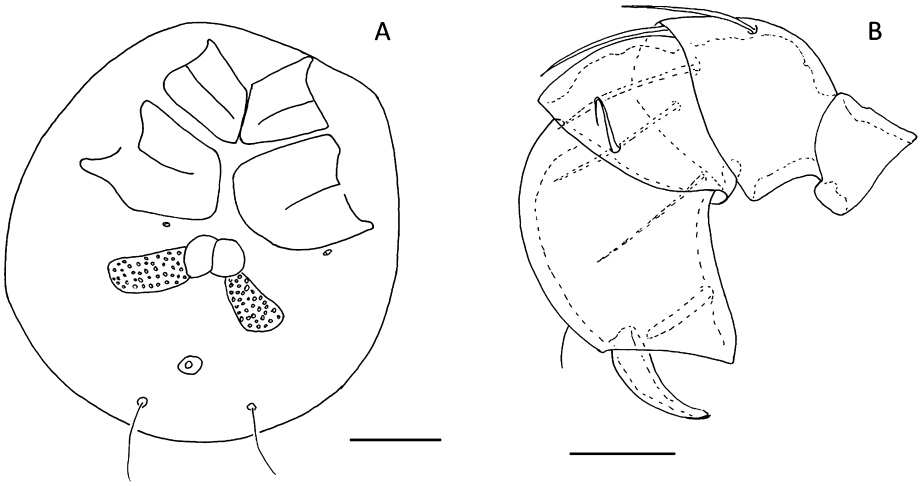


**Figure 5** *Arrenurus caboti* **n. sp.**, paratype female: A) ventral view; B) palp. Scale bars = 300 μm in A and 50 μm in B.

regurgitated soon after ingestion and been viable as adults. Had the female been gravid, her eggs could have also been viable. Regardless of the potential viability of the two specimens, the present study is the first to report the presence of a water mite species in the crop of a mallard.

Similarities in palp shape and chaetotaxy can be used to identify male and female specimens of the same species within *Arrenurus*. The two specimens of *A. caboti* n. sp., besides being found together, share a similar morphology and distribution of palp setae. The new species can be easily distinguished from the 17 species of the subgenus *Arrenurus* (*Arrenurus*) that have been registered for South America (Rosso de Ferradas and Fernandez 2005) by, among other characters, the presence of a cauda on the male body of the following species: *A. brasiliensis* Lundblad, 1941; *A. brevipetiolatus* Lundblad, 1936; *A. erectipetiolatus* Viets, 1954; *A. flagellatus* Lundblad, 1936; *A. inflatipalpis* Lundblad, 1944; *A. lobatus* Lundblad, 1941; *A. mystrophorus* Lundblad 1938; *A. oxyurus* Ribaga, 1902; *A. plaumanni* Lundblad, 1936; *A. rectipetiolatus* Lundblad, 1941; *A. ringueleti* Rosso de Ferradas, 1980; *A. sellatus* Viets, 1954; *A. subulifer* Lundblad, 1938; *A. trichophorus* Daday, 1905; *A. valdiviensis* Viets, 1964; *A. valencius* Marshall, 1919 and *A. vicinus* Lundblad, 1944.

In their survey of South American *Arrenurus* species, Rosso de Ferradas and Fernandez (2005) included two other species within the subgenus *Arrenurus*, *A. conspicuus* Viets and Böttger, 1986 and *A. ripiphorus*, Lundblad, 1937, despite their original descriptions being based only on female specimens. The female body shape of *A. conspicuus* and *A. caboti* n. sp. are similar; however, the two species differ in the number of setae on P-II, three in *A.*

**Table 2**

| Segment | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| I-Leg | 5/0 | 7/0 | 10/0 | 3/0 | 0/0 |
| II-Leg | 5/0 | 5/0 | 3/0 | 2/0 | 0/0 |
| III-Leg | 5/0 | 5/5 | 1/5 | 1/0 | 0/0 |
| IV-Leg | 11/0 | 10/11 | 0/9+11 | 0/10 | 0/0 |

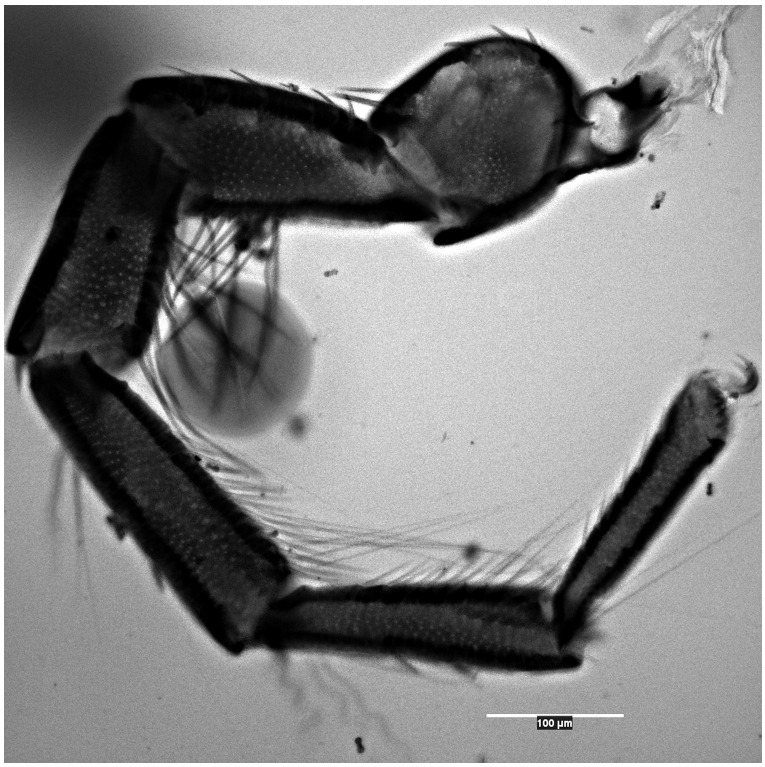


**Figure 6** *Arrenurus caboti* **n. sp.**, paratype female: Laser scanning confocal microscope MED (median) image projection and unsharp masking. IV-Leg.

*conspicuus* and six in *A. caboti* n. sp. They also differ in the shape of P-IV, almost rectangular in *A. conspicuus* but concave-convex in *A. caboti* n. sp. The new species is easily distinguished from *A. ripiphorus*, which has an oval-shaped body that is not truncated at the front.

The new species can also be distinguished from the other 24 South American *Arrenurus* species described only from female specimens by the number and size of setae on P-II and/or the general body shape of the female. Compared to the five setae in *A. caboti* n. sp., 8 of the 24 species have numerous setae (*i.e.* brittle brush) on P-II: *A. acutiepimeratus* Viets, 1954; *A. amplipenicillatus* Viets, 1954; *A. boettgeri* Viets, 1968; *A. caquetiorum* Rosso de Ferradas and Fernandez, 2001; *A. dentipalpis* Lundblad, 1936; *A. hirsutipalpis* Walter, 1919; *A. mutangulus* Daday, 1905 and *A. papilliger* Viets, 1959. Two of the species, *A. tumulosus tumulosus* Viets, 1954 and *A. tumulosus intercursor* Viets, 1954, have 10–12 strong short setae on P-II. The rounded body shape of *A. caboti* n. sp. clearly differentiates it from the species with an almost square/rectangular body shape (*A. acutidentatus* Viets, 1959; *A. amplipenicillatus* Viets, 1954; *A. mutangulus* Daday, 1905; *A. multipapillatus* Viets, 1954 and *A. uberifer* Viets, 1954) and from those with an ovoid body shape including ones that narrow at the anterior end (*A. apertus* Daday, 1905), the posterior end (*A. anisitsi* Daday1905 and *A. tumulosus tumulosus* Viets, 1954) or both ends (*A. quadrisetosus* Viets, 1954). An almost strictly ovoid female body shape is found in *A. boettgeri* Viets, 1968; *A. caquetiorum* Rosso de Ferradas and Fernandez, 2001; *A. cometes* Lundblad 1937; *A. confertus* Viets, 1954; *A. honoratus* Thor, 1911; *A. ovum* Viets, 1954; *A. pennapodus* Rosso de Ferradas, 1989; *A. promacrus* Lundblad, 1936; *A. propincuus* Daday, 1905 and *A. tortus* Viets, 1954). Taken all together, the morphological characters described above validate *A. caboti* n. sp. as a new species of the *Arrenurus* subgenus.

## Acknowledgements

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