



# Harvestmen in the semiarid: a new genus and three new species of Pachylinae (Opiliones: Gonyleptidae) from Caatinga dry vegetation, with a cladistic analysis

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## Abstract

Opiliones are highly diverse in the Neotropics. Because of biological constraints, most harvestmen communities are associated with humid forests, exhibiting a high species diversity and endemism in these habitats. Drier formations, such as the Caatinga biome in northeastern Brazil, are less diverse and still considered under-sampled for the order. This study represents an effort to examine the aforementioned diversity by describing a new Gonyleptidae genus, *Sertaneja* **gen. nov.**, comprising two new species from Ceará state, *Sertaneja bicuspidata* **sp. nov.** and *Sertaneja crassitibialis* **sp. nov.**, and one new species from Rio Grande do Norte state, *Sertaneja falcata* **sp. nov.** A morphological cladistic analysis consisting of 20 terminals and 72 characters was performed to evaluate monophyly of the new genus and relate it to other Gonyleptidae. The analysis resulted in a single most parsimonious tree, corroborating *Sertaneja* **gen. nov.** monophyly and relatedness to *Gyndoides springmanni* Soares & Soares, 1947, which in turn is the sister group to the DRMN clade. Taking into account the morphological traits and phylogenetic placement of *Sertaneja* **gen. nov.**, we chose to place the new genus in Pachylinae despite its polyphyletic status, given that the *Sertaneja* **gen. nov.** clade is closely related to one of the Brazilian Pachylinae lineage. A resolution to the Pachylinae conundrum is needed to further explain the subfamily intricacies. Future research requires a larger scope, but currently, based on the new genus monophyly, support, and relatedness, we formally propose its creation and hope to shed light on the possible evolutionary scenarios for the subfamily.

## Keywords

Arachnida, Grassatores, Neotropics, phylogeny, upland forest

## 1. Introduction

The high species diversity in the Neotropics is well documented for many taxa, and harvestmen are no exception, with many studies describing their abundance and

diversity in Neotropical rainforests (Pinto-da-Rocha and Bonaldo 2006; Proud et al. 2012; Nogueira et al. 2019). Considering this diversity, great taxonomic efforts in

the Neotropics have consistently been expended, which trace back to the 1940s, with major efforts by two main researchers, Cândido Firmino Melo Leitão and Carl Friedrich Roewer. These researchers together described over 3000 harvestmen species, prominently from the Neotropics (Tourinho and Kury 2015). Currently, the description rate continues to be substantial, with many new species being cataloged and with numerous group revisions occurring (DaSilva and Gnaspini 2010; DaSilva and Pinto-da-Rocha 2010; Hara and Pinto-da-Rocha 2010; Mendes 2011; Pinto-da-Rocha and Bragagnolo 2013; Villarreal et al. 2019; Carvalho and Kury 2021; Pessoa-Silva et al. 2021). These high diversity rates are associated with particular traits of the order, such as a high degree of endemism, restricted distribution, dependence on humid habitats, and low resistance to desiccation, which makes populations much more prone to diversification events over time (DaSilva et al. 2015; Derkarabetian et al. 2021).

Dry forests and open vegetation biomes (e.g., Caatinga and Cerrado) are less diverse compared to humid forests (Nogueira et al. 2019), but they still represent a frontier that remains to be explored for Opiliones. The Caatinga biome, located in northeastern Brazil, has a semiarid climate and is composed of dry forests and shrublands. Some efforts to study the aforementioned diversity of harvestmen have come as punctual descriptions (Kury 2008; Pinto-da-Rocha and Carvalho 2009), checklists (Azevedo et al. 2016), abundance and diversity studies (DeSouza et al. 2017), and biogeographical research (DaSilva et al. 2016), which has gradually helped unravel the actual diversity. The Caatinga biome is composed of a complex set of relictual humid forest formations that represent a relevant source of diversity for many taxa (Locatelli and Machado 2001; Albano and Girão 2008; Santos et al. 2011), but it is yet to be fully explored for Opiliones (Kury 2009). These formations, the Brejos de Altitude, are directly associated with the occurrence of high plateaus over 500 m in altitude, with precipitation exceeding 1200 mm/year, and were created mainly by the processes of expansion and retraction of different forest bulks, imposed by the glacial and interglacial events of the Pleistocene era (Tabarelli and Santos 2004; Cavalcante 2005; Silveira et al. 2019). Such heterogeneity provides potential for unexplored taxa of Opiliones, due to the altitudinal forest characteristics.

One of the most under-sampled and enigmatic harvestmen groups in the Caatinga region is the Pachylinae, the largest subfamily in Gonyleptidae, with slightly more than 300 registered species (Kury et al. 2001). This subfamily is not a monophyletic group (Pinto-da-Rocha et al. 2014; Carvalho and Kury 2018; Ázara et al. 2020; Benavides et al. 2021), and it includes several Gonyleptidae genera with symplesiomorphic characters and uncertain relationships. According to the Kury (2003) catalog, some Pachylinae representatives are most likely to occur in the Caatinga domain. For instance, *Discocyrtulus marginalis* Roewer, 1929 and *Paradiscocyrtus cerayanus* Roewer, 1929, are both described to the Ceará state where the Caatinga formation is considerable and are only known from their original descriptions, currently lacking

official confirmation. This lack of information regarding this subfamily in the Caatinga leads to an underestimation of its true diversity. This can be confirmed by the most recent inventory effort of harvestmen in the Caatinga developed by DeSouza et al. (2017) based on the literature, depositories, and new collection data from the Semiarid Biodiversity project (Bravo 2017). Despite the sampling deficit for the region, the study was able to document a total of 10 species for the subfamily, five of which were previously unknown.

The suspicion of Pachylinae polyphyly could be traced back at least 20 years (Pinto-da-Rocha 2002), and is fueled by its comprehensive diagnosis, based on the lack of exclusive diagnostic features and four scute areas (Pinto-da-Rocha et al. 2014). Because of such poor taxonomic characterization, monophyly of the group is frequently not recovered, both by morphological and molecular data (Pinto-da-Rocha 2002; Hara et al. 2012; Pinto-da-Rocha et al. 2014; Carvalho and Kury 2018). The reason for this situation is not exclusive to Pachylinae, but Opiliones as a whole because of the so called Roewerian system, named by Henriksen (1932) and explained many times in the past (for instance, Pinto-da-Rocha 1997, 2002; DaSilva and Gnaspini 2010; and Hara and Pinto-da-Rocha 2010). Simply put, Roewer subjectively chose certain set of characters to circumscribe families (e.g. type of tarsal claws and armature on anterior margin of carapace), subfamilies (e.g. number of scute areas and type of ocularium and its placement on carapace) and so on. Thus, it overlooked intraspecific variation and resulted in many monotypic groups, as well as groups of phylogenetically unrelated species (see Kury 1992 for instance). The Soares couple (Soares and Soares 1954) revised all genera of Pachylinae in their catalogue, but still under strong influence of the Roewerian system. Since their catalogue, no one has attempted to make a comprehensive revision of Pachylinae. Nevertheless, Ringuet and Acosta made noteworthy contributions, albeit limited, by revising Argentinean (Ringuet 1959; Acosta 1999) and Peruvian genera (Acosta 2001), but most of the subfamily remained untouched. Current efforts have attempted to resolve this issue by revising key taxa and using morphological and/or molecular data, which has resulted in the circumscription of the Pachylinae s.s. to only four southern South American genera, the erection of the new subfamilies to accommodate some Brazilian Pachylinae genera, such as Roeweriinae and Neopachylinae, and recognition of the megadiverse genus *Discocyrtus* Holmberg, 1878 s.s. lineage. However, a multitude of other genera still need to go through similar revisionary treatment (Pinto-da-Rocha et al. 2014; Kury and Carvalho 2016; Carvalho and Kury 2018; Carvalho and Kury 2021).

In the present paper, we describe a new Pachylinae genus for the northern Caatinga region from Ceará and Rio Grande do Norte states, comprising three new species, based on external morphological characters. We also provide a phylogeny with representatives of some of the main Pachylinae lineages, aiming to shed light on the intricate history of the Caatinga's harvestmen diversity, which has been barely explored.

## 2. Methods

### 2.1. Taxonomy

Description of the external morphology, topological terms of appendages, mensuration, meristics, genital preparation, and examination mainly follows Acosta et al. (2007) with minor modifications, such as those by Hara et al. (2012), namely, the posterior margin of the dorsal scute, carapace, and spine definitions. Dorsal scute shape terminology, penial macrosetae nomenclature, and ozopore morphology follow Kury and Medrano (2016), Kury and Villarreal M. (2015), and Hara and Gnaspini (2003), respectively. Description of colors were based on specimens in 70% ethanol preservation, and follows the notation and numeration of the 267 Color Centroids of the NBS/ISCC Color System, as described by Kury and Orrico (2006).

External morphology examination was conducted using a stereomicroscope Leica M205C. Penial examination and illustrations were performed using a Zeiss Primo Star binocular microscope fixed with a photo camera and the software ZEN 2 Lite Blue Edition (Zeiss, Germany). Illustration of the external morphology and penis were made in the vector graphics editor Inkscape v. 0.92 (<https://inkscape.org>), based on a focus-stacked image taken using the Leica stereo microscope associated with the software Leica Application Suite v. 4.2 (Leica Microsystems, Germany). Scanning electron micrographs were obtained using Shimadzu's SSX-550-SUPERS-CAN from the Laboratório de Ensaios de Materiais of the Centro de Tecnologias do Gás e Energias Renováveis, Rio Grande do Norte, Brazil. The material was prepared following the methodology of Pinto-da-Rocha (2002).

The generic characters are not repeated in the species descriptions. Specific descriptions are based only on the male holotype. Females and other described specimens (variation) are stated in separate sections of the description and are solely based on characters that differ from the holotype. Setiferous tubercles (*i* = small, *I* = large) of the pedipalp, are described from basal to apical order. All measurements are in millimeters.

Every specimen described here is deposited at the Coleção de Miriápodes e Aracnídeos da Universidade Federal da Paraíba, João Pessoa, Brazil (UFPB); Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP); and Museu Nacional do Rio de Janeiro, Rio de Janeiro, Brazil (MNRJ).

### 2.2. Taxon sampling

All specimens used in the phylogenetic analysis came from loans from Coleção de Aracnídeos e Miriápodes da Universidade Federal da Paraíba (UFPB), Museu de Zoologia da Universidade de São Paulo (MZUSP), and Museu Nacional do Rio de Janeiro (MNRJ). Considering that the

main goal of this study was to evaluate monophyly of the new genus and its phylogenetic placement, the terminals were chosen based on Pinto-da-Rocha et al. (2014) and Carvalho and Kury (2018), focusing on insights of sub-familial relationships, using only the most relevant set of taxa without an unnecessary load for larger analysis. For this purpose, our ingroup was composed by the three new species of *Sertaneja* gen. nov., and the outgroup included 17 species representing four Gonyleptoidea families and seven Gonyleptidae subfamilies, totaling 20 terminals. A list of outgroup information is shown in Table 1.

### 2.3. Character sampling

The analysis included a total of 72 morphological characters, including five related to the ocularium, 17 to the dorsal scute, three to free tergites, one to chelicerae, one to pedipalps, 31 to leg IV, and 14 to the penis. Characters were mainly based on Hara (2016) and Carvalho and Kury (2018), with adjustments and new characters created according to our ingroup. The codification considered both discrete and multistate characters. In total, 30 multistate characters were proposed, of which 19 were treated as ordered when a clinal variation of the state's transformation series was identifiable. The character matrix was edited using the software Mesquite v. 3.61 (Maddison and Maddison 2019) and exported to the respective parsimony analysis programs. Inapplicable state entries were coded as “–”, whereas uncertain ones were coded as “?”.

### 2.4. Parsimony analysis

The phylogenetic parsimony analysis was performed using TNT v. 1.5 (Goloboff and Catalano 2016). Heuristic searches were conducted with characters under implied weighting following Mirande (2009) TNT search script parameters. These parameters select 11 *K* values based on average character fits distributed in 11 regular intervals between 50% and 90% of the fit of a perfectly hierarchical one, i.e., 1.0. Then for each *K* value, the most parsimonious trees and their consensus were generated, and as a criterion for choosing the most stable trees, a similarity matrix with the values of the tree's distortion coefficient (Farris 1989) and SPR distance (Goloboff et al. 2008) was elaborated. Taxon+ notation was utilized when referring to a given taxon plus its sister group, as proposed by Amorim (1982). We also employed the notation [X(y)], where X is the character number and y is the character state.

Visualization, character evolution analysis, and optimization were performed using the software Winclada v. 1.00.08 (Nixon 2002). Relative Bremer support (Goloboff and Farris 2001) was calculated using TNT, also under implied weighting, retaining suboptimal trees with up to ten extra steps and relative fit difference of 1. All character discussions are based on ACCTRAN optimization.

**Table 1.** List of the species and their respective voucher information, used as outgroup taxa in the cladistic analysis. — *Abbreviations:* s.s. = sensu stricto; s.l. = sensu lato.

Family	Subfamily	Species	Locality	Depository
Stygnidae	Stygninae	<i>Pickeliana pickeli</i> Mello-Leitão, 1932	Brazil, São Vicente Férrer – PE	UFPB OP-789
Manaosbiidae	Manaosbiinae	<i>Saramacia lucasae</i> (Jim and Soares, 1991)	Brazil, Porto Velho – RO, Abunã	MZUSP 58150
Cranidae	Phareicraninae	<i>Phareicranus manaura</i> (Pinto-da-Rocha, 1994)	Brazil, Manaus – AM, Fazenda UFAM	MZUSP 49326
Gonyleptidae	Heteropachylinae	<i>Pseudopucrolia discrepans</i> (Roewer, 1943)	Brazil, Caaporã – PB	UFPB OP-788
Gonyleptidae	Goniosomatinae	<i>Heteromitobates inscriptus</i> (Mello-Leitão, 1922)	Brazil, Caraguatatuba – SP, base do Morro S. Antônio	UFPB OP-182
Gonyleptidae	Gonyleptinae	<i>Gonyleptes horridus</i> Kirby, 1818	Brazil, Guapimirim – RJ	MZUSP 903
Gonyleptidae	Gonyleptinae	<i>Parapachyloides uncinatus</i> (Sørensen, 1879)	Paraguay, San Pedro, Liberacion	MNRJ 8469
Gonyleptidae	Pachylinae s.s.	<i>Pachylus chilensis</i> (Gray, 1833)	Chile, Parque Nacional La Camapana	MZUSP 36797
Gonyleptidae	Pachylinae s.s.	<i>Acanthopachylus aculeatus</i> (Kirby, 1819)	Brazil, Porto Alegre – RS, Ponta Grossa	MZUSP 13830
Gonyleptidae	Pachylinae s.s.	<i>Acanthoprocta pustulata</i> Loman, 1899	Chile, Araucania, Parque Nacional Nahuelbuta	MZUSP 36807
Gonyleptidae	Mitobatinae	<i>Longiperna kuryi</i> Pinto-da-Rocha and Bragagnolo, 2010	Brazil, Bertioga – SP, trilha descendo rio Itapanhaú	UFPB OP-42
Gonyleptidae	Roeweriinae	<i>Roeweria bittencourti</i> Mello-Leitão, 1923	Brazil, Ilhota – SC, Parque Botânico Morro do Báu	MZUSP 18659
Gonyleptidae	Roeweriinae	<i>Roeweria virescens</i> (Mello-Leitão, 1940)	Brazil, São Miguel Arcanjo – SP, Parque da Onça Parda	MZUSP 46930
Gonyleptidae	Neopachylinae	<i>Pachylobos longicornis</i> (Mello-Leitão, 1922)	Brazil, Cubatão – SP, COPEBRAS, trilha Grande Fenda 1	MZUSP 31726
Gonyleptidae	Pachylinae s.l.	<i>Eusarcus nigrimaculatus</i> Mello-Leitão, 1924	Brazil, Rio de Janeiro – RJ, Floresta da Tijuca	UFPB OP-46
Gonyleptidae	Pachylinae s.l.	<i>Discocyrtus fenax</i> Kury, Pinto-da-Rocha and Carvalho, 2018	Brazil, Blumenau – SC, Parque Natural Municipal Nascentes do Garcia	MZUSP 30664
Gonyleptidae	Pachylinae s.l.	<i>Gyndoides springmanni</i> Soares and Soares, 1947	Brazil, Florianópolis – SC, Ilha do Francês	MZUSP 1943

## 2.5. Abbreviations

Morphology: **DS** dorsal scute; **DSL** dorsal scute length; **DSW** dorsal scute maximum width; **LI** leg I; **LII** leg II; **LIII** leg III; **LIV** leg IV; **VP** ventral plate; **MS A** group A macrosetae; **MS B** group B macrosetae; **MS C** group C macrosetae; **MS D** group D macrosetae; **MS E** group E macrosetae.

Repositories (all in Brazil): **MZUSP** Museu de Zoologia, Universidade de São Paulo, São Paulo; **UFPB** Coleção de Aracnídeos e Miriápodos, Universidade Federal da Paraíba, João Pessoa. **MNRJ** Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro.

Others: **SEM** scanning electron microscopy.

## 3. Results

### 3.1. Character list

Character and states used in the cladistic analysis of *Sertaneja* gen. nov. Taxon and character states matrix is included in the Supplementary Material File 1.

- Ocularium type: **(0)** divided (Pinto-da-Rocha 1997: fig. 349); **(1)** undivided (Figs 3A, G, 6A, G, 9A, G).
- Undivided ocularium width in dorsal view: **(0)** width at least  $2 \times$  the length (Pinto-da-Rocha 1994: fig. 1a); **(1)** width ca. the same as length (Figs 3A, 6A, 9A).
- Ocularium dorsal armature: **(0)** paramedian pair (Figs 3G, 9G); **(1)** central and single (Fig. 6G).
- Ocularium dorsal pair armature length: **(0)** at least the ocularium height (Figs 3G, 6G, 9G); **(1)** up to eye diameter (Hara and Pinto-da-Rocha 2010: fig. 26b).
- Ocularium height in relation to eye: **(0)** low, ca.  $1 \times$  the eye diameter; **(1)** medium, up to  $1.5 \times$  the eye diameter; **(2)** high, at least  $2 \times$  the eye diameter (Figs 3C, 6C, 9C). — Treated as ordered.
- Number of pairs of ozopores openings: **(0)** one; **(1)** two.
- Type of DS  $\gamma$ : **(0)**  $\gamma$ R (Kury and Medrano 2016: fig. 1m–o); **(1)**  $\gamma$ P (Kury and Medrano 2016: fig. 1t–v); **(2)**  $\gamma$ T (Kury and Medrano 2016: fig. 1w, x).
- DS anterior margin: **(0)** smooth; **(1)** bearing a pair or row of distinct projections.
- Type of DS anterior margin armature: **(0)** paralateral high spines (Pinto-da-Rocha 1994: fig. 1a); **(1)** row of distinct tubercles throughout the margin; **(2)** pair of paramedian tubercles (Roewer 1929: fig. 526).
- DS lateral margin ornamentation: **(0)** with external row of distinct tubercles; **(1)** without external row of distinct tubercles.



- 11 Size of tubercles in the external row of the DS lateral margin: **(0)** equally sized; **(1)** slightly increasing in size posteriorly throughout the row (Fig. 6C); **(2)** with sudden enlargement of tubercles on the posterior or distal third (Bragagnolo and Pinto-da-Rocha 2009: fig. 1b).
- 12 DS posterior margin integumentary ornamentation: **(0)** with row of equally sized tubercles throughout the entire margin; **(1)** with single median apophysis (Maury 1991: fig. 1); **(2)** with paramedian pair of distinct projections.
- 13 DS number of areas: **(0)** three; **(1)** four.
- 14 Scute areas general tuberculation aspect: **(0)** symmetrical with proportional height and length; **(1)** flat and spread.
- 15 Scute area I, armature: **(0)** with paramedian pair of distinct projections; **(1)** without paramedian pair of distinct projections.
- 16 Scute area I, distinct paramedian projection type: **(0)** conical spines (Kury 1997: fig. 1e); **(1)** round tubercles.
- 17 Scute area I, paramedian tubercles position: **(0)** placed approximately in the center of each half of scute area I; **(1)** placed close to the median longitudinal groove (Fig. 3A).
- 18 Scute area II, armature: **(0)** with paramedian pair of distinct projections (Fig. 3A); **(1)** without paramedian pair of distinct projections.
- 19 Scute area III, armature: **(0)** with paramedian pair of distinct projections; **(1)** without paramedian pair of distinct projections.
- 20 Scute area III, type of paramedian pair of distinct projections: **(0)** pair of straight, high spines (Pinto-da-Rocha 1997: fig. 350); **(1)** pair of straight, high tubercles (Bragagnolo and Pinto-da-Rocha 2009: fig. 1b); **(2)** pair of spines curved posteriorly (Figs 3A, C, 6A, C); **(3)** pair of low, rounded tubercles (Fig. 9A, C).
- 21 Median longitudinal division on scute area IV: **(0)** absent; **(1)** present.
- 22 Scute area IV, armature: **(0)** without paramedian pair of distinct projections; **(1)** with paramedian pair of distinct projections (Fig. 3A, C).
- 23 Free tergite I, type of integumentary ornamentation: **(0)** with row of equally sized tubercles; **(1)** with single, median apophysis (Roewer 1923: fig. 526); **(2)** with a pair of distinct paramedian projections (Kury 1997: fig. 1g).
- 24 Free tergite II, paramedian pair of projection: **(0)** absent; **(1)** present.
- 25 Free tergite III, paramedian pair of projection: **(0)** absent; **(1)** present.
- 26 Chelicerae, segment I posterior face: **(0)** with projections; **(1)** without projections.
- 27 Pedipalp femur, mesal apical seta: **(0)** absent; **(1)** present (Figs 3F, 6F, 9F).
- 28 Male coxae IV and coxae I–III width ratio in situ, in dorsal view: **(0)** coxae IV as wide as coxae I–III; **(1)** coxae IV up to 2 × wider than coxae I–III (Figs 3A, 6A, 9A); **(2)** coxae IV more than 2 × wider than coxae I–III (Pinto-da-Rocha and Bragagnolo 2010: fig. 5). — Treated as ordered.
- 29 Male coxa IV length compared to posterior margin of the stigmatic sternite in situ, ventral view: **(0)** not surpassing it (Hara et al. 2012: fig. 2b); **(1)** surpassing it (Kury et al. 2018: fig. 10b).
- 30 Male coxa IV dorso-lateral face, integumentary ornamentation: **(0)** present (Figs 3A, 6A, 9A); **(1)** absent.
- 31 Male coxa IV, integumentary ornamentation density: **(0)** low, ≤ 4 tubercles; **(1)** medium, > four, ≤ 13 tubercles; **(2)** high, > 13 (Figs 3A, 9A). — Treated as ordered.
- 32 Male coxa IV, prodorsal apical apophysis, type: **(0)** slender spine (Pinto-da-Rocha 1994: fig. 1a); **(1)** robust projection (Figs 3D, 6D, 9D).
- 33 Male coxa IV, prodorsal apical apophysis, length: **(0)** very small, similar to the eye diameter (Pinto-da-Rocha 1997: fig. 349); **(1)** small, ca. 1/4 of the DS posterior margin width (Mendes 2011: fig. 7a); **(2)** medium, ca. 1/3 of the DS posterior margin width (Fig. 9A); **(3)** long, > 1/2 of the DS posterior margin width (Fig. 6A). — Treated as ordered.
- 34 Male coxa IV, prodorsal apical apophysis, insertion angle in relation to body medial axis: **(0)** almost transversal (DaSilva and Gnaspini 2010: fig. 79); **(1)** oblique (Fig. 9A); **(2)** sub-parallel (Maury 1991: fig. 1). — Treated as ordered.
- 35 Male coxa IV, retro-lateral projection: **(0)** absent; **(1)** tubercle like, height comparable to width; **(2)** robust, much higher than wider (Fig. 9D). — Treated as ordered.
- 36 Male coxa IV, retro-lateral robust projection, number of branches: **(0)** only one (Fig. 9D); **(1)** two, bifid (Pinto-da-Rocha and Bragagnolo 2010: fig. 5).
- 37 Male trochanter IV, shape in dorsal view: **(0)** as long as wide (DaSilva and Gnaspini 2010: fig. 79); **(1)** longer than wide (Fig. 10).
- 38 Male trochanter IV, prolateral central apophysis: **(0)** absent (Mendes 2011: fig. 8a–d); **(1)** present (Fig. 10A).
- 39 Male trochanter IV, proapical projection: **(0)** absent; **(1)** tubercle (Fig. 10B, C); **(2)** apophysis (Fig. 4A, B). — Treated as ordered.
- 40 Male trochanter IV, proapical apophysis, size: **(0)** short, ≤ 1/2 the trochanter length (Mendes 2011: fig. 8a–d); **(1)** long, > 1/2 the trochanter length (Fig. 4A, B).
- 41 Male trochanter IV, retro-lateral central conical apophysis: **(0)** absent; **(1)** present (Fig. 10A).
- 42 Male trochanter IV, retro-apical projection: **(0)** absent (Hara and Pinto-da-Rocha 2010: fig. 26e, f); **(1)** tubercle; **(2)** apophysis (Figs 4A, 7A, 10A). — Treated as ordered.
- 43 Male femur IV and DS length comparison: **(0)** less or equal to DS; **(1)** slightly longer than DS; **(2)** at least 2 × longer than DS. — Treated as ordered.
- 44 Male femur IV, lateral curvature in relation to trochanter IV main axis: **(0)** straight, ca. straight angle; **(1)** slightly arched, ca. obtuse angle; **(2)** very arched, ca. acute angle. — Treated as ordered.

- 45 Male femur IV, retro-basal projection: **(0)** absent; **(1)** present.
- 46 Male femur IV, retro-basal projection, type: **(0)** conical tubercle, slightly larger than the ones covering the podomere surface; **(1)** large apophysis (Ázara & Ferreira 2018: fig. 28c).
- 47 Male femur IV, centro-dorsal projection: **(0)** absent; **(1)** present.
- 48 Male femur IV, centro-dorsal projection, curvature: **(0)** straight; **(1)** curved retrolaterally.
- 49 Male femur IV, medio-apical dorsal projection: **(0)** absent; **(1)** present.
- 50 Male femur IV, prodorsal apical distinct projection: **(0)** absent; **(1)** present.
- 51 Male femur IV, prodorsal apical distinct projection, shape: **(0)** slender spine with tapered apex (DaSilva and Gnaspini 2010: fig. 81); **(1)** spine with rounded apex (Figs 7B, 10B).
- 52 Male femur IV, retro-dorsal apical distinct projection: **(0)** absent; **(1)** present.
- 53 Male femur IV, ventro-apical distinct projections, type: **(0)** tubercles; **(1)** spines (Figs 4C, 7C, 10C); **(2)** apophyses. — Treated as ordered.
- 54 Male patella IV, dorsal face ornamentation: **(0)** a pair of paralateral apical spines (Hara and Pinto-da-Rocha 2008: fig. 4); **(1)** rounded tubercles (Bragagnolo and Pinto-da-Rocha 2009: fig. 3a, b); **(2)** with high spines (Fig. 4B, D).
- 55 Male patella IV, ventral face ornamentation: **(0)** granule-like projections (Pinto-da-Rocha and Bragagnolo 2010: fig. 13); **(1)** rounded tubercles (Bragagnolo and Pinto-da-Rocha 2009: fig. 3c); **(2)** with spines (Figs 4B, 10B); **(3)** with distinct retro-lateral apophysis.
- 56 Male tibia IV, retro-ventral row, type of integumentary ornamentation: **(0)** similar sized tubercles; **(1)** tubercles that increase in size posteriorly (Figs 7D, 10B, D); **(2)** similar sized spines.
- 57 Male tibia IV, ventro-apical armature: **(0)** tubercles; **(1)** spines; **(2)** apophyses. — Treated as ordered.
- 58 Male tarsal process on legs III–IV: **(0)** vestigial, setae-like (Pinto-da-Rocha 1997: fig. 593); **(1)** < 1/2 claw length; **(2)** almost claw length (Kury 1997: figs 27, 28).
- 59 Penis glans ventral process: **(0)** absent (Figs 5, 8, 11); **(1)** present (Pinto-da-Rocha et al. 2012: fig. 7). — Treated as ordered.
- 60 Penis glans, ventral process, stem: **(0)** absent (Kury and Villarreal 2015: fig. 13a–c); **(1)** present, slightly shorter than stylus (Pinto-da-Rocha et al. 2012: fig. 7); **(2)** present,  $\geq$  than stylus (Pinto-da-Rocha and Bragagnolo 2010: figs 28–30). — Treated as ordered.
- 61 Ventral process, apex shape: **(0)** as a triangle shaped tongue with fringes (Kury and Villarreal 2015: fig. 13a–c); **(1)** as a small fan (Pinto-da-Rocha and Bragagnolo 2010: figs 28–30); **(2)** as a wide flabellum (Pinto-da-Rocha et al. 2012: fig. 7). — Treated as ordered.
- 62 Dorsal process of glans: **(0)** present (Pinto-da-Rocha and Bragagnolo 2010: figs 28–30); **(1)** absent (Figs 5B, 8B, 11B).
- 63 Penis VP, apical margin, shape: **(0)** straight or roughly straight (Figs 5, 8, 11); **(1)** with shallow cleft (DaSilva and Gnaspini 2010: fig. 164); **(2)** with deep cleft (Pinto-da-Rocha et al. 2012: fig. 7a, b). — Treated as ordered.
- 64 Penis VP, basal lobes in dorsal view, shape: **(0)** indistinct from VP outline; **(1)** laterally projected, as long or slightly longer than distal part of VP (Pinto-da-Rocha and Bragagnolo 2010: fig. 28); **(2)** laterally projected, much longer than distal part of VP (Bragagnolo and Pinto-da-Rocha 2009: fig. 6a). — Treated as ordered.
- 65 Stylus apex, trichomes: **(0)** absent; **(1)** present.
- 66 Stylus apex, trichomes, density: **(0)** low, few sparse (Figs 5B, 8B, 11B); **(1)** high (Kury et al. 2018: fig. 11d).
- 67 Stylus apex, winglet like projections: **(0)** without those projections; **(1)** with a dorsal, single projection (Figs 5, 8, 11); **(2)** with paralateral projections (Bragagnolo and Pinto-da-Rocha 2009: fig. 6a–c).
- 68 Penis VP, MS A arrangement: **(0)** single row (Pinto-da-Rocha et al. 2012: fig. 7c); **(1)** clustered (Figs 5B, 8B, 11B).
- 69 Penis VP, MS C shape: **(0)** robust, not twisted (Figs 5, 11); **(1)** slender and twisted (Pinto-da-Rocha and Bragagnolo 2010: figs 28, 30).
- 70 Penis VP, MS C arrangement: **(0)** clustered and equally spaced (Figs 8A, 11A); **(1)** subequally spaced, distance between setae increasing basally; **(2)** apical setae clustered, most basal one far apart from the others (Bragagnolo and Pinto-da-Rocha 2009: fig. 6a). — Treated as ordered.
- 71 Penis VP, MS D quantity: **(0)** one pair; **(1)** two pairs.
- 72 Penis, podium position relative to MS insertion points: **(0)** placed basally, not reaching MS A/B (Kury 1997: figs 12, 13); **(1)** reaching middle of MS A set; **(2)** reaching top of most apical MS A pair (Pinto-da-Rocha et al. 2012: fig. 7a, c); **(3)** reaching MS D (Kury and Villarreal 2015: fig. 13a, b) — Treated as ordered.

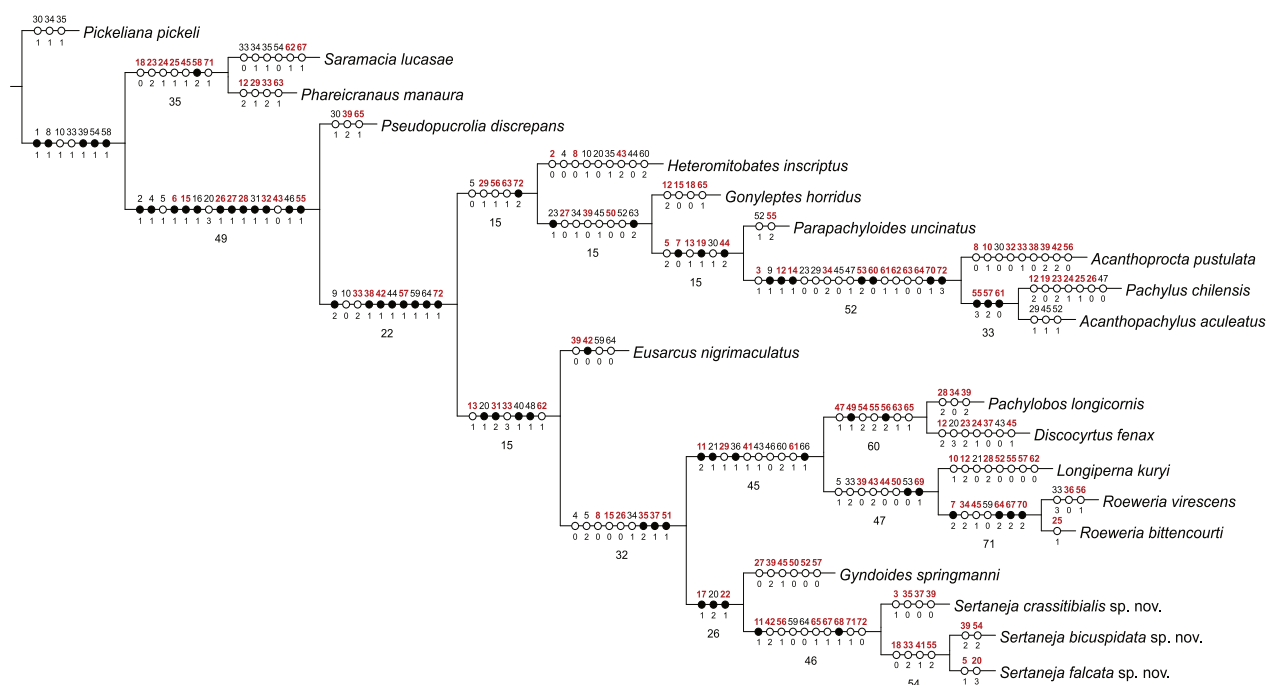
### 3.2. Cladistic analysis

The implied weighting analysis retrieved a single most parsimonious tree for each fit interval, but the most stable trees ( $L = 240$ ;  $CI = 0.43$ ;  $RI = 0.63$ ), according to the SPR distance and distortion coefficient similarity matrices, were found from the fifth to the eleventh intervals at  $K$  values of 2.496, 3, 3.659, 4.558, 5.857, 7.898 and 11.571, respectively (Table 2). The tree presented in Figure 1 is the single topology retrieved in this range.

All three new species were recovered as a monophyletic group closely related to *G. springmanni*. The clade *G. springmanni*+ is supported by three exclusive synapomorphies: (i) scute area I with a pair of slightly prominent tubercles placed near the median groove [17(1)]; (ii) scute area III bearing a pair of paramedian spines curved posteriorly [20(2)]; and (iii) scute area IV with a pair of paramedian tubercles slightly more prominent than the

**Table 2.** Summary of the results from the Mirande (2009) script search. DC (distortion coefficient) and SPR distance columns indicate the mean values of each fit interval (kx) in relation to the others; intervals with higher mean values are highlighted in bold and represent the most stable topology.

	<i>K</i>	Steps	N° of trees	Fit	DC	SPR
k1	1.286	244	1	36.005	0.871427	0.80586
k2	1.509	242	1	33.800	0.963156	0.93531
k3	1.776	242	1	31.523	0.963156	0.93531
k4	2.098	242	1	29.174	0.963156	0.93531
<b>k5</b>	<b>2.496</b>	<b>240</b>	<b>1</b>	<b>26.737</b>	<b>0.980001</b>	<b>0.96471</b>
<b>k6</b>	<b>3.000</b>	<b>240</b>	<b>1</b>	<b>24.192</b>	<b>0.980001</b>	<b>0.96471</b>
<b>k7</b>	<b>3.659</b>	<b>240</b>	<b>1</b>	<b>21.537</b>	<b>0.980001</b>	<b>0.96471</b>
<b>k8</b>	<b>4.558</b>	<b>240</b>	<b>1</b>	<b>18.757</b>	<b>0.980001</b>	<b>0.96471</b>
<b>k9</b>	<b>5.857</b>	<b>240</b>	<b>1</b>	<b>15.830</b>	<b>0.980001</b>	<b>0.96471</b>
<b>k10</b>	<b>7.898</b>	<b>240</b>	<b>1</b>	<b>12.732</b>	<b>0.980001</b>	<b>0.96471</b>
<b>k11</b>	<b>11.571</b>	<b>240</b>	<b>1</b>	<b>9.432</b>	<b>0.980001</b>	<b>0.96471</b>



**Figure 1.** Most parsimonious and stable tree topology retrieved under implied weighting through Mirande (2009) search script, representing the *Sertaneja* gen. nov. new species relationship among some representatives of the Gonyleptidae family ( $L = 240$ ;  $CI = 0.43$ ;  $RI = 0.63$ ). The dark circles on stems represent unique synapomorphies, the white ones homoplasies. Each circle is labeled by its character number (above) and character state (below). The highlighted character numbers in red are unambiguous. Numbers below the branches represent relative Bremer support, calculated for  $K = 11.571$  under implied weighting. The characters are optimized in ACCTRAN.

surrounding ones [22(1)]. Despite the new genus being sister taxa to *G. springmanni*, the former's penial structure differs considerably, being characterized by a rectangular VP, particular macrosetae disposition, stylus morphology, and the absence of a ventral process of the glans. The *G. springmanni*+ clade, in turn, is a sister group to representatives that could be related to that which Carvalho and Kury (2018) defined as DRMN (Fig. 2).

The new genus is supported by 10 synapomorphies of which two are exclusive: (i) external row of tubercles on the DS lateral margin slightly increasing in size posteriorly [11(1)], and (ii) MS A in a clustered arrangement

[68(1)] (Fig. 1). Moreover, the non-exclusive synapomorphies that commonly supported *Sertaneja* gen. nov. are: (i) the presence of a retro-apical apophysis on male trochanter IV [42(2)], (ii) male tibia IV with a retro-ventral row of tubercles increasing in size posteriorly [56(1)], (iii) penis glans without ventral process [59(0)], (iv) basal lobes of the penis VP indistinct in the dorsal view [64(0)], (v) penis stylus apex with trichomes [65(1)], (vi) stylus apex with a distinct dorsal, single projection [67(1)], (vii) penis VP with two pairs of MS D [71(1)], (viii) and penis podium placed very basally, not reaching MSA/B group [72(0)].

### 3.3. Taxonomy

Gonyleptidae Sundevall, 1833

Pachylinae Sørensen, 1884

#### 3.3.1. *Sertaneja* gen. nov.

Figs 3–11

<http://zoobank.org/E8C17C0C-3C72-48A2-B38F-3CEC7307-8D51>

**Diagnosis.** *Sertaneja* gen. nov. resembles *Gyndoides* because of the ocularium armature (despite being variable in *Sertaneja*), four scute areas, a pair of paramedian spines on scute area II (except *S. falcata* sp. nov.) and unarmed free tergites. *Sertaneja* gen. nov. differs from *Gyndoides* Mello-Leitão, 1927a by: (i) the lateral margin of DS with an external row of tubercles slightly increasing in size posteriorly, (ii) presence of the mesal apical seta on the pedipalp femur (Figs 3F, 6F, 9F), (iii) male trochanter IV retro-apical projection as a straight apophysis instead of a tubercle (Figs 3D, 6D, 9D), (iv) the absence of a retro-basal apophysis on male femur IV, (v) male femur IV bearing a prodorsal apical distinguished apophysis, (vi) male tibia IV ventral face armed, (vii) glans without ventral process (Figs 5, 8, 11), (viii) stylus apex bearing distinct projections (Figs 5, 8, 11), (ix) VP of penis without prominent ventral lobes (Figs 5, 8, 11), and, (x) 4 pairs of MS A clustered instead of lined up in a row (Figs 5, 8, 11). It differs from other Pachylinae genera by the combination of the sub-rectangular VP, 2 paralateral pairs of MS D, glans stylus bearing a dorso-apical longitudinal projection and lack of ventral process of the glans.

**Description.** DS gamma ( $\gamma$ ) to alpha ( $\alpha$ ) shaped (Figs 3A, B, 6A, B, 9A, B). Ocularium height at least two to up to three times the size the eye diameter, with posterior face tuberculate, and slightly close to the anterior margin

of DS, in lateral view (Figs 3C, 6C, 9C); bearing a pair of divergent large spines (Figs 3G, 9G), or a single central robust one (Fig. 6G). Four scute areas; scute areas I, II and IV with one to two pairs of slightly enlarged paramedian tubercles; scute area III with a pair of distinct paramedian elevations, ranging from acuminate tubercles (Fig. 9A, C) to large posteriorly curved spines (Figs 3A, C, 6A, C). Chelicerae segment I posterior face covered with acuminate tubercles. Pedipalp femora with a mesal sub-apical setiferous tubercle. Coxa IV well developed, bearing dense and high tuberculation, with robust prodorsal apical apophysis. Trochanter III with a retro-ventral apical conical tubercle. Trochanter IV with a straight retro-apical conical apophysis (Figs 4A, C, D, 7A, C, D, 10A, C, D), and a short probasal apophysis. Penis VP sub-rectangular (Figs 5A, 8A, 11A); glans without dorsal or ventral processes (Figs 5B, 8B, 11B), stylus with a dorso-apical projection slightly curved posteriorly, ventral face with sub-apical transversal row of trichome-like projections. MS A group generally composed of four to five pairs of paralateral setae, at instances showing asymmetry between the sides (Fig. 8A). MS C composed by three (Figs 5, 8) or five pairs of setae (Fig. 12) inserted laterally on the apical third of the VP. MS D as two pairs of paralateral setae, inserted more dorsally on the VP, between de MS A and C sets. MS E as a pair of paralateral small setae, inserted ventrally near the MS C and D groups. Ventral surface of VP sparsely covered by microsetae.

**Included species.** *S. bicupidata* sp. nov., *S. crassitibialis* sp. nov., and *S. falcata* sp. nov.

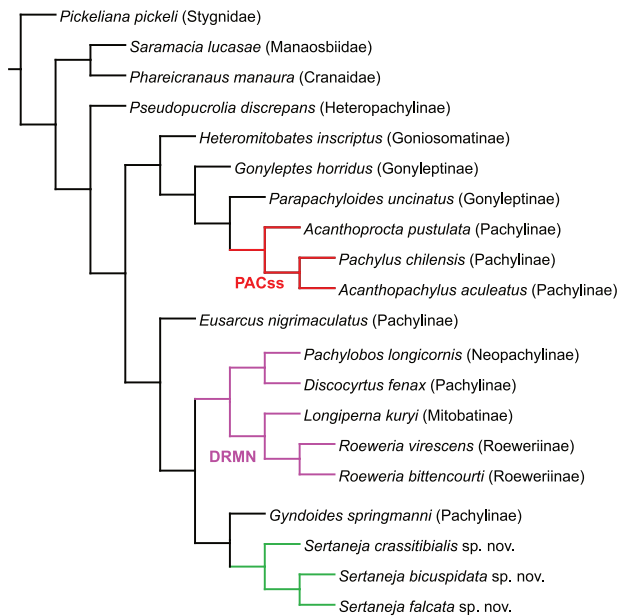
**Type species.** *S. bicupidata* sp. nov.

**Etymology.** ‘Sertaneja’ is a Brazilian adjective (fem.) that refers to a woman who lives in the Sertão regions in rural communities often in harsh survival conditions. Sertão is the largest sub-region of Brazilian Northeast characterized by dry climates and Caatinga vegetation.

#### 3.3.2. Key to species of *Sertaneja* gen. nov.

- 1 Ocularium with a single robust apical spine (Fig. 6G); trochanter IV square-shaped (Fig. 6D); tibia IV swollen in males (Fig. 7); most penis macrosetae spatulate, with basal MS D closer to MS A set, and MS B inserted basally near the podium (Fig. 8).....*S. crassitibialis* sp. nov.
- 1' Ocularium with a pair of apical spines (Figs 3G, 9G); trochanter IV elongated (Figs 3D, 9D); legs IV bearing strong armature (Figs 4, 10); tibia IV not swollen in males (Figs 4, 10); penis macrosetae conical, basal MS D pair closer to MS C, MS B adjacent to MS A set (Figs 5, 11).....2
- 2 Body surface densely tuberculate (Fig. 3A); scute area III with a paramedian pair of spines (Figs 3A, C); coxa IV with a bifid prodorsal apical apophysis, and a conical retro-apical apophysis (Fig. 3A, D); trochanter IV with much developed retro- and proapical apophyses (Fig. 4); penis with three pairs of MS C (Fig. 5). .....*S. bicupidata* sp. nov.
- 2' Body surface sparsely tuberculate (Fig. 9A); scute area III with a paramedian pair of rounded tubercles (Fig. 9A, C); coxa IV with a simple prodorsal apical apophysis, and a developed, internally curved retro-apical apophysis (Fig. 9A, D); trochanter IV retro-apical apophysis small, proapical one absent (Fig. 10); penis with five pairs of MS C (Fig. 11). .....*S. falcata* sp. nov.





**Figure 2.** Most parsimonious and stable tree topology retrieved under implied weighting (see Fig. 1), highlighting the main groups. — **Abbreviations:** PACss (red) = Pachylinae s.s.; DRMN (magenta) = monophyletic group first defined by Carvalho and Kury (2018).

### 3.3.3. *Sertaneja bicuspidata* sp. nov.

Figs 3–5, 12B, 13

<http://zoobank.org/4C09C7B0-0FF4-4ED4-9BCD-78FC1E8B-9A31>

**Type locality.** BRAZIL, Ceará: Ubajara, Parque Nacional de Ubajara.

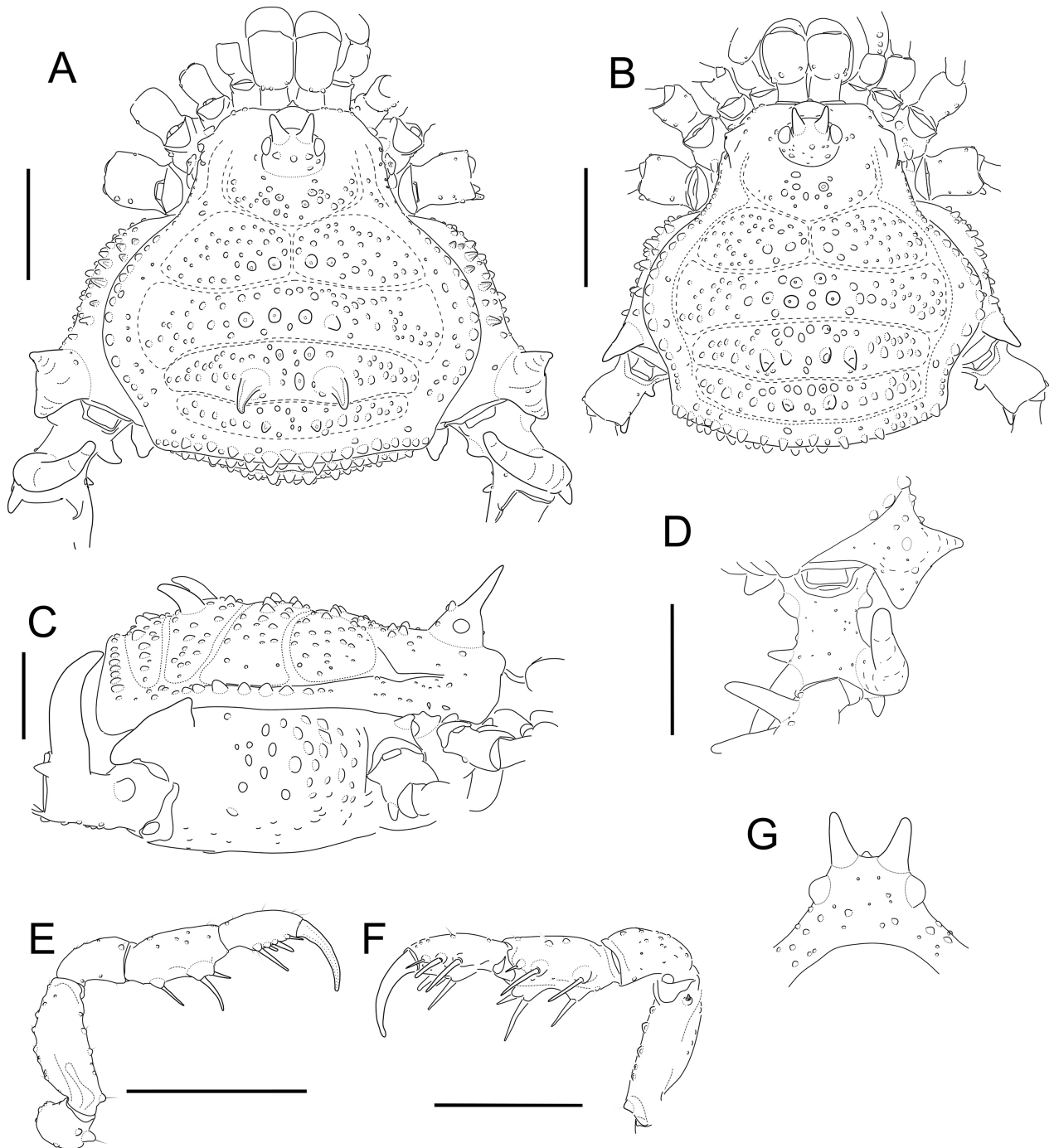
**Type material.** **Holotype.** BRAZIL. Ceará: Ubajara PARNA de Ubajara, Rio Gameleira, elev. 840 m, 27.i.2014, DaSilva M.B. Saraiva N.E.V. and Sampaio C., ♂ (UFPB OP-163) [dissected]. **Paratypes.** BRAZIL. Ceará: Quixadá, Serra do Estevão, estrada para Dom Mauricio, elev. 482 m, 18.iv.2014, DaSilva M.B. and Saraiva N.E.V., 1 ♂ (UFPB OP-724) [dissected]; Quixadá, Serra do Urucu, Santuário de Nossa Senhora Imaculada Rainha do Sertão, elev. 344 m, 19.iv.2014, DaSilva M.B. and Saraiva N.E.V., 1 ♂ 2 imm (MZUSP 76645) [male genitalia used for SEM], 1 ♂ (MNRJ 60616) [dissected]; Quixadá, Jardim dos Monólitos, inselbergs do Açude Euclides, elev. 180–200 m, 20.iv.2014, DaSilva M.B. and Saraiva N.E.V., 1 ♀ (UFPB OP-726) [female description].

**Diagnosis.** This species can be distinguished from the other species of the genus by the denser tuberculation of the body surface (Fig. 3A); scute area III paramedian pair of spines enlarged and slightly more robust when compared to *S. crassitibialis* sp. nov. (Fig. 3A, C); coxa IV with uniquely shaped bifid prodorsal apical apophysis and conical retro-apical apophysis (Fig. 3A, D); trochanter IV with the largest retro-apical apophysis among the genus, and a large proapical apophysis curved dorsally (Figs 3D, 4); femur IV with a retro-lateral row of large conical apophyses (Fig. 4A, D). It most resembles *S. fal-*

*cata* sp. nov. by the male femur IV dorsal row with equally sized high tubercles; penis glans' stylus straight and with a rounded dorso-apical projection; VP macrosetae conical, MS A and MS B sets adjacent, and MS D pairs closer to each other and to MS C set (Fig. 5).

**Description.** **Holotype MALE** (UFPB OP-163; Figs 3–4); **Measurements:** DSL: 4.86; DSW: 4.97; LI: 9.13; LII: 17.62; LIII: 10.78 (broken metatarsus); LIV: 15.48.

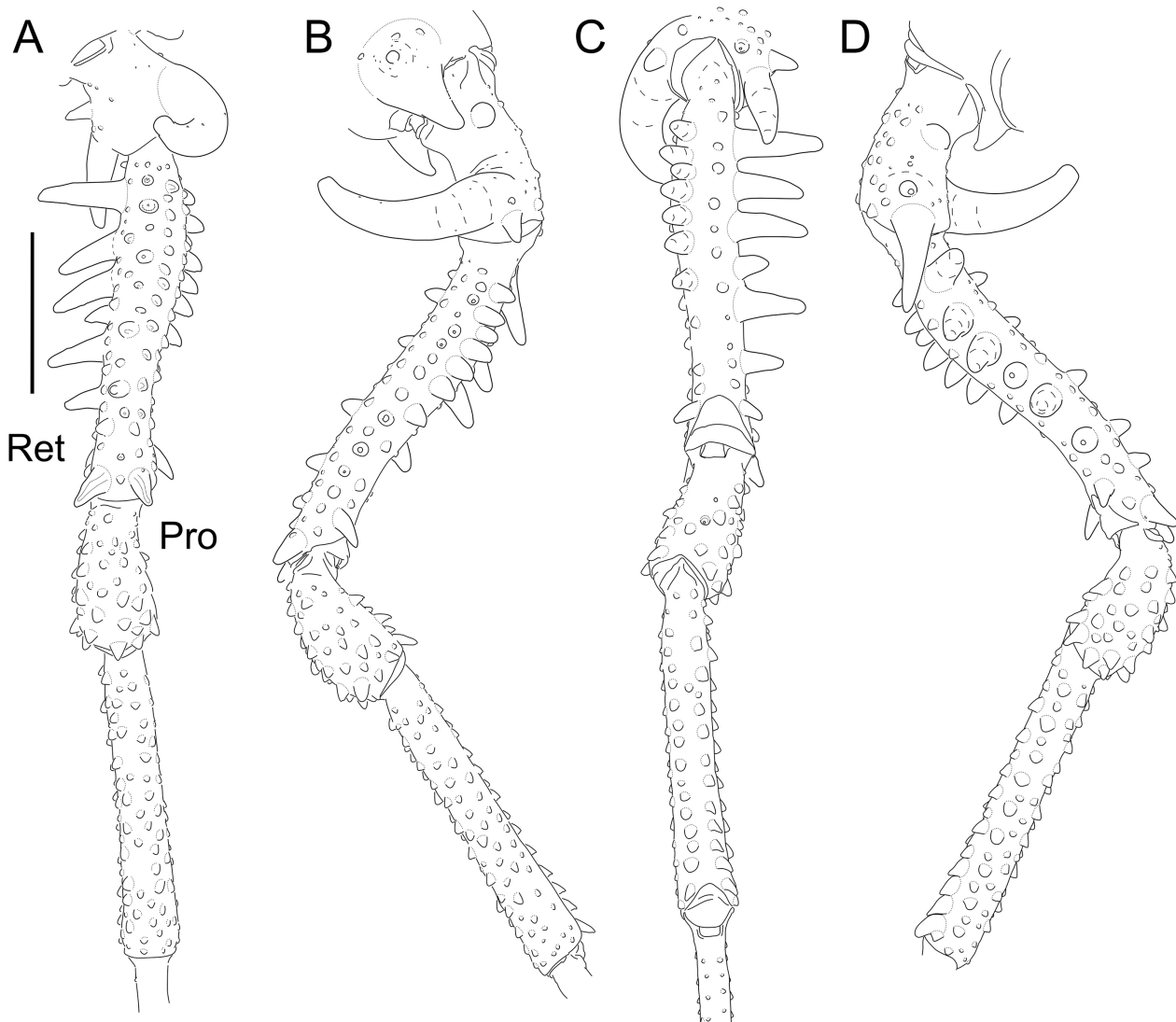
**Dorsum** (Fig. 3A, C, G): DS anterior margin with a pair of small tubercles on each side. Prosoma covered with distinctive large tubercles concentrated on the middle of posterior half. Ocularium tuberculate, with a pair of spines slightly longer than the ocularium height, and a pair of large tubercles just behind (Fig. 3C). Two pairs of ozopores of similar size, anterior one placed more laterally, and posterior one more rounded and slightly dislocated dorsally; lateral channel well developed followed by distinguished tuberculate oblong sensorial pegs. Scute areas I–IV densely tuberculate, tubercles increasing in size medially. Scute area III paramedian pair of spines recurved, slightly reaching scute area IV. Lateral margin of DS with an external row of tubercles increasing in size towards scute area II, becoming slightly acuminate (Fig. 3C). Posterior margin of DS and free tergites I–III each with a transversal row of tubercles. Free tergite I with tubercles increasing in size medially. Anal operculum tuberculate. **Venter:** Coxa I with three longitudinal rows of tubercles increasing in size apically, median row largest; coxae II–III with slightly enlarged apical tubercles; coxa IV tuberculate. **Chelicerae:** Segment I with a transversal row of five tubercles on the posterior face of bulla. Fixed and movable fingers with five and four teeth, respectively. **Pedipalps** (Fig. 3E, F): Trochanter inflated dorsally, ventral face with a pair of setiferous tubercles, mesal largest (Fig. 3E). Femur with a dorsal median row of five tubercles, ventral face with a basal large setiferous tubercle (Fig. 3E, F); an external lateral row of five tubercles. Tibial setation: mesal and lateral Ili/Iii. Tarsal setation: mesal Ili, lateral Ilii. **Legs** (Figs 3D, 4): Coxae I–IV each with one prodorsal and one retro-dorsal apophysis; coxa II with a trifid retro-lateral apophysis. Coxa IV bearing a robust, bifid, prodorsal apical apophysis, almost square-shaped, the large branch pointing backwards and the smaller one almost transversal, obliquely angled (Fig. 3D); and a conical retro-lateral apophysis, comparable in size and shape with the small, transversal branch of the prolateral one (Fig. 3D). Trochanter IV apically swollen in dorsal view, prolateral surface with a short, blunt, conical, basal apophysis, and a large, apical apophysis, perpendicular in lateral view, dorsally curved along its entire length, bearing a basal small acute straight apophysis pointing posteriorly (Fig. 4B); retro-lateral face with a basal short conical apophysis (ca. same size as the coxa IV retro-lateral apophysis), a sub-apical small, straight, transversal conical apophysis, and a long, straight apical apophysis 2/3 the length as the podomere (Fig. 4). Femur III slightly curved in dorsal view, with a paralateral pair of dorso-apical tubercles (retro-dorsal largest); ventral surface with two rows of tubercles increasing in size api-



**Figure 3.** *Sertaneja bicuspidata* sp. nov. (A, C–G) Male holotype (UFPB OP-163), A: habitus, dorsal view; C: same, right lateral view; D: right coxa and trochanter IV in dorsal view; E: right pedipalp lateral view; F: same, mesal view; G: ocularium frontal view. (B) Female paratype (UFPB OP-726) habitus, dorsal view. Scale bars: 1 mm.

cally from their apical half, prolateral ones larger. Femur IV slightly curved inwards and upwards; dorsal surface with a median row of five enlarged, blunt, conical tubercles placed between the sub-basal and sub-apical regions of the podomere (Fig. 4B); dorso-apical surface with two paralateral large spines; prolateral row of low rounded tubercles; retro-lateral row of seven high apophyses roughly decreasing in size apically, the large basal ones approximately the same size as the trochanter IV retro-apical apophysis (Fig. 4A); two ventral rows of tubercles, pro-ventral row with seven enlarged, blunt, conical tubercles on the basal half, retro-ventral row of small rounded

tubercles (Fig. 4C); ventro-apical surface with a pair of paralateral enlarged acuminate tubercles, ca. three times the size of the immediately following tubercles (prolateral largest). Patella IV covered with conical tubercles that increase in size apically, ventral face with two rows of tubercles increasing in size apically, retro-lateral ones larger. Tibia IV covered by conical tubercles, ventral row of tubercles slightly increasing in size apically (Fig. 4B, D). Tarsal counts: 6, 10, 6, 6. **Penis** (UFPB OP-725; Fig. 5): Glans stylus cylindrical. VP apex convex with a slight median concavity, lateral margins slightly concave presenting a subtle constriction on its medial portion. VP



**Figure 4.** *Sertaneja bicuspidata* sp. nov. Male holotype (UFPB OP-163) right trochanter–tibia IV. **A:** dorsal view; **B:** prolateral view; **C:** ventral view; **D:** retro-lateral view. — **Abbreviations:** Pro = prolateral; Ret = retro-lateral. Scale bars: 1 mm.

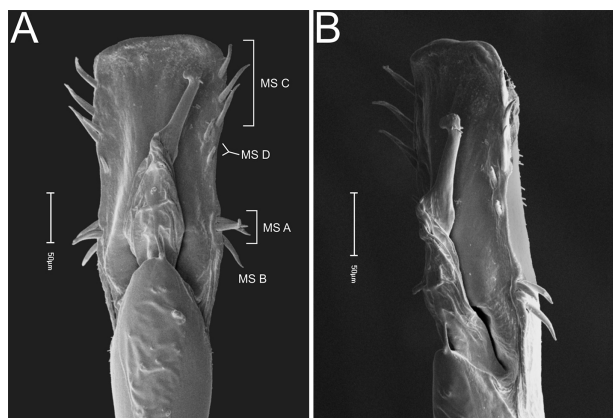
bearing three paralateral pairs of MS A in a tight cluster in lateral view (Fig. 5B); one pair of MS B of same size as MS A, placed more basally and adjacent to the MS A cluster; three pairs of MS C, the apical spine slightly smaller; MS D set closer to MS C group, setae close to each other; and two pairs of reduced, sub-apical, ventro-lateral MS E positioned between the MS C setae (not visible in the SEM photograph, but confirmed in the other dissected males). **Coloration:** DS, tergites I–III, chelicerae, pedipalps coxae, coxae I–IV, and leg IV general coloration strong yellowish brown (74). DS with posterior and lateral margins bearing a moderate yellowish brown (77) outline; scute areas, prosoma and ocularium with moderate yellowish brown (77) granulation. Pedipalps trochanter–tibia, and legs I–III dark yellow (88).

**FEMALE** (UFPB OP-726; Fig. 3B): **Measurements:** DSL: 4.34; DSW: 4.20; LI: 8.32; LII: 15.48; LIII: 10.77; LIV: 14.27. **Dorsum:** DS gamma ( $\gamma$ ), but coda section is slightly longer. Ocularium spines length as tall as the ocularium. Scute area III central armature shorter than male and more acuminate. Scute area IV with median pair of tubercles more conspicuous than male. Posterior

margin of DS and free tergites I–III each with leaner tubercles on the sides. **Legs:** Coxa IV narrower and shorter than in male, with a short, conical, proapical apophysis obliquely inserted; retro-apical apophysis reduced. Trochanter III retro-apical projection smaller than in male. Trochanter IV shorter than in male, apical half swollen, bearing a terminal tubercle, with unarmed prolateral face; retro-lateral face with short basal apophysis, and blunt apical apophysis smaller than in male. Femur III ventral row and ventro-apical tubercles smaller than in male. Femur IV dorso-medial row with small and slender projections on basal 4/5; a retro-lateral, a proventral and a retro-ventral rows of small conical tubercles; dorso-apical and ventro-apical paralateral projections reduced. Tibia III proventral and retro-ventral rows of small granule-like tubercles. Patella–tibia IV dorsal face covered by conical blunt tubercles. Tarsal count: 6, 9–10, 6, 6.

**Variation. Males** (n = 4): **Measurements:** DSL: 4.33–4.86; DSW: 4.47–4.97; LI: 8.52–9.13; LII: 15.60–17.62; LIII: 10.78–12.30; LIV: 14.25–15.83. **Dorsum:** Ocularium spines as tall as, or slightly taller than the oculari-





**Figure 5.** *Sertaneja bicuspidata* sp. nov. (UFPB OP-725), apical portion of penis. **A:** dorsal view; **B:** right lateral view.

um. Scute area III paramedian pair of spines medium to large, length reaching backwards up to halfway of scute area IV. **Pedipalps:** Pedipalpal setation: tibial mesal IiIi, lateral IiIi/i-Ii; tarsal mesal III/IIi, lateral IiIi/Iii. **Legs:** Minor males, compared to major males as the holotype, with less developed armature on scute area III and weaker armature of legs: coxa IV narrower and shorter, prodorsal apical and retro-apical apophyses smaller and slender (on major males prodorsal apical apophysis shorter projection can be acuminate); trochanter III retro-lateral projection reduced; trochanter IV all apophyses smaller; femur III prolateral and ventral rows of tubercles less developed, with smaller proapical tubercles; femur IV pro- and ventro-apical tubercles smaller; tibia IV proventral and retro-ventral rows reduced. Tarsal count: 6, 9–10, 6, 6.

**Etymology.** ‘Bicuspidata’ is a Latin adjective (adj. perf. part., nom. fem.) that refers to the diagnostic bifid apophysis of male coxa IV in this species.

**Distribution (Fig. 13).** Caatinga shrublands and dry forests of northern interior Ceará and Brejos de Altitude humid montane forests of Ibiapaba mountains.

### 3.3.4. *Sertaneja crassitibialis* sp. nov.

Figs 6–8, 12A, 13

<http://zoobank.org/EA58E870-AE35-4802-AB14-665CE6AC-DB39>

**Type locality.** BRAZIL, Ceará: Quixadá, Serra do Urucu, Santuário Nossa Senhora Imaculada Rainha do Sertão.

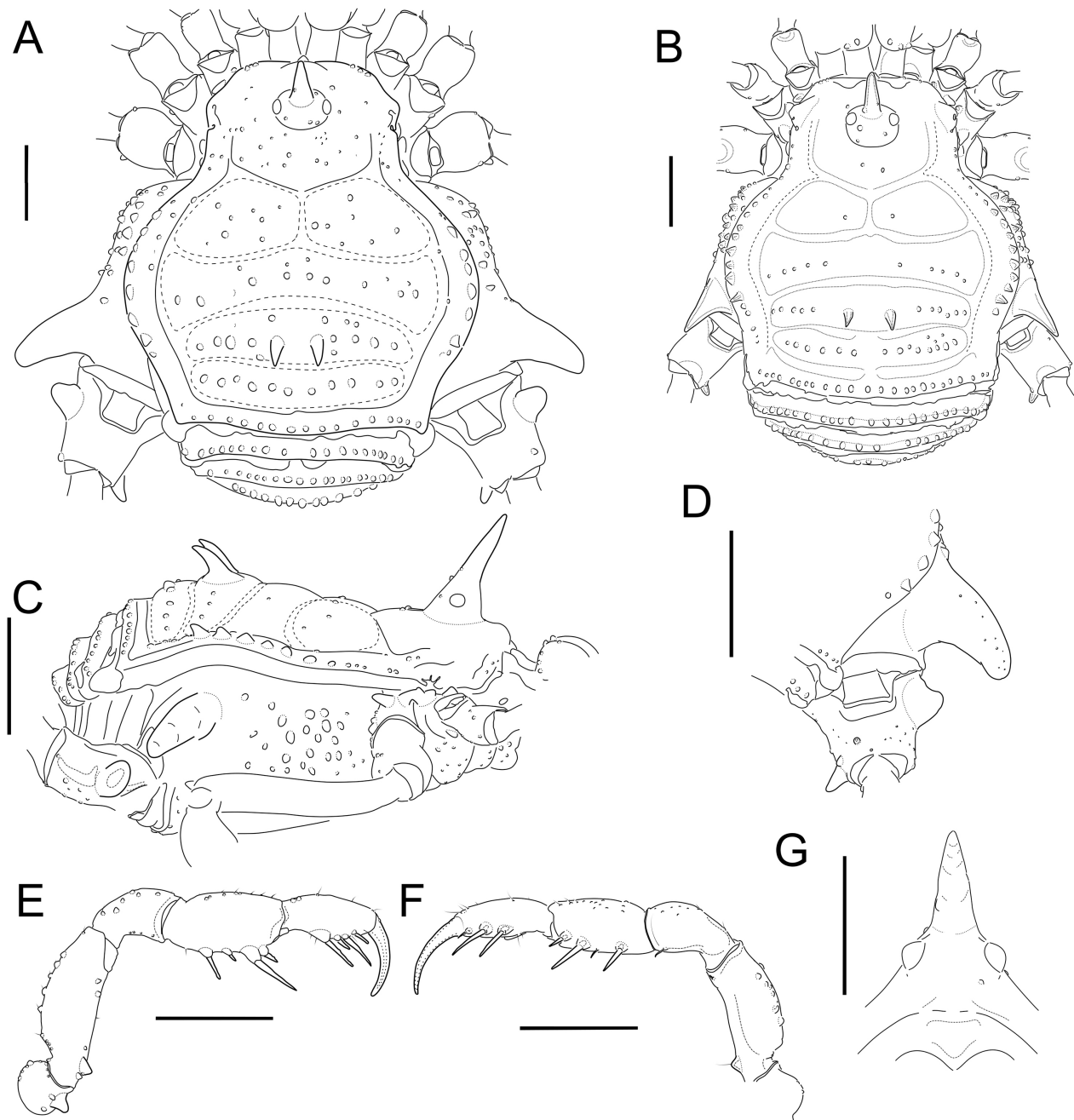
**Type material. Holotype.** BRAZIL, Ceará: Quixadá, Serra do Urucu, Santuário Nossa Senhora Imaculada Rainha do Sertão, elev. 344 m, 19.iv.2014, DaSilva M.B. and Saraiva N.E.V., ♂ (UFPB OP-487). **Paratypes.** BRAZIL, Ceará: Ubajara, PARNA de Ubajara, Brejo de Altitude, 700 m, 27.i.2014, DaSilva M.B., Saraiva N.E.V. and Sampaio C., 1 ♂ (MNRJ 60614) [genitalia used for SEM]; Ubajara, PARNA de Ubajara, Rio Gameleira, 840 m, 27.i.2014, DaSilva M.B.; Saraiva N.E.V. and Sampaio C., 2 ♀ (UFPB OP-480), 1 ♀ (UFPB OP-727) [female

description]; Ubajara, PARNA de Ubajara, Gr. Morcego Branco, Gr. Ubajara, Trilha Portão Planalto, 22.x.2011, DeSouza A.M., Araujo E.S., Carvalho L., 1 ♀ (MNRJ 60615); Ubajara, PARNA de Ubajara, Trilha da Samambaia, 30.iv.2018, Silvino A.C.S. and Saraiva N.E.V., 1 ♂ 1 ♀ 1 imm. (MZUSP 76646) [male dissected].

**Diagnosis.** Differs from the other species by the lower density of tubercles and armature (Fig. 6A); ocularium is the tallest in the genus and bears a robust, single spine (Fig. 6C); lateral margin of DS with a large acuminate tubercle on the external row, placed close to scute area III (Fig. 6C); scute area III paramedian pair of spines slender when compared to *S. bicuspidata* sp. nov. (Fig. 6C); coxa IV with an unbranched, robust prodorsal apical apophysis, missing a retro-apical apophysis (Fig. 6D); trochanter IV short, square-shaped with a robust, blunt central apophysis (Figs 6D, 7); femur IV less armed; tibia IV sexually dimorphic, swollen in males (Fig. 7); penis glans’ stylus with an angular dorso-apical projection (Fig. 8B); VP macrosetae spatulated, except for the basal MS D pair and MS E; MS B inserted very basally; and MS D pairs much apart from each other (Fig. 8).

**Description. Holotype MALE** (UFPB OP-487; Figs 6, 7): **Measurements:** DSL: 4.91; DSW: 4.67; LI: 9.35; LII: 16.17; LIII: 12.44; LIV: 16.14. **Dorsum** (Fig. 6A, C, G): Prosoma sparsely covered by small granule-like tubercles. Ocularium twice as tall as the eye diameter, with a robust, conical spine projected anteriorly, slightly larger than the ocularium (Fig. 6G). Two pair of ozopores placed on the lateral surface, both slit shaped; lateral channel well developed, conspicuous and with small sensorial pegs. Scute area II, III and IV with a central transversal row of tubercles (Fig. 6A). Scute area III paramedian pair of spines slightly curved posteriorly in all its extension, barely reaching scute area IV (Fig. 6A). Lateral margin of DS with an external row of tubercles increasing in size posteriorly, becoming acuminate, largest one placed near scute area III (Fig. 6C). Posterior margin of DS and free tergites I–III each with a row of similar sized round tubercles. Anal operculum tuberculate. **Venter:** Coxae I–IV with low tubercles; coxa I with median row of enlarged tubercles. Coxa IV covered by granule-like tubercles. **Chelicerae:** Segment I with the posterior portion of the bulla bearing a transversal row of four tubercles. Fixed and movable fingers each with five and five to six teeth, respectively. **Pedipalps** (Fig. 6E, F): Trochanter inflated dorsally; ventral face with two setiferous tubercles, mesal tubercle largest. Femur with a dorsal median row of six tubercles (Fig. 6E); ventral surface with a large basal setiferous tubercle and a retro-lateral row of three tubercles on apical half. Tibial setation: mesal and lateral IiIi. Tarsal setation: mesal IiI, lateral IiIi. **Legs** (Figs 6D, 7): Coxae I–III each with one prodorsal and 1 retro-dorsal apophysis; coxa II retro-dorsal apophysis trifid and fused in the apex with coxa III prodorsal one. Coxa IV large, tuberculate, bearing a robust, unbranched prodorsal apical apophysis, this almost transversally inserted, slightly curved downwards and posteriorly (Fig. 6A, C, D). Trochanter IV with a robust, slightly bifid, blunt cen-

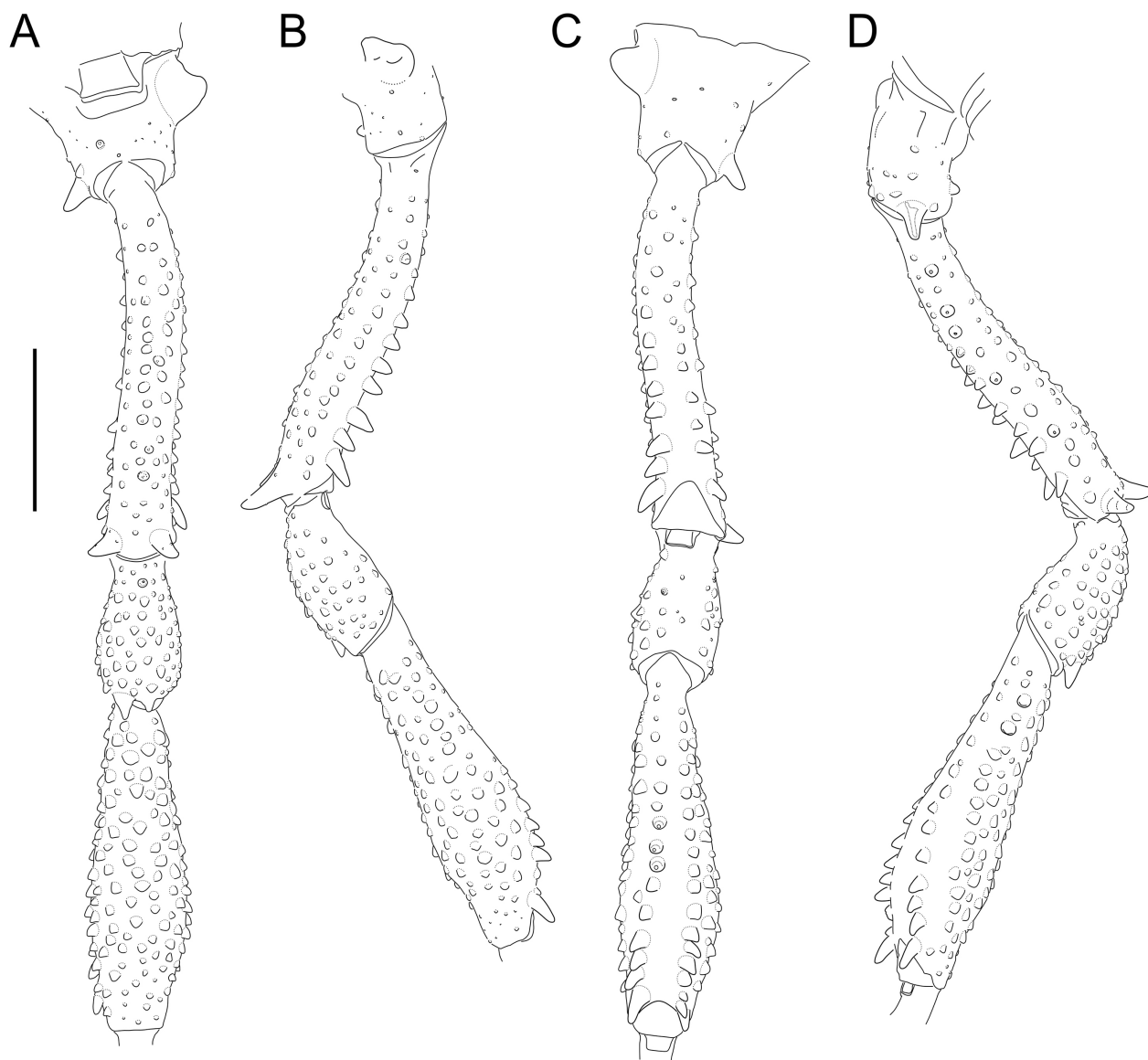




**Figure 6.** *Sertaneja crassitibialis* sp. nov. (A, C–G) Male holotype (UFPB OP-487), A: habitus, dorsal view; C: same, right lateral view; D: right coxa and trochanter IV in dorsal view; E: right pedipalp in lateral view; F: same, mesal view; G: ocularium frontal view. (B) Female paratype (UFPB OP-727) habitus, dorsal view. Scale bars: 1 mm.

tral apophysis, a prodorsal sub-apical enlarged tubercle, and an acuminate, straight retro-apical apophysis (Figs 6D, 7). Femur III with an enlarged retro-apical dorsal spine; ventral face with a pro- and retro-lateral rows of tubercles increasing in size apically on apical half. Tibia III sub-apical surface slightly swollen, with retro-ventral sub-apical row of enlarged tubercles. Femur IV slightly curved inwards and upwards; dorsal surface covered by small tubercles, with a pair of paralateral apical spines slightly curved upwards (prolateral spine largest) (Fig. 7A); lateral rows of tubercles slightly increasing in size apically, retro-lateral row largest; with pro and retro-ventral rows that increase in size apically, proventral row largest and with tubercles more close to each other (Fig.

7C); apically with a pair of paralateral spines, prolateral largest (Fig. 7C). Patella IV tuberculate, with a slightly swollen retro-dorsal apical spine (Fig. 7A). Tibia IV swollen at apical 3/4 of its length, with a proventral and retro-ventral row of enlarged sub-apical tubercles, and a pair of paralateral ventro-apical spines (Fig. 7B, C, D). Tarsal counts: 6, 8, 6, 6. **Penis** (UFPB OP-171; Fig. 8): VP apex slightly concave, lateral margin sub-straight. Proximal portion of VP with four pairs MS A and one pair MS B placed far from A4 and placed more basally. MS C set apically curved and showing asymmetry between left (3) and right (2) sides (Fig. 8A). MS D apical pair flattened and acuminate, basal spine conical and blunt; and two pairs of MS E placed more ventrally and close



**Figure 7.** *Sertaneja crassitibialis* sp. nov. Male holotype (UFPB OP-487) right trochanter–tibia IV. **A:** dorsal view; **B:** prolateral view; **C:** ventral view; **D:** retro-lateral view. Scale bars: 1 mm.

to MS C and MS D (Fig. 8B). **Coloration:** DS predominantly dark grayish yellowish brown (81) with scute areas limits, area III paramedian spines, and specks on prosoma dark orange yellow (72). Chelicerae, pedipalps, coxae I–III, and legs I–III dark yellow (88). Leg IV dark grayish yellowish brown (81).

**FEMALE** (UFPB OP-727; Fig. 6B): **Measurements:** DSL: 4.70; DSW: 4.26; LI: 8.88; LII: 15.36; LIII: 11.19; LIV: 14.81. **Dorsum:** Overall less developed armature and tubercles. DS alpha ( $\alpha$ ), coda slightly longer. Ocularium spine slender. Scute area III central armature small. Lateral margin of DS with external row of smaller tubercles than in male. **Legs:** Coxa IV narrower and shorter than in male, with an obliquely inserted, slender, conical, prodorsal apical apophysis, slightly curved downwards. Trochanter III retro-apical apophysis reduced. Trochanter IV narrower than in male, prolateral face unarmed, retro-lateral face as in male but with smaller apical apophysis. Femur III with ventral rows of small tubercles. Femur IV less armed, ventral rows of tubercles slightly

increasing in size apically, dorso- and ventro-apical pair of spines small. Patella IV prodorsal apical projection reduced. Tibiae III–IV unarmed, not inflated. Tarsal counts: 6, 7, 6, 6.

**Variation. Males** (n = 3): **Measurements:** DSL: 4.91–4.99; DSW: 4.67–4.90; LI: 8.98–10.08; LII: 15.31–16.17; LIII: 11.58–12.44; LIV: 16.14–16.34. **Dorsum:** Ocularium spine more, or less acute. DS lateral margin external row of rounded to acuminate tubercles, becoming almost spine-like. Scute area II with tubercles placed near the lateral margins. **Legs:** Tibia IV retro-ventral apical spine single or bifid. Tarsal counts: 6, 8–9, 6, 6. **Females** (n = 5): **Measurements:** DSL: 4.61–4.75; DSW: 4.20–4.55; LI: 8.56–9.45; LII: 13.93–15.97; LIII: 10.25–11.28; LIV: 14.80–15.52. **Pedipalps:** Pedipalp tibial setation: mesal IiIi/IIIi, lateral IiIi; tarsal setation: mesal Iii, lateral IiIi/Iiii. **Legs:** Femur IV proventral row of tubercles slightly enlarged or not. Patella IV with or without prodorsal apical projection. Tarsal counts: 5–6, 8–9, 6, 6.



**Figure 8.** *Sertaneja crassitibialis* sp. nov. (UFPB OP-171), apical portion of penis. **A:** dorsal view; **B:** right lateral view.

**Etymology.** ‘Crassi-’ is a Greek adjective, meaning thick, and ‘tibia’ is the Latin noun meaning the podomere; combined to ‘crassitibia’ (nom. sing. fem.) in reference to the diagnostic male tibia IV of the species.

**Distribution (Fig. 13).** Brejos de Altitude humid montane forests of Ibiapaba mountains and Caatinga shrublands and dry forests of northern interior Ceará.

### 3.3.5. *Sertaneja falcata* sp. nov.

Figs 9–11, 12C–E, 13

<http://zoobank.org/D2951940-FBC8-45DB-B91B-5B968A1-1B1B8>

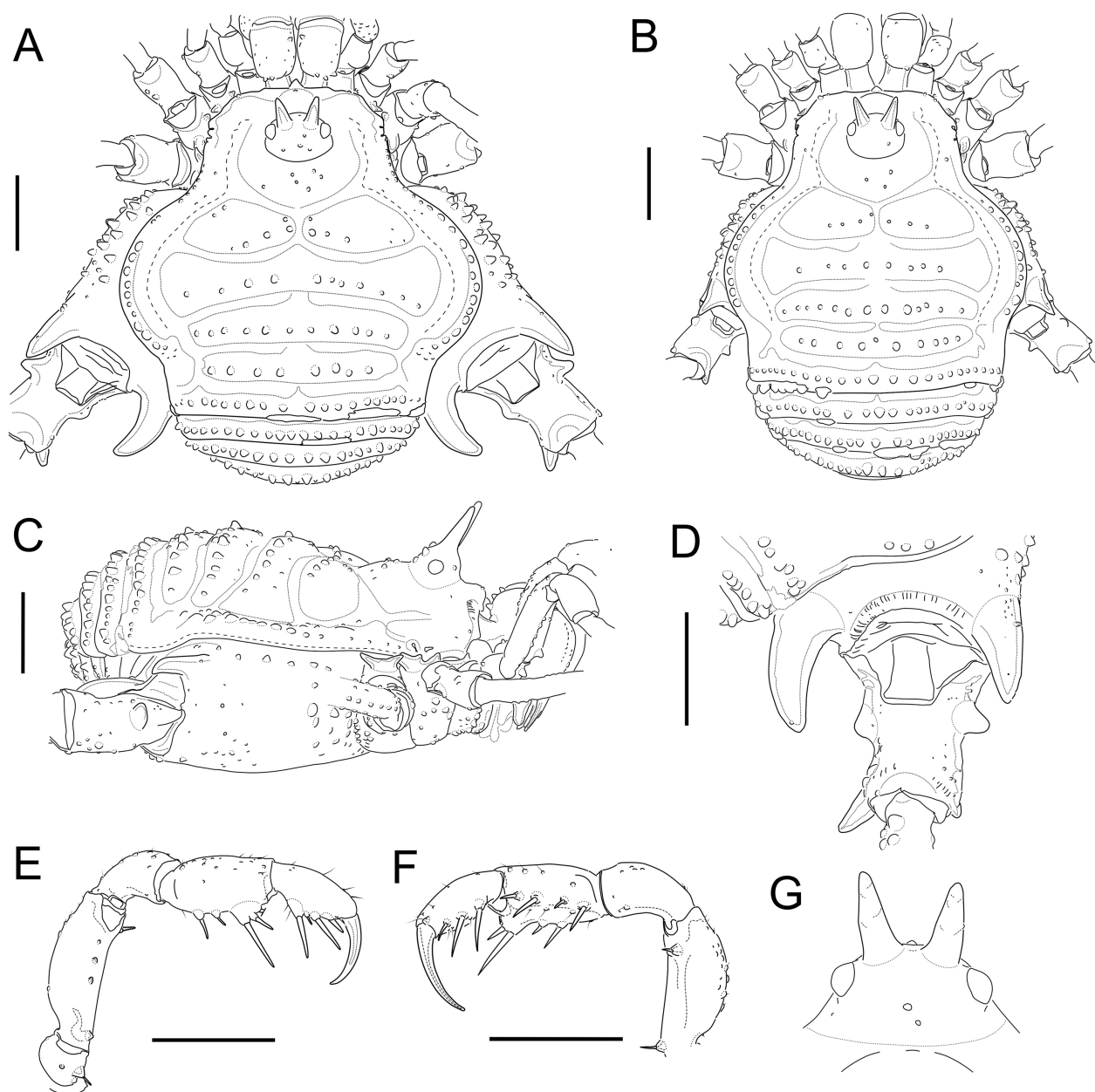
**Type locality.** BRAZIL, Rio Grande do Norte: Portalegre, Cachoeira do Pinga.

**Type material.** **Holotype.** BRAZIL. Rio Grande do Norte: Portalegre, Cachoeira do Pinga, encosta da serra, elev. 431 m, 23–24.iv.2014, Da-Silva M.B. and Saraiva N.E.V., ♂ (UFPB OP-481). **Paratypes.** same as for holotype, 3 ♂ (UFPB OP-482), 1 ♂ (UFPB OP-728) [dissected], 2 ♀ (UFPB OP-729) [female description], 1 ♂ (MZUSP 76647), 1 ♂ (MNRJ 60617).

**Diagnosis.** Distinguished from other species by the presence of a pair of slightly enlarged paramedian tubercles on scute area III (Fig. 9A, C), instead of spines; coxa IV bearing a short, conical, straight prodorsal apical apophysis and a long, curved, sickle-like retro-apical apophysis (Fig. 9D); femur IV retro-lateral face with three central elongated apophysis (Fig. 10A, D); and contains five pairs of MS C (Fig. 11). Most similar to *S. bicuspidata* sp. nov. by the slightly elongated trochanter IV; penis glans’ stylus with a rounded dorso-apical projection; similar MS A and MS B; and MS D pairs close MS C group.

**Description.** **Holotype MALE** (UFPB OP-481; Figs 9, 10): **Measurements:** DSL: 4.43; DSW: 4.87; LI: 8.91; LII: 19.48; LIII: 12.24; LIV: 16.53. **Dorsum** (Fig. 9A, C, G): Prosoma with few tubercles. Front margin bearing a

single small median tubercle. Ocularium twice as tall as the eye diameter, with a pair of divergent spines slightly projected anteriorly (Fig. 9C, G). Two pairs of ozopores of similar size, anterior one placed laterally, and posterior one rounded and more dorsal; lateral channel developed and followed by oblong sensorial pegs that increase in size posteriorly. Scute area I with tubercles placed in a row along the longitudinal groove and scute groove II, with a pair of slightly enlarged paramedian tubercles (Fig. 9A). Scute areas II–IV each with a transversal central row of enlarged tubercles increasing in size towards the middle, paramedian pair larger than the others. Scute areas III–IV with more conical tubercles compared to those on other areas. Lateral margin of DS with an external row of low, rounded tubercles slightly increasing in size posteriorly. Posterior margin of DS and free tergites I–III each with a row of conical tubercles. Anal operculum tuberculate. **Venter:** Coxa I tuberculate, median row of large ones, apical face with two prolateral and two retro-lateral tubercles. Coxae II–III with small tubercles, pro- and retro-apical tubercles reduced. Coxa IV tuberculate. **Chelicerae:** Segment I with ectodorsal row of three tubercles on posterior face of bulla. Fixed and movable fingers with five and three teeth, respectively. **Pedipalps** (Fig. 9E, F): Trochanter inflated dorsally, ventral face with two setiferous tubercles, mesal largest. Femur with a basal setiferous tubercle, an external lateral row of 2–3 smaller setiferous tubercles on the middle 1/3 (Fig. 9E), and a mesal apical seta. Tibial setation: mesal Ilii, lateral Ilii. Tarsal setation: mesal Ili, lateral Ili/Iii. **Legs** (Figs 9D, 10): Coxae I–III each with one prodorsal and one retro-dorsal apophysis; coxa II retro-dorsal apophysis trifid and fused at the apex with coxa III prodorsal apophysis. Coxa IV large, covered by more acuminate tubercles than those of the rest of the body (Fig. 9A); with an obliquely inserted, conical prodorsal apical apophysis that is slightly curved downwards (Fig. 9C, D); and a sickle-shaped retro-apical apophysis, twice the size of proapical apophysis, curved out and downwards (Figs 9D, 10D). Trochanter III with a reduced retro-apical projection. Trochanter IV long, with pro- and a retro-lateral central blunt apophyses, the prolateral one slightly acuminate (Fig. 10A); apical portion with a long, conical retro-apical apophysis and a small proapical round tubercle (Fig. 10). Femur III slightly curved retrolaterally in dorsal view, with a slightly acuminate retro-apical dorsal tubercle; ventral surface with two rows of tubercles increasing in size subapically, prolateral row larger. Femur IV slightly curved inwards at the base, medio-dorsal row of tubercles twice the height of those covering the podomere, almost on the entire femur (except the sub-apical surface), basal and sub-apical tubercles more conspicuous (Fig. 10A, B, D); a pair of long, curved dorso-apical paralateral spines, retro-lateral spine largest and strongly curved upwards (Fig. 10A, D); retro-lateral face with three long, conical, central apophyses (Fig. 10A, D); ventral surface with a prolateral row of large tubercles alternating with small ones on apical half, and a retro-lateral row with round tubercles (Fig. 10B, C); ventro-apical portion with two paralateral large straight spiniform apophyses, proapical largest (Fig. 10C). Patella IV tuberculate, ventral sur-

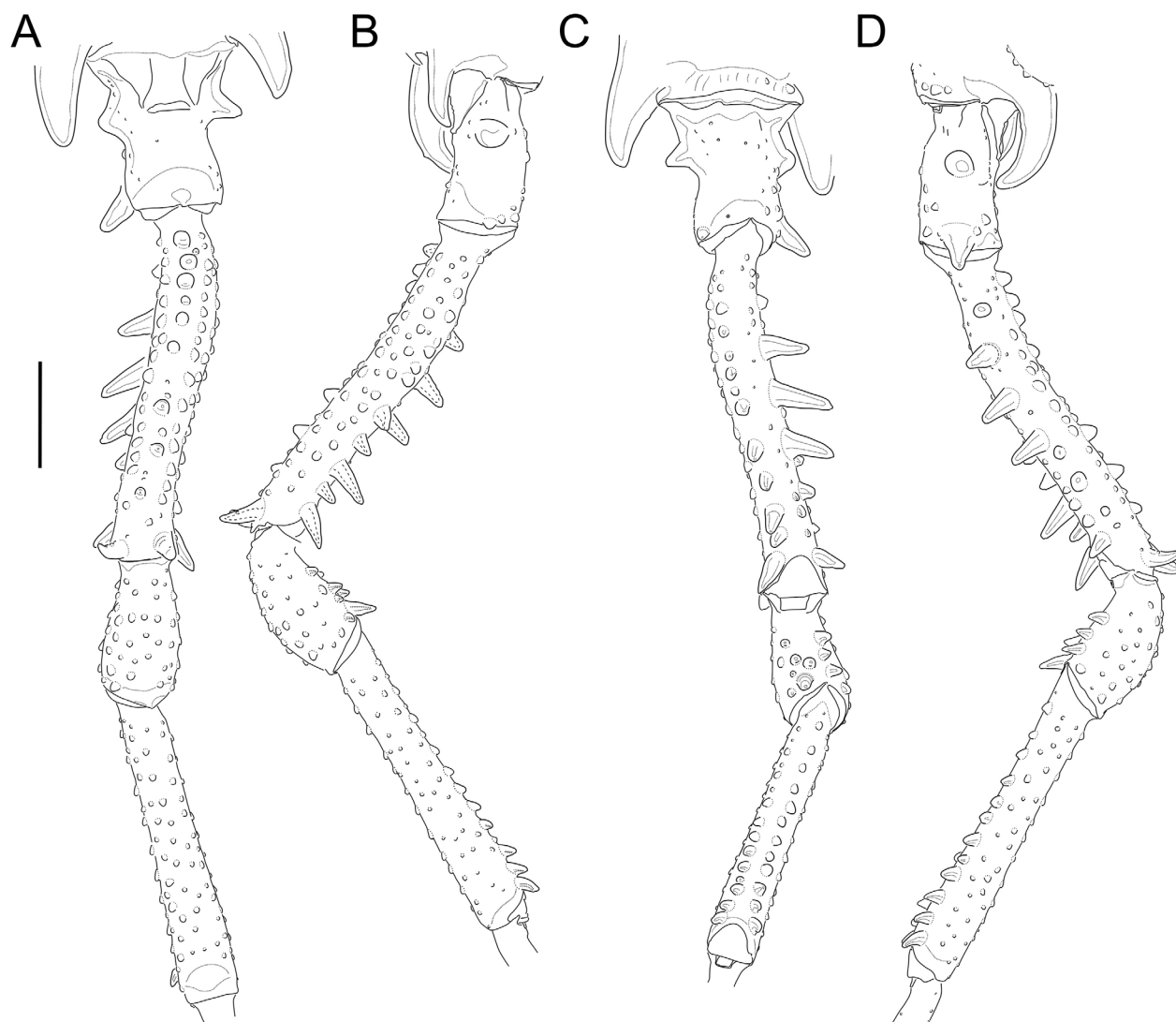


**Figure 9.** *Sertaneja falcata* sp. nov. (A, C–G) Male holotype (UFPB OP-481), A: habitus, dorsal view; C: same, right lateral view; D: right coxa and trochanter IV in dorsal view; E: right pedipalp in lateral view; F: same, mesal view; G: ocularium frontal view. (B) Female paratype (UFPB OP-729) habitus, dorsal view. Scale bars: 1 mm.

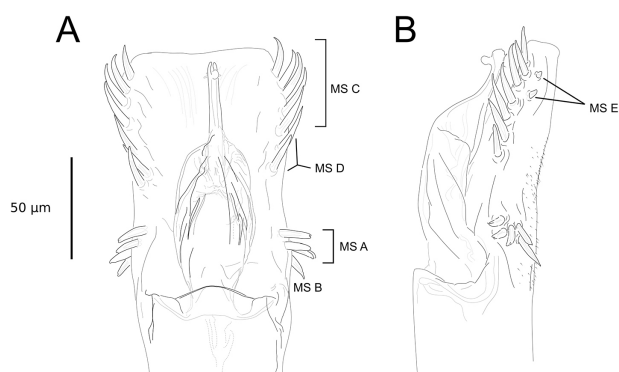
face covered by enlarged, acuminate tubercles, with a large proapical spine (twice the size of the surrounding ones) (Fig. 10B). Tibia IV with two ventral rows of tubercles increasing in size apically, pointing posteriorly (Fig. 10B, D). Metatarsus I slightly swollen. Tarsal counts: 6, 9, 6, 6. **Penis** (UFPB OP-728; Fig. 11): VP apex and lateral margins slightly concave. MS A set showing asymmetry between right (4) and left (3) sides (Fig. 10A, B); MS B almost undistinguishable from MS A but inserted more basally. Five pairs of conical, curved MS C, decreasing in size apically; two pairs of MS D close to MS C5, but slightly smaller and placed more dorsally; two pairs of small MS E, ventral to the MS C set (Fig. 10B). **Coloration:** General coloration predominantly moderate yellow (87). DS scute areas, prosoma and margins, free tergites I–III moderate olive brown (95) granulation.

**FEMALE** (UFPB OP-729; Figs 6B, 12D) **Measurements:** DSL: 4.13; DSW: 4.32; LI: 8.83; LII: 16.57; LIII: 10.93; LIV: 14.40. **Dorsum:** Less armed compared to male. DS narrower. Lateral margin of DS with an external row of tubercles, posterior tubercles slightly larger than in male. **Pedipalps:** Pedipalp tibial setation: lateral lili. **Legs:** Coxa IV narrower and shorter than in male, with a small prolateral apophysis, and a conical, straight retro-apical apophysis of same size. Trochanter IV narrower and shorter than in male, the prolateral basal apophysis as a large, blunt tubercle, and a small retro-lateral apophysis. Femur III lacking a proventral row of enlarged tubercles, reduced retro-dorsal apical tubercle. Femur IV unarmed, covered by small conical tubercles that slightly increase in size apically, with a pair of small dorso-apical spines of similar size. Patella–tibia IV unarmed. Tarsal counts: 6, 9–10, 6, 6.





**Figure 10.** *Sertaneja falcata* sp. nov. Male holotype (UFPB OP-481) right trochanter–tibia IV. **A:** dorsal view; **B:** prolateral view; **C:** ventral view; **D:** retro-lateral view. Scale bars: 1 mm.



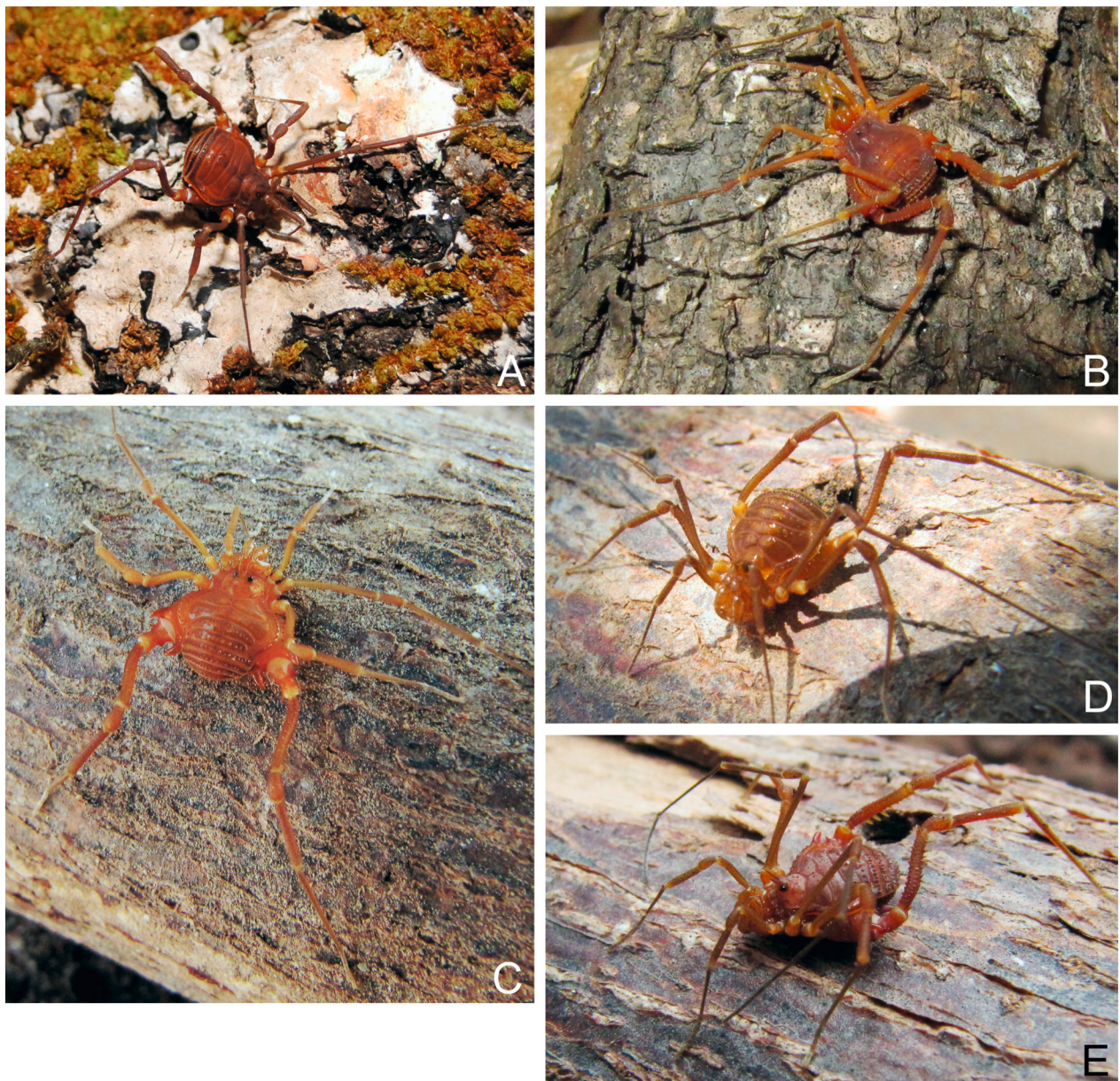
**Figure 11.** *Sertaneja falcata* sp. nov. (UFPB OP-728), apical portion of penis. **A:** dorsal view; **B:** right lateral view.

**Variation. Males** ( $n = 6$ ): **Measurements:** DSL 4.43–4.66; DSW 4.84–5.06; LI 8.91–10.21; LII 17.52–19.48; LIII 12.24–13.08; LIV 16.19–17.51. **Dorsum:** Front margin with or without tubercles. Ocularium with parallel or diverging spines, inclination of these ranging from

near-horizontal to vertical. **Pedipalps:** Femur external lateral row with 2–3 sub-apical tubercles. **Legs:** Femur IV dorso-apical spines with similar size to retro-lateral largest and strongly curved upwards; retro-lateral central conical apophyses sometimes with an additional apophysis of half the height of the remaining apophyses in the middle; apical half of proventral row bearing small tubercles alternated with large ones. Tarsal counts: 6, 10–12, 6, 4–6. **Females** ( $n = 2$ ): **Measurements:** DSL 4.13–4.27; DSW 4.32–4.46; LI 8.83–8.84; LII 16.16–16.57; LIII 10.93–11.62; LIV 10.09. **Pedipalps:** Pedipalp tibial setation: mesal Ili, lateral Ili. Tarsal setation: mesal Ili, lateral Ili/Ilii. **Legs:** Tarsal counts: 6, 9–10, 6, 6.

**Etymology.** ‘Falcata’ is a Latin adjective (adj. nom. fem.) that means sickle-shaped and refers to the diagnostic retro-apical apophysis of male coxa IV of the species.

**Distribution (Fig. 13).** Known only from type locality. Caatinga dry forest of tableland slopes of interior Rio Grande do Norte.



**Figure 12.** Photographs of live *Sertaneja* gen. nov. **A:** Female of *S. crassitibialis* sp. nov. (courtesy of Leonardo Sousa Carvalho); **B:** Male of *S. bicuspidata* sp. nov.; **C, E:** Male of *S. falcata* sp. nov.; **D:** Female of *S. falcata* sp. nov.

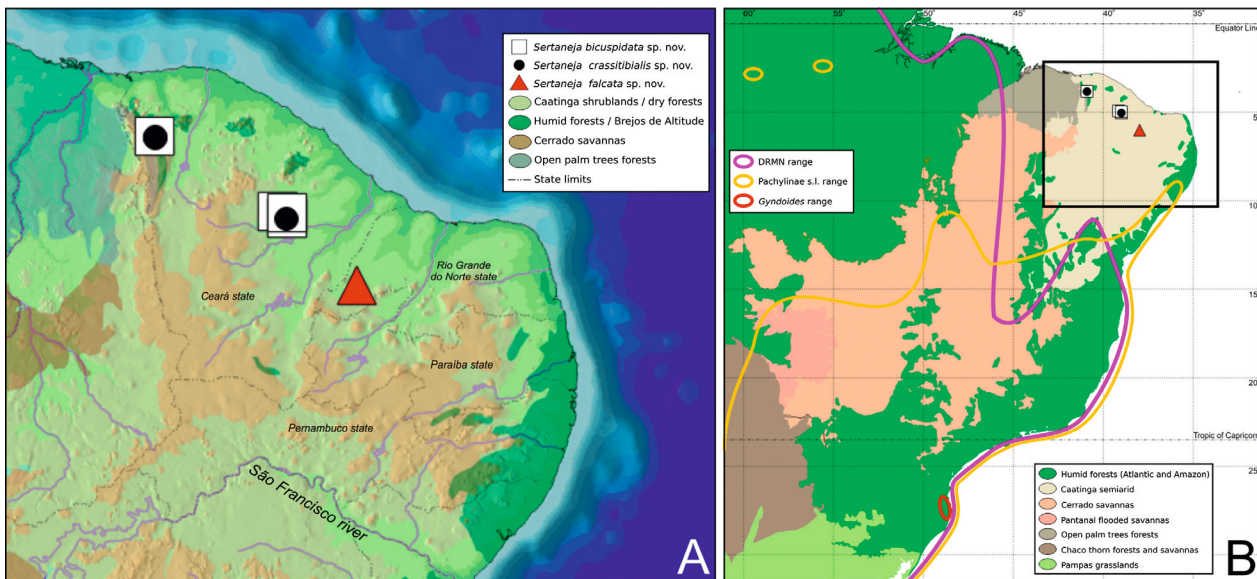
## 4. Discussion

These three new species represent a great discovery for Brazilian semiarid diversity and Gonyleptidae phylogeny. Taxonomically, we could assign the three new species to *Gyndoides* based on their apparent morphological similarity. However, the undivided scute area IV and male genitalia homogeneity of the three new species differed considerably from that of *Gyndoides* by the (i) lack of a glans ventral process; (ii) mostly rectangular and long ventral plate; and (iii) amount and placement of the MS. Additionally, the three new species inhabit northeastern Brazil in the Ceará and Rio Grande do Norte states, approximately 2,700 km from where *Gyndoides* species are found (Fig. 13). Therefore, as a result of the distinct penis morphology, its phylogenetic placement, and the disjunct

distribution, we decided to propose *Sertaneja* gen. nov. as a new genus. As mentioned above, the penis morphology of the new genus is quite homogeneous, despite the heterogeneous external body features.

From a historical perspective (namely, the Roewerian system) and intuitively, based solely on the overall morphology (except for the penile one) it would be plausible to propose three different genera based on such external variation. But as thoroughly discussed (Kury 1990), this classification system relied on a small set of external variable characters (i.e., tarsal counts, ocularium armature, scute area III armature) to define different supraspecific groups, resulting in many artificial units. There are many cases demonstrating those issues, such as in *Eusarcus* Perty, 1833 (Hara and Pinto-da-Rocha 2010). In that case, there were four Pachylinae genera bearing a central spine in scute area III (*Metagraphinotus* Mello-Leitão, 1927a,





**Figure 13.** Geographic distribution of *Sertaneja* gen. nov. and biomes. **A:** northeastern Brazil detail; **B:** distribution compared to Pachylinae groups.

*Pareusarcus* Roewer, 1929 and *Antetriceras* Roewer, 1949, besides *Eusarcus* itself) before the revision. Those could be distinguished by the different combination of states of the ocularium armature, number of tarsal counts, armature on both scute area IV and femur pedipalp. After the revision that also performed a cladistic analysis, all those characters did not corroborate those genera, and they were synonymized with *Eusarcus*, which has a typical penile pattern. Another example would be *Sadocus* Sørensen, 1886, recently revised by Pessoa-Silva et al. (2021) where *Carampangue* Mello-Leitão, 1937 and *Sadocus* differed from each other mainly by the number of scute areas, the former bearing three, while the latter had four. Kury (2003) noted their similarity, and propose their synonymization, that proved to be right later on. As can be seen from such examples, current taxonomical studies with the order always take the Roewerian characters and morphological variations into account, including a greater number of phylogenetic evidence in the form of characters, especially those from the penile structure, which are considered one of the main foundations of the harvestmen taxonomy (Macías-Ordóñez et al. 2010).

*Gyndoides springmanni*+ is the sister group to the clade that is equivalent to DRMN in the analyses (Figs 1, 2). *Gyndoides* is a genus that currently comprises two species, *G. springmanni* and *G. elaphus* Mello-Leitão, 1927a, both recorded from the Santa Catarina state in southern Brazil. Previously, Pinto-da-Rocha et al. (2012) based on the overall morphology of the body, suggested a close relationship between *Gyndoides*, *Discocyrtus*, *Gyndesops* Roewer, 1943, and *Paraluederwaldtia* Mello-Leitão, 1927b, even suggesting the synonymy of *Gyndoides* and the latter two under *Discocyrtus*. However, Pinto-da-Rocha et al. (2014) and Carvalho and Kury (2018) proposed a close relationship between *Discocyrtus* and *Mitobatinae*. In the present analysis, we could not retrieve this sister-group relationship, but we found evidence that *Gyndoides* is not closely related to *Discocyrtus* as once suggested.

As a side note, we justify why we did not assign the three new species to other genera deemed close to *Gyndoides* according to Pinto-da-Rocha et al. (2012). The monotypic *Gyndesops* penis (Pinto-da-Rocha et al. 2012: fig. 17) closely resembles that of *Gyndoides*, the leg II tarsal counts are unusually high (12–13) while *Sertaneja* gen. nov. has up to 10 tarsal segments, and femur IV is straight and unarmed, in addition to inhabiting Santa Catarina, a southern state in Brazil. *Paraluederwaldtia* comprises two species, both with a divided scute area IV: *P. bituberculata* (Mello-Leitão, 1922) from Rio de Janeiro is only known from the female holotype, hampering further comparisons, and *P. caramaschii* Soares and Soares, 1979 from Amazonas and Pará, northern Brazilian states, have unknown penis morphology.

In the present analyses, Pachylinae s.s., represented by *A. pustulata*+, was also retrieved, and is supported by 17 synapomorphies with relative Bremer support of 52 (Figs 1, 2). The remainder of Pachylinae included in this analysis, the s.l. classification compose the clade *E. nigrimaculatus*+ (relative Bremer support 15) in conjunction with DRMN (Figs 1, 2). The DRMN clade, here represented by members of *Discocyrtus*, *Pachylobos*, *Longiperna*, and *Roeweria* was recovered as a monophyletic group (relative Bremer support 45), even though the internal generic relationships were not consistent with the most recent proposition (Carvalho and Kury 2021: fig. 7). This is not an issue, considering that DRMN internal relationships are not settled (Carvalho and Kury 2018; Carvalho and Kury 2021). Therefore, despite this divergence, our results corroborated the DRMN group in general.

Our goal was not to present a Pachylinae s.l. phylogeny, which would certainly be a large, exhaustive, and meticulous task. Currently, the subfamily Pachylinae is one of the greatest challenges in Gonyleptidae systematics because it is species-rich, polyphyletic (Pinto-da-Rocha 2002; Hara et al. 2012; Pinto-da-Rocha et al. 2014), and with ill-circumscribed genera. The polyphyly issue

of Pachylinae has been gradually addressed by different approaches, such as using molecular data as in Pinto-da-Rocha et al. (2014) and Benavides et al. (2021), which pointed out major clades that were further corroborated by morphological data, resulting in the proposal of new groups, such as Roeweriinae, Neopachylinae, DRMN group, and Pachylinae s.s. Many other ongoing revisions (Hara 2016; Carvalho and Kury 2018; Kury et al. 2020) should further aid the proposal of monophyletic units, as well as their relationships within Gonyleptidae. We are confident regarding the proposal of *Sertaneja* gen. nov., based on its monophyletic status, which was supported by many unambiguous synapomorphies, as well as its sister-relationship to *G. springmanni* that is equally well corroborated. We should have our hypothesis tested using more taxa and characters in a more comprehensive phylogeny, including those genera putatively close to *Gyndoides* (Pinto-da-Rocha et al. 2012).

The semiarid region of northeastern Brazil contains 29 Laniatores species north of the São Francisco River, which is considered a major geographical barrier in the region (Carnaval et al. 2009; Nascimento et al. 2013). Most (17 spp.) are restricted to humid forests, mainly the Brejos de Altitude, whereas others can live in drier vegetation, such as the Caatinga shrublands and dry forests (DeSouza et al. 2017). *Sertaneja* gen. nov. matches the latter pattern, as all three species have been recorded from dry vegetation. *Sertaneja bicuspidata* sp. nov. and *S. crassitibialis* sp. nov. are sympatric with records in the shrublands and dry forests of low mountain slopes of Quixadá, and in the humid altitudinal forests of Ubajara. *Sertaneja falcata* sp. nov. is only known from the slopes of a dry forest remnant plateau in the southwestern Rio Grande do Norte state. Other species that share the same pattern of occurrence and are commonly found in drier locations include the cosmetids *Cynorta unciscripta* Roewer, 1927, *Eupoecilaema megaypsilon* Piza, 1938, *Gryne perlata* Mello-Leitão, 1936, *Gryne pluriarcuata* Mello-Leitão, 1936, and the stygnid *Stygnus polyacanthus* (Mello-Leitão, 1923) (DeSouza et al. 2017). Figure 13 here, page width

The high diversity and endemism rates of the harvestmen in the northeastern region of coastal Atlantic Forest, when compared to interior drier formations, are generally associated to intrinsic physiological traits, such as the group propensity for rapid dehydration, as well as behavior attributes (Machado and Macias-Ordóñez 2007), like philopatry and low vagility. As a result, most neotropical harvestmen species, such as gonyleptids, exhibit narrow and endemic ranges (DaSilva et al. 2015), resulting in historically-driven distribution patterns (Nogueira et al. 2019). Similar range and distributional patterns are also observed in harvestmen groups outside of the neotropics (Emata and Hedin 2016; Derkarabetian et al. 2021; Giribet et al. 2021). Although Opiliones occurrence in arid formations is not something unheard of for some Laniatores families—e.g., representatives of Cosmetidae, Stygnidae, Phalangodidae (e.g., DiDomenico and Hedin 2016, infer Sitalcina species diversification in North America deserts)—this new genus is one of the few records for

Gonyleptidae. Nevertheless, Neotropical drier ecosystems, just as the Caatinga vegetation, should harbor a diversity of harvestmen yet to be discovered, like the new genus described here.

## 5. Conclusion

*Sertaneja* gen. nov. is the first Gonyleptidae recorded from semiarid vegetation, except for some cavernicolous species from Bahia, and was an unexpected find because harvestmen are often associated with humid environments. Through the cladistic analysis, we were able to evaluate the monophyly of the new genus and its proximity to some key, recently revised, Pachylinae s.l. groups.

These new findings help shed light on the potential diversity of the order in northeastern Brazil, which currently is the leading country in the number of registered harvestmen species, with slightly more than 1000 according to Kury (2002+). However, little is known about the Caatinga opilionofauna in the semiarid and humid forest enclaves. Nevertheless, we hope to have moved forward in Pachylinae systematics, and expect to find more unknown harvestmen in Caatinga semiarid vegetation as more comprehensive collection projects are conducted in this vast and complex ecosystem in the near future.

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## Supplementary material 1

### Character matrix

**Authors:** Saraiva et al. (2021)

**Data type:** .pdf

**Explanation note:** Character matrix.

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