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Checklist of Arrenurids (Acari: Hydrachnidia: Arrenuridae) of Mexico, with New Records from the Yucatan Peninsula, and the Description of Five New Species of the Subgenera *Megaluracarus* and *Dadayella* †

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Abstract: A checklist of arrenurids of Mexico is presented, including three new records from the Yucatan Peninsula. We provide updated descriptions of *Arrenurus mexicanus*, *A.* (*Megaluracarus*) *colitus*, and *A.* (*Megaluracarus*) *marshalli*. Additionally, four new species of the subgenus *Megaluracarus* and one of *Dadayella* are described by using integrative taxonomy: *Arrenurus* (*Megaluracarus*) *eduardoi* n. sp., characterized by a large, thorn-shaped hump in the middle dorsal shield; *Arrenurus* (*Megaluracaurus*) *federicoi* n. sp., with large pores in the body, including the idiosoma; *Arrenurus* (*Megaluracarus*) *ecosur* n. sp., with a peculiar pattern of setation in the legs; *Arrenurus* (*Megaluracarus*) *beatrizae* n. sp., with a short cauda with two pairs of lateral notches, and *Arrenurrus* (*Dadayella*) *cristinae* n. sp., characterized by a male cauda with two falcate setae. Non-destructive methods allowed the taking of scanning electron microscope images and DNA sequencing of the designed type material. All new species have a divergence using the DNA mitochondrial gene COI from 21.1% to 28.6% within them. With these records and descriptions, the number of *Arrenurus* registered for Mexico increases to 42, most of them from a single locality.

Keywords: taxonomy; morphology; DNA barcodes; COI; karstic; *Arrenurus*

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1. Introduction

Arrenurus Dugés, 1834 is the most species-rich water mite genus, with approximately 1000 species described worldwide, and is currently divided into 11 accepted subgenera: *Arrenurus*, *Arrhenuropsides*, *Arrhenuropsis*, *Brevicaudaturus*, *Dadayella*, *Dividuracarus*, *Megaluracarus*, *Micruracarus*, *Rhinophoracarus*, *Truncaturus*, and *Stygarrenurus* [1,2]. In Mexico, 37 species are reported, divided into five subgenera: *Arrenurus*, *Arrhenuropsis*, *Dadayella*, *Megaluracarus*, and *Truncaturus*. Six of the total species recorded are only known from the Yucatan Peninsula [3–7]. Likely, this number does not represent the total species number for the genus in this region, as Mexico is one of the countries with the greatest biological diversity in the world due to its complex topography, the variety of climates, and the convergence of the two main biogeographic zones of the Americas: The Nearctic and the Neotropics [8]. In particular, the Yucatan Peninsula, one of the worlds' largest karstic aquifer systems, has a great diversity of aquatic ecosystems with unique geohydrological characteristics [9,10].

Recently, Montes-Ortiz and Elías-Gutiérrez [11] studied the water mites' diversity from 24 sites in the Yucatan Peninsula using the sequences of the mitochondrial cytochrome subunit I (COI). Their main results indicated the presence of 77 genetic groups or putative

species represented through a barcode index number (BIN), and 17 of them corresponded to the genus *Arrenurus*. This result illustrates the potential water mite diversity for this region since only six species are described in this area.

Megaluracarus Viets, 1911 can be considered the most complex subgenus of *Arrenurus* in terms of diversity and range of morphological characteristics [6]. Another subgenus, *Dadayella*, is difficult in taxonomy, since some of its descriptions have been based only on females [1,4]. This study supplies a checklist of arrenurids from Mexico, providing three new records and describing four new species of the subgenus *Megaluracarus*: *A. eduardoi* n. sp., *A. federicoi* n. sp., *A. ecosur* n. sp., and *A. beatrizae* n. sp. and one from the *Dadayella* subgenus, *A. cristinae* n. sp., using morphological and molecular data.

2. Materials and Methods

The specimens were collected in five different karst systems from the southern Yucatan Peninsula (Figure 1) during a sampling survey in April and August 2019 [11] using light traps and a hand net with a mesh size of 50 µm. The mites collected with the light trap were sieved, washed, and fixed in 96% cold ethanol [12]. Specimens collected with a hand net were sorted in the field from the samples using a pipette and fixed in ethanol 96%. All specimens were stored at −18 °C for at least seven days [13].

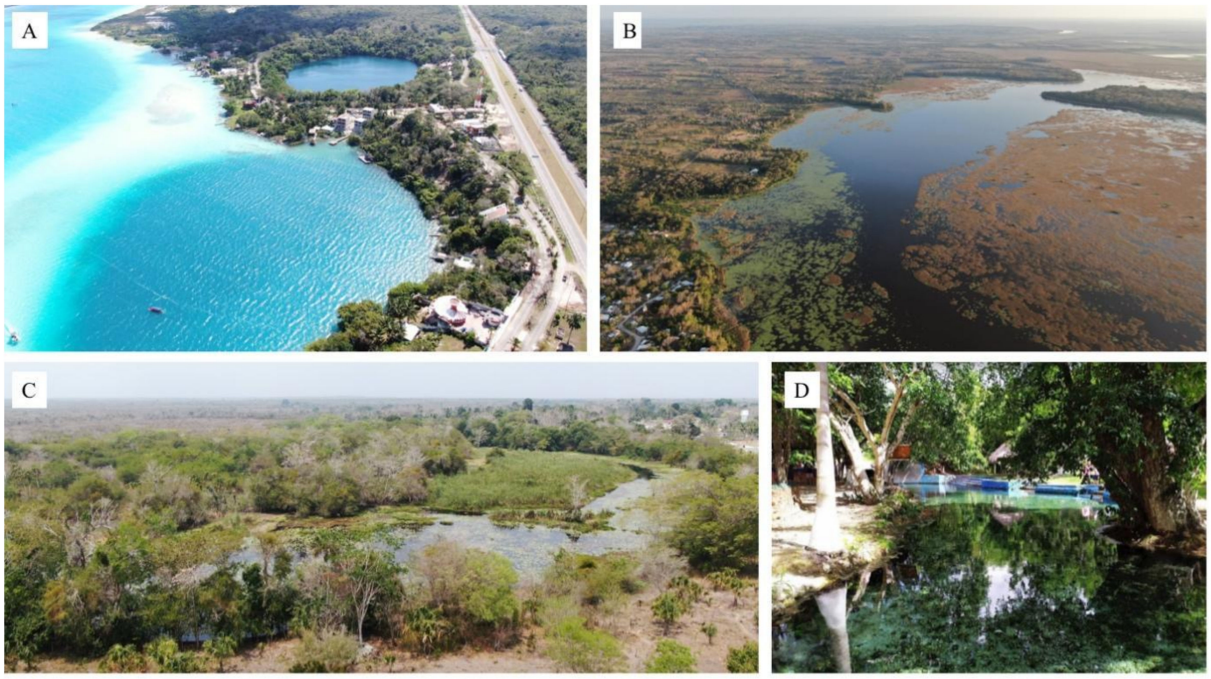

Figure 1. Sampling sites. (**A**) Bacalar lagoon, Cenote Cocalitos (**front**) and Cenote Azul (**back**); (**B**) Silvituc lagoon; (**C**) Ramonal wetland; (**D**) Acapulquito stream.

The arrenurids were separated under a stereomicroscope; representative morphospecies were photographed using a Zeiss Discovery stereomicroscope with an attached Eos Rebel T3i camera. Five individuals (when this was possible) from every morphospecies were used for DNA analyses, using a non-destructive extraction method [14]. After the process, most of the specimens were recovered, and the selected type was dissected and mounted in glycerin jelly. In the case of new species from subgenus *Megaluracarus*, after the DNA extraction, detailed images were obtained with a low vacuum and a freezing platina to −31 °C attached to a Jeol JSM-6010 scanning electron microscope (SEM) at the Chetumal Unit of El Colegio de la Frontera Sur. This non-destructive method allows the recovery of the studied specimens, as it does not need the critical drying point and gold coating. Subsequently, whole specimens and the dissected parts were examined and measured

under a compound microscope, LW Scientific. The drawings were made using a graphic digital tablet on Inkscape V. 0.92.4 (www.inkscape.org, accessed on 18 March 2022) [15].

All specimen preparations recovered were deposited in the Reference Collection of Zooplankton (ECO-CH-Z) at El Colegio de la Frontera Sur (ECOSUR, Chetumal, Mexico), except for the two paratypes of *Arrenurus* (*Megaluracarus*) *beatrizae* n. sp. deposited in the water mites collection of the Aquatic Zoology Laboratory (AAL) at Facultad de Ciencias, Universidad Nacional Autónoma de México.

Molecular analysis. DNA extraction was performed using a standard glass fiber method [16] modified, following Porco et al. [14]. For voucher recovery, specimens were recovered after the lysis step from the glass fiber filter plates or the 96-well original plates and preserved in Koenike's fluid. For the PCR process, see [11,13,17]. PCR products were visualized on 2% agarose gels (E-Gel 96 Invitrogen), and positive PCR products were selected for sequencing bidirectionally at Eurofins Scientific in Louisville, Kentucky.

All sequences were edited using Codon Code v. 3.0.1 and uploaded to the Barcode of Life Database (BOLD: www.boldsystems.org, accessed on 18 March 2022) and are in the public dataset DS_ARRENURI; DOI: XXXX. The sequences of the new species of *Megaluracarus* were included in a maximum likelihood (ML) tree generated with 1000 replicates using MEGA version X [18]. Two sequences of the *Krendowskia* genus were used to root the three GENWM130-16 and GENWM138-16 (Table 1).

Finally, a total of 1111 good-quality public sequences of the genus *Arrenurus* from the BOLD database were used to build a neighbor-joining (NJ) tree for a general comparison with all sequenced specimens from the globe.

We provide the consensus sequence for each species described in this study as an additional character. The resulting tree is included as Supplementary File S1.

All measurements are given in μm. Terminology and abbreviations in the descriptions of the new species follow [1,6,19].

Abbreviations used: BIN = barcode index number; Cxgl-1 = coxoglandularia 1; Cxgl-2 = coxoglandularia 2; Cxgl-4 = coxoglandularia 4; Cx-I–IV = first to fourth coxae; Dgl-1–4 = first to fourth dorsoglandularia; L = length; IV-Leg-1–6 = first to sixth segments of the fourth leg; P1–P5 = first to fifth palp segments; W = width.

Nomenclatural Acts

This published work and the nomenclatural acts were registered in ZooBank, the online registration system for the ICZN. The ZooBank Life Science Identifiers (LSIDs) were resolved, and the associated information can be viewed through any standard web browser by appending the LSID to the prefix http://zoobank.org/, accessed on 18 March 2022. The online version of this work is archived and available from the following digital repositories: Diversity, Basel.

Table 1. Sequences used in the descriptions for this study.

Species	Type Locality *	Accession Number of the Type Material	ID in BOLD	Barcode Index Number
Arrenurus (*Megaluracarus*) *eduardoi* n. sp.	Acapulquito, Riviera del Río Hondo, Quintana Roo (Mexico) *	ECO-CH_000XXXXX	YUCWM195-20 YUCWM087-19 YUCWM085-19 YUCWM084-19	AEA7844
Arrenurus (*Megaluracarus*) *federicoi* n. sp.	Acapulquito, Riviera del Río Hondo, Quintana Roo (Mexico) *	ECO-CH_000XXXXX	YUCWM198-20 YUCWM196-20 YUCWM197-20	AEB7095

Table 1. *Cont.*

Species	Type Locality *	Accession Number of the Type Material	ID in BOLD	Barcode Index Number
Arrenurus (*Megaluracarus*) *ecosur* n. sp.	Bacalar lagoon *, Cenote Cocalitos, Chichancanab, Muyil lagoon 1, Cenote Azul, Cenote Chancah, Cenote Sijil Noh Ha, Cenote del Padre, Quintana Roo (Mexico)	ECO-CH_000XXXXX	BACWM287-16 BACWM016-15 BACWM014-15 BACWM007-15 BACWM005-15 BACWM003-15 BACWM002-15 BACWM244-15 BACWM243-15 BACWM193-15 BACWM133-15 BACWM127-15 BACWM100-15 BACWM083-15 BACWM082-15 BACWM078-15 BACWM074-15 BACWM073-15 BACWM059-15 YUCWM103-19 YUCWM036-19 YUCWM035-19 YUCWM047-19 YUCWM040-19 YUCWM039-19 YUCWM037-19 YUCWM034-19 YUCWM032-19 YUCWM031-19 CAZUL452-17 SKAAN-079-19 SKAAN-019-19 SKAAN-370-19 BACWM047-15 BACWM046-15 BACWM045-15 BACWM043-15 BACZP2234-16 SKAAN-160-19	ACX8463
Arrenurus marshallae	Silvituc lagoon *, Escarcega, Campeche (Mexico)	ECO-CH_000XXXXX	EXD479-20 EXD493-20 EXD510-20 EXD567-21	ACL2521
Arrenurus (*Dadayella*) *cristinae* n. sp.	Ramonal, Quintana Roo * (Mexico)	ECO-CH_000XXXXX	YUCWM012-19 YUCWM017-19	AEA7842

3. Results

Before our study, there were 37 *Arrenurus* species registered for Mexico, grouped into five subgenera: *Megaluracarus*, *Arrenurus*, *Dadayella*, *Truncaturus*, and *Arrhenuropsis* and one species represented by a female, without a subgenus assigned, *A.* (?) *nayaritensis* (Table 2). Of these, six species are distributed in the Yucatan Peninsula; with our new records and species descriptions (Figure 2), the total number increases to 42 arrenurids registered for the country, and 11 of them are found in the Yucatan Peninsula (Table 2).

Table 2. List of *Arrenurus* species (Acari: Hydrachnidia: Arrenuridae) known from Mexico.

Genus	Subgenus	Specie	Author	Distribution	Habitat
Arrenurus	*Arrenurus*	*dentipetiolatus*	Marshall, 1908	United States of America, Mexico (Oaxaca/Guanajuato)	Pond
		valencius	Marshall, 1919	Venezuela, Cuba, Haití, Guatemala, Mexico (Campeche/Tabasco)	Water-filled roadside
		munovus	Cook, 1980	Mexico (Chiapas)	Stream
		wucabus	Cook, 1980	Mexico (Oaxaca)	Pond
		tamaulipensis	Cramer and Cook, 1992	Mexico (Tamaulipas)	Lake
		xochimilcoensis	Cramer and Cook, 1992	Mexico (Mexico City)	Lake
	Megaluracarus	*manubriator*	Marshall, 1903	Marshall, 1903	Standing waters
		birgei	Marshall, 1903	United States of America, Mexico (Tabasco)	Pond
		marshallae	Piersig 1904	United Sates of America, Canada, Mexico (Campeche)	Lagoon
		gricalus	Cook, 1980	Mexico (Campeche)	Water-filled ditch
		hartesus	Cook, 1980	Mexico (Veracruz)	Pond
		neoexpansus	Cook, 1980	Mexico (Tabasco)	Pond
		tabascoensis	Cook, 1980	Mexico (Tabasco)	Pond
		trassamus	Cook, 1980	Mexico (Campeche)	Water-filled ditch
		zitavus	Cook, 1980	Mexico (Tabasco)	Pond
		campechensis	Cook, 1980	Mexico (Campeche)	Water-filled ditch
		wolardus	Cook, 1980	Mexico (Campeche)	Water-filled ditch
		costeroae	Cramer and Cook, 1992	Mexico (Veracruz, Colima)	Pond
		alloexpansus	Cramer and Cook, 1992	Mexico (Tamaulipas)	Lake
		apizanus	Cramer and Cook, 1992	Mexico (Colima)	Not specified
		catoi	Cramer and Cook, 1992	Mexico (Tamaulipas)	Lake
		champayanus	Cramer and Cook, 1992	Mexico (Tamaulipas)	Lake
		colitus	Cramer and Cook, 1992	Mexico (Tamaulipas)	Lake
		anae	Cramer and Cook, 1998	Mexico (Tamaulipas)	Lake
		anitahoffmannae	Ramírez-Sánchez and Rivas, 2013	Mexico (Tabasco)	Lake, pond, canal
		olmeca	Ramírez-Sánchez and Rivas, 2013	Mexico (Tabasco)	Lake, pond, canal
		maya	Ramírez-Sánchez and Rivas, 2013	Mexico (Yucatan/Quintana Roo)	Cenote
		urbanus	Ramírez-Sánchez and Rivas, 2013	Mexico (Mexico City)	Canal
		eduardoi n. sp.	Montes-Ortiz et al., 2022	Mexico (Quintana Roo)	Pool (in a stream)
		federicoi n. sp.	Montes-Ortiz et al., 2022	Mexico (Quintana Roo)	Pool (in a stream)
		ecosur n. sp.	Montes-Ortizet al., 2022	Mexico (Quintana Roo)	Cenote, lagoon, wetlands
		beatrizae n. sp.	Montes-Ortiz et al., 2022	Mexico (Quintana Roo/Tabasco)	Wetland, lagoon
	Dadayella	*zempoala*	Cook, 1980	Mexico (Mexico state)	Small stream
		adrianae	Cramer and Cook, 1992	Mexico (Colima/Michoacán)	Wetland, lagoon
		veracruzensis	Cramer and Cook, 1992	Mexico (Veracruz)	Pond
		aztecus	Cramer and Cook, 1992	Mexico (Veracruz)	Wetland, lagoon
		colimensis	Cramer and Cook, 1992	Mexico (Colima)	Wetland, lagoon
		cristinae n. sp.	Montes-Ortizet al., 2022	Mexico (Quintana Roo)	Wetland
	Truncaturus	*plevamus*	Cook, 1980	Costa Rica, Mexico (Guerrero)	Small stream
		zukovus	Cook, 1980	Mexico (Chiapas)	Gravel-bottom stream
		teoceloensis	Rivas and Cramer, 1998	Mexico (Veracruz)	Stream
	Arrhenuropsis	*mexicanus*	Cramer and Cook, 1992	Mexico (Tamaulipas/Colima)	Lagoon
	?	*nayaritensis*	Cook, 1980	Mexico (Nayarit)	Small stream

We obtained four sequences for *Arrenurus* (*Megaluracarus*) *marshallae*, and 14 more are public in the BOLD database with the associated BIN ACL2521. In the case of *A.* (? *Arrhenuropsis*) *mexicanus* Cramer and Cook, 1992, we could not obtain the genetic information. However, we provide morphological notes. *A.* (*Megaluracarus*) *colitus* (Cramer and Cook, 1992) was represented by one sequence and the BIN AEA8234. Some measurements and notes are provided for these three species to achieve a more complete record. For *A.* (*Megaluracarus*) *eduardoi* n. sp., we obtained four sequences, and the BIN AEA7844 was assigned. *A.* (*Megaluracarus*) *federicoi* n. sp. has three sequences and the BIN AEB7095. *A.* (*Megaluracarus*) *ecosur* n. sp. is represented by 39 sequences and the BIN ACX8463. In the case of *A.* (*Megaluracarus*) *beatrizae* n. sp., we were unable to obtain the genetic information. Nonetheless, all the morphological data are given. Finally, for *A.* (*Dadayella*) *cristinae* n. sp., we obtained two sequences, and the BIN assigned was AEA 7842.

In the NJ tree comparing our material with all worldwide, sequenced arrenurids (Supplementary File S1), the 1111 specimens represented 148 BINs, of which only 50 have a taxonomical identification. The BINs reported for Mexico (including those used for descriptions or new records in this study) are separated from those reported for other world regions, except for *A. marshallae*, BIN ACL2521 and BIN ACL2418, which are found in Canada as well.

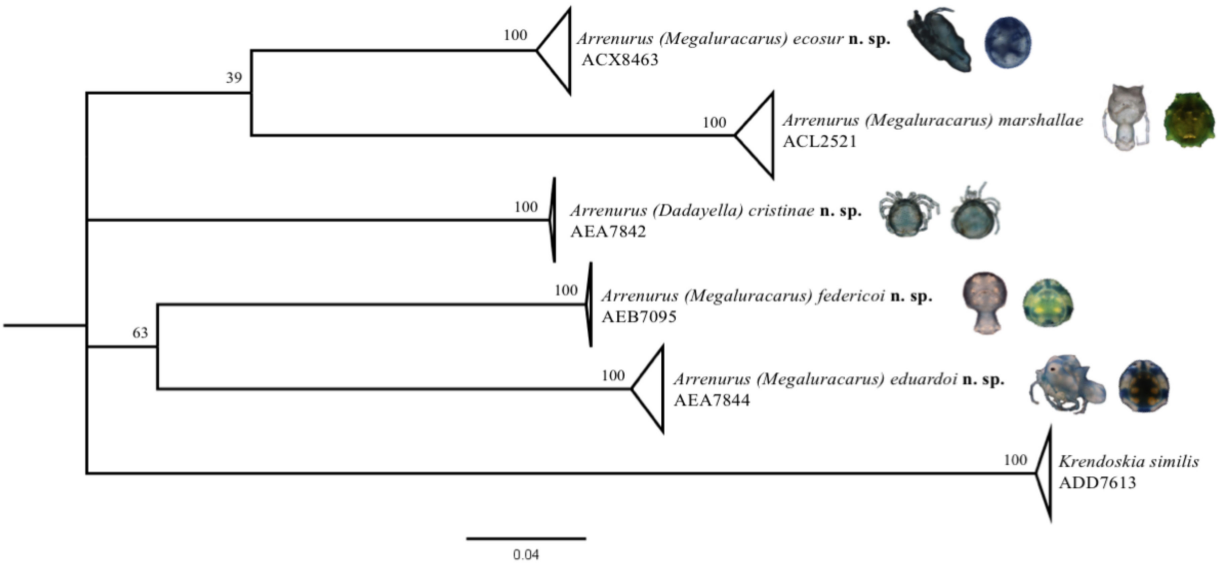

Figure 2. Maximum likelihood tree, based on COI sequences. Bootstrap support values were generated after 1000 replicates. The name is followed by the barcode index number and corresponding photograph of male and female. *Krendoskia similis* was used as an outgroup.

Systematic Part

Family Arrenuridae (Thor, 1900)
Genus *Arrenurus* (Dugés, 1834)
Subgenus *Arrhenuropsis* (Viets, 1954)
Arrenurus (? *Arrhenuropsis*) *mexicanus* (Cramer and Cook, 1992), (Figure 3).

Material examined: One male from Ramonal pond (access number: ECO-CH-Z-10608), Quintana Roo, 19°23′31″ N, −82°37′27″ W; emergent vegetation, 14 April 2019.

Description. MALE: Idiosoma blue-greenish with white areas in the Dgl 1–4 regions, 799 L without petiole and 493 W. Dorsal shield small, oval, and located in the anterior part of the dorsum, 296 L and 345 W (Figure 3A). Genital field 394 W, gonopore 69 L and 48 W (Figure 3B). Dorsal L of palpal segments L: P1: 27; P2: 74; P3: 29; P4: 84; P5: 84. Dorsal L of fourth leg segments: IV-Leg-1: 32; IV-Leg-2: 104; IV-Leg-3: 101; IV-Leg-4: 148; IV-Leg-5: 151; IV-Leg-6: 109.

Figure 3. *Arrenurus* (? *Arrhenuropsis) mexicanus* (Cramer and Cook), male. (**A**) Habitus, dorsal view; (**B**) Habitus, ventral view. Scale bar: 200 µm.

Remarks. Male and female were described by Cramer and Cook [4]. Therefore, we only give some diagnostic measurements. This record represents the second of this species for the country.

Distribution. Previously known from the Champayan lagoon, Altamira, Tamaulipas state, 22°22′49″ N, −97°58′34″ W (Mexico).

Subgenus *Megaluracarus* (Viets, 1911).

Arrenurus (Megaluracarus) colitus (Cramer and Cook, 1992), (Figure 4).

Material examined: One female from Ramonal pond (access number: ECO-CH-Z-10609), Quintana Roo state, 19°23′31″ N, −82°37′27″ W; emergent vegetation, 14 April 2019.

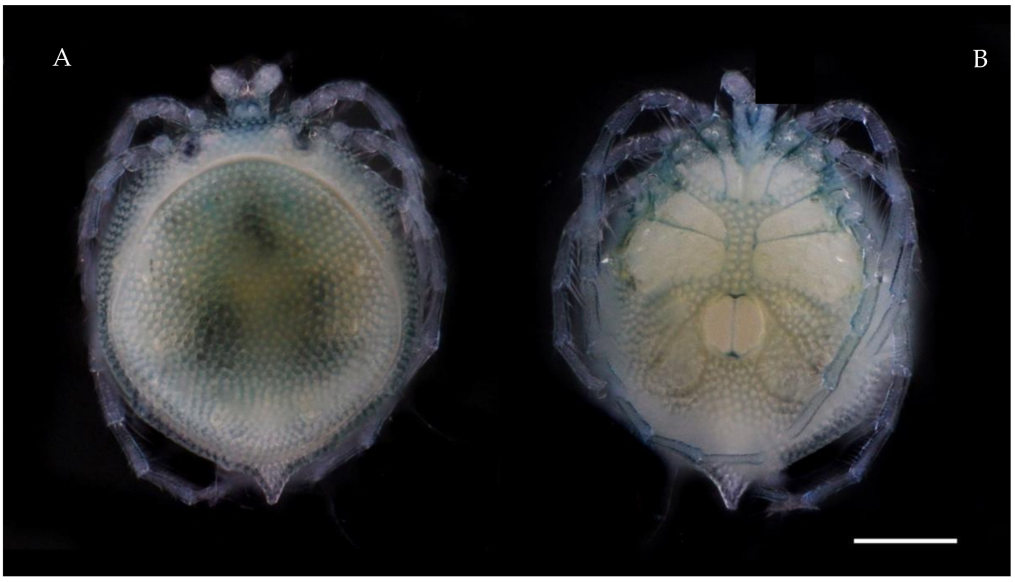

Figure 4. *Arrenurus* (*Megaluracarus*) *colitus* (Cramer and Cook), female. (**A**) Dorsal view; (**B**) ventral view. Scale bar: 200 µm. The sequence of this specimen, recovered after DNA extraction, is represented by the BIN AEA8234.

Description. FEMALE: Idiosoma bluish-green with white areas in the Dgl 1–4 regions, 680 L and 552 W; dorsal furrow complete, dorsal shield 512 L and 483 W (Figure 4A). Genital field 305 W, gonopore 99 L and 116 W (Figure 4B). Dorsal L of fourth leg segments: IV-Leg-1: 74; IV-Leg-2: 101; IV-Leg-3: 99; IV-Leg-4: 119; IV-Leg-5: 106; IV-Leg-6: 116.

Sequence: ATCTATGATACCATTGGAACAGCCCATGCTTTGATTATAATTTTCTTT-ATAGTCATACCCATCATAATTGGAGGATTTGGAAATTGACTCGTTCCCCTCATGTT-AGAAGCTCCAGATATAGCATTCCCACGAATAAATAACATAAGATTTTGATTACTTC-CACCCCCCTTAACACTCCTTCTATCAAGATCATTAACTTCTTCAGGAGCAGGAAC-TGGATGAACAGTTTACCCTCCTTTATCAAGAAATATCGCCCATGGAGGACCTTCA-GTAGACCTAGCAATTTTCTCCCTACACCTTGCAGGTGTGTCCTCAATTTTAGGAGC-AATTAACTTCTTGGCTACATTTATAAACATAAAACCTAAACATATAAAATATGACC-GAATCCCCCTATTTGTAATTTCTATTTTTATCACCGTAATCCTCCTTCTTCTTTCCCT-CCCCGTATTAGCTGGAGCCATTACTATACTTCTTACTGATCGAAATTTTAATACTTC-ATTTTTTGACCCGGCGGGGGGAGGAGATCCCATCCTTTACCAACATCTATTT.

Remarks. Female and male were described by Cramer and Cook [4]. We provide some additional measurement data. The chaetotaxy of the palp and IV-Leg-5–6, as well as the position of ventral and dorsal glandularia, agree with the original description. The only noticeable difference is that the first and second coxae tips extend slightly beyond the body proper in our specimen. The associated sequence was obtained, representing a unique BIN (BOLD: AEA8234).

Distribution. Previously known from the Champayan lagoon, Altamira, Tamaulipas state (Mexico). This record represents the second of this species for the country.

Arrenurus (*Megaluracarus*) *marshalli* (Piersig, 1904)

Syn. A. globator (*err*) (Marshall, 1903); A. marshallae (Viets, 1914); *A. marshallae* (Marshall, 1940), (Figure 5).

Material examined: One male, one female, and one nymph from Silvituc lagoon (access number: ECO-CH-Z-10610-10611), Escarcega municipality, Campeche state, 18°37′26″ N, −90°17′5.9″ W, 18 March 2020.

Description. MALE: Idiosoma light-bluish, 962 L (including cauda) and 560 W; dorsal shield 776 L (including cauda) and 422 W (Figure 5A). Genital field 281 W, gonopore 47 L and 61 W (Figure 5B). Dorsal L of palpal segments: P1: 34; P2: 63; P3: 33; P4: 66; P5: 47. Dorsal L of fourth leg segments: IV-Leg-1: 86; IV-Leg-2: 128; IV-Leg-3: 151; IV-Leg-4: 178; IV-Leg-5: 165; IV-Leg-6: 138.

FEMALE: Idiosoma light bluish, 986 L and 907 W; dorsal furrow complete, dorsal shield 719 L and 680 W. Genital field 454 W, gonopore 138 L and 140 W.

Consensus sequence: ACATTATACTTCGCATTCGGAGCTTGATCGGGTATAG-TAGGAGCAAGACTTAGAAGTCTAATCCGACTAGAATTAGGGCAACCAGGAAGAC-TTTTAGGAAATGATCAAATTTACAACACCATTGTTACAGCGCATGCTTTCATTATA-ATCTTCTTTATAGTTATACCAATTATAATCGGAGGATTCGGAAACTGATTAGTACCC-CTAATACTAGCCGCCCCTGATATGGCATTCCCACGAATAAATAATATAAGATTCTG-ACTTCTACCGCCAGCCTTAACACTTCTTTTATCAAGATCGTTAACTTCAGTAGGAG-CAGGAACCGGATGAACAGTCTACCCTCCCCTATCCAGAAACATTGCACATGGTG-GACCTTCAGTAGATATAGCTATCTTCTCATTACATTTAGCAGGAGTCTCCTCAATTT-TAGGAGCTATCAATTTTCTAGCTACAATTTTAAATATAAAGCCTAAACATATAAAAT-ATGACAGAATTCCATTATTTGTAGTTTCAATTTTTATTACAGTAATTCTTCTTTTACTT-TCACTGCCTGTATTAGCAGGAGCTATTACTATACTTCTTACAGATCGAAATTTTAAC-ACCTCTTTCTTCGATCCAGCTGGAGGAGGAGATCCTATTTTATACCAA.

Remarks. Our specimens agree with the descriptions given by Marshall (1903) and Wilson (1961). According to Cook [20], the status of *A. marshallae* is complex because the species is a member of a closely related group characterized by the possession of a long cauda and horn-like projections over the eyes. It can be separated from other species (*A. megalurus megalurus*, *A. megalurus intermedius*) by the slightly indented posterior end of the cauda.

Figure 5. *Arrenurus* (*Megaluracarus*) *marshallae* (Piersig), male. (**A**) Dorsal view; (**B**) ventral view. Scale bar: 200 μm. The sequence of this specimen, recovered after DNA extraction, is represented by the BIN ACL2521.

The sequences obtained in this study with the BIN ACL2521 agree with another 14 public sequences from *A. marshallae.* Some of these were identified morphologically by Bruce Smith. Morphological and molecular identification agree (Figure 2). These public sequences in the BOLD database integrated with the morphology make it possible to verify the records of putative *A. marshallae* in other localities and other members of this complex group.

Distribution. Previously known from the United States and Canada. This record constitutes the first for Mexico.

Arrenurus (*Megaluracarus*) *eduardoi* n. sp., (Figures 6 and 7).

Holotype: Male from Acapulquito stream, Rivera del Río hondo, Othon P. Blanco municipality, Quintana Roo state (access number: ECO-CH-Z-10612), 18° 25′ 55″ N, 88° 31′51″ W; emergent vegetation and submerged roots, 11 April 2019, coll. L. Montes.

Paratypes: Two females and two males, same data as holotype (access number: ECO-CH-Z-10613-10614).

Diagnosis. Male with a large, thorn-shaped hump in the middle of the dorsal shield (Figure 6C,D), falcate setae on Dgl-2 and Dgl-3 (Figure 7A); three pinnate setae on P2 (two in anterolateral position and one in anteromedial position) and one falcate seta on medial position on P3. Bipectinate setae on all lateral IV-Leg-3 segment and serrate setae in the anterolateral position of IV-Leg-2 segment (Figure 7G).

Description. MALE: Idiosoma bluish with yellow spots in the Dgl-1–4 regions (Figure 7A), 1178 L and 785 W; anterior part of idiosoma very wide (Figures 6 and 7A). Dgl-2 and Dgl-3 setae falcate. Dorsal shield 1000 L (cauda included dorsal portion), 571 W. Cauda long, representing almost half of the total body length, 470 L and 478 W, small humps in Lgl-4 region. Dorsal furrow complete, passing ventrally at base of cauda and continuing immediately posterior to the acetabular plates. In lateral view, there is a large, thorn-shaped hump centrally on the dorsum (212 height) (Figure 6C,D). Anterior and posterior coxal groups separated, Cxgl-1 between Cx-II and Cx-III, Cx-IV laterally slightly extending beyond the idiosoma, posterior region concave. Cxgl-2 is located between Cx-IV and the acetabular plates (Figure 7C). Genital field 457 W, gonopore 113 L and 102 W, acetabular plate extending laterally from the gonopore region with two setae posterior to each plate (Figure 7C). Dorsal L of palpal segments: P1: 21; P2: 73; P3: 47; P4: 79;

P5: 47; P3 with a long, falcate seta on anterolateral position (Figure 6B D). Dorsal L of fourth leg segments: IV-Leg-1 120; IV-Leg-2: 155; IV-Leg-3: 196; IV-Leg-4: 210; IV-Leg-5: 189; IV-Leg-6: 172; IV-Leg-2 with three serrate setae in anterolateral position and IV-Leg-3 with ten bipectinate setae on IV-Leg-4 and IV-Leg-5 with 10 and 11 small, pinnate setae, respectively (Figure 7G). IV-Leg-2–6 bear numerous swimming setae.

FEMALE: Idiosoma 1000 L and 948 W, dorsal shield 800 L and 680 W, bears the postocularia and four pairs of glandularia. Anterior idiosoma margin rounded with distinctive posterolateral projections (Figures 6E and 7F). Acetabular plates wing-shaped, laterally directed, narrow and slightly bowed. Genital field 514 W, gonopore 182 L and 187 W. Anterior and posterior coxal group separated, Cx-I and Cx-II extending beyond the anterior margin of idiosoma (Figures 6 and 7F). Idiosoma and legs are bluish with yellow areas on Dgl-1–4 regions (Figure 7E).

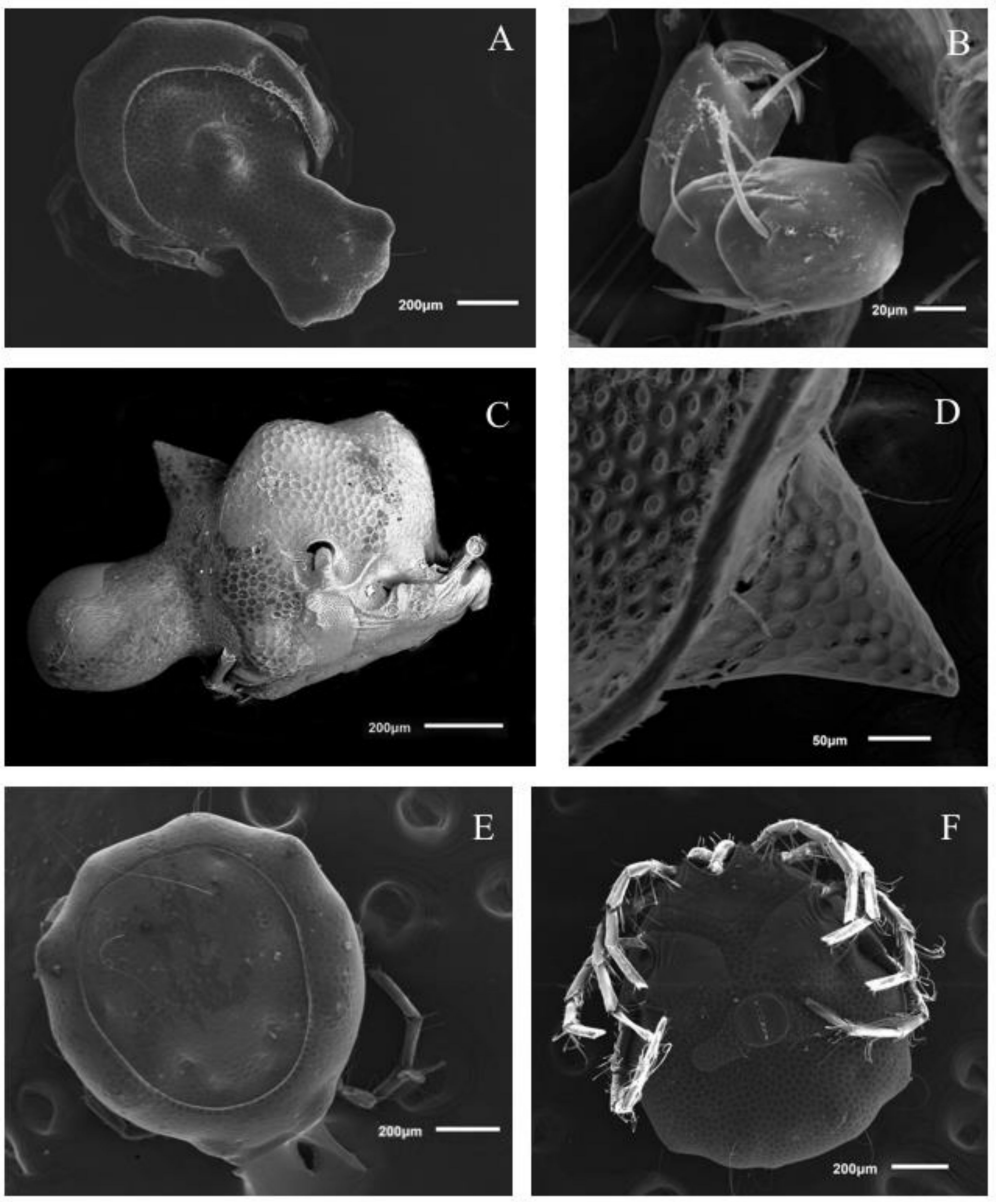

Figure 6. SEM micrograph at a low vacuum of *Arrenurus* (*Megaluracarus*) *eduardoi* n. sp. Male. (**A**) Dorsal view; (**B**) palp, medial view; (**C**) lateral view; (**D**) detail on the thorn-shaped hump on the dorsal shield. Female. (**E**) Dorsal view; (**F**) ventral view. The sequence of this specimen, recovered after DNA extraction, is represented by the BIN AEA7844.

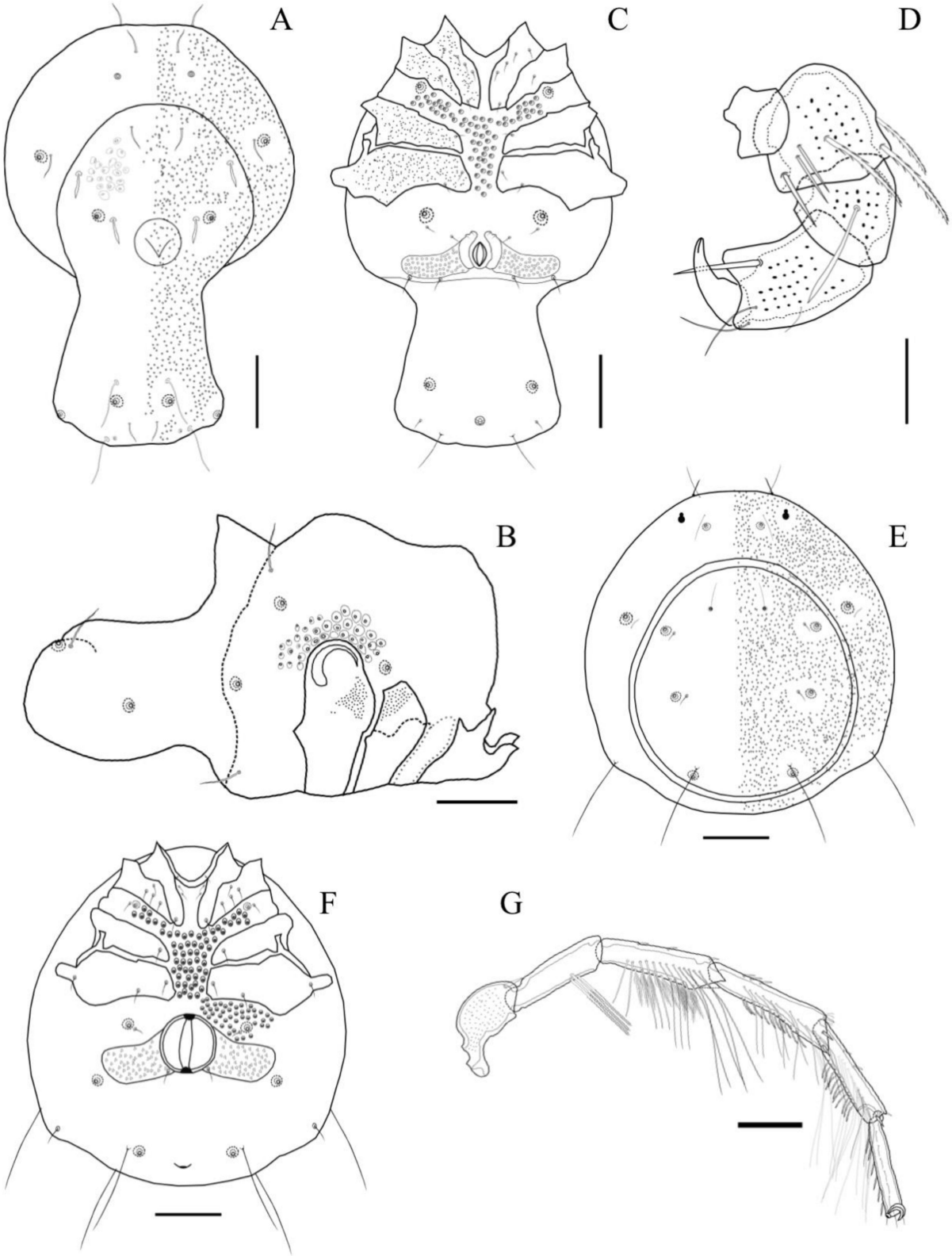

Figure 7. *Arrenurus* (*Megaluracarus*) *eduardoi* n. sp. Male. (**A**) Dorsal view; (**B**) lateral view; (**C**) ventral view; (**D**) palp, medial view; (**G**) Leg IV, lateral view; Female. (**E**) Dorsal view; (**F**) ventral view. Scale bars: (**A**–**C**,**E**,**F**) = 200 μm, (**D**) = 50 μm, (**G**) = 100 μm.

Consensus sequence: ACTCTATACTTCGCTTTTGGCGCTTGATCAGGCATAATC-GGAGCTAGCCTTAGAAGTCTTATCCGTTTAGAACTTGGACAACCTGGTAATCTTTT-

AGGAAACGATCAAATATACAACACAATTGTCACTGCCCACGCATTTGTTATAATCT-
TTTTCATAGTTATGCCAATCATAATCGGAGGATTCGGAAACTGATTAGTTCCTATTA-
TACTAGCAGCCCCAGATATAGCTTTCCCACGAATAAATAATATAAGATTTTGACTT-
CTTCCCCCCGCTTTAACTCTTCTACTNTCAAGATCTCTATCTTCTTCAGGAGCGGG-
GACTGGCTGAACAGTTTACCCCCCTCTTTCNAGTAATATCGCTCACGGAGGACCA-
TCTGTCGATATAGCTATTTTCTCACTTCACTTAGCAGGAGTTTCGTCTATTCTAGGG-
GCAATTAACTTCTTAGCCACAACTATAAACATAAAGCCAAAATATATAAAATATGA-
CCGAATCCCCTTATTTGTAGTCTCAATTTTCATCACAGTCATTCTCCTCCTCTTATC-
ATTACCAGTCTTAGCTGGAGCTATCACAATACTATTAACTGATCGAAACTTTAACA-
CATCATTCTTTGACCCTGCCGGAGGGGGAGACCCAATTCTTTACCAA.

Etymology. This species is named after Eduardo Montes, brother of the first author, for his empathy, solidarity, and for the lovingly provided support.

Remarks. *A.* (*Megaluracarus*) *eduardoi* n. sp. is similar to *A. campechensis* (Cook, 1980) and *A. maya* (Ramírez-Sánchez and Rivas, 2013) in terms of overall shape and sturdy idiosoma. However, males of *A. eduardoi* n. sp. present a distinctive, large, thorn-shaped hump in the middle of the dorsal shield (in lateral view) that easily separates this species from the latter two. This hump resembles *A. gibberifer* (Viets, 1933), originally described from Uruguay. Nevertheless, the shape of both species is quite different, especially in the dorsal view of cauda; *A. eduardoi* n. sp. presents a trapezoidal shape (Figure 6A), while *A. gibberifer* has a quadrangular shape. Additionally, the reported size for *A. gibberifer* is much smaller (742 L and 528 W) than that registered for *A. eduardoi* n. sp. Furthermore, the palp chaetotaxy of these two species is distinct. The BOLD database assigned the unique BIN AEA7844 (Table 1), used to pair the sexes. The result of the ML tree (Figure 2) and the NJ tree (Supplementary File S1) separates *A. eduardoi* n. sp. from the others registered in the database and strongly supports the status of these new species.

Distribution. So far only known from the type locality, Acapulquito stream, Riviera del Río Hondo, Quintana Roo (Mexico).

Arrenurus (*Megaluracarus*) *federicoi* n. sp., (Figures 8 and 9).

Type material. **Holotype**: Male from Acapulquito stream, Riviera del Río Hondo, Othon P. Blanco, Quintana Roo (access number: ECO-CH-Z-10615), 18°25′55″ N, 88°31′51″ W; emergent vegetation and submerged roots, 11 April 2019, coll. L. Montes.

Paratypes: Two females and one male, same data as holotype (access number: ECO-CH-Z-10616-10617).

Diagnosis. Pores huge (on the idiosoma as well as the legs and palps), Dgl-1 and Cxgl-2 on distinct humps in males. Numerous setae surround the acetabular field in both sexes.

Description. MALE: Idiosoma 1037 L and 693 W, uniformly bluish with large pores. The anterior part of the idiosoma is wide, with noticeable humps in the Dgl-1 area which are visible in the lateral view (Figures 8C and 9B). Dorsal shield 718 L (cauda included dorsal portion) and 436 W. Cauda of medium length, representing a third of the total length of the body, 365 L and 394 W (Figures 8 and 9A), with lobes posterolaterally directed and Lgl-4 on small humps. Dorsal furrow complete, passing ventrally at base of cauda and continuing immediately posterior to the acetabular plates. In lateral view, a big hump is visible in the anterior part of the idiosoma in the Dgl-1 region (Figures 8C and 9B). Coxae with a porous surface, anterior and posterior coxal groups separated, Cxgl-1 located in the middle of Cx-II and Cx-III; Cx-II and Cx-IV slightly extending beyond the anterolateral margin of the idiosoma; Cx-III slightly overlapping Cx-IV (Figures 8B and 9C). Cxgl-2 is located between Cx-IV and the acetabular plates. Genital field 403 W, gonopore 102 L and 75 W. Acetabular plates extending laterally from the gonopore and surrounded by numerous setae (anterior ones small, 24 L, posterior ones longer, 82 L) (Figures 8D and 9C). Dorsal L of palpal segments: P1: 37, P2: 63, P3: 41, P4: 63, P5: 38 (Figure 9D). Dorsal L of fourth leg segments: IV-Leg-1: 125, IV-Leg-2: 165, IV-Leg-3: 209, IV-Leg-4: 159, IV-Leg-5: 193, IV-Leg-6: 165: IV-Leg-5 bears six swimming setae, IV-Leg-4 distal process bears nine

short swimming setae, IV-Leg-3 bears 12 swimming setae, both IV-Leg-2 and IV-Leg-3 bear three tiny, spine-like setae on lateral surface (Figure 9G).

FEMALE: Idiosoma bearing huge pores, bluish with yellow spots on the region of Dgl-1–4 and eyes (Figure 9E), 1170 L and 1066 W, dorsal shield 714 L and 790 W, bears the postocularia and three pairs of glandularia. Idiosoma rounded in the anterior margin and with posterolateral lobes (Figures 8F and 9E). Acetabular plates curved and anterolaterally directed, narrow in telation to the gonopore length. Genital field 499 W surrounded by small setae (38–52 L), gonopore 190 L and 204 W. (Figure 8E). The anterior and posterior coxal groups separated, Cx-II and Cx-IV extending slightly beyond the margin of the idiosoma (Figures 8 and 9G).

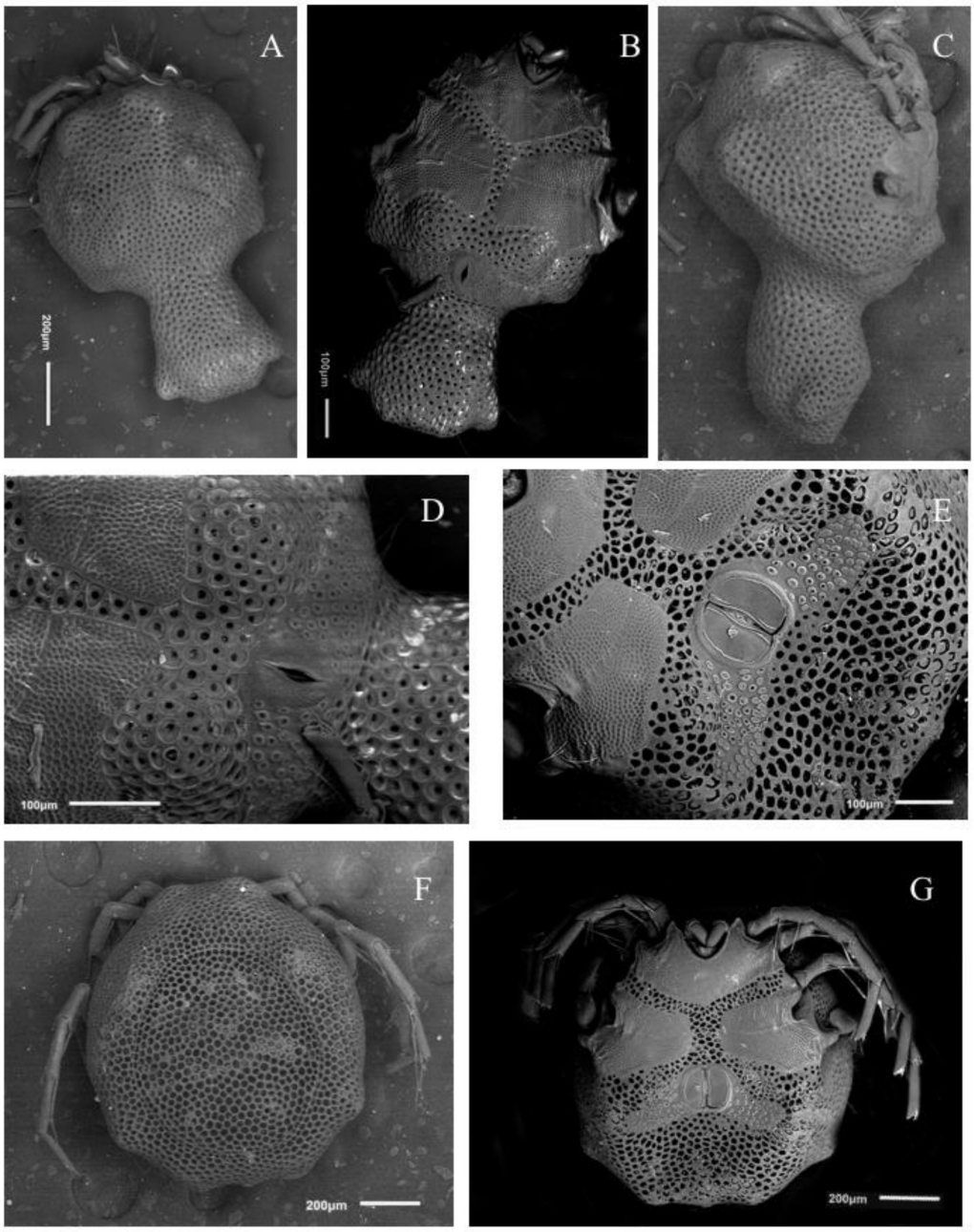

Figure 8. SEM micrograph at a low vacuum of *Arrenurus* (*Megaluracarus*) *federicoi* n. sp. Male. (**A**) Dorsal view; (**B**) ventral view; (**C**) lateral view; (**D**) detail of genital field. Female. (**E**) Detail of genital field; (**F**) dorsal view; (**G**) ventral view. The sequence of this specimen, recovered after DNA extraction, is represented by the BIN AEB7095.

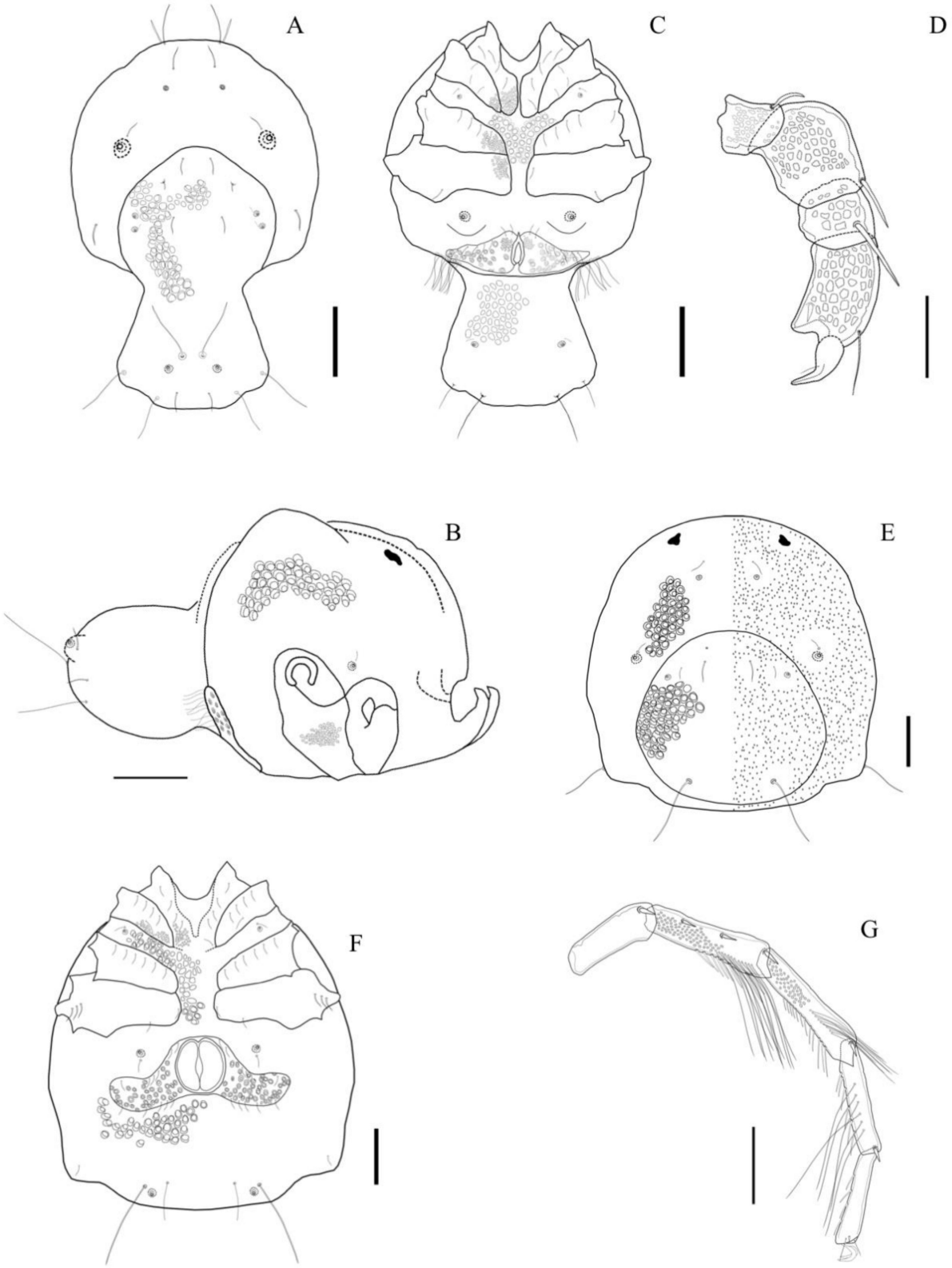

Figure 9. *Arrenurus* (*Megaluracarus*) *federicoi* n. sp. Male. (**A**) Dorsal view; (**B**) lateral view; (**C**) ventral view; (**D**) palp, medial view; (**G**) IV-Leg-2-6, lateral view. Female. (**E**) Dorsal view; (**F**) ventral view. Scale bars: (**A**–**C**,**E**,**F**) = 200 μm, (**D**) = 50 μm, (**G**) = 100 μm.

Consensus sequence: CTCTATTTCGCCTTTGGAGCATGATCAGGAATAATTGGAGCAAGATTAAGAAGTCTAATTCGCTTAGAACTAGGACAACCAGGAAGACTATTAGGAAACGATCAAATTTATAACACTATTGTTACAGCTCATGCATTCATCATAATTTTCTTCATAGTAATACCTATCATAATCGGAGGATTTGGAAATTGATTAGTACCATTAATACTAGCTGCTCCAGATATAGCTTTTCCTCGAATAAATAATATAAGATTTTGACTATTACCCCCAGCATTATCCCTTCTACTAGCAAGCTCCCTTTCTTCATCAGGAGCAGGAACAGGATGAACAGTTTACCCCCCATTATCAAGAAATATCGCACACGGAGGACCTTCAGTTGATATAGCTATCTTCTCACTCCACCTAGCAGGAGTATCTTCAATTCTAGGAGCCATCAATTTTCTAGCAACAATCATAAATATAAAACCTAAATACATAAAATATGATCGAATCCCTTTATTTGTTATCTCTATCTTTATCACAGTAATCTTACTCTTATTATCCTTACCAGTTTTAGCTGGAGCTATCACTATACTATTAACAGATCGAAACTTTAATACATCATTCTTCGACCCAGCAGGAGGAGGAGATCCTATCCTATACCAACAT.

Etymology. This species is named after Federico Montes, father of the first author, in the form of gratitude for bringing her closer to science since childhood.

Remarks. *Arrenurus* (*Megaluracarus*) *federicoi* n. sp. is similar to *A. maya* (Ramírez-Sánchez and Rivas, 2013), described from a cenote in Yucatan, in the shape of idiosoma, the pattern of dorsoglandularia position, and in the presence of setae surrounding the genital field. The significant difference is in the palp chaetotaxy; *A. maya* presents three long, thickened setae while *A. federicoi* n. sp. does not. In IV-Leg-6, *A. federicoi* n. sp. presents four spine-like setae while *A. maya* presents ten. Furthermore, *A. maya* has very small, Dgl-4 associated setae, while *A. federicoi* n. sp. Dgl-4 associated setae are at least four times longer than in *A. maya* (Figure 9A). Additionally, the cauda in *A. maya* is more slender than in *A. federicoi* **n. sp**. Both *A. catoi* (Cramer and Cook, 1992) and *A. campechensis* (Cook, 1980) are similar to the new species in the shape of the anterior idiosoma in dorsal view and Dgl-1 over humps. However, *Arrenurus federicoi* n. sp. can be separated from both latter species by the chaetotaxy of the palp, IV-Leg, the distinctive shape of cauda in dorsal view, and especially the integument with large pores. The BOLD database assigned the unique BIN AEB7095 (Table 1), used to pair the sexes. The ML tree (Figure 2) and the NJ tree (Supplementary Material) separate *A. federicoi* **n. sp**. from the others registered in the database and strongly support the status of these new species.

Distribution. So far only known from the type locality, Acapulquito stream, Riviera del Río Hondo, Quintana Roo (Mexico).

Arrenurus (*Megaluracarus*) *ecosur* n. sp., (Figures 10 and 11).

Holotype: Male from Mis Casas, Bacalar lagoon, Bacalar, Quintana Roo (access number: ECO-CH-Z-10618), 18°25′55 N, 88°31′51 W; littoral, emergent vegetation, 14 April 2019, coll. L. Montes.

Paratypes: Three males and one female, with same data as the holotype. Six females and one male from Chichancanab lagoon, José María Morelos, Quintana Roo (access number: ECO-CH-Z-10619-10622), 19°55′26 N, 88°36′14 W.

Diagnosis. Male with cauda of moderate length (330) with Dgl-3 and Dgl-4 on distinct humps. P2 with three long, pinnate setae laterally and three medial, short, spine-like setae in the posterior margin; P3 with one thin and long, pinnate seta lateromedially situated; IV-Leg-3 with three pilose setae lateromedially situated. Considerably long setae of Cxgl-2.

Description. MALE: Idiosoma 864 L and 483 W, light blue, some specimens with purple legs. Dorsal shield 729 L (including cauda) and 374 W. Dorsal furrow complete, continuing posterior to genital field. The non-caudal portion of the dorsal shield bearing two pairs of glandularia, Dgl-3 on a hump, each one. (Figures 10C and 11B). Cauda is relatively short, representing one-third of the total length of idiosoma, with a rounded posterior margin. Dgl-4 on small humps. In lateral view, the base of the cauda is thicker than the anterior idiosoma (Figures 10C and 11B). Anterior and posterior coxal groups separated. Cx-I and Cx-II extend slightly beyond the idiosoma margin. Cxgl-2 between Cx-IV and the acetabular plates, with the associated setae considerably long (146 L) (Figure 11C). Genital field 293 W, gonopore 58 L and 56 W. Acetabular plates extending laterally from the gonopore region with numerous long (50 L) setae along their posterior margin (Figure 11C).

Dorsal L of palpal segments: P1: 29; P2: 58; P3: 31; P4: 62; P5: 25 (Figures 10B and 11D). Dorsal L of fourth leg segments: IV-Leg-1: 151, IV-Leg-2: 119, IV-Leg-3: 112, IV-Leg-4: 135, IV-Leg-5: 154, IV-Leg-6: 109. IV-Leg-3 bears eight swimming setae, three small, pilose setae, and six medium-length, swimming setae on the dorsal surface.

Female: Idiosoma oval, uniformly bluish, 655 L and 590 W, with the postocularia and four pairs of glandularia, dorsal shield 773 L and 716 W (Figures 10D and 11E). Acetabular plates wing-shaped, laterally directed, narrow in relation to gonopore length. Genital field 378 W, gonopore 138 L and 141 W. Anterior and posterior coxal groups separated, Cx-I slightly reaching the margin of the ventral shield (Figures 10E and 11F).

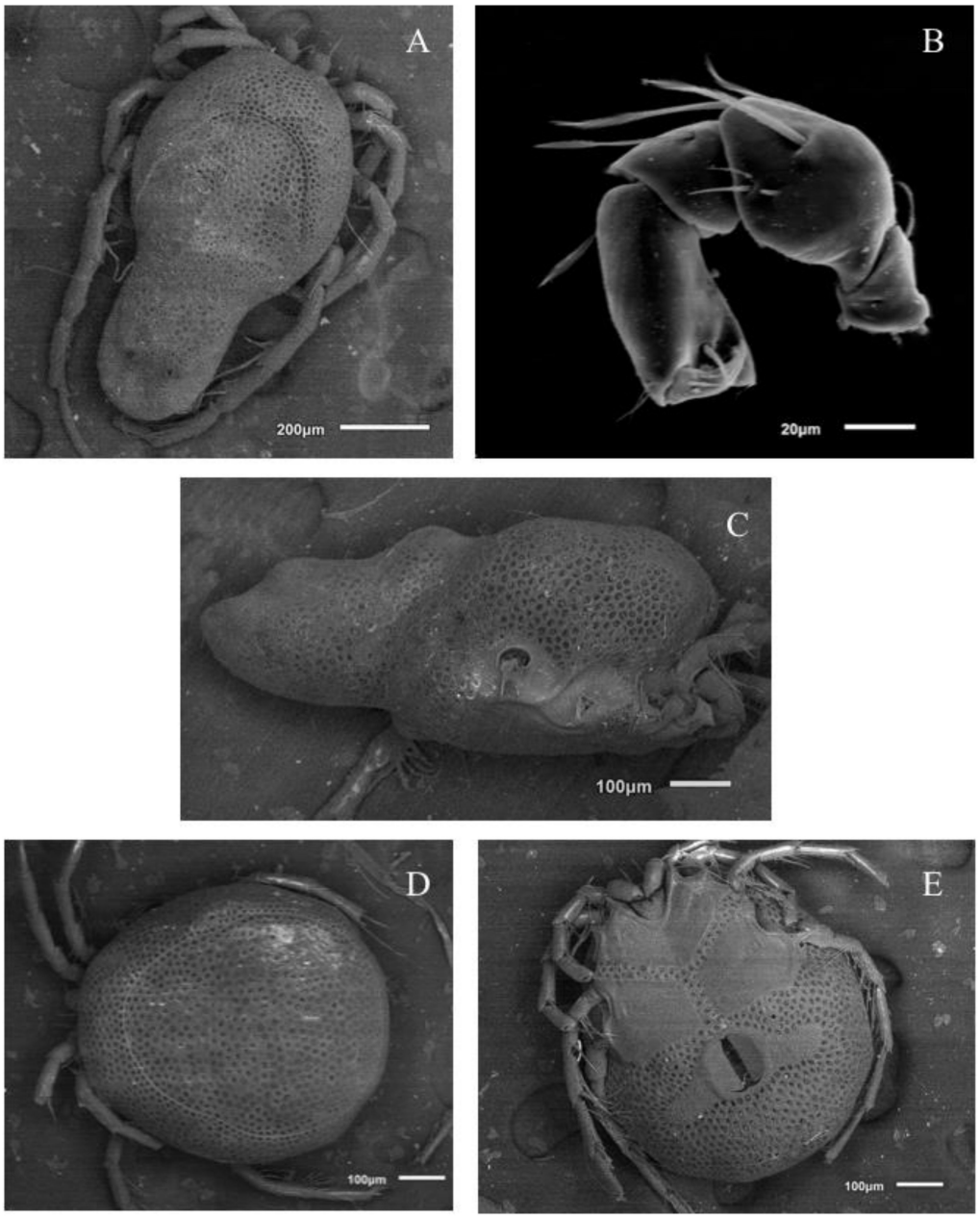

Figure 10. *Arrenurus* (*Megaluracarus*) *ecosur* n. sp. SEM micrograph of n. sp. Male. (**A**) Dorsal view; (**B**) palp; (**C**) lateral view; Female. (**D**) Dorsal view; (**E**) ventral view. The sequence of this specimen, recovered after DNA extraction, is represented by the BIN ACX8463.

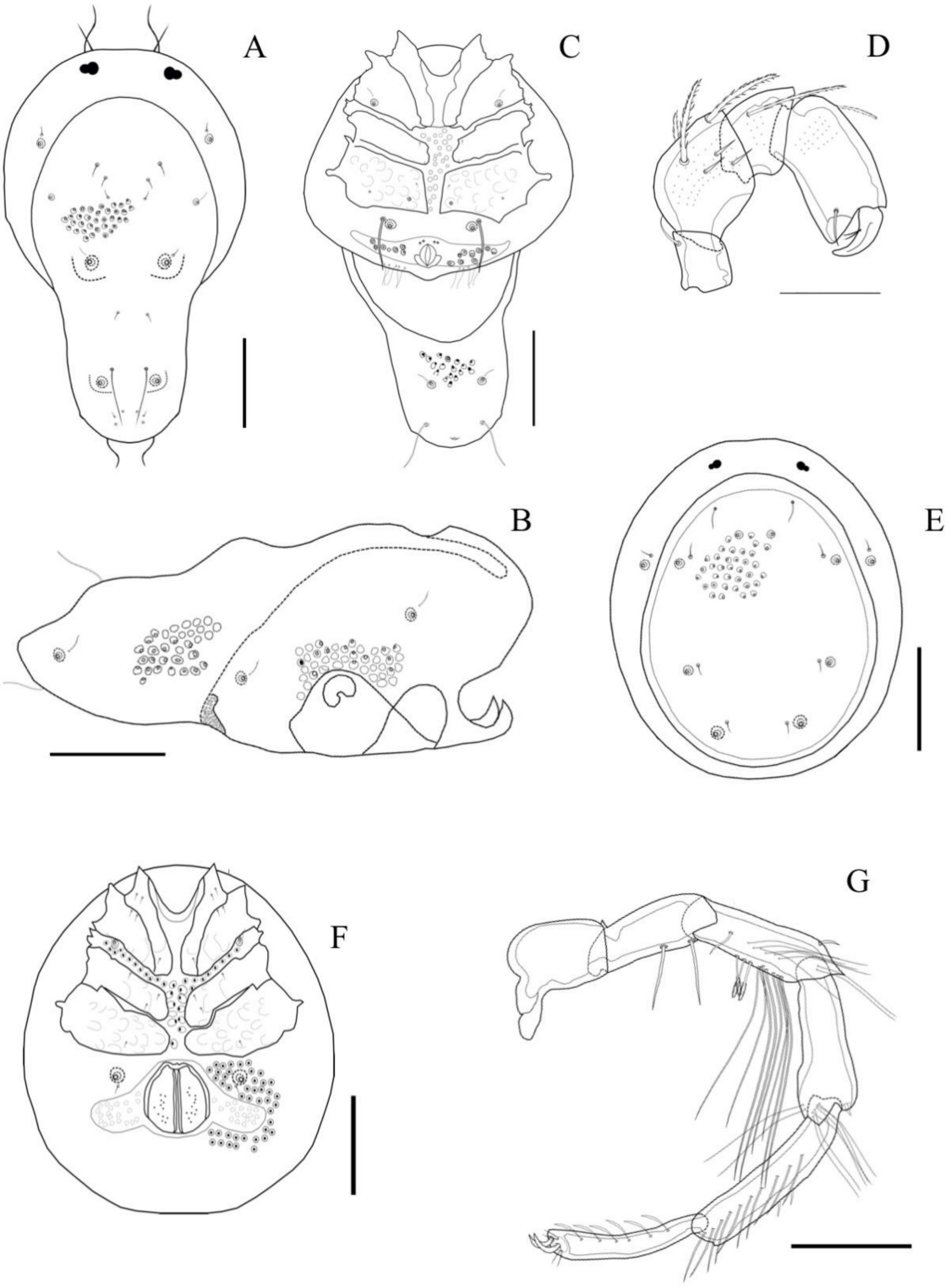

Figure 11. *Arrenurus* (*Megaluracarus*) *ecosur* n. sp. Male. (**A**) Dorsal view; (**B**) lateral view; (**C**) ventral view; (**D**) palp, medial view; (**G**) IV-Leg, lateral view. Female. (**E**) Dorsal view; (**F**) ventral view. Scale bars: (**A**–**C**,**E**,**F**) = 200 μm, (**D**) = 50 μm, (**G**) = 100 μm.

Consensus sequence: ACACTTTATTTTGCATTTGGAGCTTGATCAGGTATAGTA-GGAGCTAGACTAAGAAGTCTAATTCGCCTAGAACTAGGACAACCAGGAAATCTT-TTAGGAAACGATCAAATTTACAACACAATTGTAACAGCTCACGCTTTTATTATAAT-CTTTTTCATAGTTATACCAATCATAATCGGAGGATTCGGAAACTGACTAGTTCCATT-

AATACTAGCAGCCCCAGACATAGCGTTCCCACGAATAAACAATATAAGATTCTGA-
CTTTTACCACCTGCCCTTACACTCCTACTATCTAGATCACTATCATCCACTGGAGC-
AGGAACAGGGTGAACTGTTTATCCACCCCTTTCAAGAAACATTGCCCATGGAGG-
ACCGTCAGTAGACATAGCAATCTTCTCACTACACTTAGCAGGTGTGTCATCAATTT-
TAGGAGCTATCAACTTTTTAGCCACAATCATAAACATAAAACCTAAACACATAAA-
ATACGATCGAATTCCCCTTTTTGTTGTATCAATTTTTATTACTGTTATCCTACTTCTTC-
TCTCACTTCCAGTTTTAGCAGGAGCTATTACAATGCTACTAACAGATCGAAATTTC-
AATACATCATTCTTTGACCCAGCCGGGGGGGGAGACCCTATCTTATACCAA.

Etymology. This species is named in honor of El Colegio de la Frontera Sur (ECOSUR), the research center where the first author completed her graduate studies.

Remarks. *Arrenurus ecosur* n. sp. is similar to *A. tabascoensis* (Cook, 1980) and *A. birgei* (Marshall, 1903), both known from Tabasco (Mexico), mainly in the distinct hump in the area of Dgl-3 (when viewed laterally). However, the cauda of the new species is slightly tapering, contrary to *A. tabascoenis*. Moreover, the posterior margin of the cauda is convex in *A. ecosur* **n. sp**. and straight in *A. tabascoensis*. Aditionally the principal difference among these species is the chaetotaxy of the palps. The new species presents three distinct, pinnate setae on P2. *Arrenurus ecosur* n. sp. is also similar to *A. urbanus* (Ramírez-Sánchez and Rivas, 2013) in the overall shape of the idiosoma in the lateral and dorsal view. Nevertheless, the cauda of the new species is longer and thinner.

Additionally, *A. urbanus* possesses a characteristic patch of two types of seta medially on P2, which are absent in *A. ecosur* **n. sp**. The BOLD database assigned the BIN ACX8463 (Table 1), which was used to pair the sexes. The result of the ML tree (Figure 2) and the NJ tree (Supplementary Material) separate *A. eduardoi* **n. sp**. from the others registered in the database and support the status of this new species.

Distribution. Wide regional distribution in the Yucatan Peninsula: Bacalar lagoon, Chichancanab lagoon, Muyil lagoon, Cenote Azul, Cenote Chancah Veracruz, Cenote Sijil Noh Ha, and Cenote del Padre, Quintana Roo (Table 1).

Arrenurus (*Megaluracarus*) *beatrizae* n. sp., (Figures 12 and 13).

Holotype: One male from Ramonal wetland, Quintana Roo (access number: ECO-CH-Z-10623), 19°23′31″ N, –82°37′27″ W, emergent vegetation, 14 April 2019. Coll. L. Montes and T. Goldschmidt.

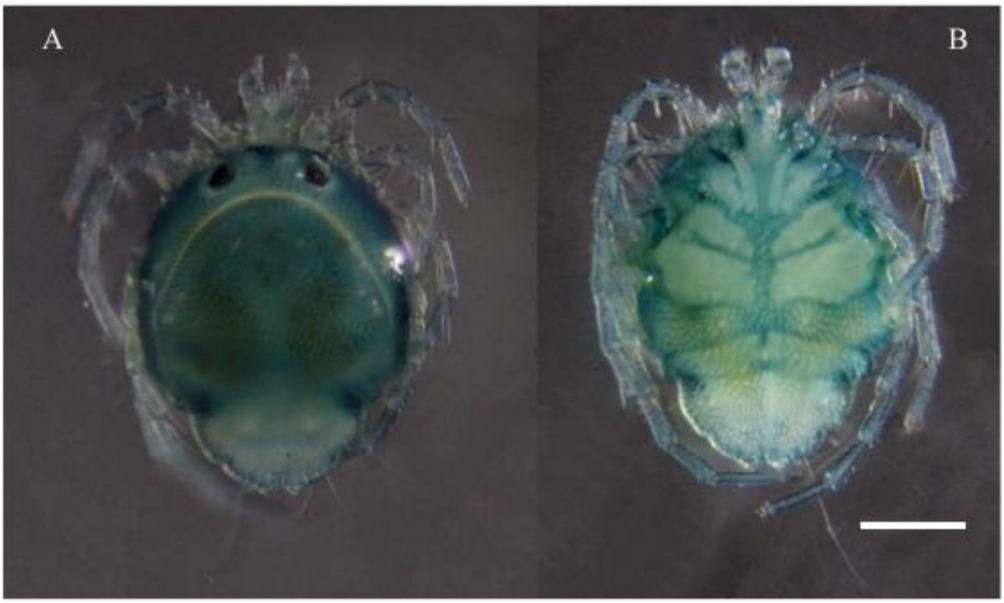

Figure 12. *Arrenurus* (*Megaluracarus*) *beatrizae* n. sp. Male. (**A**) Dorsal view; (**B**) lateral view. Scale bar = 200 μm.

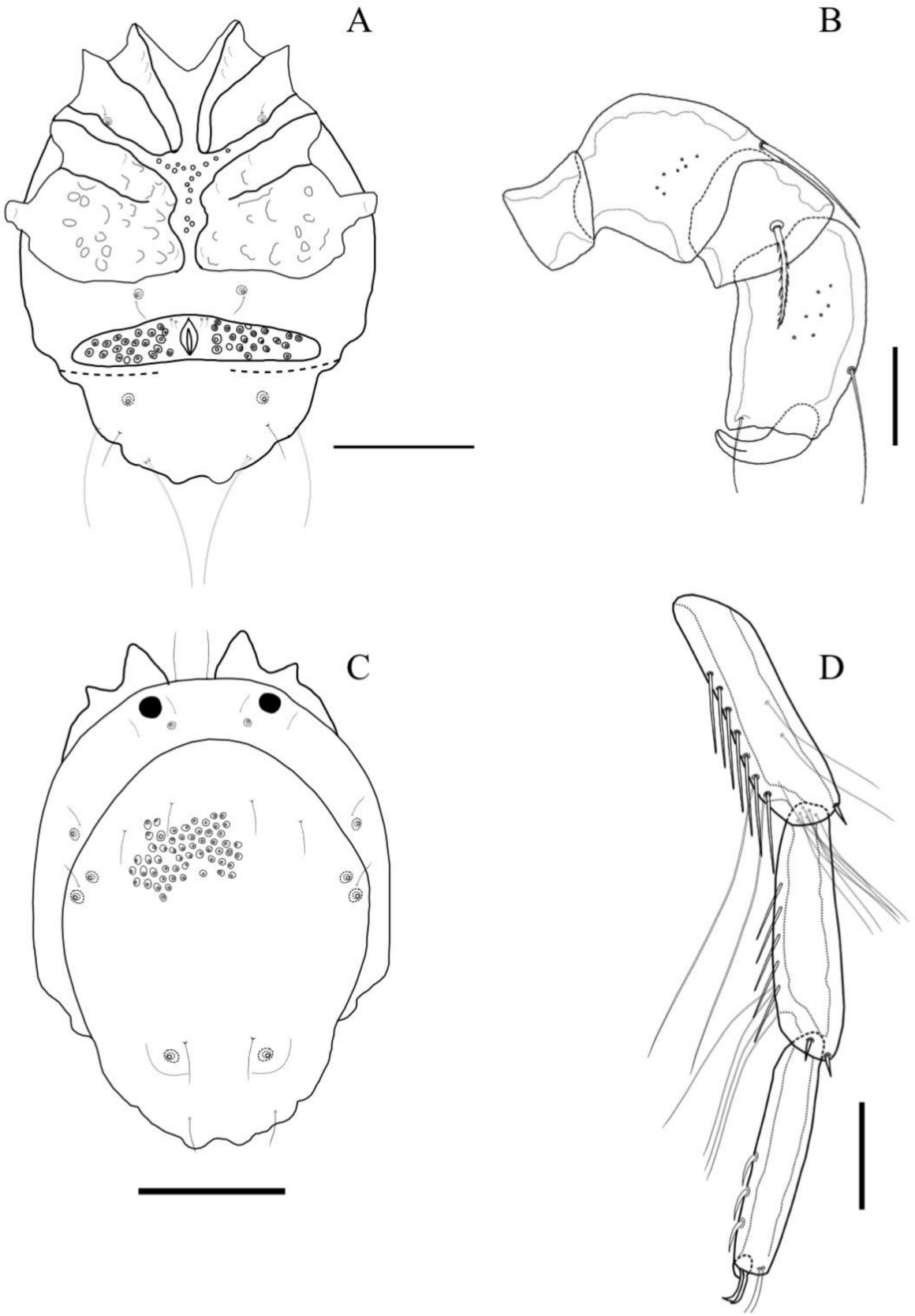

Figure 13. *Arrenurus* (*Megaluracarus*) *beatrizae* n. sp. Male. (**A**) Ventral view; (**B**) palp, medial view; (**C**) dorsal view; (**D**) IV-Leg-3-6, distal segments. Scale bars: (**A**,**C**) = 200 µm, (**B**) = 30 µm, (**D**) = 50 µm.

Paratypes: Three males, one with the same data as the holotype (access number: ECO-CH-Z-10624), the other two from San Pedrito lagoon, Pantanos de Centla, Tabasco (access number: AAL00273, AAL00274), 18°21′58.7″ N, −92°36′03.6″ W, 6 February 2002. Coll. M. Ramírez-Sánchez.

Diagnosis. Characteristic short cauda with two pairs of lateral notches, tips of Cx-II significantly protruding beyond the anterior margin of the idiosoma, P3 presents a long, pinnate seta located medially.

Description. MALE: Idiosoma 640 L, 512 W, dark blue with whitish cauda. Dorsal shield 581 L, 423 W. Dorsal furrow incomplete but continuing posterior to genital field. Cauda is short, 187 L and 285 W, bearing one medial and two pairs of lateral notches (Figures 12A and 13C). The anterior part of the idiosoma is wide with a slight constriction at the base of the cauda. Dgl-2 and Dgl-3 are close to each other. Dgl-4 is located at the end of the cauda on small humps. The anterior coxal group with complete suture lines, Cx-III and Cx-IV, separated with an incomplete suture line. Tips of Cx-II significantly protrude beyond the idiosoma's anterior margin (Figure 13A). Cxgl-1 is located posteromedially in the margin of Cx-I. Apodemes of Cx-IV protrude slightly beyond the lateral part of the idiosoma. Cxgl-2 with an associated seta posteriorly to Cx-IV (Figure 13A). Genital field 315 W, gonopore 69 L and 27 W. Dorsal L of palpal segments: P1: 27; P2: 47; P3: 41; P4: 58; P5: 33, P3 with a long, pinnate seta located medially (Figure 13B). Dorsal L of fourth leg segments: IV-Leg-3: 104, IV-Leg-4: 126, IV-Leg-5: 119, IV-Leg-6: 116, IV-Leg-4-5, with numerous swimming setae and lateral, spine-like setae (seven on IV-Leg-4 and five on IV-Leg-5) (Figure 13D). FEMALE: Unknown.

Etymology. This species is named after Beatriz Rosso de Ferradás for her invaluable contributions to water mite acarology in South America.

Remarks. This species belongs to the subgenus *Megaluracarus*. However, the cauda is relatively short compared with other members of the subgenus. The short cauda is a particular characteristic only shared by *A. olmeca* (Ramírez-Sánchez and Rivas, 2013) from Mexico and *A. amazonicus* (Viets, 1954) from Brazil. However, both *A. olmeca* and *A. amazonicus* have a patch of spatulate setae on the medial side of P2, while *A. beatrizae* exhibits only one long, pinnate seta. Additionally, the cauda posterior margin in both *A. olmeca* and *A. amazonicus* is not indented. Finally, the number of swimming setae on IV-Leg-4 is reduced in *A. olmeca* compared with *A. beatrizae* n. sp.

Distribution. So far only known from el Ramonal, Quintana Roo and San Pedrito lagoon, Tabasco.

Subgenus *Dadayella* (Koenike, 1907)
Arrenurus (*Dadayella*) *cristinae* n. sp., (Figures 14–16).

Holotype: Male from Ramonal wetland, Quintana Roo (access number: ECO-CH-Z-10625), 19°23′31″ N, −82°37′27″ W; emergent vegetation, 14 April 2019. Coll. L Montes and T. Goldschmidt.

Paratypes: One male and two females. Same data as holotype (access number: ECO-CH-Z-10626-10627).

Diagnosis. Male cauda with two falcate setae located posterolaterally, P2 medially with three simple setae, and one pinnate seta on the anterolateral part.

Description. MALE: Idiosoma 364 L and 295 W, uniformly dark blue (Figure 14A). Dorsal furrow incomplete. Dorsal shield 305 L and 207 W, short and relatively square cauda, 49 L. Dgl-4 anteriorly located on the cauda with the associated setae located on small humps and posteriorly in the idiosoma, with two small falcate setae on the posterolateral part of the cauda (Figure 16A). Coxae are occupying two-thirds of the ventral region, suture lines complete. Suture lines of Cx-I–III are diagonally elongated. Cxgl-2 between Cx-II and Cx-IV. Posteriorly to Cx-IV, is the Cxgl-2 located (Figure 16B). Genital field, 246 W, elongated almost reaching the sides of the ventral area, gonopore 59 L and 14 W. Dorsal L of palpal segments L: P1: 30; P2: 58; P3: 38; P4: 63; P5: 30. P2 with three simple setae medially located and one pinnate seta on the anterolateral, P4 rotated (Figure 16C). L of fourth leg segments: IV-Leg-3: 63, IV-Leg-4: 73, IV-Leg-5: 100, IV-Leg-6: 101, IV-Leg-5

with one pinnate seta posteromedially located and four spine-like setae along the dorsal medially surface (Figure 16E).

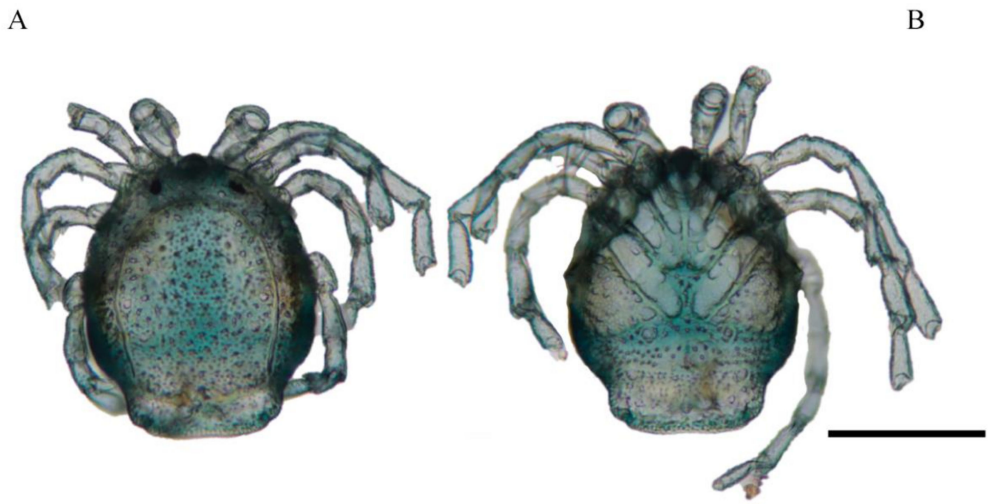

Figure 14. *Arrenurus* (*Dadayella*) *cristinae* n. sp. Male. (**A**) Dorsal view; (**B**) ventral view. Scale bar = 200 μm. The sequence of this specimen, recovered after DNA extraction, is represented by the BIN AEA7842.

FEMALE: Idiosoma 522 L and 483 W, uniformly dark blue (Figure 15A), dorsal shield oval, 463 L and 384 W (dorsal furrow complete), four dorsal pairs of glandularias present. Dgl-2 (on the ventral plate) is close to Dgl-3 (on the dorsal plate). Dgl-3 setae are located posteriorly and separated from their respective glandularia (Figure 16D). With complete suture lines, coxae occupy half of the ventral area, Cx-I, and Cx-II, elongated and extended diagonally. Cx-III and Cx-IV separated, Cx-III elongated and diagonally located, suture lines of Cx-III−IV sloping, Cx-IV triangular without medial margin. Cxgl-1 is located between Cx-II and Cx-III. Genital field 335 W, straight and with numerous associated acetabula, gonopore 118 L and 112 W. Cxgl-2 between genital area and Cx-IV (Figure 16F).

Figure 15. *Arrenurus* (*Dadayella*) *cristinae* n. sp. Female. (**A**) Dorsal view; (**B**) ventral view. Scale bar = 200 μm. The sequence of this specimen, recovered after DNA extraction, is represented by the BIN AEA7842. The difference in color is due to the DNA extraction process.

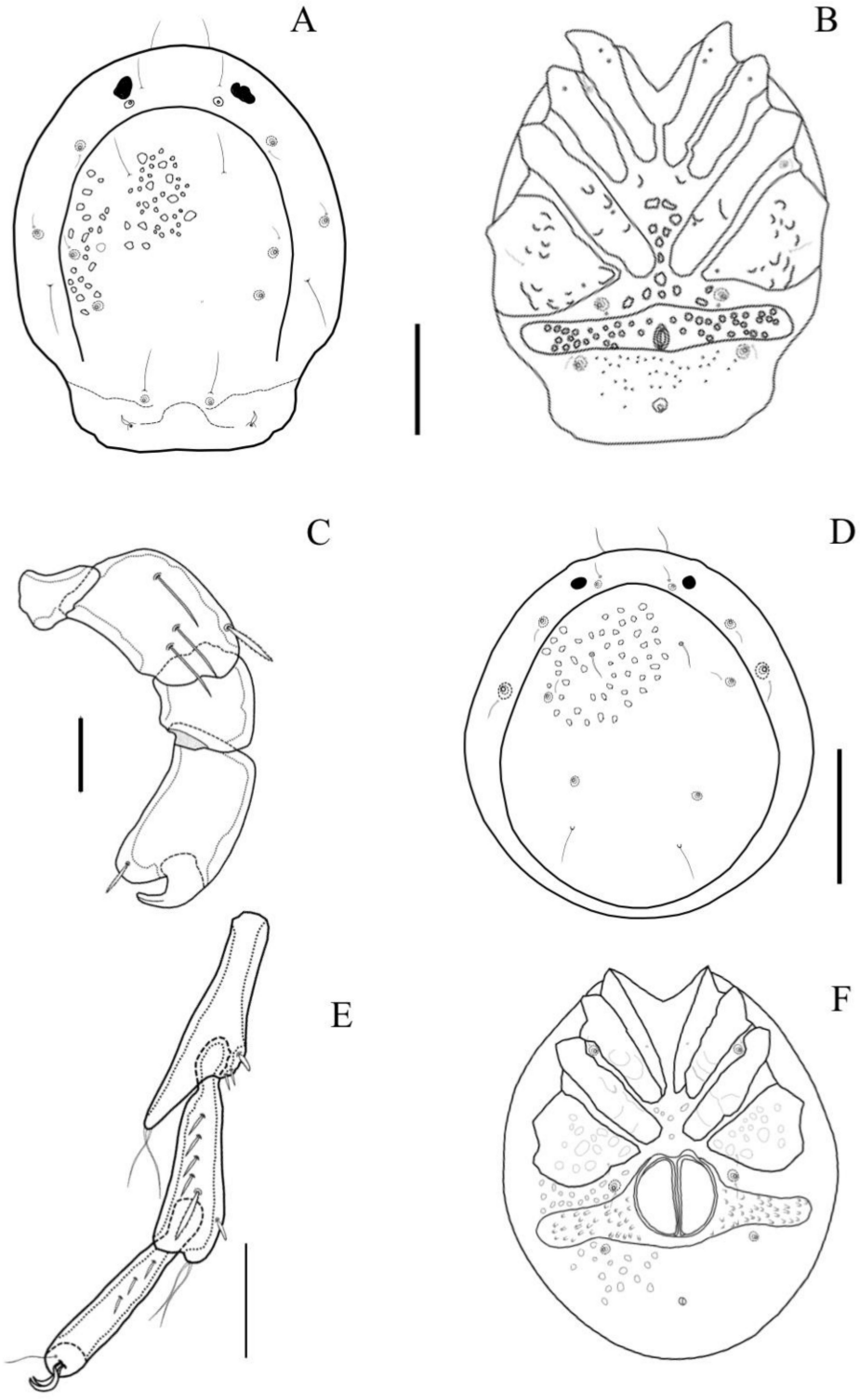

Figure 16. *Arrenurus* (*Dadayella*) *cristinae* n. sp. Male. (**A**) Dorsal view; (**B**) ventral view; (**C**) palp; (**E**) IV-Leg-3-6. Female. (**D**) Dorsal view; (**F**) ventral view. Scale bars: (**A**,**B**) = 100 μm, (**C**) = 30 μm, (**E**) = 50 μm, (**D**,**F**) = 150 μm.

Consensus sequence: ACTCTTTATTTTGCCTTTGGATTCTGATCAGGTATGGTA-GGTGCAAGATTAAGAAGACTAATTCGCTTAGAATTAGGACAACCAGGGAGACTCT-TAGGGAGAGACCAAATTTACAACACAATCGTAACAGCTCATGCTTTTATCATAAT-CTTTTTTATAGTTATACCTATTATAATTGGAGGTTTCGGAAACTGACTAGTTCCTCTT-ATACTAGCAGCTCCAGATATGGCATTCCCACGAATAAACAATATAAGATTTTGAC-

TTCTTCCCCCAGCTTTAATTCTCCTTCTATCTAGATCTCTCTCCTCAACAGGAGCAG-
GAACAGGGTGAACAGTATATCCNCCACTTTCAAGTAACATTGCACATGGAGGAC-
CTTCAGTTGACATAGCAATCTTTTCCCTCCATTTAGCAGGAGTCTCATCAATTCTA-
GGTGCTATCAATTTCTTAGCTACAACCATCAATATAAAACCAAAATATATAAAATA-
TGATCGTATTCCTCTATTTGTCATTTCAATTTTCATCACAGTTATTCTCCTTCTCCTA-
TCTTTACCAGTCTTAGCAGGAGCCATTACCATACTTTTAACTGACCGAAACTTTAA-
TACATCATTTTTTGATCCAGCTGGAGGAGGAGACCCAATTCTATATCAA.

Etymology. This species is named after Cristina Cramer Hemkes for her invaluable contributions to water mite acarology in Mexico.

Remarks. The present species belong to the *Dadayella* subgenus, characterized by males with a small or undifferentiated cauda with an incomplete dorsal furrow and P2 with a simple chaetotaxy [4]. *Arrenurus* (*Dadayella*) *cristinae* n. sp. is similar to *A. veracruzensis* (Cramer and Cook, 1992) in the shape and size of the idiosoma, particularly in the quadrangular silhouette of the cauda. The female of *A. veracruzensis* is similar to the new species. However, the dorsal shield of the A. veracruzensis female has three pairs of glandularia, while *A. cristinae* n. sp. has two. Furthermore, the chaetotaxy of P2 is quite different; *A. cristinae* n. sp. presents three simple, medial setae and a little, pinnate seta in the anterior-lateral part while *A. veracruzensis* presents four medial, spine-like setae. Additionally, *A. cristinae* n. sp. presents two falcate setae on the posterolateral part of the cauda, which are absent in *A. veracruzensis*. Most of the *Dadayella* species described are known from females, making comparisons difficult due to their scarce morphological variation. It was possible for *A. cristinae* n. sp. to obtain the DNA barcode with the BIN AEA7842. Therefore, we could, undoubtedly, assign the female to the respective male (Figure 2). These data represent the first sequences obtained for this subgenus.

Distribution. So far only known from the type locality (Ramonal, Quintana Roo).

4. General Remarks

With these new records and species descriptions, the list of arrenurids from Mexico increases from 37 to 42. The subgenus *Megaluracarus* is the richest in species, with 26 known species (as well as four of the new species described in the present paper). This figure is followed by subgenera *Arrenurus* and *Dadayella*, with six species each. The subgenera with fewer representatives are *Truncaturus* and *Arrhenuropsis*, with only three and one species, respectively. The case of *Arrenurus* (?) *nayaritensis* is particular, and the relationships of this species will not be known until the male is described [3]. According to the checklist (Table 2), only five species have a continuous distribution between the USA and Mexico, one between Costa Rica and Mexico, and one with a more extensive range of distribution in the Neotropics and the Caribbean islands: *Arrenurus valencius*, known from Venezuela, Cuba, Haití, Guatemala, and Mexico.

The new record of *Arrenurus marshallae* from Mexico is shared with Canada and the USA. The remaining species exhibit a restricted distribution to one or two localities (at the present stage of knowledge), and the new records of *Arrenurus colitus* and *A.* (? *Arrhenuropsis*) *mexicanus*, previously known from Tamaulipas state, are now extending the known distribution of these species to Quintana Roo state.

The available molecular information also supports the species diagnoses. Comparing all available sequences of genus *Arrenurus* from the BOLD database (1111 sequences, see Supplementary Information) the discriminated sequences from Mexico indicate a restricted distribution as only two putative species are shared with Canada. This pattern is repeated in the rest of the tree, where other putative species are recorded in only one country or a maximum of two. However, these inferences are strongly biased due to the few sequences and countries with molecular information available. However, this comparison supports our previous conclusion about the new species presented here.

All the arrenurids currently known from Mexico have been reported for 14 of the 32 states in the country. From these, Tamaulipas heads the listing with six species, while Mexico state, Michoacán, and Yucatan have only one species recorded. For 18 entities,

particularly in the north, there is no information. As stated in the introduction, due to the geographical position of Mexico and its great variety of ecosystems (many unique in the world, e.g., Bacalar lagoon in the tropics and Cuatrocienegas in the semi-desert), a great diversity of water mites should be expected.

Once we know the diversity of mites, we can make progress to understand their ecological significance and value as water quality indicators.

Supplementary Materials: The following are available online at: https://www.mdpi.com/article/10.3390/d14040276/s1. Figure S1: N.J. compressed tree based on worldwide COI sequences of *Arrenurus* (In total 1111 sequences, representing 148 putative species).

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