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MISAEAL AUGUSTO DE OLIVEIRA NETO

REVISÃO DE PSEUDOESCORPIÕES GEOGARYPIDAE (PSEUDOSCORPIONES)  
COM ÊNFASE NA DIVERSIDADE BRASILEIRA



João Pessoa, Paraíba  
Fevereiro de 2025

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**REVISÃO DE PSEUDOESCORPIÕES GEOGARYPIDAE (PSEUDOSCORPIONES)  
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Dissertação apresentada ao Programa de Pós-Graduação em Ciências Biológicas (Zoologia) da Universidade Federal da Paraíba, como requisito parcial para a obtenção do título de Mestre em Ciências Biológicas.

Orientador: Prof. Dr. Douglas Zeppelini

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“Por natureza, entendo somente a ação combinada e os resultados complexos de um grande número de leis naturais; e, por leis, a série de fatos que temos reconhecido.”

Charles Darwin

## RESUMO

A perda global de biodiversidade está ocorrendo em um ritmo alarmante, com 69% das populações de vida selvagem monitoradas tendo desaparecido nos últimos 40 anos. O entendimento da diversidade de artrópodes é limitado, com mais de 80% das espécies ainda não descritas. Este estudo se concentra na diversidade de Geogarypidae nas florestas tropicais do Nordeste do Brasil, enfatizando as descobertas de espécies endêmicas. Além disso, avalia a eficácia do novo método de descrição codificada para acelerar a identificação de espécies, um avanço necessário em vista da crise de extinção em ecossistemas frágeis. Foi utilizado o método de descrição taxonômica codificada proposto por Zeppelini *et al.* (2024), que permite rápida importação, transformação e expansão de dados de espécies. Um total de 181 espécimes de Geogarypidae foram encontrados, distribuídos em 27 espécies, incluindo 22 novas espécies e um novo gênero. Além disso, foram identificados quatro novos morfotipos, e neste estudo foram descritas 15 novas espécies do gênero *Geogarypus* (*G. alagoensis* **sp nov.**, *G. brescoviti* **sp nov.**, *G. calon* **sp nov.**, *G. caatinguensis* **sp nov.**, *G. chaetomaculatus* **sp nov.**, *G. chamberlini* **sp nov.**, *G. curumim* **sp nov.**, *G. eliptycus* **sp nov.**, *G. montanus* **sp nov.**, *G. rajatus* **sp nov.**, *G. salimoni* **sp nov.**, *G. sergipensis* **sp nov.**, *G. sertanejus* **sp nov.**, *G. talhadensis* **sp nov.**, *G. volkeri* **sp nov.**) e uma descrição complementar (*G. cuyabanus* (Balzan, 1887)). Nos últimos cinco anos, aproximadamente 75 novas espécies de pseudoescorpiões foram descritas, com a família Geogarypidae respondendo por apenas 1,33% dessa taxa. Em contraste, este estudo descreveu 60% das espécies anuais. A aplicação do método de descrição codificada ao gênero *Geogarypus* demonstrou um aumento significativo na taxa de descrição de espécies, revelando uma diversidade morfológica mais complexa e novas estruturas não observadas anteriormente. A revisão da família Geogarypidae indicou que o número de espécies descritas ainda é subestimado, com várias espécies novas esperando para serem documentadas.

**Palavras-chave:** *Geogarypus*, novas espécies, taxa de descrição da espécie. taxonomia.

## ABSTRACT

Global biodiversity loss is occurring at an alarming rate, with 69% of monitored wildlife populations having disappeared in the last 40 years. Understanding of arthropod diversity is limited, with over 80% of species still undescribed. This study focuses on the diversity of Geogarypidae in the tropical forests of Northeastern Brazil, emphasizing discoveries of endemic species. In addition, it evaluates the effectiveness of the new coded description method to accelerate species identification, a necessary advance in view of the extinction crisis in fragile ecosystems. The coded taxonomic description method proposed by Zeppelini *et al.* (2024) was used, which allows rapid import, transformation, and expansion of species data. A total of 181 specimens of Geogarypidae were found, distributed in 27 species, including 22 new species and one new genus. In addition, four new morphotypes were identified, and in this study 15 new species of the genus *Geogarypus* were described (*G. alagoensis* **sp nov.**, *G. brescoviti* **sp nov.**, *G. calon* **sp nov.**, *G. caatinguensis* **sp nov.**, *G. chaetomaculatus* **sp nov.**, *G. chamberlini* **sp nov.**, *G. curumim* **sp nov.**, *G. eliptycus* **sp nov.**, *G. montanus* **sp nov.**, *G. rajatus* **sp nov.**, *G. salimoni* **sp nov.**, *G. sergipensis* **sp nov.**, *G. sertanejus* **sp nov.**, *G. talhadensis* **sp nov.**, *G. volkeri* **sp nov.**) and one complementar description (*G. cuyabanus* (Balzan, 1887)). In the last five years, approximately 75 new species of pseudoscorpions have been described, with the family Geogarypidae accounting for only 1.33% of this rate. In contrast, this study described 60% of the annual species. The application of the coded description method to the genus *Geogarypus* demonstrated a significant increase in the rate of species description, revealing a more complex morphological diversity and new structures not previously observed. The review of the family Geogarypidae indicated that the number of species described is still underestimated, with several new species waiting to be documented.

**Keywords:** *Geogarypus*, new species, species description rate. taxonomy.

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## LISTA DE ABREVIATURAS E SIGLAS

### Estados Brasileiros:

|    |              |    |                   |
|----|--------------|----|-------------------|
| AL | Alagoas      | PB | Paraíba           |
| BA | Bahia        | PE | Pernambuco        |
| CE | Ceará        | RS | Rio Grande do Sul |
| GO | Goiás        | SE | Sergipe           |
| MG | Minas Gerais |    |                   |
| PA | Pará         |    |                   |

### Anexos cuticulares:

|     |                       |      |                        |
|-----|-----------------------|------|------------------------|
| eb  | external basal        | bs   | basal seta             |
| esb | external sub-basal    | sbs  | sub-basal seta         |
| est | external sub-terminal | ls   | laminal seta           |
| et  | external terminal     | is   | interior seta          |
| ib  | internal basal        | es   | exterior seta          |
| isb | internal sub-basal    | sg   | galea seta             |
| ist | internal sub-terminal | pls  | pit like struture      |
| it  | internal terminal     | pnso | pig nose sensory organ |
| b   | basal                 | lyf  | lyrifissures           |
| sb  | sub-basal             |      |                        |
| st  | sub-terminal          |      |                        |
| t   | terminal              |      |                        |

### Morfologia:

|      |                           |      |                 |
|------|---------------------------|------|-----------------|
| a    | eyes                      | fe   | femur           |
| A    | anal plate                | ff   | fixed finger    |
| an   | anterior edge             | g    | galea           |
| arr  | arrolliun                 | h    | hand            |
| caf  | color anterior furrow     | in   | internal region |
| clw  | claw                      | int  | interna         |
| cmf  | color medial furrow       | lyf  | lyrifissure     |
| cor  | color ocular region       | me   | medial region   |
| cu   | cucullus format           | mf   | movable finger  |
| cuc  | cucullus color            | mta  | metatarsus      |
| cx   | coxa                      | oc   | ocular region   |
| d    | dorsal                    | P    | Pedipalp        |
| dist | distal                    | pa   | patella         |
| dld  | darkspots lateral-dorsal  | plm  | pleoral membran |
| dmp  | darkspot medial posterior | po   | posterior edge  |
| ext  | external                  | prox | proximal        |

|      |                 |      |                   |
|------|-----------------|------|-------------------|
| r    | rallum          | Td   | tergite darkspots |
| S    | sternite        | td   | tergital discs    |
| scl  | sclerites       | tdsp | total darkspots   |
| serr | serrula         | ti   | tibia             |
| sfrm | shield format   | tr   | trochanter        |
| shc  | shield color    | v    | ventral           |
| T    | tergite         | vd   | venom ducts       |
| Tb   | tergite bridges |      |                   |

Biomass:

|      |                     |
|------|---------------------|
| Am   | Amazon              |
| Af   | Atlantic Rainforest |
| Caa  | Caatinga            |
| Cerr | Cerrado             |
| Pt   | Pantanal            |

## SUMÁRIO

### Revisão de Pseudoescorpiões Geogarypidae (Pseudoscorpiones) com ênfase na diversidade críptica brasileira

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### CAPITULO 1. Enhancing species descriptions rate by means of coded taxonomy methodology, an alternative to fight the global biodiversity crisis

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**APPENDIX 1** The following list of characters is presented in a sequence from the prosoma and appendages to the opisthosomal segments. It is a perfect match of Table 2 and is also represented by an individualized table in each species description plate. This list presents the observed conditions of each character included in our study, a total of 107 morphological characters and 646 different conditions are listed. .... 137

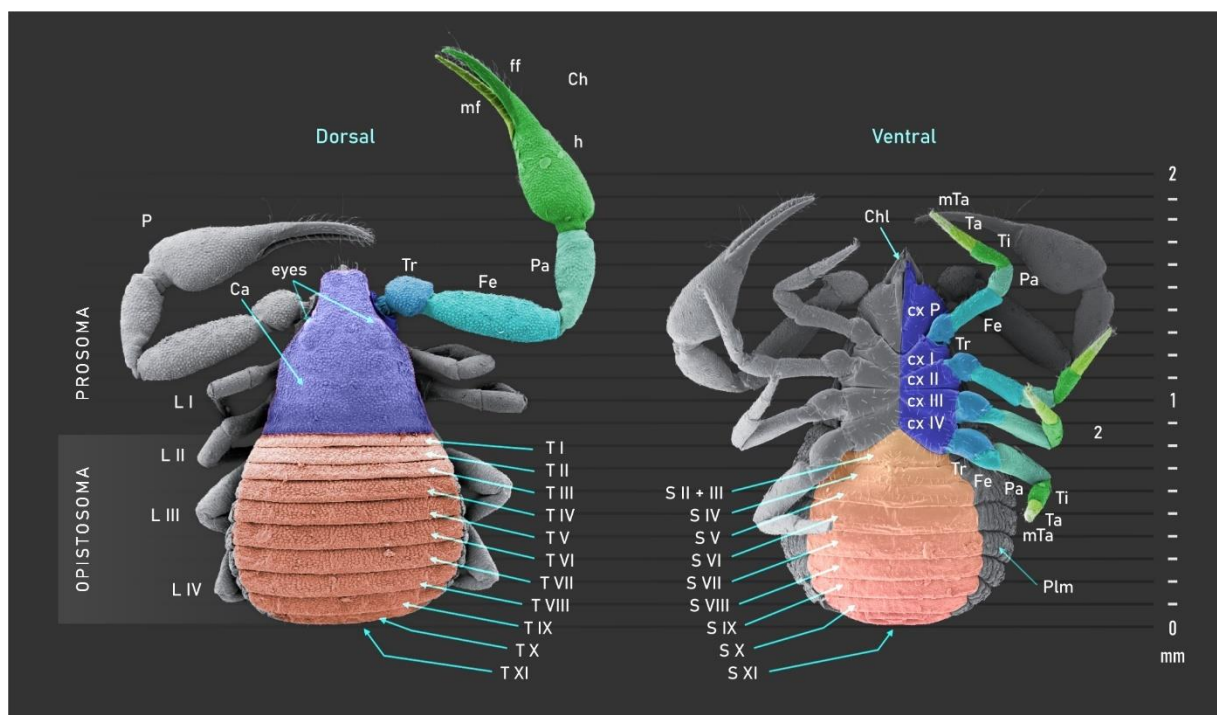
## 1. Introdução

### 1.1. Ordem Pseudoscorpiones

Pseudoscorpiones de Geer, 1778 é uma ordem diversa de pequenos aracnídeos, que podem chegar até 1cm de comprimento, o tamanho médio para a maioria das famílias varia entre 1 a 5 mm. Ocupa atualmente uma ampla variedade de habitats terrestres, como fendas, folhíço e micro espaços (Weygoldt, 1969; Muchmore, 1990). Conta atualmente com cerca de 4.122 taxons, distribuídos em todos os continentes, exceto na Antártica (Harvey, 2013a; Benavides *et al.*, 2019; WPC, 2024). com uma clara preferência por regiões tropicais e subtropicais (Weygoldt, 1969; Muchmore, 1990).

Os Pseudoescorpiões são um grupo muito antigo, com registro fóssil datado do Devoniano Médio, cerca de 392Ma. Apresenta registro fóssil para a grande maioria das 25 famílias atuais, aproximadamente 49 espécies, a família Dracochelidae possui o fóssil mais antigo, sendo conhecido apenas uma única espécie. O registro mais antigo para as famílias atuais varia entre 100-16Ma, pseudoescorpiões já foram encontrados em mais de 20 depósitos fossilíferos ao redor do mundo, especialmente em âmbar (Shear *et al.*, 1989; Schawaller *et al.*, 1991; Harms & Dunlop, 2017). Estudos moleculares e morfológicos sugerem o monofiletismo de Pseudoscorpiones (Shultz, 2007; Murienne *et al.*, 2008; Benevides *et al.*, 2019).

Figura 1. Morfologia geral de um Pseudoescorpião.



O corpo dos pseudoescorpiões é dividido em prosoma e opistosoma (Fig. 1), o prosoma conta com a carapaça e seis pares de apêndices, o primeiro segmento do prosoma é um par de quelíceras bissegmentadas, articuladas ventralmente e utilizados para autolimpeza e alimentação, o segundo segmento do prosoma é um par de pedipalpos com seis artículos, os dois últimos artículos são modificados em pinça, utilizados em diversas funções como predar, se defender e acasalar. Os apêndices dos quatro últimos segmentos do prosoma são quatro pares de pernas locomotoras, variando entre seis e sete artículos. O opistosoma possui 12 segmentos achatados dorso ventralmente, recobertos por placas tergais, tergito dorsal e esternito ventral, as duas últimas placas dorsais e ventrais são fundidas, em forma de cone anal. Em geral o corpo é recoberto por diversos anexos cuticulares, como cerdas, tribobótrias e estruturas sensoriais. Os pseudoescorpiões podem ter 4, 2 ou 0 olhos, todos possuem uma série de cerdas sensoriais nos dedos fixo e móvel, que varia em quantidade de acordo com o estágio de desenvolvimento (Chamberlin, 1931; Weygoldt, 1969; Muchmore, 1990). Dentre as diversas famílias de Pseudoscorpiones, Geogarypidae se destaca por suas características morfológicas exclusivas e ampla distribuição geográfica, sendo o foco deste estudo.

### 1.1. Família Geogarypidae

A família Geogarypidae Chamberlin, 1930 (Fig. 1) é facilmente diferenciada de outras famílias de pseudoescorpiões pela seguinte combinação de caracteres: carapaça subtriangular, olhos em tubérculos oculares, dedo fixo da queela com estruturas em forma de poço (pls) na margem antiaxial, placas anais localizadas entre o tergito XI e esternito XI (Harvey, 1986). Essa família contém atualmente dois gêneros: *Afrogarypus* Beier, 1931 e *Geogarypus* Chamberlin, 1930. *Afrogarypus* com 23 espécies e *Geogarypus* contendo 50 espécies. Geogarypidae apresenta ampla distribuição ao redor do mundo, ocorrendo preponderantemente em áreas tropicais e subtropicais, possuindo ainda clara afinidade biogeográfica gondwânica (Harvey, 1986; 1992; 1996; 2013; Nassirkhani, 2014; Neethling e Haddad, 2017; Gardini *et al.*, 2017; Novák e Harvey, 2018; Novák e Harvey, 2019).

A América do Sul, atualmente, possui registros de nove espécies da família Geogarypidae, todos pertencentes ao gênero *Geogarypus*, sendo encontrados na maioria dos ecossistemas neotropicais. O Brasil possui registro de quatro espécies: *G. amazonicus* Mahnert, 1979; *G. cuyabanus* Balzan, 1887; *G. formosus* Mello-Leitão, 1937 e *G. paraguayanus* Beier, 1931. *Geogarypus* adapta-se bem às condições flutuantes do clima das florestas tropicais, sendo capazes de migrar vertical e temporariamente durante as cheias dos rios. No Brasil, geogaropídeos já foram coletados na serapilheira, sob e sobre pedras, troncos de árvores vivas

ou em decomposição, copa, epífitas, em associação forética com insetos voadores, em termiteiros e mais recentemente encontrados vivendo em cavernas brasileiras e na Caatinga (Mahnert, 1979; 1987; Mahnert e Adis, 1985; Adis, 1997; Moraes *et al.*, 1997; Aguiar e Bührnheim, 1998; Harvey, 2013; Battirola, 2017; Schimonsky e Bichuette, 2019; Lira *et al.*, 2020).

### 1.2. Diversidade brasileira

O Brasil possui 174 espécies validas, 66 gêneros e 16 das 25 famílias atuais, com ocorrência de pseudoescorpiões em todos os biomas brasileiros (Lira *et al.* 2020). Sendo comumente encontrados em serapilheira, sob a casca e dossel das arvores, no solo, em rochas, áreas sazonalmente inundáveis, habitats litorâneos e costeiros, dentro de cavernas e outros habitats subterrâneos, zonas desérticas, galerias de colônias de insetos e também ninhos de mamíferos e aves (Muchmore, 1971; Harvey & Adis 1985; Adis, 1997; Nair & Aguiar 2002; Murienne *et al.*, 2008; Aguiar & Bührnheim, 2011; Marques *et al.*, 2011; Battirola *et al.*, 2017; Schimonsky & Bichuette, 2019b; Lira *et al.*, 2020; Oliveira-Neto *et al.*, 2024). A fauna brasileira de pseudoescorpiões é atualmente a quarta mais diversa do mundo, ficando atrás apenas da Australia, Itália e U.S.A, respectivamente (Harvey, 2011; 2013a).

Os pseudoescorpiões em geral são pouco conhecidos, não mencionados em iniciativas de conservação ou em estudos que explorem ou discutam os aspectos comportamentais e ecológicos, sendo ainda, escassamente mencionados em estudos taxonômicos e levantamentos faunísticos em geral (Andrade, 2004; Rodrigues e Tizo-Pedrozo, 2017; Silva, 2021). O conhecimento acerca desses animais no Brasil é fragmentado e dados sobre o habitat, distribuição e ecologia ainda são incipientes (Mahnert, 2001).

### 1.3. Crise global da biodiversidade

A compreensão da biodiversidade deu um salto significativo no século XVIII com os primeiros esforços taxonômicos, como os de Linnaeus. Contudo, estimativas quantitativas rigorosas sobre o número de espécies só surgiram no final do século XX (May, 1988). Desde então, uma série de pesquisas levou a estimativas mais abrangentes, o consenso mais conservador é de que existem atualmente entre 5.0-7.3 milhões de espécies. Por outro lado, estimativas mais otimistas sugerem que o número pode alcançar, no mínimo, 30 milhões de espécies (Gaston & Gauld, 1991; Hammond, 1992; Hebert *et al.*, 2004; May, 1988, 1990, 2000; Scheffers, 2012; Stork, 1988, 1993, 1997, 1999a, b, 2018).

Apesar dos avanços no entendimento da biodiversidade, perda global de espécies ocorre em uma taxa sem precedentes. Em apenas 40 anos, 69% das populações monitoradas de vida selvagem foram perdidas (WWF, 2022). Com mais de 80% da diversidade de artrópodes ainda por ser descoberta, nossa compreensão é limitada, tanto em relação ao número de espécies existentes (Gaston & Gauld, 1991; Hammond, 1992; Hebert *et al.*, 2004; May, 1988, 1990, 2000; Scheffers, 2012; Stork, 1988, 1993, 1997, 1999a, b, 2018), quanto à quantidade de espécies extintas anualmente (Scheffer *et al.*, 2017; WWF, 2022). Essas regiões abrigam ecossistemas frágeis, cuja degradação avança em ritmo alarmante (Finn *et al.*, 2023). Levantamentos recentes indicam uma perda de mais de 90% da vida selvagem tropical monitorada nas últimas décadas (WWF, 2022, 2024).

Essa crise reforça a urgência de estratégias taxonômicas inovadoras para acelerar a descrição de espécies (Butcher, 2012; Sharkey *et al.*, 2021; Zeppelini *et al.*, 2024). Este estudo documenta a diversidade de Geogarypidae nas florestas tropicais de terras altas do Nordeste do Brasil, enfatizando a descoberta de espécies endêmicas. Além disso, testa a replicabilidade do novo método de descrição codificada e capacidade de acelerar a descrições de espécies.

## 2. Objetivos

### 2.1. *Objetivo geral*

Revisar a família Geogarypidae no Brasil, com ênfase na diversidade escondida nas áreas de exceção ambientes espécieais e descrever as novas espécies por meio da Taxonomia Codificada.

### 2.2. *Objetivos específicos*

- Identificar, revisar e descrever as espécies da família Geogarypidae.
- Mapear as unidades morfológicas através de Microscopia Eletrônica de Varredura para definir parâmetros refinados de morfologia.
- Codificar a morfologia integral dos espécimes examinados.
- Testar a eficiência da Taxonomia Codificada na elucidação de diversidade críptica, para estabelecer um modelo metodológico replicável para acelerar a taxa de descrição de espécies de grupos taxonômicos negligenciados.

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## CAPITULO 1

**Enhancing species descriptions rate by means of coded taxonomy methodology, an  
alternative to fight the global biodiversity crisis**



Journal: Biological Conservation

## Enhancing species descriptions rate by means of coded taxonomy methodology, an alternative to fight the global biodiversity crisis

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### Abstract.

Global biodiversity loss is occurring at an alarming rate, with 69% of monitored wildlife populations having disappeared in the last 40 years. Understanding of arthropod diversity is limited, with over 80% of species still undescribed. This study focuses on the diversity of Geogarypidae in the tropical forests of Northeastern Brazil, emphasizing discoveries of endemic species. In addition, it evaluates the effectiveness of the new coded description method to accelerate species identification, a necessary advance in view of the extinction crisis in fragile ecosystems. The coded taxonomic description method proposed by Zeppelini *et al.* (2024) was used, which allows rapid import, transformation, and expansion of species data. A total of 181 specimens of Geogarypidae were found, distributed in 27 species, including 22 new species and one new genus. In addition, four new morphotypes were identified, and in this study 15 new species of the genus *Geogarypus* were described (*G. alagoensis* **sp nov.**, *G. brescoviti* **sp nov.**, *G. calon* **sp nov.**, *G. caatinguensis* **sp nov.**, *G. chaetomaculatus* **sp nov.**, *G. chamberlini* **sp nov.**, *G. curumim* **sp nov.**, *G. eliptycus* **sp nov.**, *G. montanus* **sp nov.**, *G. rajatus* **sp nov.**, *G. salimoni* **sp nov.**, *G. sergipensis* **sp nov.**, *G. sertanejus* **sp nov.**, *G. talhadensis* **sp nov.**, *G. volkeri* **sp nov.**) and one complementar description (*G. cuyabanus* (Balzan, 1887)). In the last five years, approximately 75 new species of pseudoscorpions have been described, with the family Geogarypidae accounting for only 1.33% of this rate. In contrast, this study described 60% of the annual species. The application of the coded description method to the genus *Geogarypus* demonstrated a significant increase in the rate of species description, revealing a more complex morphological diversity and new structures not previously observed. The review of the family Geogarypidae indicated that the number of species described is still underestimated, with several new species waiting to be documented.

### Key words.

*Geogarypus*, Brazil, Taxonomy, Pseudoscorpiones

## 1Introduction

The understanding of biodiversity took a significant leap forward in the 18th century with the first taxonomic efforts, such as those of Linnaeus. However, rigorous quantitative estimates of the number of species did not emerge until the late 20th century (May, 1988). Since then, a series of studies have led to more comprehensive estimates, with the most conservative consensus being that there are currently between 5.0–7.3 million species living in the planet. On the other hand, more optimistic estimates suggest that the number could reach at least 30 million species (Gaston, 1991; Hammond, 1992; Hebert et al., 2004; May, 2000, 1990, 1988; Scheffers et al., 2012; Stork, 1997, 1993, 1988, 2018, 1999a, 1999b).

Despite advances in the understanding of biodiversity, its decline is occurring at an unprecedented rate. In just 40 years, 69% of monitored wildlife populations have been lost (WWF, 2024, 2022). With over 80% of arthropod diversity yet to be discovered, our understanding is limited, both in terms of the number of extant species (Gaston, 1991; Hammond, 1992; Hebert et al., 2004; May, 2000, 1990, 1988; Scheffers et al., 2012; Stork, 1997, 1993, 1988, 2018, 1999a, 1999b) and the number of species that go extinct each year (Scheffers et al., 2012; WWF, 2024). Recent surveys indicate a loss of more than 90% of tropical wildlife in recent decades (WWF, 2022). These regions are home to fragile ecosystems whose degradation is progressing at an alarming rate (Finn et al., 2023), reinforcing the urgency of strategies to document and conserve biodiversity.

Brazil is internationally recognized for the exuberance of nature (Darwin, 1845) and its megadiverse fauna (Lewinsohn and Prado, 2005), presenting an incredible number of endemic species in their biomes (MMA/ICMBio, 2018), with regions considered priority hotspots for the protection of global biodiversity (Mittermeier et al., 2005; Myers et al., 2000).

The Brazilian Northeast is a biogeographically complex environment (Morley, 2000; Rizzini, 1977; Silva and Casteleti, 2003), made up mainly of the Caatinga (Caa) and Atlantic Forest (Af) biomes, that have entangled evolutionary histories (Ab'Sáber, 1997; Mittermeier et al., 2005; Sá et al., 2004; Sobral-Souza et al., 2015). During the Paleogene, the Northeastern Brazil was mainly covered by rainforests, the ancient Amazon and Af were spatially interconnected (Morley, 2000), the Andean uplift during Pleistocene caused drastic climate changes and shaped the Caa (Ab'Sáber, 1997), separated ancient rainforests and isolating the Af (Bigarella et al., 1975; Costa, 2003; Hoorn et al., 2010), however, after the Paleogene, there was recurrent cycles of connections between rainforests, followed by periods of isolation (Auler

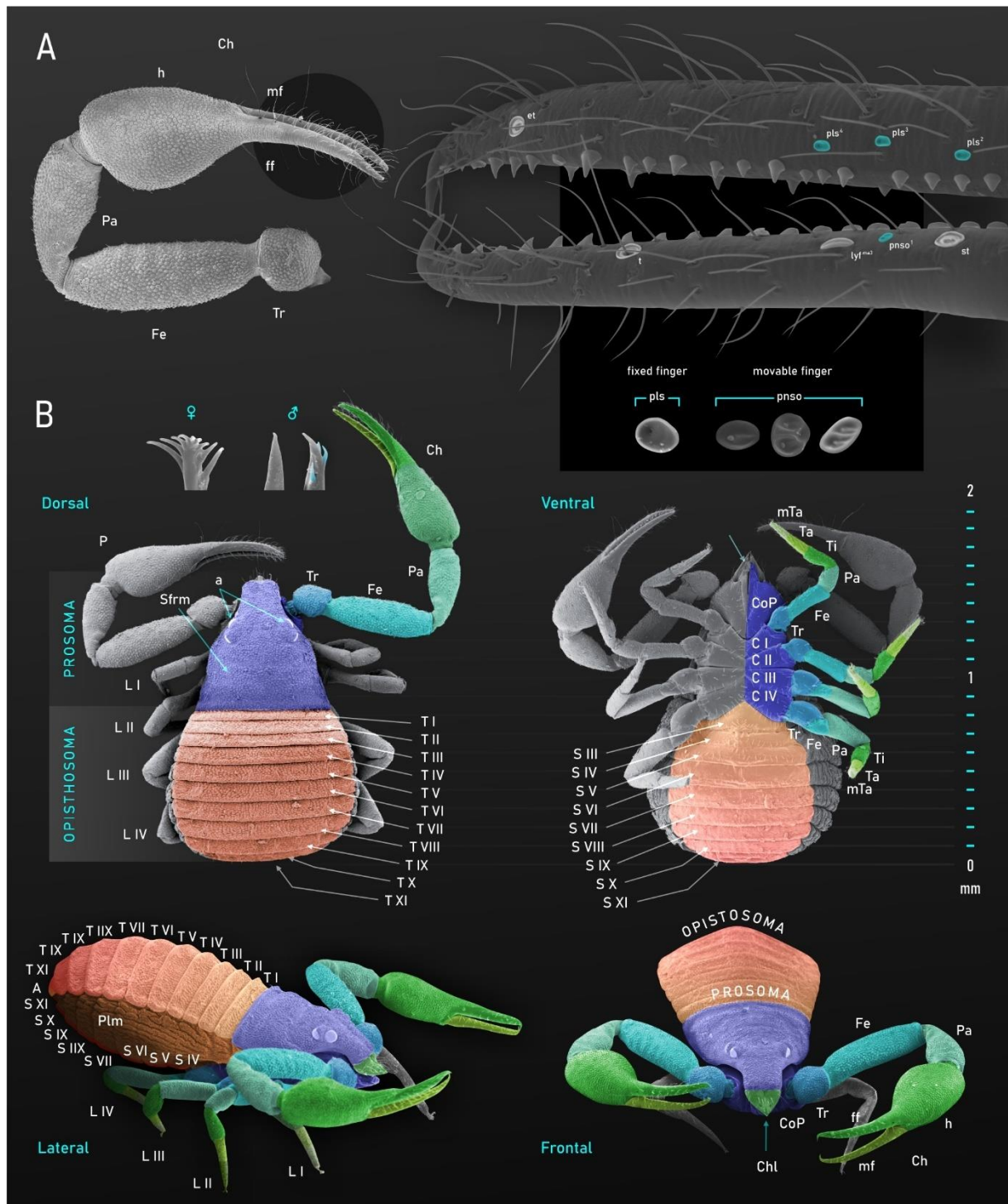
et al., 2004; Auler and Smart, 2001; Behling et al., 2000; Costa, 2003; De Oliveira et al., 1999; Edwin O. Willis, 1992; Fouquet et al., 2012; Pellegrino et al., 2011; Wang et al., 2004). Such isolation has permitted the evolution of a unique endemic biota (Rizzini, 1977; Silva and Casteleti, 2003). This biogeographic scenario reflects the complexity of its fauna and is perfect for testing the coded description method for separating species and accelerating the description rate of species from the neglected arachnids order in Brazil.

Among the diverse taxa in Brazil, pseudoscorpions (order Pseudoscorpiones) are an ecologically significant yet understudied group. These arachnids inhabit a variety of terrestrial environments, with a preference for tropical and subtropical regions (Muchmore, 1990; Weygoldt, 1969). The order currently encompasses approximately 4,122 species and 472 genera (World Pseudoscorpiones Catalog, 2022). Brazil hosts 194 valid species, distributed among 66 genera, representing 16 out of the 25 existing families. Pseudoscorpions are found in all Brazilian phytogeographical domains and 2 oceanic islands (Bedoya-Roque et al., 2023; Lira et al., 2020; Oliveira-Neto et al., 2024; World Pseudoscorpiones Catalog, 2022).

The family Geogarypidae Chamberlin, 1930 currently contains two genera: *Afrogarypus* Beier, 1931 and *Geogarypus* Chamberlin, 1930. *Afrogarypus* with 23 species and *Geogarypus* with 52 species. Geogarypidae has a wide distribution around the world, occurring predominantly in tropical and subtropical areas, with a clear Gondwanic biogeographic affinity (Bedoya-Roque et al., 2023; Cullen and Harvey, 2021; Gardini et al., 2017; Harvey, 2013, 1986; Nassirkhani, 2014; Neethling, 2015; Neethling and Harms, 2024; Novák and Harvey, 2019, 2018).

There are only five species recorded from Brazil up to date, nevertheless, geogarypids have already been collected from litter, under rocks, trunks and decomposing trees, canopy, epiphytes, in phoretic association with flying insects, termite mounds and more recently found living in Caatinga and caves (Aguiar and Bührnheim, 2011; Balzan, 1890; Battistola et al., 2017; Bedoya-Roque et al., 2023; Lira et al., 2020; Mahnert, 1987, 1979; Mahnert and Adis, 1985; Morais, 1997; Schimonsky and Bichuette, 2019).

The knowledge about pseudoscorpions in Brazil is fragmented and data on their habitat, distribution and ecology are still incipient (Mahnert, 2001). Conservation initiatives and ecological studies rarely mention pseudoscorpions, and they are often overlooked in taxonomic surveys (Andrade and Gnaspini, 2003; Rodrigues and Pedroso, 2017; Silva, 2021). This study documents the diversity of Geogarypidae in Brazil. Additionally, it tests a replicable methodological framework for accelerating species descriptions.



**Figure 2.** Geogarypidae habitus and structures: A. Pedipalp dorsal view, dark circle shows position of sensory structures on fingers; Fingers frontal view, with sensory structures, such as trichobotria and liryfissure, colored white, but also, *pit like structures* (pls) and the *pig nose sensory organ* (pnso) in blue. B. SEM habitus dorsal, ventral, lateral and frontal view.

## 2Methods

## 2.1 Distribution Mapping

The distribution of *Geogarypidae* species from Brazil and nearby regions was mapped according to literature data (Aguiar and Bührnheim, 2003; Mahnert, 1979) (eg. Mahnert 1979d, Adis 1981, Aguiar & Bührnheim 1994, Morais, Adis, Mahnert & Berti-Filho 1997; Aguiar & Bührnheim 1998b; Aguiar & Bührnheim 2000; Aguiar & Bührnheim 2003; Battirolo et al., 2017a, b; Schimonsky & Bichuette, 2019b; Lira et al., 2020) and this study. All maps were generated using Geographic Information System QGIS 3.16 (<http://qgis.osgeo.org>).

## 2.2 Electron Microscopy and Macrophotography

For the study of the Scanning Electron Microscope (SEM), the specimens were dehydrated by graduable series of ethanol, dried in a critical point dryer model Autosamdri®-931 by Tousimis, metallized with system for electron microscopes, HP Desk V model by Denton Vacuum and observed in scanning electron microscope by Tescan's Vegas III model. For macrophotography was used one stereomicroscope Stemi DV4 model by Carl Zeiss with adapter to dock smartphone. Figure and illustrations were generated and assembled using CorelDRAW Graphics Suite 2020 for Windows (<https://www.coreldraw.com>) and Affinity Photo (<https://affinity.serif.com>).

## 2.3 Terminology

Measurements of specimens examined follow Beier (1963), terminology used for trichobotries and appendices follows Chamberlin (1931), modified by Harvey (1992), Judson (2017) and Harvey et al., (2012), chelal lyrifissures terminology follows Zaragoza (2017). The use of “prolateral” and “retrolateral” follows Harvey et al., (2012).

## 2.4 Treatment of Specimens

The samples are stored in 96% ethanol. Each sample is accompanied by an collection number. The pedipalps, chelicerae, carapace, opisthosome, first and fourth legs were dissected, clarified with Nesbitt's solution and mounted on glass microscope slides in Hoyer's solution for study under phase contrast microscope on Axio Scope A1 binocular microscope by Carl Zeiss.

## 2.5 Color Pattern

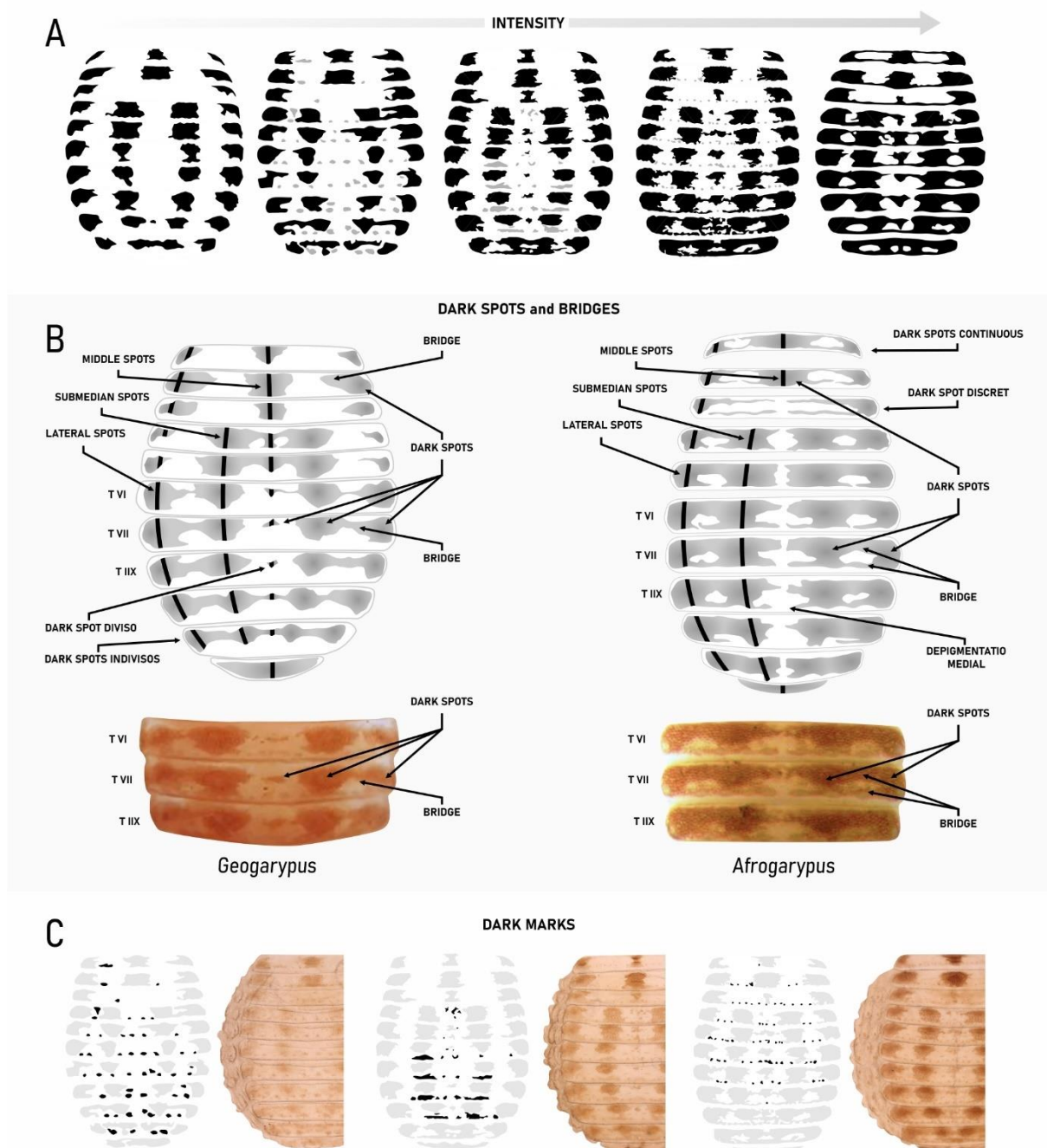
Recent studies have highlighted the taxonomic significance of the color pattern in the carapace, palps and tergites, within this family (Dashdamirov, 2004; Harvey, 2010, 1986;

Nassirkhani, 2016; Neethling and Haddad, 2016; Novák and Harvey, 2018). Studies on color patterns are bringing different approaches resulting in a more efficient species delimitation.

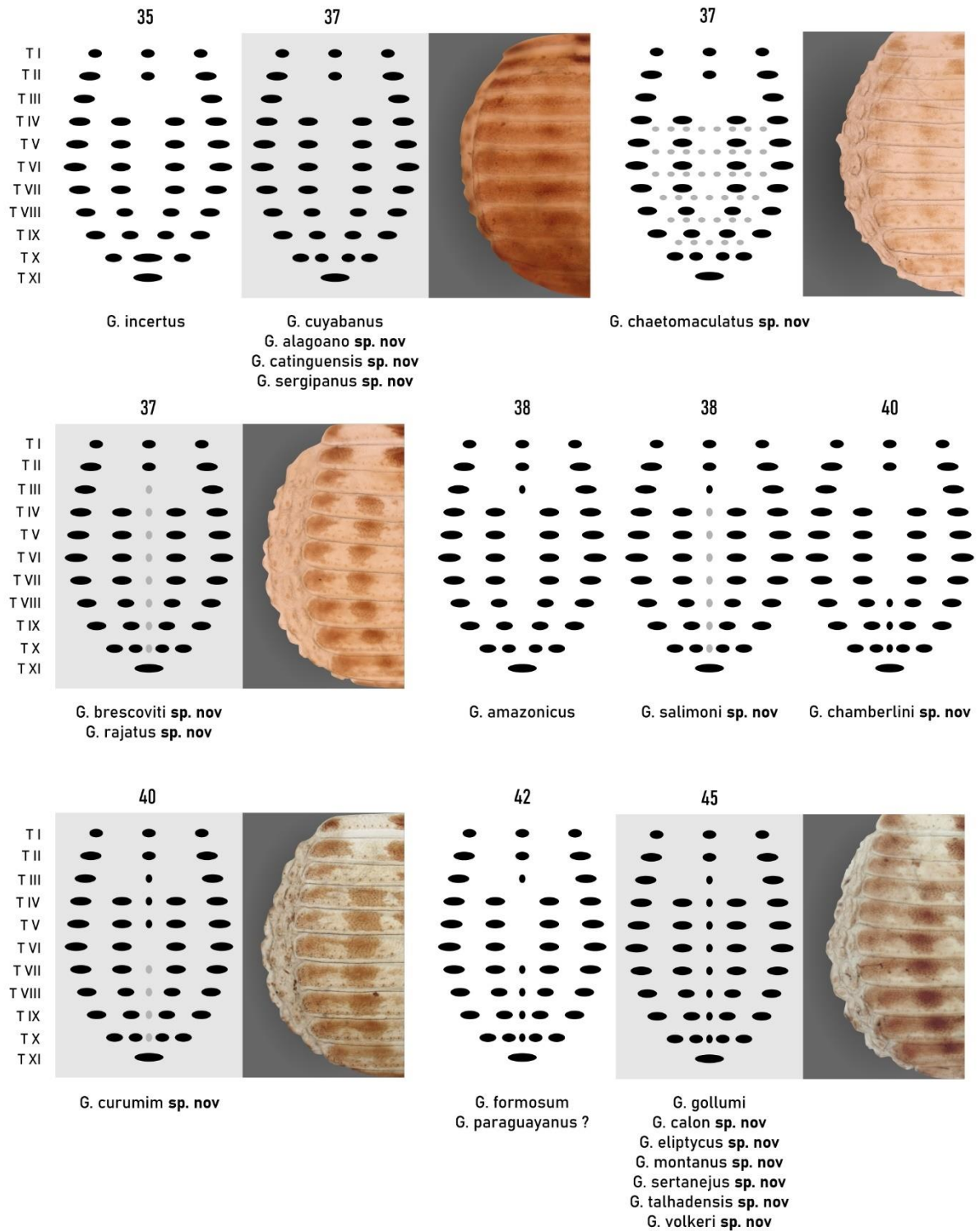
The color pattern within the family is variable (Fig. 3A), ranging from entirely brown to various patterns of brown and white areas (Harvey, 1986). The brown areas are commonly referred to as darkspots (Fig. 3B). The fossil *G. gorski* (46Mi), preserved in Baltic amber, exhibits a unique pigmentation pattern consisting of three darkspots along the medial line, six along the submedial line and seven along the lateral line (Henderickx, 2005). These darkspots may vary in their degree of connection, forming a distinct pigmentation pattern (see, Henderickx, 2005 fig. 2).

The typical coloration of extant species is exemplified by the Brazilian species *G. amazonicus* e *G. formosus* (Harvey, 1986). Both species display three longitudinal lines of darkspots, with *G. amazonicus* having four darkspots on the medial line and *G. Formosus* having seven. Both species exhibit seven darkspots on submedial line and ten darkspots on lateral line (see, Mahnert, 1979 fig. 85; Mello-Leitão, 1937 fig. 1). They primarily differ in the number of darkspots along the medial line, as in the shape and degree of connection between the spots (Fig. 4).

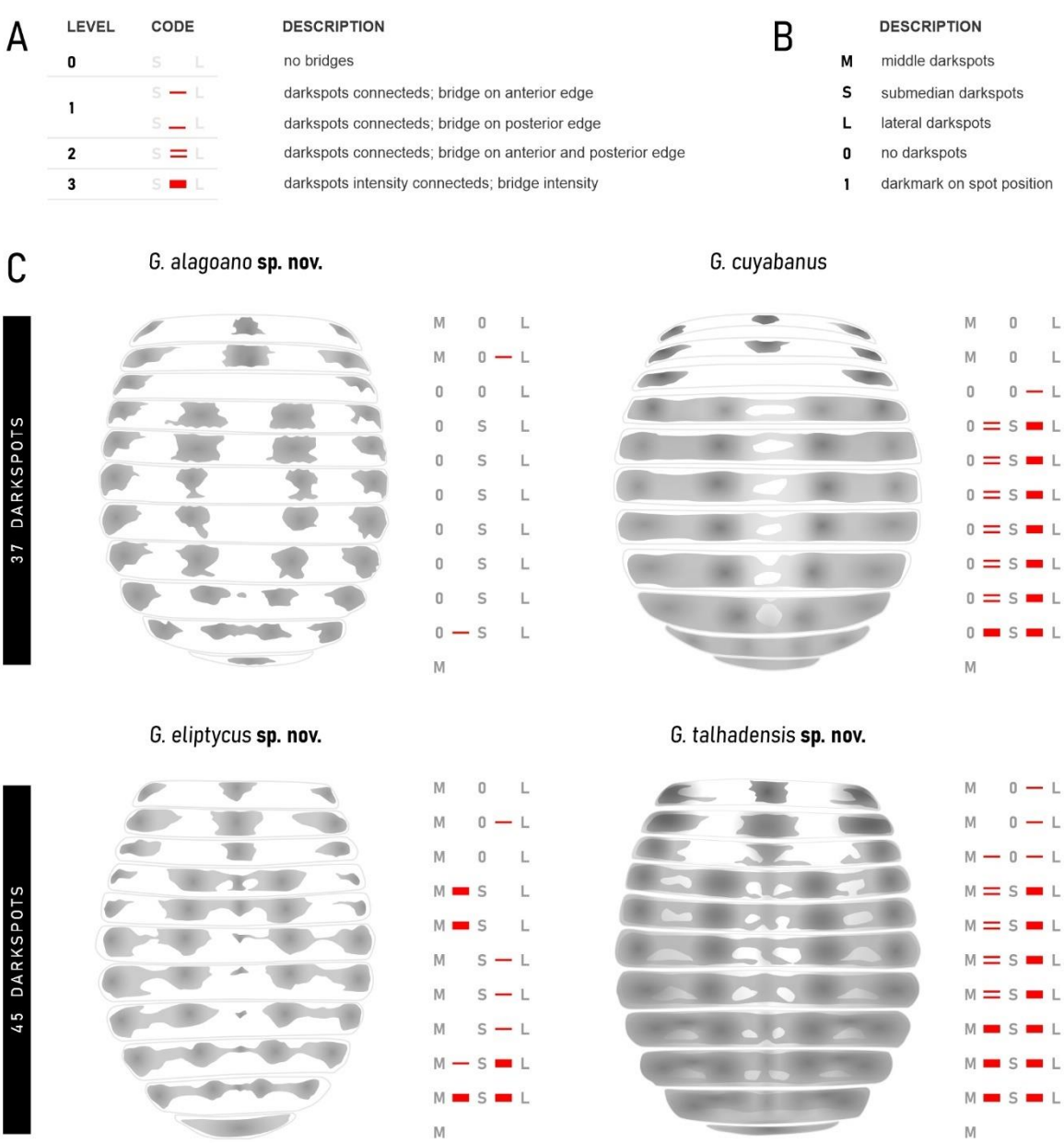
To describe color patterns comparatively in Brazilian species, we introduce the term bridge to refer to lighter colored areas (or areas of the same color as the darkspots) that connect darkspots. These bridges can exhibit varying degrees of connection, covering large areas in some species but being absent in others (Fig. 5, see, *G. alagoensis* **sp. nov.** and *G. sergipensis* **sp. nov.**).

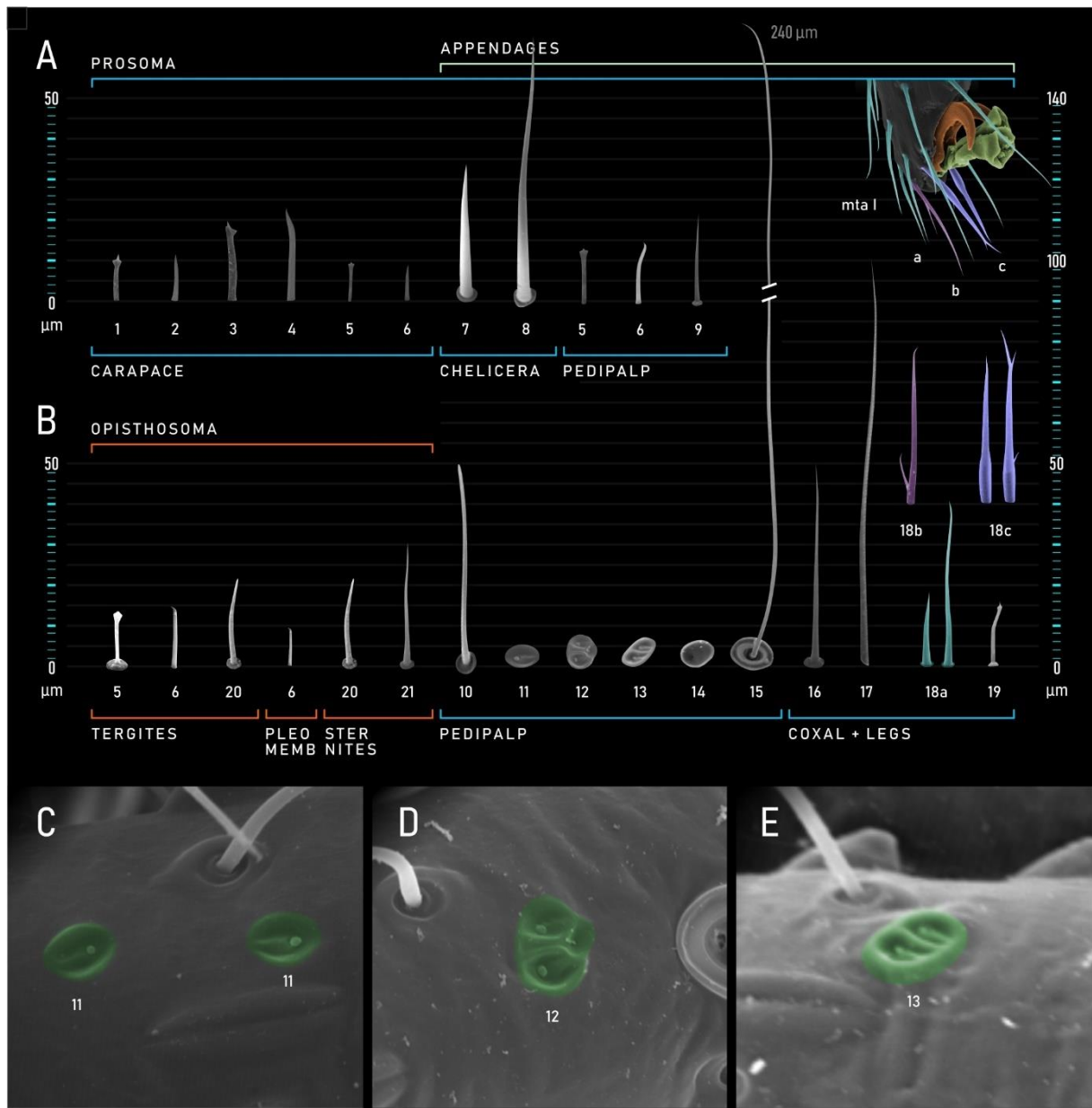


**Figure 3.** A. Definition of the different levels of pigments intensity on of the *Geogarypus* Brazilian species, variable number of dark spots, presence and intensity of bridges and presence and intensity of dark marks. B. Synthesis and examples of terms related to the coloration of the *Geogarypidae* and exemplification of the terms used to describe the color patterns of the genera *Geogarypus* and *Afrogearypus*, highlighting the position of the bridges. C. Common location of dark marks.



**Figure 4.** *Geogarypus* tergites I–XI with dark spots count from Brazil and nearby regions, according to literature and data from this study. ? – Represents inconsistent or lacking data.





**Figure 6.** Chaetae bank, it is a collection of SEM photographs of different chaetae found along the body, the chaetae are representatives of their shapes, sizes and position in the body. A. Prosoma and appendages chaetae. B. Opisthosoma chaetae. C. *pns* type 11. *G. sergipensis* sp. nov. D. *pns* type 12. *G. salimoni* sp. nov. E. *pns* type 13. *G. eliptycus* sp. nov.

## 2.6 Coded description

To describe the species, we are using the new coded taxonomic description method proposed by Zeppelini et al., 2024. The coded description can be easily imported, transformed, changed, corrected or expanded. The coded description allows new morphological, molecular and ecological characters to be easily added to the list, improving the descriptive matrix as new information is produced. The information from the entire collection of data of each species

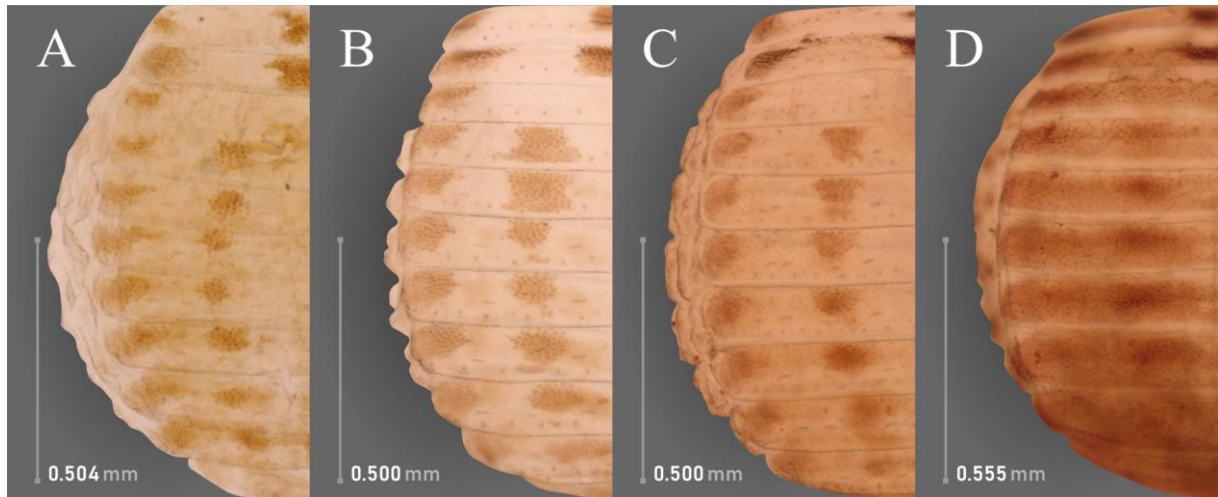
results in a dataset as synthesized in Table 1. The quantitative description of the character is replaced by the respective number in the chaetae bank (Fig. 6) that represents the actual observed shape and size. The coded dataset is hierarchically ordered in four columns, namely, Tagma, Segment, Field and Morphological unit (Tab. 2). A fifth column is inserted with the coded information. The cells in the column of morphological unit are the actual features to be observed in the specimen, where each one is a recognizable morphological unit of the animal whole morphology, that is described and coded in the character list (Appendix 1).

| <b>Tagma</b> | <b>Segment</b> | <b>Field</b>   | <b>Morphologic unit</b> | <b>Morphologic unit state</b>                 | <b>Code</b> |
|--------------|----------------|----------------|-------------------------|-----------------------------------------------|-------------|
| PROSOMA      | Carapace       | shield         | sfrm                    | strongly sub-triangular                       | 0           |
|              |                |                | cu                      | snout-like                                    | 0           |
|              |                |                | a                       | 4; same size                                  | 0           |
|              |                |                | an                      | 4 2(1) + 2(3)                                 | 0           |
|              |                |                | oc + me + in            | 90 90(6)                                      | 1           |
|              |                |                | po                      | 16 16(6)                                      | 2           |
|              |                | color          | shc                     | uniformly red-brown to light-brown            | 0           |
|              |                |                | cuc                     | light-brown                                   | 0           |
|              |                |                | cor                     | red-brown with dark line on eyes              | 2           |
|              |                |                | cmf                     | light-brown                                   | 1           |
|              |                |                | caf                     | light-brown                                   | 0           |
|              |                | darkspot       | dld                     | blackened                                     | 0           |
|              |                |                | dmp                     | red-brown; discrete                           | 0           |
|              | Chelicera      | hand           | h                       | 5 5(9)                                        | 1           |
|              |                |                | lyf d + v               | 2+1                                           | 0           |
|              |                |                | r                       | 1 blade pointed                               | 0           |
|              |                | fixed finger   | ff                      | 0                                             | 0           |
|              |                |                | serr int                | 10 blades                                     | 0           |
|              |                |                | tooth                   | 5 distinct teeth                              | 0           |
|              |                | movable finger | mf                      | 1 1(11)                                       | 0           |
|              |                |                | serr ext                | 16 blades                                     | 2           |
|              |                |                | galea                   | coniform, left with 3 spinules; 9 distal rami | 4           |
|              |                |                | tooth                   | 2 small subapical teeth                       | 0           |
|              | Pedipalp       | chaela         | tr                      | 40 40(6)                                      | 0           |
|              |                |                | fe                      | 88 85(6) + 3(5)                               | 5           |
|              |                |                | pa                      | 39 34(6) + 5(5)                               | 11          |
|              |                |                | h                       | 60 60(6)                                      | 5           |
|              |                |                | hfrm                    | simple                                        | 0           |
|              |                | faster finger  | ff                      | 42 30(13) + 8(17) + 4(18)                     | 11          |

|            |                   |        |              |                              |    |
|------------|-------------------|--------|--------------|------------------------------|----|
|            | movable<br>finger |        | tooth        | 34 teeth; heterodontate      | 2  |
|            |                   |        | dist         | conic acuminate              | 0  |
|            |                   |        | prox         | conic acuminate              | 0  |
|            |                   |        | vd           | short                        | 0  |
|            |                   |        | mf           | 35 30(13) + 1(16) + 4(17)    | 8  |
|            |                   |        | tooth        | 23–25 teeth                  | 0  |
|            |                   |        | dist         | triangular acuminate         | 0  |
|            |                   |        | prox         | rounded                      | 0  |
|            |                   |        | vd           | short                        | 0  |
|            | Coxal<br>region   | setae  | cx P         | 26 22+3(19) + 1 (22)         | 6  |
|            |                   |        | cx I         | 9 9(19)                      | 8  |
|            |                   |        | cx II        | 12 12(19)                    | 8  |
|            |                   |        | cx III       | 20 20(19)                    | 9  |
|            |                   |        | cx IV        | 30 30(19)                    | 0  |
|            | Legs              | leg I  | tr           | 7 7(20a)                     | 3  |
|            |                   |        | fe           | 13 13(20a)                   | 4  |
|            |                   |        | pa           | 18 18(20a)                   | 10 |
|            |                   |        | ti           | 22 22(20a)                   | 2  |
|            |                   |        | ta           | 23 23(20a)                   | 1  |
|            |                   |        | mta          | 28 25(20a) + 1(20b) + 2(20c) | 9  |
|            |                   |        | clw          | simple                       | 0  |
|            |                   |        | arr          | slightly longer than claws   | 0  |
|            |                   | leg IV | tr           | 13 10(20a) + 3(22)           | 1  |
|            |                   |        | fe           | 6 6(20a)                     | 0  |
|            |                   |        | pa           | 17 17(20a)                   | 7  |
|            |                   |        | ti           | 26 26(20a)                   | 7  |
|            |                   |        | ta           | 30 30(20a)                   | 0  |
|            |                   |        | mta          | 26 24(20a) + 2(20c)          | 1  |
|            |                   |        | clw          | simple                       | 0  |
|            |                   |        | arr          | slightly longer than claws   | 0  |
| OPISTOSOMA |                   | plm    | 18 18(6)     | 0                            |    |
|            |                   | scl    | 12 sclerites | 0                            |    |
|            | Tergites          | td     | 14; IV–X     | 1                            |    |
|            |                   | T I    | 18 18(5)     | 2                            |    |
|            |                   | T II   | 18 18(5)     | 4                            |    |
|            |                   | T III  | 31 31(5)     | 8                            |    |
|            |                   | T IV   | 38 38(5)     | 10                           |    |
|            |                   | T V    | 43 43(5)     | 7                            |    |
|            |                   | T VI   | 36 36(5)     | 9                            |    |
|            |                   | T VII  | 35 35(5)     | 6                            |    |
|            |                   | T VIII | 37 37(5)     | 7                            |    |
|            |                   | T IX   | 34 34(5)     | 7                            |    |
|            |                   | T X    | 35 35(5)     | 5                            |    |
|            |                   | T XI   | 36 36(5)     | 8                            |    |

|  |           |             |              |               |   |
|--|-----------|-------------|--------------|---------------|---|
|  |           | A           | 2 2(23)      | 0             |   |
|  |           | darkspots   | tdsp         | 45 darkspots; | 0 |
|  |           | Td I        | 3 discrete   | 0             |   |
|  |           | Td II       | 3 discrete   | 0             |   |
|  |           | Td III      | 3 discrete   | 1             |   |
|  |           | Td IV       | 5 continuous | 0             |   |
|  |           | Td V        | 5 continuous | 1             |   |
|  |           | Td VI       | 5 continuous | 1             |   |
|  |           | Td VII      | 5 continuous | 1             |   |
|  |           | Td VIII     | 5 continuous | 1             |   |
|  |           | Td IX       | 5 continuous | 0             |   |
|  |           | Td X        | 5 continuous | 0             |   |
|  |           | Td XI       | 1 continuous | 0             |   |
|  |           | bridges     | Tb I         | M 0 L         | 0 |
|  |           |             | Tb II        | M 0 – L       | 1 |
|  |           |             | Tb III       | M 0 – L       | 2 |
|  |           |             | Tb IV        | M – S – L     | 3 |
|  |           |             | Tb V         | M – S – L     | 3 |
|  |           |             | Tb VI        | M S – L       | 1 |
|  |           |             | Tb VII       | M – S ■ L     | 7 |
|  |           |             | Tb VIII      | M ■ S ■ L     | 1 |
|  |           | Tb IX       | M ■ S ■ L    | 0             |   |
|  |           | Tb X        | M ■ S ■ L    | 0             |   |
|  |           | Tb XI       | M            | 0             |   |
|  | Sternites | setae + lyf | S II         | 14 14(24)     | 1 |
|  |           |             | S III        | 12 12(24)     | 3 |
|  |           |             | S IV         | 12 12(24)     | 2 |
|  |           |             | S V          | 22 22(24)     | 1 |
|  |           |             | S VI         | 24 24(24)     | 0 |
|  |           |             | S VII        | 27 27(24)     | 5 |
|  |           |             | S VIII       | 28 28(24)     | 6 |
|  |           |             | S IX         | 20 20(24)     | 2 |
|  |           |             | S X          | 18 18(24)     | 4 |
|  |           |             | S XI         | 0             | 1 |

**Table 1.** Morphologic unit state description and coded description of *G. calon* sp. nov.



**Figure 7.** Brazilian Geogarypids opisthosome: Tergites I–XI with dark spots and bridges in colors: Species that do not have dark spots or dark marks in the medial region of the tergites III–VIII. A. *G. caatinguensis* **sp. nov.** B. *G. alagoensis* **sp. nov.** C. *G. sergipanus* **sp. nov.** D. *G. cuyabanus* Balzan, 1887.

### 3Results

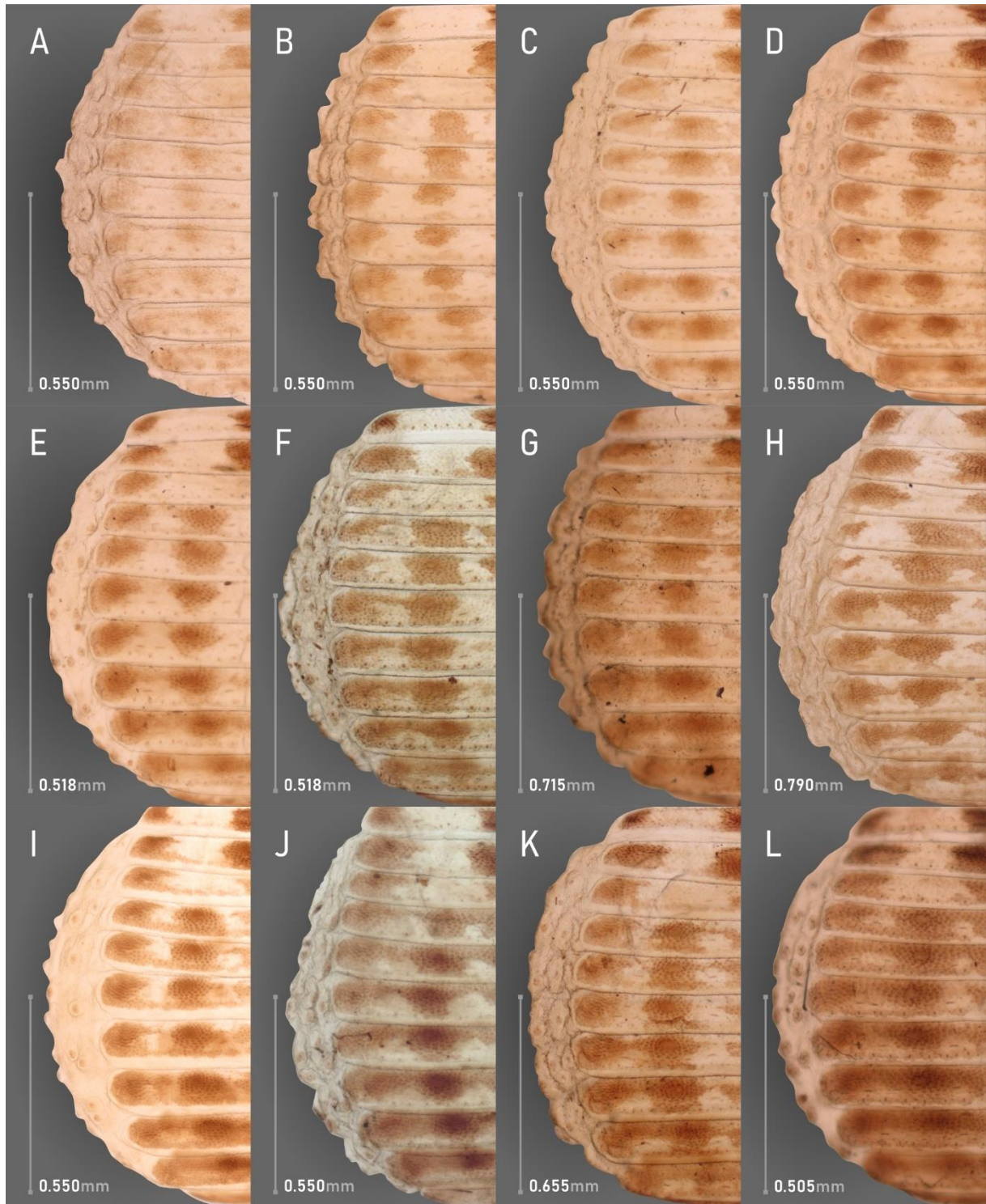
#### 3.1Key to South American Geogarypids Species

- 1' Species that do not have dark spots or dark marks in the medial region of the tergites II–VIII (Fig. 7) ..... 2
- 1'' Species that have dark spots or dark marks in the medial region of the tergites III–VIII (Fig. 8) ..... 8
- 2' Fingers smaller than hand with pedicel ..... 3
- 2'' Fingers longer or the same size than hand with pedicel ..... 4
- 3' Opisthosome softly orange; Not defined edges of the dark spots; Bridges covering all tergites, except the medial region; Without dark spot medial posterior of the carapace; Chelae fingers smaller than hand with pedicel; Galea of male coniform with 1 spinule; Pedipalpal patella ratio: 2.4x; Total chaetae faster finger: 62 50(13) + 8(17) + 4(18); Chela with pedicel ratio: 3.4x; Leg IV femur with patella ratio: 4.4x; Leg IV patella ratio: 3.1x ..... *G. cuyabanus*
- 3'' Opisthosome yellowish; Well-defined edges of the dark spots; Bridges absent; With dark spot medial posterior of the carapace; Chelae fingers smaller than hand with pedicel; Galea of male coniform simple; Pedipalpal patella ratio: 1.9x; Total chaetae faster finger: 47 3(12) + 30(13) + 8(17) + 3+3(18); Chela with pedicel ratio: 2.6x; Leg IV femur with patella ratio: 3.0x; Leg IV patella ratio: 2.3x ..... *G. caatinguensis* **sp. nov.**

- 4' Without Setose pustules on the carapace and pedipalps; Tergites not divided; body: 1.5–1.7mm ..... 5
- 4'' Setose pustules on the carapace and pedipalps; All or some tergites divided; body: 2.3–2.5mm ..... 7
- 5' Chelae fingers longer than hand with pedicel; Pedipalpal patella ratio: 2.5x; Chela with pedicel ratio: 3.1–3.3x ..... 6
- 5'' Chelae fingers the same size that hand with pedicel; Pedipalpal patella ratio: 3.7x; Chela with pedicel ratio: 3.7x ..... *G. fiebrigi* (Paraguay)
- 6' Galea of male coniform with 1 spinule; Galea of female with 9 ramis; Pedipalpal femur without granular humps; Chela with pedicel ratio: 3.1x; Pedipalpal femur ratio: 4.0x; Leg I tarso ratio: 2.4x; Leg I metatarso ratio: 3.2x; Leg IV femur with patella ratio: 4.2x; Leg IV tarso ratio: 3.2x; Leg IV metatarso ratio: 4.0x ..... *G. alagoensis* **sp. nov.**
- 6'' Galea of male coniform simple; Galea of female with 9 rami; Pedipalpal femur without granular humps; Chela with pedicel ratio: 3.3x; Pedipalpal femur ratio: 3.3x; Leg I tarso ratio: 2.0x; Leg I metatarso ratio: 2.2x; Leg IV femur with patella ratio: 3.3x; Leg IV tarso ratio: 2.6x; Leg IV metatarso ratio: 3.2x ..... *G. sergipensis* **sp. nov.**
- 6''' Galea of male coniform simple; Galea of female with 7 rami; Pedipalpal femur with granular humps; Chela with pedicel ratio: 3.6x; Pedipalpal femur ratio: 3.1x; Leg I tarso ratio: 2.4x; Leg I metatarso ratio: 3.2x; Leg IV femur with patella ratio: 3.6x; Leg IV tarso ratio: 2.9x; Leg IV metatarso ratio: 2.6x ..... *G. incertus* (French Guiana)
- 7' Galea of female with 6–7 rami; ..... *G. buculentus* (Chile)
- 7'' Galea of female with 10 rami; ..... *G. postulatus* (Argentina and Chile)
- 8' Species that have dark spots in the medial region of the tergites III–X ..... 10
- 8'' Species that no have dark spots in the medial region of the tergites III–X ..... 9
- 9' Galea of female with 8 ramis; Chelicera with 1 small subapical teeth on fixed finger and 6 distinct teeth on movable finger; Pedipalpal femur without granular humps Pedipalpal hand ratio: 1.4x; Total chaetae faster finger: 92 80(13) + 8(17) + 4(18); Leg I femur ratio: 2.7x; Leg IV trochanter ratio: 1.4x; Leg IV femur ratio: 1.3x; Leg IV femur with patella ratio: 3.6x; Pleoral membran with 33 sclerites ..... *G. brescoviti* **sp. nov.**

- 9'' Galea of female with 9 ramis; Chelicera with 2 small subapical teeth on fixed finger and 4 distinct teeth on movable finger; Pedipalpal femur without granular humps Pedipalpal hand ratio: 1.7x; Total chaetae faster finger: 66 48(13) + 7(6) + 8(17) + 3(18); Leg I femur ratio: 2.6x; Leg IV trochanter ratio: 1.5x; Leg IV femur ratio: 1.6x; Leg IV femur with patella ratio: 3.7x; Pleoral membran without sclerites ..... *G. rajatus* **sp. nov.**
- 9''' Galea of female with 10 ramis; Chelicera with 2 small subapical teeth on fixed finger and 5 distinct teeth on movable finger; Pedipalpal femur with granular humps; Pedipalpal hand ratio: 1.6x; Total chaetae faster finger: 75 5(5) + 60(13) + 8(17) + 2(18); Leg I femur ratio: 3.2x; Leg IV trochanter ratio: 2.0x; Leg IV femur ratio: 1.8x; Leg IV femur with patella ratio: 4.5x; Pleoral membran with 16 sclerites ..... *G. chaetomaculatus* **sp. nov.**
- 10' Species that have middle dark spots on the tergite III. .... 11
- 10'' Specie without middle dark spots on the tergite III. .... *G. chamberlini* **sp. nov.**
- 11' Species that have above 39 dark spots total ..... 13
- 11'' Species that have 38 dark spots total ..... 12
- 12' Chelicera rallum with 1 blade pointed; Pedipalpal patella ratio: 2.4–2.5x; Pedipalpal hand ratio: 1.6–1.8x; Leg I tarsus ratio: 2.1–2.5x; Leg I metatarsus ratio: 2.6–3.1x; Leg IV tibia ratio: 2.2–2.5x; Leg IV metatarsus ratio: 2.8–3.2x; Tergites IV–X without dark marks ..... *G. amazonicus*
- 12'' Chelicera rallum with 1 long blade pointed; Pedipalpal patella ratio: 2.1x; Pedipalpal hand ratio: 1.3x; Leg I tarsus ratio: 2.8x; Leg I metatarsus ratio: 4.3x; Leg IV tibia ratio: 3.4x; Leg IV metatarsus ratio: 4.5x; Tergites IV–X with dark marks ..... *G. salimoni* **sp. nov.**
- 13' Species that have 40–42 dark spots total ..... 14
- 13'' Species that have 45 dark spots total ..... 16
- 14' Species that have 40 dark spots total; Dark spots in the medial region of the tergite VI; Dark spots in the medial region of the tergites VII–X ..... 15
- 14'' Species that have 42 dark spots total; Without dark spots in the medial region of the tergite VI; Dark marks in the medial region of the tergites VII–X ..... *G. curcumim* **sp. nov.**
- 15' Body: 2.0mm; Carapace and pedipalpal blackened; Anterior eyes smaller than posterior eyes; Pedipalpal femur L: 0.65mm; Pedipalpal patella L: 0.50mm; Total teeth fixed finger/movable finger: 38/32. .... *G. formosus*

- 15'' Body: 1.6mm; Carapace and pedipalpal redbrown; Anterior eyes same size than posterior eyes; Pedipalpal femur L: 0.56mm; Pedipalpal patella L: 0.40mm; Total teeth fixed finger/movable finger: 27/22. .... *G. paraguayanus*
- 16' Four thrichobotria on movable finger. .... 17
- 16'' Three thrichobotria on movable finger. .... *G. gollumi*
- 17' Carapace (oc + an + in) chaetae type 6. .... 18
- 17'' Carapace (oc + an + in) chaetae type 5. .... 19
- 18' Chelicera coniform with 3 spinules; Chelicera rallum with 1 blade pointed; Pleoral membran with 12 scletires. .... *G. calon sp. nov.*
- 18'' Chelicera coniform simple; Chelicera rallum with 1 blade bifurcated; Pleoral membran with 18 scletires. .... *G. sertanejus sp. nov.*
- 18''' Chelicera coniform simple; Chelicera rallum with 1 blade pointed; Pleoral membran with 27 scletires. .... *G. talhadensis*
- 19' Without *pnso* on movable finger; Total *pls*: 5; Tergital discs (td): 14 (T IV–X). ....  
..... *G. montanus sp. nov.*
- 19'' With *pnso* type 16 on movable finger; Total *pls*: 3; Tergital discs (td): 4 (T IV–V). ....  
..... *G. volkeri sp. nov.*
- 19''' With *pnso* type 16 on movable finger; Total *pls*: 7; Tergital discs (td): 14 (T IV–X). ....  
..... *G. eliptycus sp. nov.*



**Figure 8.** Brazilian Geogarypids opisthosome: Tergites I–XI with dark spots and bridges in colors: Species that do not have dark spots or dark marks in the medial region of the tergites III–VIII. A. *G. chaetomaculatus* **sp. nov.** B. *G. salimoni* **sp. nov.** C. *G. rajatus* **sp. nov.** D. *G. brescoviti* **sp. nov.** E. *G. chamberlini* **sp. nov.** F. *G. curumim* **sp. nov.** G. *G. volkeri* **sp. nov.** H. *G. eliptycus* **sp. nov.** I. *G. montanus* **sp. nov.** J. *G. calon* **sp. nov.** K. *G. sertanejus* **sp. nov.** L. *G. talhadensis* **sp. nov.**

**Table 2.** Morphologic units' ratio of Brazilian new *Geogarypus* species.

|                     | <i>G. cuyabanus</i> Balzan, 1887 | <i>G. alagoensis</i> sp. nov. | <i>G. brescovit</i> sp. nov. | <i>G. colon</i> sp. nov. | <i>G. caatinguensis</i> sp. nov. | <i>G. chaetomaculatus</i> sp. nov. | <i>G. chamberlini</i> sp. nov. | <i>G. curumim</i> sp. nov. | <i>G. eliptycus</i> sp. nov. | <i>G. montanus</i> sp. nov. | <i>G. rajatus</i> sp. nov. | <i>G. saminonium</i> sp. nov. | <i>G. sergipensis</i> sp. nov. | <i>G. sertanejus</i> sp. nov. | <i>G. talhadensis</i> sp. nov. | <i>G. volkeri</i> sp. nov. |
|---------------------|----------------------------------|-------------------------------|------------------------------|--------------------------|----------------------------------|------------------------------------|--------------------------------|----------------------------|------------------------------|-----------------------------|----------------------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|----------------------------|
| <i>body</i>         | 1.63–2.3                         | 1.70                          | 1.93                         | 1.78                     | 1.60                             | 2.00                               | 1.60                           | 2.10                       | 2.40                         | 2.00                        | 1.68                       | 2.0                           | 1.57                           | 1.91                          | 1.66                           | 2.13                       |
| <i>Ca</i>           | 0.86x                            | 0.94x                         | 0.94x                        | 0.9x                     | 0.87x                            | 0.89x                              | 0.9x                           | 0.8x                       | 0.9x                         | 0.9x                        | 0.88x                      | 0.9x                          | 0.8x                           | 0.96x                         | 1.0x                           | 0.9x                       |
| <i>cu</i>           | 0.55x                            | 0.53x                         | 0.61x                        | 0.68x                    | 0.55x                            | 0.56x                              | 0.6x                           | 0.6x                       | 0.61x                        | 0.69x                       | 0.59x                      | 0.6x                          | 0.56x                          | 0.64x                         | 0.8x                           | 0.67x                      |
| <i>P tr</i>         | 1.77x                            | 1.32x                         | 0.82x                        | 1.0x                     | 1.2x                             | 1.1x                               | 1.2x                           | 1.3x                       | 1.36x                        | 1.0x                        | 0.75x                      | 1.3x                          | 1.33x                          | 0.73x                         | 0.8x                           | 1.25x                      |
| <i>P fe</i>         | 3.3x                             | 4.0x                          | 3.0x                         | 3.1x                     | 2.4x                             | 3.4x                               | 3.3x                           | 3.1x                       | 3.2x                         | 3.2x                        | 3.6x                       | 3.0x                          | 3.3x                           | 3.2x                          | 3.6x                           | 3.3x                       |
| <i>P pa</i>         | 2.4x                             | 2.5x                          | 2.5x                         | 2.7x                     | 1.9x                             | 2.5x                               | 2.3x                           | 2.3x                       | 2.3x                         | 2.2x                        | 2.7x                       | 2.1x                          | 2.5x                           | 2.6x                          | 2.5x                           | 2.5x                       |
| <i>P h</i>          | 1.4x                             | 1.4x                          | 1.4x                         | 1.4x                     | 1.4x                             | 1.6x                               | 1.3x                           | 1.4x                       | 1.6x                         | 1.4x                        | 1.7x                       | 1.3x                          | 1.5x                           | 1.4x                          | 1.4x                           | 1.5x                       |
| <i>P Ch</i>         | 3.4x                             | 3.1x                          | 3.2x                         | 2.9x                     | 2.6x                             | 3.3x                               | 3.1x                           | 3.1x                       | 3.3x                         | 3.1x                        | 3.6x                       | 2.9x                          | 3.3x                           | 3.2x                          | 3.2x                           | 2.9x                       |
| <i>P fi</i>         | 0.9x                             | 1.0x                          | 0.9x                         | 0.9x                     | 1.0x                             | 1.0x                               | 1.0x                           | 1.0x                       | 1.0x                         | 1.0x                        | 1.0x                       | 0.9x                          | 1.0x                           | 1.0x                          | 0.9x                           | 1.0x                       |
| <i>L I tr</i>       | 2.0x                             | 1.4x                          | 1.1x                         | 1.4x                     | 1.2x                             | 1.2x                               | -                              | 1.3x                       | 1.4x                         | 1.2x                        | 1.2x                       | 1.2x                          | 1.4x                           | 1.6x                          | 1.1x                           | 1.6x                       |
| <i>L I fe</i>       | 3.0x                             | 2.1x                          | 2.7x                         | 2.6x                     | 2.5x                             | 3.2x                               | -                              | 3.0x                       | 2.9x                         | 2.5x                        | 2.6x                       | 2.7x                          | 2.4x                           | 2.6x                          | 3.0x                           | 2.3x                       |
| <i>L I pa</i>       | 1.6x                             | 1.7x                          | 1.6x                         | 1.5x                     | 1.7x                             | 2.0x                               | -                              | 1.2x                       | 2.0x                         | 1.8x                        | 1.8x                       | 1.5x                          | 1.7x                           | 2.0x                          | 1.6x                           | 2.0x                       |
| <i>L I ti</i>       | 2.6x                             | 2.5x                          | 2.7x                         | 2.0x                     | 2.5x                             | 2.5x                               | -                              | 2.5x                       | 2.8x                         | 2.7x                        | 2.8x                       | 2.5x                          | 2.0x                           | 2.3x                          | 2.4x                           | 2.5x                       |
| <i>L I ta</i>       | 3.0x                             | 2.4x                          | 2.8x                         | 2.8x                     | 2.5x                             | 2.8x                               | -                              | 2.1x                       | 2.4x                         | 2.5x                        | 2.2x                       | 2.8x                          | 2.0x                           | 2.4x                          | 2.2x                           | 2.1x                       |
| <i>L I mt</i>       | 4.3x                             | 3.2x                          | 4.0x                         | 3.2x                     | 3.3x                             | 3.7x                               | -                              | 2.6x                       | 3.5x                         | 4.0x                        | 4.3x                       | 4.3x                          | 2.2x                           | 2.5x                          | 3.5x                           | 3.5x                       |
| <i>L IV tr</i>      | 1.5x                             | 1.5x                          | 1.4x                         | 1.3x                     | 1.2x                             | 2.0x                               | -                              | 1.5x                       | 1.6x                         | 1.4x                        | 1.5x                       | 1.3x                          | 1.6x                           | 1.4x                          | 1.6x                           | 1.7x                       |
| <i>L IV fe</i>      | 1.4x                             | 1.7x                          | 1.3x                         | 1.5x                     | 1.6x                             | 1.8x                               | -                              | 1.6x                       | 1.7x                         | 1.8x                        | 1.6x                       | 1.6x                          | 1.7x                           | 1.6x                          | 1.5x                           | 1.5x                       |
| <i>L IV pa</i>      | 3.1x                             | 3.2x                          | 2.9x                         | 2.7x                     | 2.3x                             | 3.5x                               | -                              | 3.0x                       | 3.3x                         | 2.9x                        | 3.0x                       | 2.7x                          | 2.3x                           | 3.0x                          | 2.7x                           | 3.0x                       |
| <i>L IV fe + pa</i> | 4.4x                             | 4.2x                          | 3.6x                         | 3.5x                     | 3.0x                             | 4.5x                               | -                              | 4.0x                       | 4.0x                         | 3.6x                        | 3.7x                       | 3.6x                          | 3.3x                           | 4.0x                          | 3.5x                           | 3.8x                       |
| <i>L IV ti</i>      | 3.1x                             | 3.0x                          | 4.2x                         | 3.6x                     | 3.4x                             | 4.5x                               | -                              | 3.6x                       | 4.1x                         | 3.1x                        | 3.8x                       | 3.4x                          | 2.8x                           | 3.2x                          | 3.7x                           | 3.6x                       |
| <i>L IV ta</i>      | 2.8x                             | 3.2x                          | 3.0x                         | 2.8x                     | 2.2x                             | 3.0x                               | -                              | 3.1x                       | 3.4x                         | 3.0x                        | 3.2x                       | 3.0x                          | 2.6x                           | 2.6x                          | 3.2x                           | 3.3x                       |
| <i>L IV mta</i>     | 3.0x                             | 4.0x                          | 4.0x                         | 2.8x                     | 3.0x                             | 3.4x                               | -                              | 3.2x                       | 4.0x                         | 3.4x                        | 3.7x                       | 4.5x                          | 3.2x                           | 3.5x                          | 3.7x                           | 3.6x                       |

### 3.2 Dazzling Endemic Diversity

A review of Brazilian Geogarypidae specimens deposited in various arachnids collections (see topic 3.3 *Taxonomy*), analyzed approximately 1,600 samples, identifying around 2000 specimens from different terrestrial and subterranean ecosystems across Brazil. Geogarypidae was recorded in less than 12% of the samples and only 9% of the identified pseudoscorpions belonged to this family.

Despite the relative rarity and low number of records for the family in Brazil, we identified 181 specimens, representing 27 species and one new genus. In total, 22 new species and four new morphotypes were discovered. Among all the species analyzed, only one, *G. cuyabanus* (Balzan, 1887), had been previously described.

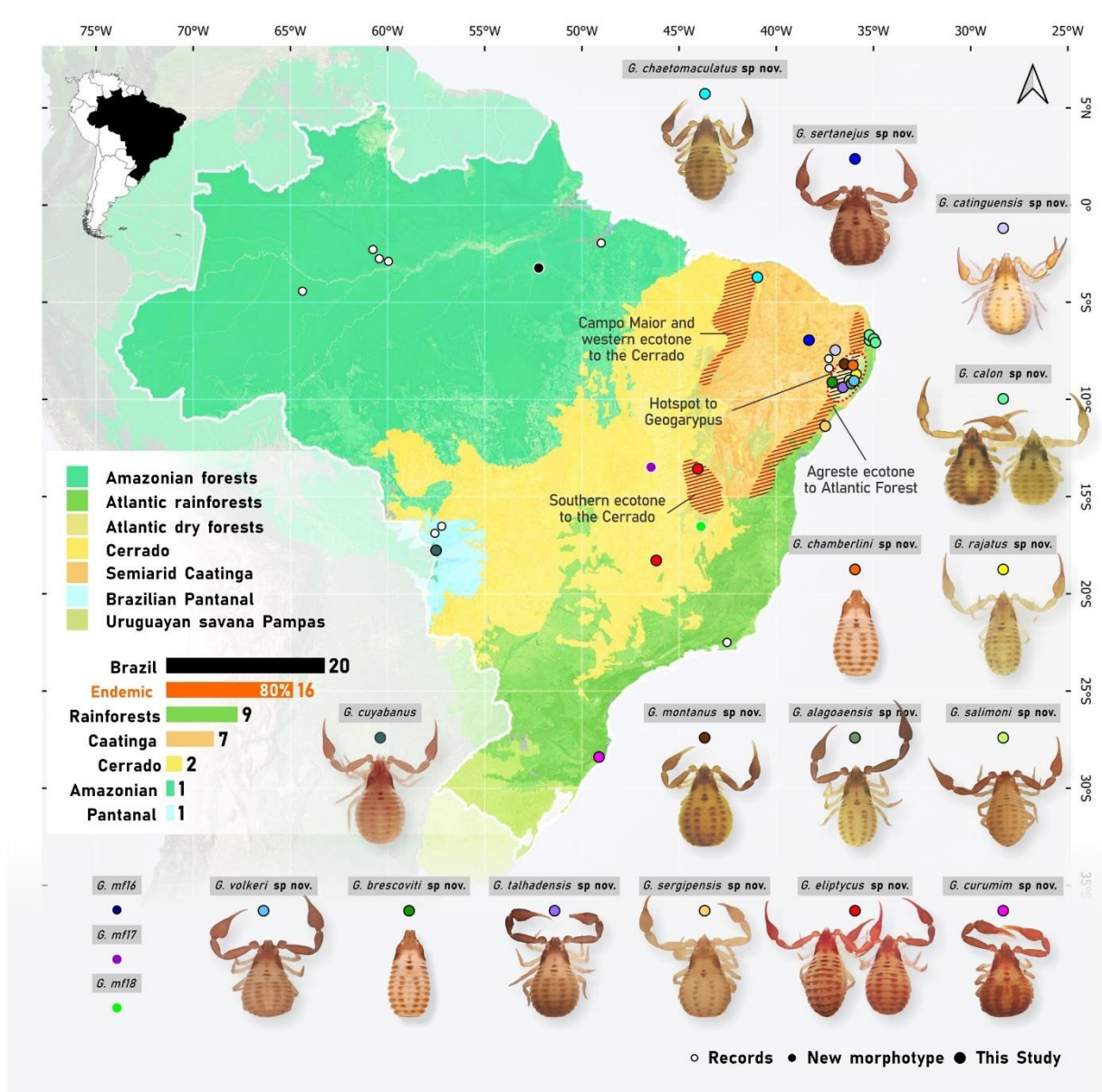
Of the newly recorded fauna, 15 species new species are endemic to specific ecosystems (Tab. 3 and Fig. 9), this implies that 80% of Brazilian Geogarypids are endemic. The

remarkable number of new species is distributed across nearly all biomes, including (Amazon, Atlantic Rainforest, Brazilian Cerrados, Pantanal, Caatinga), except for the Pampas.

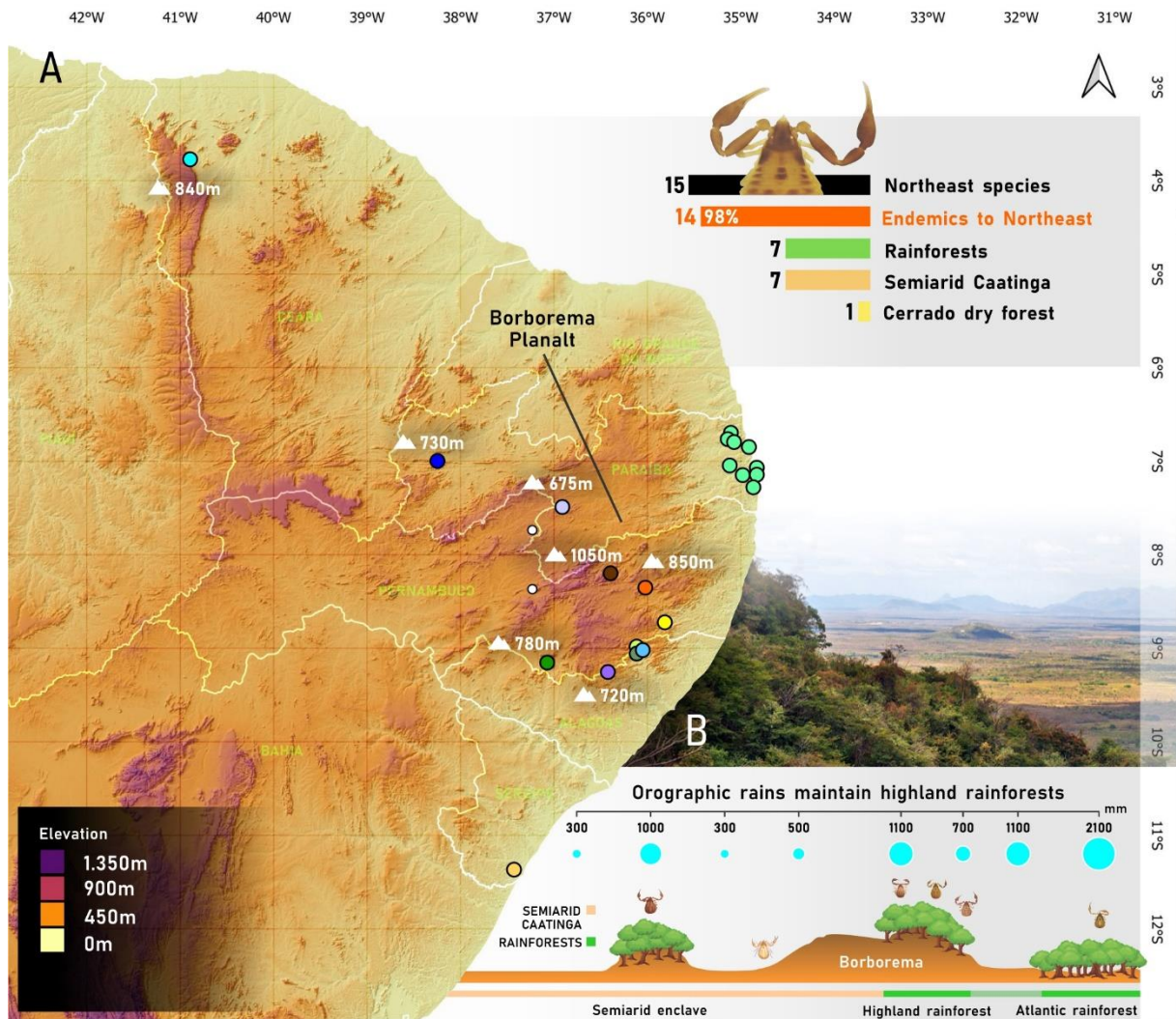
The newly described Brazilian species are primarily found in the northeastern and southeastern regions, specifically in the Caatinga enclaves of humid forests (five species) and highland rainforests (six species). Additionally, new species were recorded in the Atlantic Rainforest (eight species), Brazilian Cerrado (two species), and Caatinga (six species), as well as in cave (two species). Furthermore, we identified three new cave morphotypes, with one from the Amazon and two from the Brazilian Cerrado (Fig. 9 and 10). The findings position Brazil as the most diverse country in the world for Geogarypidae, harboring approximately 30% of the global species richness for the family.

**Table 3.** Brazilian *Geogarypus* species on biomes and states records, showing caves records and endemic species. Biomes abbreviation: Am – Amazonia; Af – Atlantic Rainforest; Caa – Caatinga; Cerr – Cerrado; Pt – Pantanal. States abbreviation: AL – Alagoas; AM – Amazonas; BA – Bahia; GO – Goiás; MG – Minas Gerais; MT – Mato Grosso; PA – Pará; PE – Pernambuco; PB – Paraíba; RS – Rio Grande do Sul; SE – Sergipe; ? – Represents inconsistent or unconfirmed data.

| species                                     | biome | state       | cave | endemic |
|---------------------------------------------|-------|-------------|------|---------|
| <i>Geogarypus amazonicus</i> Mahnert, 1979  | Am    | AM, PA, PE? |      |         |
| <i>G. cuyabanus</i> (Balzan, 1887)          | Pt    | MT          |      | ●       |
| <i>G. formosum</i> (Mello-Leitão, 1937)     | Af    | RJ          |      |         |
| <i>G. gollumi</i> Bedoya-Roque et al., 2023 | Caa   | PE          | ●    | ●       |
| <i>G. paraguayanus</i> Beier, 1931          | Cerr? | ?           |      |         |
| <i>G. alagoensis</i> sp. nov.               | Af    | AL, PE      |      | ●       |
| <i>G. brescoviti</i> sp. nov.               | Af    | PE          |      | ●       |
| <i>G. calon</i> sp. nov.                    | Af    | PB          |      | ●       |
| <i>G. caatinguensis</i> sp. nov.            | Caa   | PB          |      | ●       |
| <i>G. chaetomaculatus</i> sp. nov.          | Caa   | CE          |      | ●       |
| <i>G. chamberlini</i> sp. nov.              | Caa   | PE          |      | ●       |
| <i>G. curumim</i> sp. nov.                  | Af    | RS          | ●    | ●       |
| <i>G. eliptycus</i> sp. nov.                | Cerr  | BA, MG      | ●    |         |
| <i>G. montanus</i> sp. nov.                 | Caa   | PE          |      | ●       |
| <i>G. rajatus</i> sp. nov.                  | Af    | AL, PE      |      | ●       |
| <i>G. salimoni</i> sp. nov.                 | Af    | AL, PE      |      | ●       |
| <i>G. sergipensis</i> sp. nov.              | Af    | SE          |      | ●       |
| <i>G. sertanejus</i> sp. nov.               | Caa   | PB          |      | ●       |
| <i>G. talhadensis</i> sp. nov.              | Af    | AL, PE      |      | ●       |
| <i>G. volkeri</i> sp. nov.                  | Af    | AL, PE      |      | ●       |
| <i>G. mf1</i>                               | Cerr  | MG          | ●    | ?       |
| <i>G. mf2</i>                               | Cerr  | GO          | ●    | ?       |
| <i>G. mf3</i>                               | Am    | PA          | ●    | ?       |



**Figure 9.** Distribution records of Geogarypidae species in Brazil. Brazilian biomes highlighted. With new species, morphotypes and records from literature.



**Figure 10.** Distribution map of *Geogarypus* species in northeastern Brazil: A. Northeastern Brazil with elevation and distribution of the species described in this study. Bar graph shows total and endemic species counts and counts by biome. The mountain symbol indicates the highland rainforests and enclaves with records of *Geogarypus* at higher elevations. B. Illustrative diagram depicting how the orographic rainfalls maintain highland rainforests on the Borborema plateau. Adapted from Tabarelli and Santos (2004).

### 3.3 Taxonomy

#### 3.3.1 Family Geogarypidae Chamberlin, 1930

Garypinae Simon, 1879: 42; Tömösváry, 1882: 208; Balzan, 1892: 534.

Garypidae (Simon); Hansen, 1893: 231; Ellingsen, 1904: 2; With, 1906: 89.

Geogarypinae Chamberlin, 1930: 609; Beier, 1932a: 227; Murthy & Ananthakrishnan, 1977: 104.

[Type-genus: *Geogarypus* Chamberlin, 1930]

Geogarypidae (Chamberlin); Harvey, 1986: 754; Harvey, 1992b: 1420.

**Remarks.** This study identified two unusual structures: the forked rallun and the long rallun, the forked rallun is one of the features that connects the genus *Geogarypus* to an undescribed new

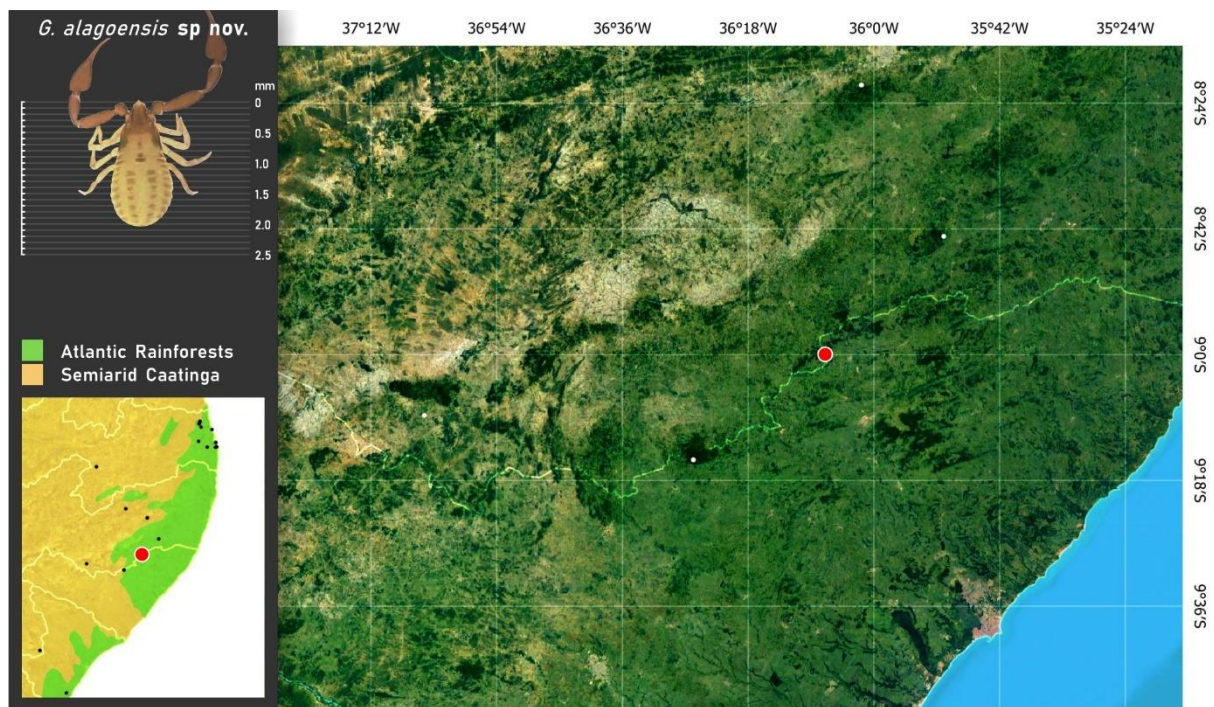
genus 1. Bridges are present in all genera of Geogarypidae (*Afrogarypus*, *Geogarypus*, undescribed genus 1, 2 and 3) and in other families that have well-defined darkspots. Darkmarks have been observed in only a few species and may also occur, in other genera, though this characteristic remains poorly understood.

### 3.3.2 Genus *Geogarypus* Chamberlin, 1930

*Geogarypus* Chamberlin, 1930: 609; Beier, 1932b: 227; Beier, 1963: 241; Murphy & Ananthakrishnan, 1977: 104; Harvey, 1986: 760; Harvey, 1992b: 1420.

[**Type species:** *Garypus minor* Koch, 1873]

### 3.3.3 Coded Descriptions



**Figure 11.** *G. alagoensis* sp. nov.: Habitus, size and distribution.

### 3.3.3.1 *Geogarypus alagoensis* Oliveira-Neto and Zeppelini sp. nov.

Figures 4, 5, 7, 9–15; Table 2, 3; Appendix 1

**Material examined.** Holotype: (UFPB-AR0037) BRAZIL, Alagoas, Itateguara, Usina Serra Grande – Mata de Coimbra, 08°59'19.79"S, 36°06'54.35"W, 456m ASL, February 2012, Semideciduous Seasonal Forest, Atlantic Rainforest. Col. AM, DeSouza; PHS, Pozzi.

Paratype (UFPB-AR0036II) BRAZIL, Alagoas, São José da Laje, Usina Serra Grande – Mata do Brejo, 09°0'3.42"S, 36°7'21.89"W, 413m ASL, February 2012, Semideciduous Seasonal Forest, Atlantic Rainforest. Col. AM, DeSouza.

Paratype (UFPB-AR0039II) BRAZIL, Alagoas, São José da Laje, Usina Serra Grande – Mata de Maria Maior, 08°59'36.92"S, 36°07'40.97"W, 435m ASL, February 2012, Semideciduous Seasonal Forest, Atlantic Rainforest. Col. AM, DeSouza; MB, DaSilva, PHS, Pozzi

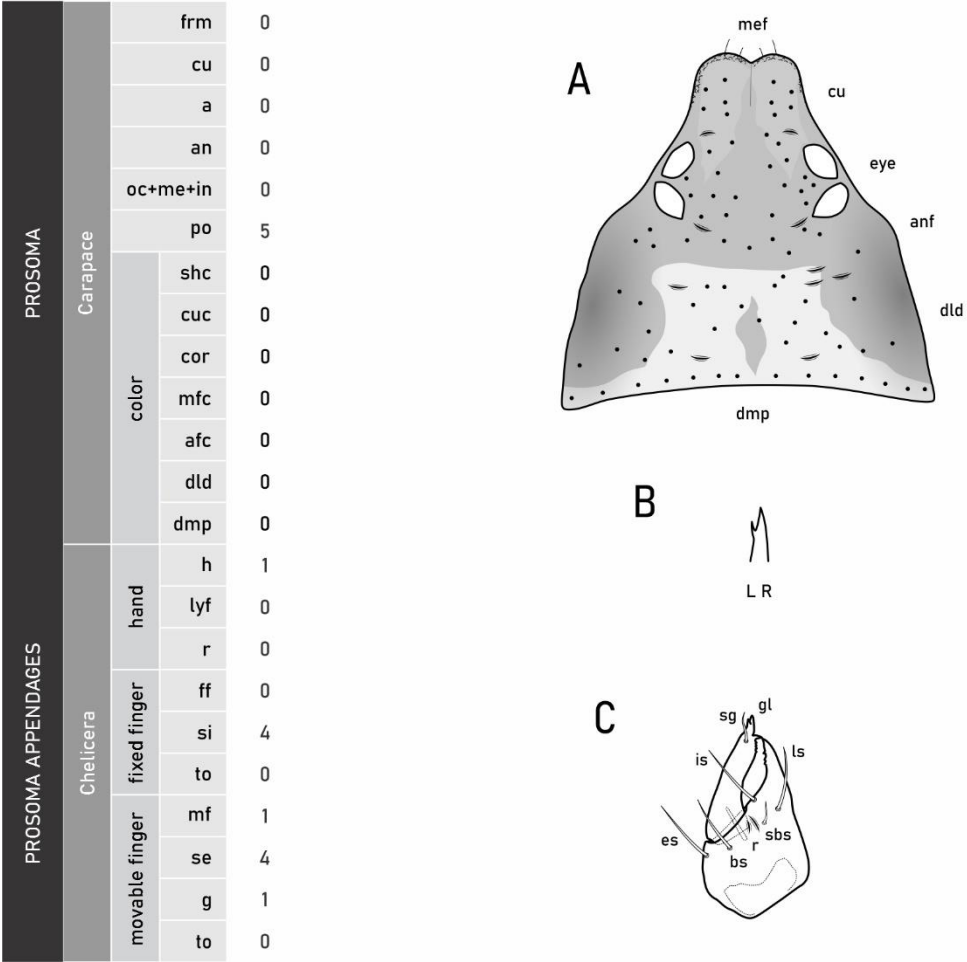
**Etymology.** The species was named after the State of the Type locality.

**Distribution.** Northeastern Brazil (Atlantic Forest) (Fig. 11). This specimen exhibit strong regionalism, being found in the municipalities of: Itateguara and São José da Laje. It has been recorded on three forests: Mata de Coimbra, Mata do Brejo and Mata de Maria Maior.

**Diagnosis.** *G. alagoensis* **sp. nov.** can be easily recognized by the presence of: Carapace posterior edge total chaetae: 12(5); one *pnso* type 12; Legs metatarsus with chaetae type 19; Tergites V, X total chaetae: 14 14(5), 12 12(5); Tergite X darkspots: 3 continuous, 2 discrete; Pedipalpal femur ratio: 4.0x.

**Coded Description.** Figs. 6, 12–15 and Appendix 1.

**Remarks.** (see *G. salimoni* **sp. nov.** and *G. volkeri* **sp. nov.** remarks) This species shares the same distribution as the *G. salimoni* **sp. nov.** and *G. volkeri* **sp. nov.** and can be easily distinguished from the *G. volkeri* **sp. nov.** by the carapace posterior edge chaetae, coxa IV chaetae, total sclerites and darkspots of tergites III-IX, is absent in *G. alagoensis* **sp. nov.**. Likewise, the *G. alagoensis* **sp. nov.** can be easily distinguished from *G. salimoni* **sp. nov.** through the shape of the rallum, which is long in the *G. salimoni* **sp. nov.**, but also the Leg I tarsos and Leg IV femur, tibia and tarsos chaetae, furthermore, *G. salimoni* **sp. nov.** has 38 darkspots + 7 darkmarks.



**Figure 12.** *G. alagoensis* sp. nov. Coded description: Carapace and Chelicera: Carapace with chaetotaxy and color intensity spots, dorsal view.; Male galea.; Chelicera with chaetotaxy.

| PROSOMA APPENDAGES |          |                |      |    |
|--------------------|----------|----------------|------|----|
| PROSOMA APPENDAGES | Pedipalp |                | tr   | 5  |
|                    |          |                | fe   | 7  |
|                    |          |                | pa   | 0  |
|                    |          | hand           | h    | 1  |
|                    |          |                | hfrm | 0  |
|                    |          | fixed finger   | ff   | 10 |
|                    |          |                | to   | 0  |
|                    |          |                | dis  | 0  |
|                    |          |                | pro  | 0  |
|                    |          |                | vd   | 0  |
|                    |          | movable finger | mf   | 10 |
|                    |          |                | to   | 4  |
|                    |          |                | dis  | 0  |
|                    |          |                | pro  | 0  |
|                    |          |                | vd   | 0  |

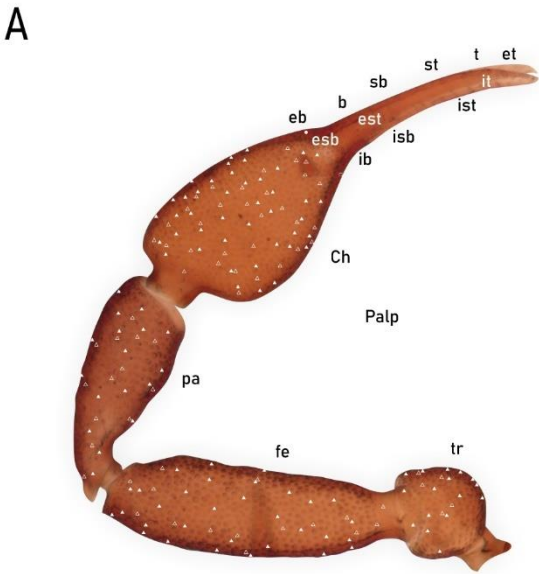
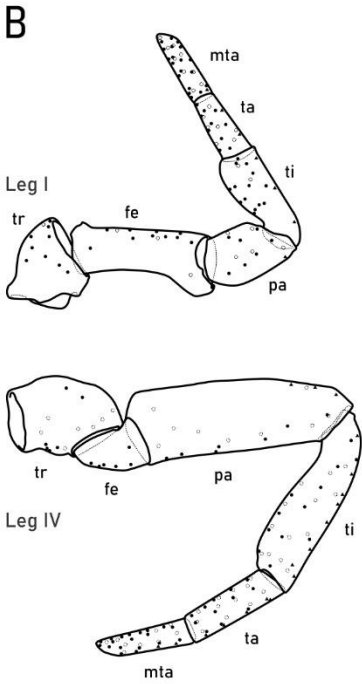
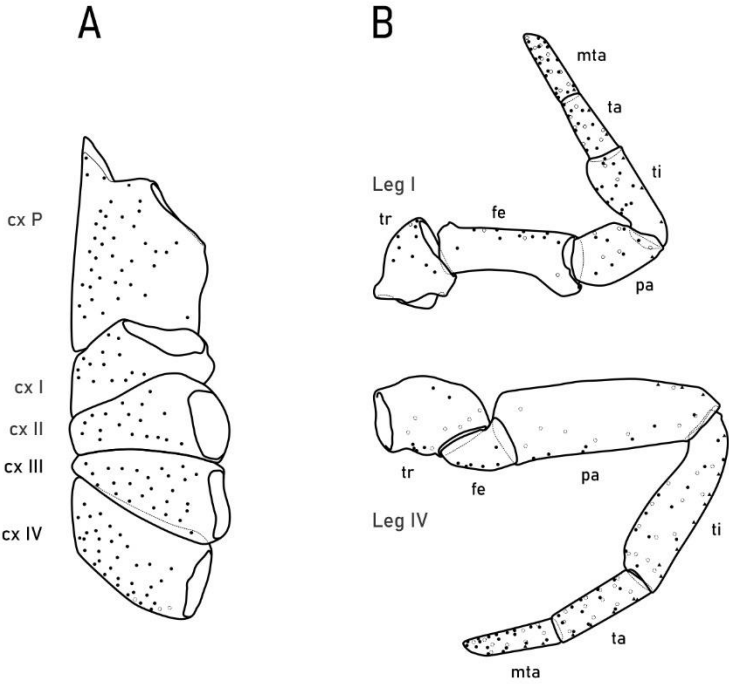


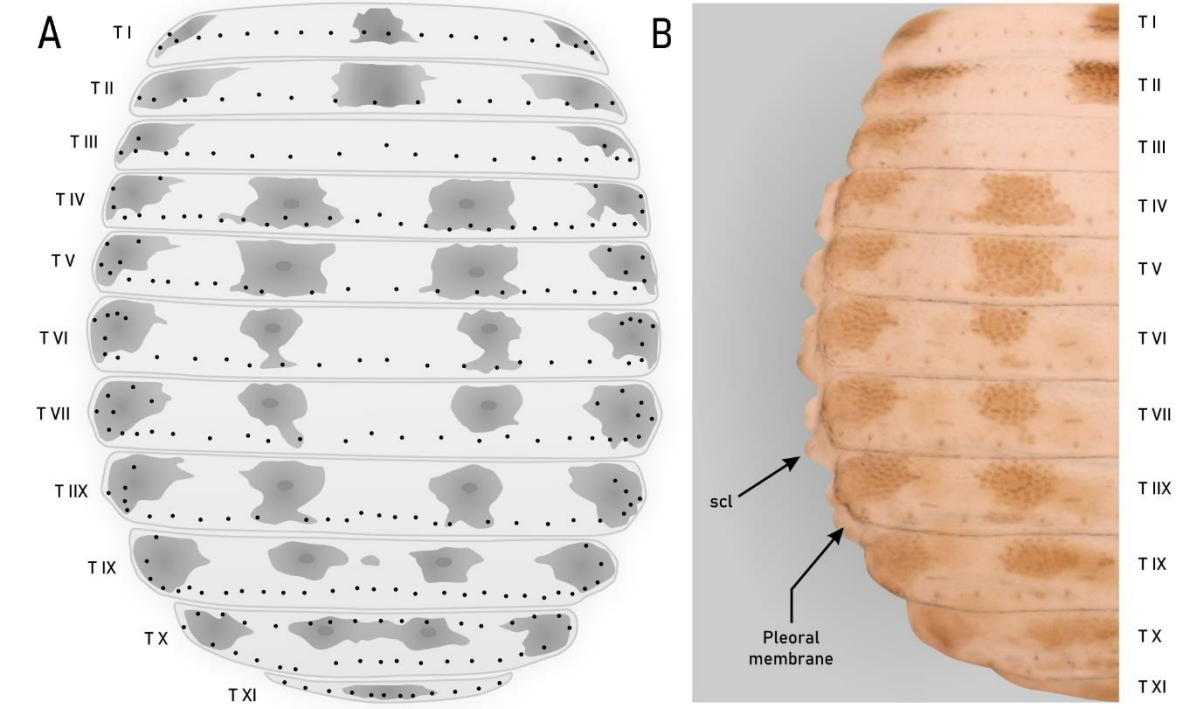
Figure 13. *G. alagoensis* sp. nov. Coded description Pedipalp: Pedipalp with chaetotaxy pattern and color.

| PROSOMA APPENDAGES |      |              |        |   |
|--------------------|------|--------------|--------|---|
| PROSOMA APPENDAGES | Legs | Coxal Region | cx P   | 5 |
|                    |      |              | cx I   | 3 |
|                    |      |              | cx II  | 1 |
|                    |      |              | cx III | 0 |
|                    |      |              | cx IV  | 6 |
|                    |      | leg I        | tr     | 2 |
|                    |      |              | fe     | 0 |
|                    |      |              | pa     | 8 |
|                    |      |              | ti     | 1 |
|                    |      |              | ta     | 0 |
|                    |      |              | mta    | 8 |
|                    |      |              | clw    | 0 |
|                    |      |              | arr    | 0 |
|                    |      | leg IV       | tr     | 0 |
|                    |      |              | fe     | 2 |
|                    |      |              | pa     | 5 |
|                    |      |              | ti     | 6 |
|                    |      |              | ta     | 3 |
|                    |      |              | mta    | 8 |
|                    |      |              | clw    | 0 |
|                    |      |              | arr    | 0 |

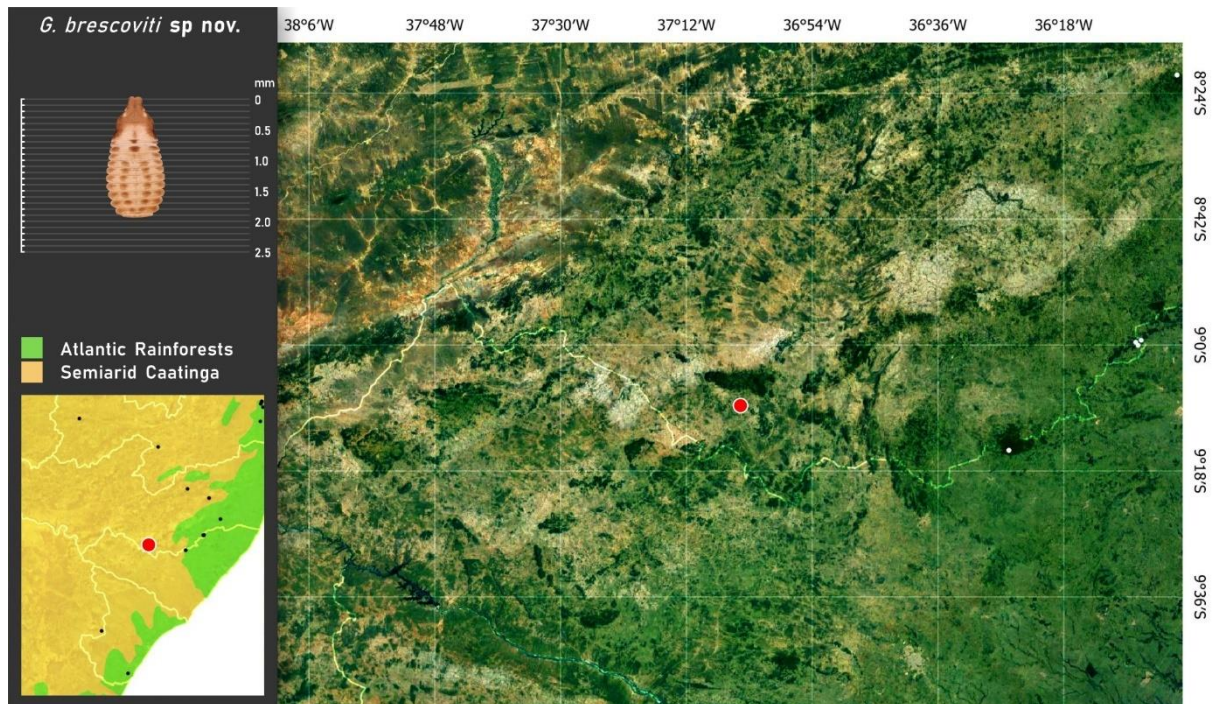


**Figure 14.** *G. alagoensis* sp. nov. Coded description Coxal region and Legs. A. Coxa of pedipalp and I-IV. B. Legs I, IV.

|             |          |        |    |          |           |       |   |          |           |        |   |          |           |        |   |           |        |   |
|-------------|----------|--------|----|----------|-----------|-------|---|----------|-----------|--------|---|----------|-----------|--------|---|-----------|--------|---|
| OPISTHOSOMA | Tergites | plm    | 0  | Tergites | darkspots | T IX  | 5 | Tergites | darkspots | TdVII  | 0 | Tergites | bridges   | TbVII  | 0 | Sternites | S VIII | 1 |
|             |          | scl    | 0  |          |           | T X   | 3 |          |           | TdVIII | 0 |          |           | TbVIII | 0 |           | S IX   | 1 |
|             |          | td     | 0  |          |           | T XI  | 2 |          |           | TdIX   | 2 |          |           | TbIX   | 1 |           | S X    | 0 |
|             |          | T I    | 6  |          |           | A     | 1 |          |           | TdX    | 3 |          |           | TbX    | 1 |           | S XI   | 0 |
|             |          | T II   | 1  |          |           | tdsp  | 2 |          |           | TdXI   | 0 |          |           | TbXI   | 0 |           |        |   |
|             |          | T III  | 3  |          |           | TdI   | 0 |          |           | TbI    | 0 |          | Sternites | S II   | ? |           |        |   |
|             |          | T IV   | 4  |          |           | TdII  | 0 |          |           | TbII   | 0 |          |           | S III  | ? |           |        |   |
|             |          | T V    | 12 |          |           | TdIII | 0 |          |           | TbIII  | 0 |          |           | S IV   | ? |           |        |   |
|             |          | T VI   | 7  |          |           | TdIV  | 0 |          |           | TbIV   | 0 |          |           | S V    | 8 |           |        |   |
|             |          | T VII  | 3  |          |           | TdV   | 0 |          |           | TbV    | 0 |          |           | S VI   | 2 |           |        |   |
|             |          | T VIII | 6  |          |           | TdVI  | 1 |          |           | TbVI   | 0 |          |           | S VII  | 1 |           |        |   |



**Figure 15.** *G. alagoensis* sp. nov. Coded description Tergites and Sternites: Tergites I–XI with chaetotaxy and color intensity spots, dorsal view. A. schematic and color.



**Figure 16.** *G. brescoviti* sp. nov.: Habitus, size and distribution.

### 3.3.3.2 *Geogarypus brescoviti* Oliveira-Neto and Zeppelini sp. nov.

Figures 4, 8–10, 16–20; Table 2, 3; Appendix 1

**Material examined.** Holotype: (UFPB–no code) BRAZIL, Pernambuco, Águas Belas, Mata do Papa-Mel – Serra do Comunaty, 9°08'42.02"S, 37°04'22.58"W, 590m ASL, October 2016, Seasonally dry tropical forest, Caatinga. Col. DeSouza, AM; DaSilva, MB; Sales, TS; Tales, D.

**Etymology.** The species is named after Antonio Domingos Brescovit, who is the director of the Zoological Collections Laboratory at the Butantan Institute, for his incredible contribution to Brazilian arachnology.

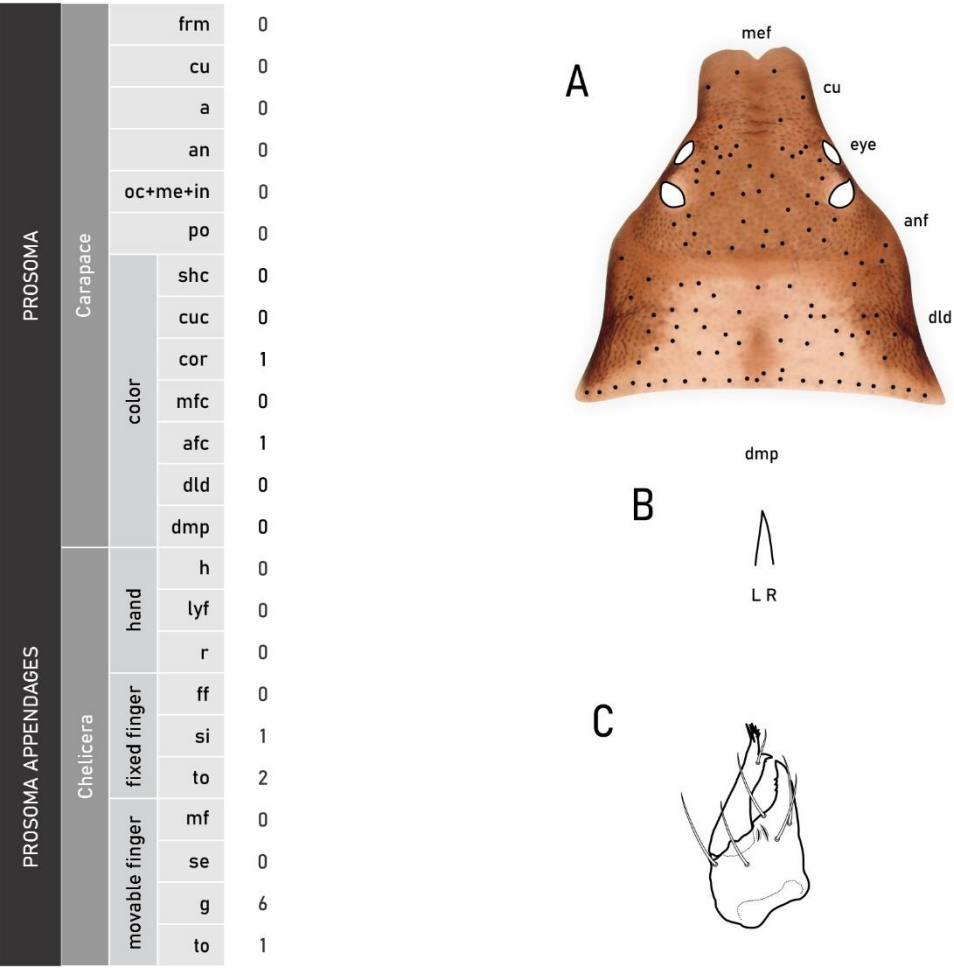
**Distribution.** Northeastern Brazil (Caatinga) (Fig. 16). found in the single municipality: Águas Belas, recorded on single forest: Mata do Papa-Mel located on highland rainforest Serra do Comunaty.

**Diagnosis.** *G. brescoviti* sp. nov. can be easily recognized by the presence of: Coxa IV total chaetae: 46(16); Pleural membrane with 33 sclerites; Tergites total darkspot: 37 darkspots + 8 darkmarks; Tergites III and X pattern of bridges; Leg IV femur ratio: 1.3x.

**Coded Description.** Figs. 6, 17–20 and Appendix 1.

**Remarks.** *G. brescoviti* sp. nov. can be easily differentiated from *G. calon* sp. nov., *G. volkeri* sp. nov., *G. montanus* sp. nov., *G. sertanejus* sp. nov., *G. curumim* sp. nov., *G. talhadensis* sp. nov., *G.*

*eliptycus* **sp. nov.** and *G. salimoni* **sp. nov.** due to the absence of tergal discs and can be distinguished from *G. rajatus* **sp. nov.**, *G. alagoensis* **sp. nov.**, *G. sergipensis* **sp. nov.**, *G. chaetomaculatus* **sp. nov.**, *G. caatinguensis* **sp. nov.**, *G. montanus* **sp. nov.** and *G. chamberlini* **sp. nov.** by the total number of sclerites, which is greater than 30 in *G. brescoviti* **sp. nov.**.



**Figure 17.** *G. brescoviti* **sp. nov.** Coded description: Carapace and Chelicera: Carapace with chaetotaxy and color intensity spots, dorsal view.; Male galea.; Chelicera with chaetotaxy.

| PROSOMA APPENDAGES |  |              |      |      |   |
|--------------------|--|--------------|------|------|---|
| Pedipalp           |  |              |      |      |   |
|                    |  | fixed finger | hand | tr   | 6 |
|                    |  |              |      | fe   | 0 |
|                    |  |              |      | pa   | 8 |
|                    |  |              |      | h    | 3 |
|                    |  |              |      | hfrm | 0 |
|                    |  |              |      | ff   | 2 |
|                    |  |              |      | to   | 0 |
|                    |  |              |      | dis  | 0 |
|                    |  |              |      | pro  | 0 |
|                    |  |              |      | vd   | 0 |
|                    |  |              |      | mf   | 0 |
|                    |  |              |      | to   | 2 |
|                    |  |              |      | dis  | 0 |
|                    |  |              |      | pro  | 0 |
|                    |  |              |      | vd   | 0 |

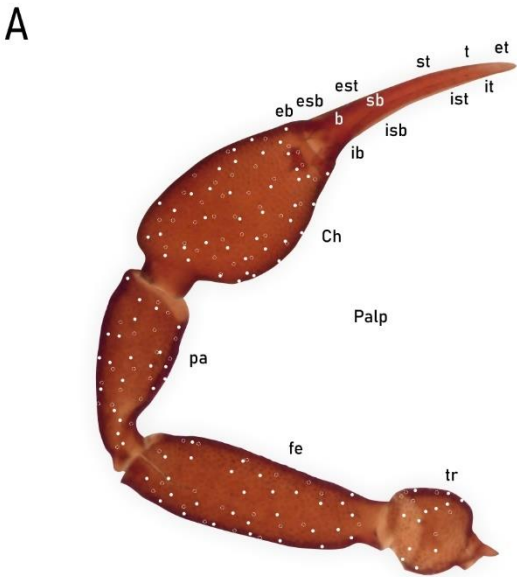
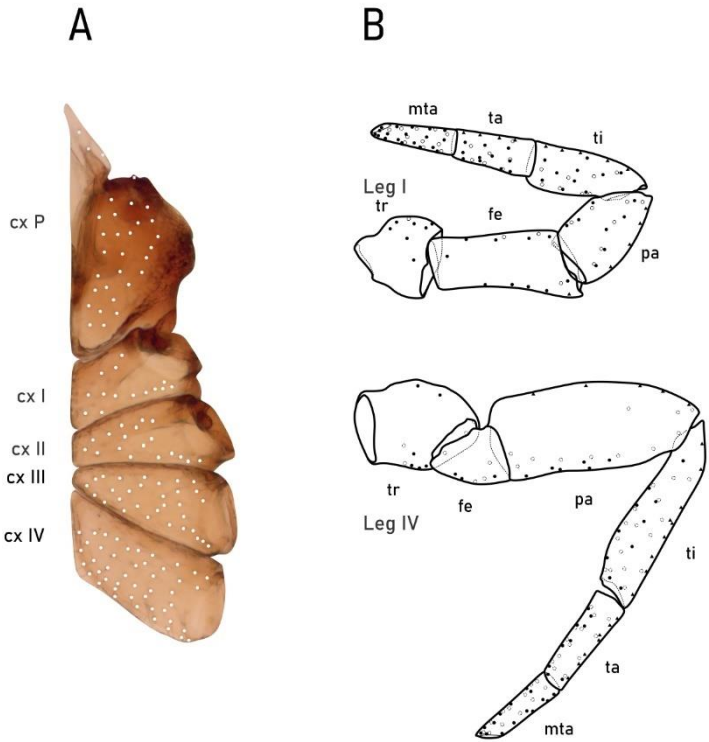


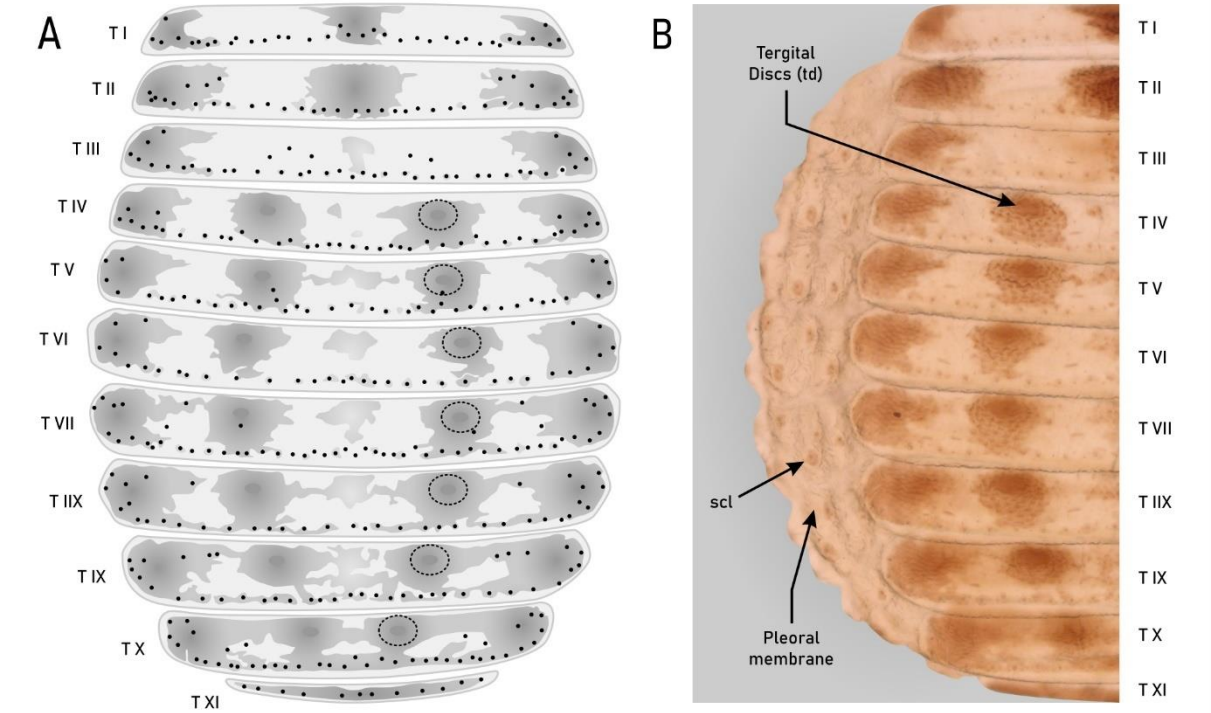
Figure 18. *G. brescoviti* sp. nov. Coded description Pedipalp: Pedipalp with chaetotaxy pattern and color.

| PROSOMA APPENDAGES |   |  |              |    |
|--------------------|---|--|--------------|----|
| Legs               |   |  | Coxal Region |    |
| leg I              |   |  | cx P         | 8  |
|                    |   |  | cx I         | 3  |
|                    |   |  | cx II        | 1  |
|                    |   |  | cx III       | 5  |
|                    |   |  | cx IV        | 12 |
|                    |   |  | tr           | 0  |
|                    |   |  | fe           | 1  |
|                    |   |  | pa           | 5  |
|                    |   |  | ti           | 3  |
|                    |   |  | ta           | 1  |
| leg IV             |   |  | mta          | 3  |
|                    |   |  | clw          | 0  |
|                    |   |  | arr          | 0  |
|                    |   |  | tr           | 5  |
|                    |   |  | fe           | 2  |
|                    |   |  | pa           | 10 |
|                    |   |  | ti           | 8  |
|                    |   |  | ta           | 4  |
|                    |   |  | mta          | 3  |
|                    |   |  | clw          | 0  |
| arr                | 0 |  |              |    |

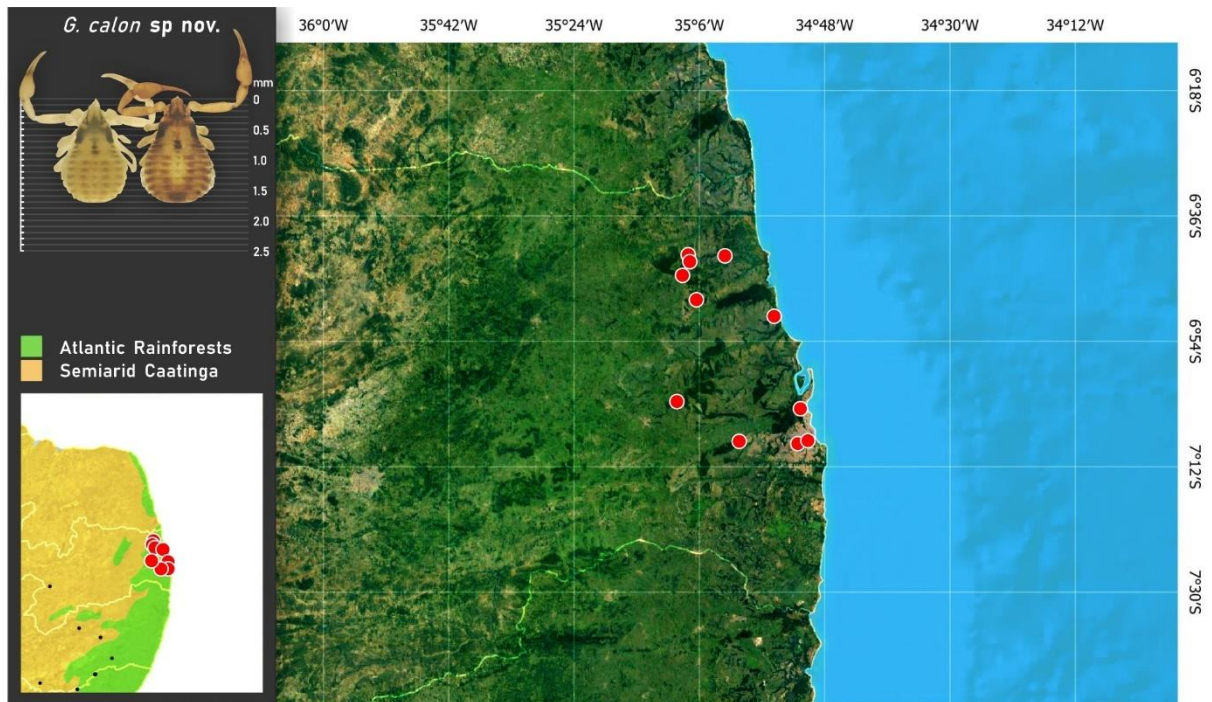


**Figure 19.** *G. brescoviti* sp. nov. Coded description Coxal region and Legs. A. Coxa of pedipalp and I-IV. B. Legs I, IV.

|             |          |        |   |          |           |       |   |          |           |        |   |          |           |        |   |           |        |   |
|-------------|----------|--------|---|----------|-----------|-------|---|----------|-----------|--------|---|----------|-----------|--------|---|-----------|--------|---|
| OPISTHOSOMA | Tergites | plm    | 0 | Tergites | darkspots | T IX  | 3 | Tergites | darkspots | TdVII  | 2 | Tergites | bridges   | TbVII  | 2 | Sternites | S VIII | 2 |
|             |          | scl    | 8 |          |           | T X   | 0 |          |           | TdVIII | 2 |          |           | TbVIII | 4 |           |        | 0 |
|             |          | td     | 0 |          |           | T XI  | 1 |          |           | TdIX   | 1 |          |           | TbIX   | 5 |           |        | 1 |
|             |          | T I    | 0 |          |           | A     | 0 |          |           | TdX    | 1 |          |           | TbX    | 7 |           |        | 0 |
|             |          | T II   | 3 |          |           | tdsp  | 3 |          |           | TdXI   | 0 |          |           | TbXI   | 0 |           |        |   |
|             |          | T III  | 2 |          |           | TdI   | 0 |          |           | TbI    | 0 |          | Sternites | S II   | ? |           |        |   |
|             |          | T IV   | 1 |          |           | TdII  | 0 |          | bridges   | TbII   | 0 |          |           | S III  | 1 |           |        |   |
|             |          | T V    | 4 |          |           | TdIII | 0 |          |           | TbIII  | 4 |          |           | S IV   | 4 |           |        |   |
|             |          | T VI   | 1 |          |           | TdIV  | 1 |          |           | TbIV   | 2 |          |           | S V    | 2 |           |        |   |
|             |          | T VII  | 1 |          |           | TdV   | 0 |          |           | TbV    | 6 |          |           | S VI   | 7 |           |        |   |
|             |          | T VIII | 1 |          |           | TdVI  | 0 |          |           | TbVI   | 2 |          |           | S VII  | 2 |           |        |   |



**Figure 20.** *G. brescoviti* sp. nov. Coded description Tergites and Sternites: Tergites I–XI with chaetotaxy and color intensity spots, dorsal view. A. schematic and color. B. photograph of the dorsal view of the abdomen with labels for Tergal Discs (td), scl, and Pleoral membrane.



**Figure 21.** *G. calon* sp. nov.: Habitus, size and distribution.

### 3.3.3.3 *Geogarypus calon* Oliveira-Neto and Zeppelini sp. nov.

Figures 1, 4, 8–10, 21–25; Table 1–3; Appendix 1

**Material examined.** Holotype: (UEPB–CRFS–PB051) BRAZIL, Paraíba, João Pessoa, Federal University of Paraíba, 7°08'14.18"S, 34°50'17.95"W, 35m ASL, October 2021, Semideciduous Seasonal Forest, Atlantic Rainforest, Active Search in litter layer, Col. Oliveira-Neto M.

Paratype (UEPB–CRFS–PB013) BRAZIL, Paraíba, Santa Rita, Usina São João, 7°08'24.88"S, 34°59'59.97"W, 77m ASL, May 2012, Semideciduous Seasonal Forest, Atlantic Rainforest, Pitfall trap, Col. Ferreira AS.

Paratype (UEPB–CRFS–PB014) BRAZIL, Paraíba, Mamanguape, Guaribas Biological Reserve, Sema II, 6°44'21.73"S, 35°08'22.71"W, 180m ASL, May-June 2012, Semideciduous Seasonal Forest, Atlantic Rainforest, Pitfall trap, Col. Brito RA.

Paratype (UEPB–CRFS–PB015) BRAZIL, Paraíba, Mamanguape, Guaribas Biological Reserve, Sema I, 6°42'24.36"S, 35°7'25.06"W, 159m ASL, May-June 2012, Northeastern Coastal Tableland, Atlantic Rainforest, Pitfall trap, Col. Brito RA.

Paratype (UEPB–CRFS–PB016) BRAZIL, Paraíba, Mamanguape, Guaribas Biological Reserve, Sema II, 6°44'29.70"S, 35°8'34.80"W, 185m ASL, December 2011, Northeastern Coastal Tableland, Atlantic Rainforest, Pitfall trap, Col. Brito RA.

(UEPB-CRFS-PB017) BRAZIL, Paraíba, Mamanguape, Guaribas Biological Reserve, Sema III, 6°47'55.10"S, 35°6'22.50"W, 111m ASL, December 2011, Northeastern Coastal Tableland, Atlantic Rainforest, Pitfall trap, Col. Brito RA.

(UEPB-CRFS-PB021) BRAZIL, Paraíba, Sapé, Private Natural Patrimony Reserve Fazenda Pacatuba, 7°02'30.14"S, 35°08'55.69"W, 134m ASL, May-June 2012, Semideciduous Seasonal Forest, Atlantic Rainforest, Pitfall trap, Col. Ferreira AS.

(UEPB-CRFS-PB018) BRAZIL, Paraíba, Mamanguape, Guaribas Biological Reserve, Barro Branco, 06°41'59.67"S, 35°07'27.22"W, 164m ASL, December 2011, Northeastern Coastal Tableland, Atlantic Rainforest, Pitfall trap, Col. Brito RA.

(UEPB-CRFS-PB073) BRAZIL, Paraíba, Mamanguape, Guaribas Biological Reserve, Barro Branco, 06°41'59.67"S, 35°07'27.22"W, 164m ASL, November 2022, Northeastern Coastal Tableland, Atlantic Rainforest, Pitfall trap, Col. Oliveira-Neto M.

(UFPB-PG154) BRAZIL, Paraíba, João Pessoa, JB Benjamin Maranhão, Mata do Buraquinho, 7°8'40.17"S, 34°51'38.97"W, 56m ASL, November 2011, Northeastern Coastal Tableland, Atlantic Rainforest, Pitfall trap, Col. Lorenzo, EP. *et al.*

(UFPB-PG145) BRAZIL, Paraíba, Cabedelo, FLONA Cabedelo, Mata do Amém, 7°3'51.34"S, 34°51'11.49"W, 26m ASL, November 2011, Northeastern Coastal Tableland, Atlantic Rainforest, Pitfall trap, Col. Lorenzo, EP. *et al.*

(UFPB-PG0069) BRAZIL, Paraíba, Cabedelo, FLONA Cabedelo, Mata do Amém, 7°3'51.34"S, 34°51'11.49"W, 26m ASL, November 2011, Northeastern Coastal Tableland, Atlantic Rainforest, Pitfall trap, Col. Lorenzo, EP. *et al.*

(UEPB-CRFS-PB052) BRAZIL, Paraíba, João Pessoa, Federal University of Paraíba, Bosque CCS, 07°08'07.34"S, 34°50'35.22"W, 58m ASL, November 2022, Northeastern Coastal Tableland, Atlantic Rainforest, Pitfall trap, Col. Oliveira-Neto M.

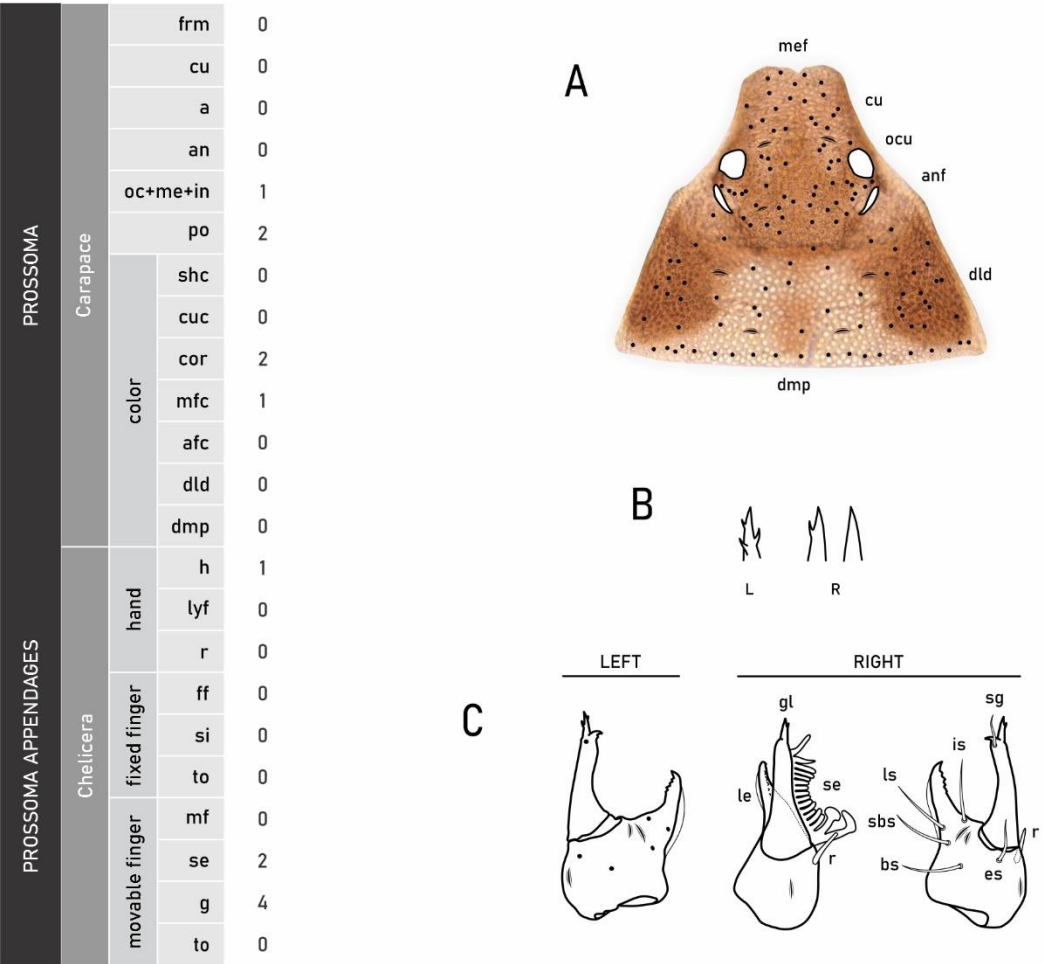
**Etymology.** The name is a tribute to the Brazilian gypsies, the word "calon" in the gypsy language means gypsy.

**Distribution.** Northeastern Brazil (Atlantic Forest) (Fig. 21). This specimen is endemic to the Atlantic rainforests of Paraíba State, exhibiting a strong regionalism, being found in the municipalities of: Cabedelo, João Pessoa, Mamanguape, Santa Rita and Sapé. mainly in two rainforest ecosystems: Northeastern coastal tableland and semideciduous seasonal forests.

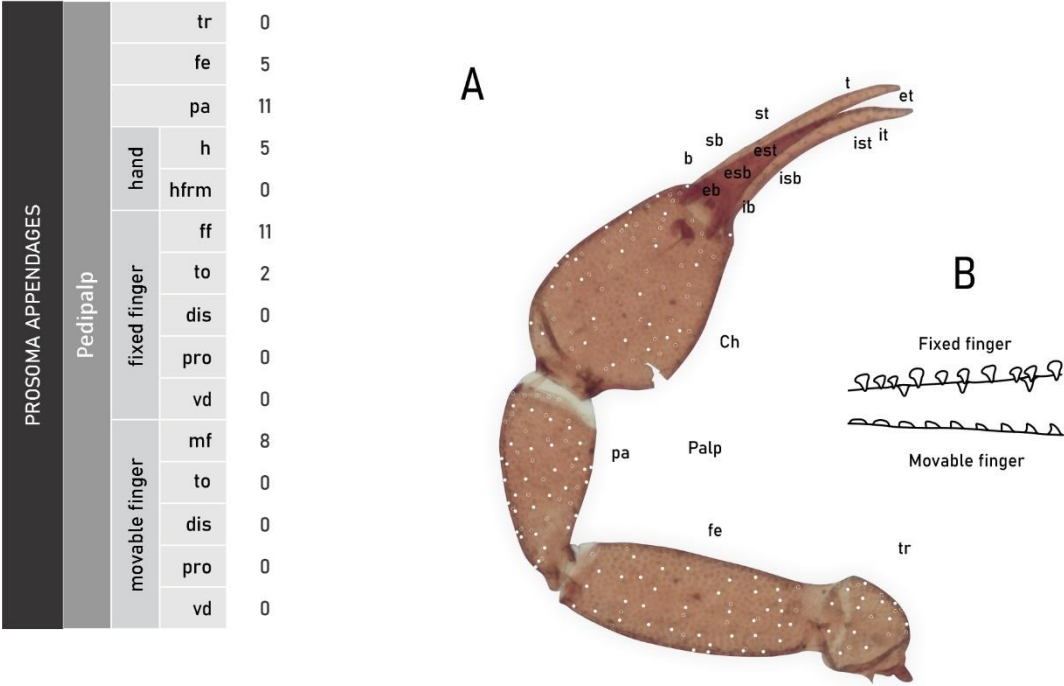
**Diagnosis.** *G. calon* **sp. nov.** can be easily recognized by the presence of: Galea of male coniform with 1–3 spinules; Coxa I, II total chaetae: 6(16), 8(16); Leg I metatarsus total chaetae: 24 20(18a) + 1(18b) + 2(18c) + 1(19); Tergites IV, VI, VII, X, XI total chaetae: 38(5), 36(5), 35(5), 35(5), 36(5); Sternite X total chaetae: 18(21).

**Coded Description.** Figs. 6, 22–25, Tab. 1 and Appendix 1.

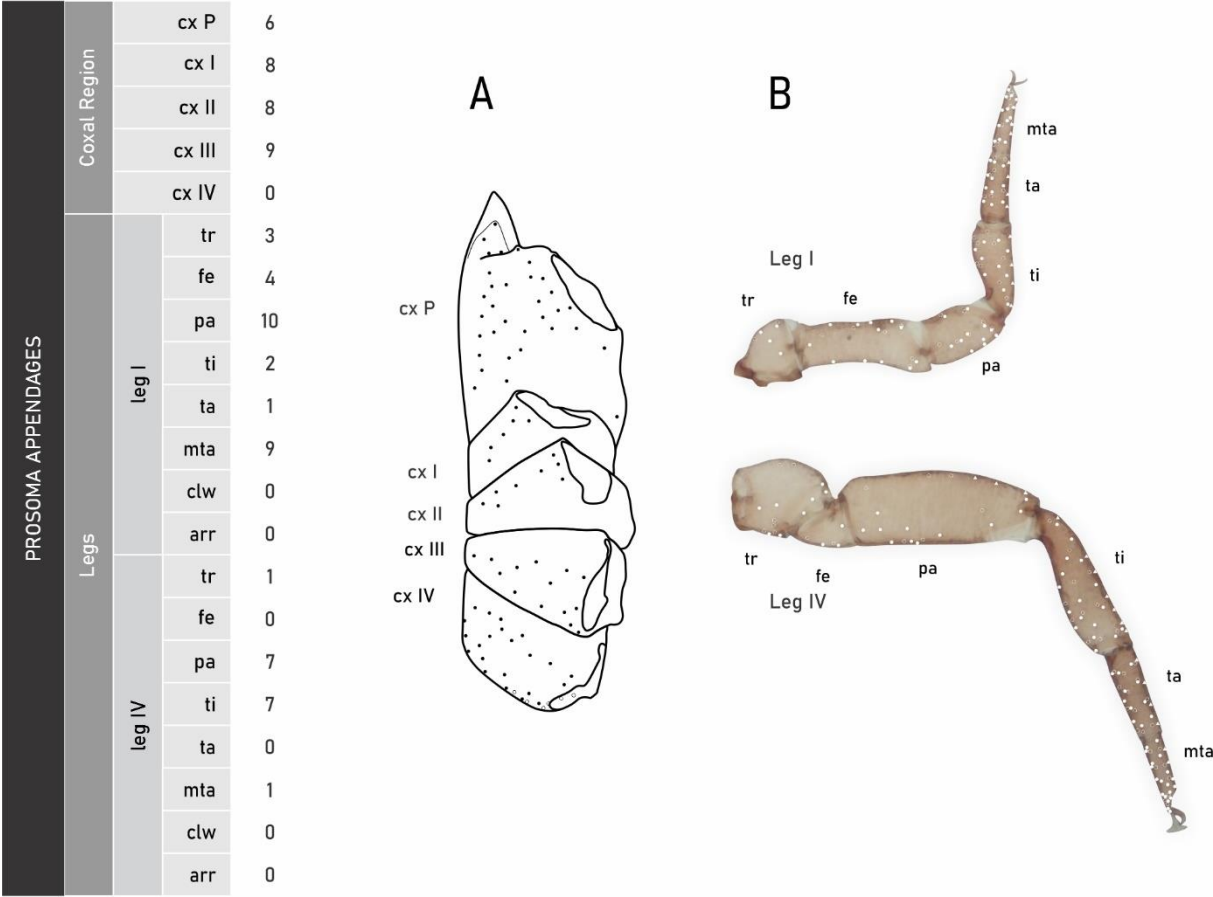
**Remarks.** This species is easily distinguished from the others by the presence of chaetae type 18b on metatarsus and by having 3 spinulas on the male's galea. The *G. calon* **sp. nov.** presents variation in the tone of adult individuals from different locations, the species occurring in the Biological Reserve Guaribas region are subtly lighter, under a microscope the number of darkspots and bridge pattern is maintained despite the variation in tone.



**Figure 22.** *G. calon* **sp. nov.** Coded description: Carapace and Chelicera: Carapace with chaetotaxy and color intensity spots, dorsal view.; Male galea.; Chelicera with chaetotaxy.

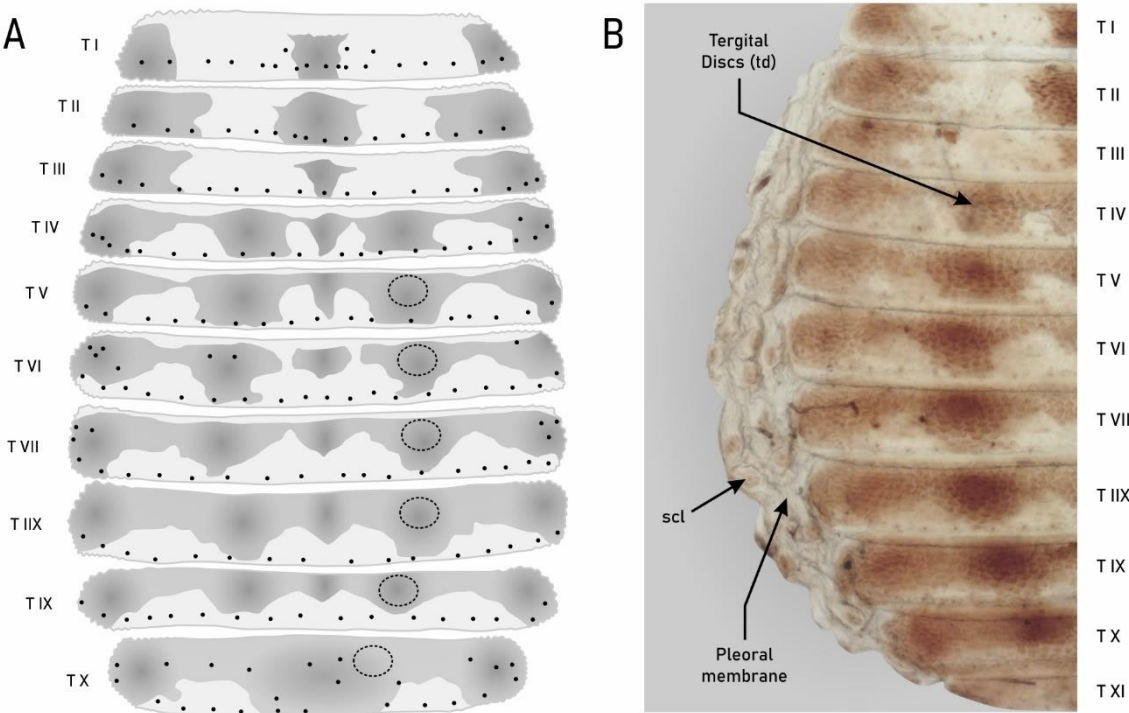


**Figure 23.** *G. calon* sp. nov. Coded description Pedipalp: A. Pedipalp with chaetotaxy pattern, dorsal view. B. Teeth arrangement of fingers, prolateral view.

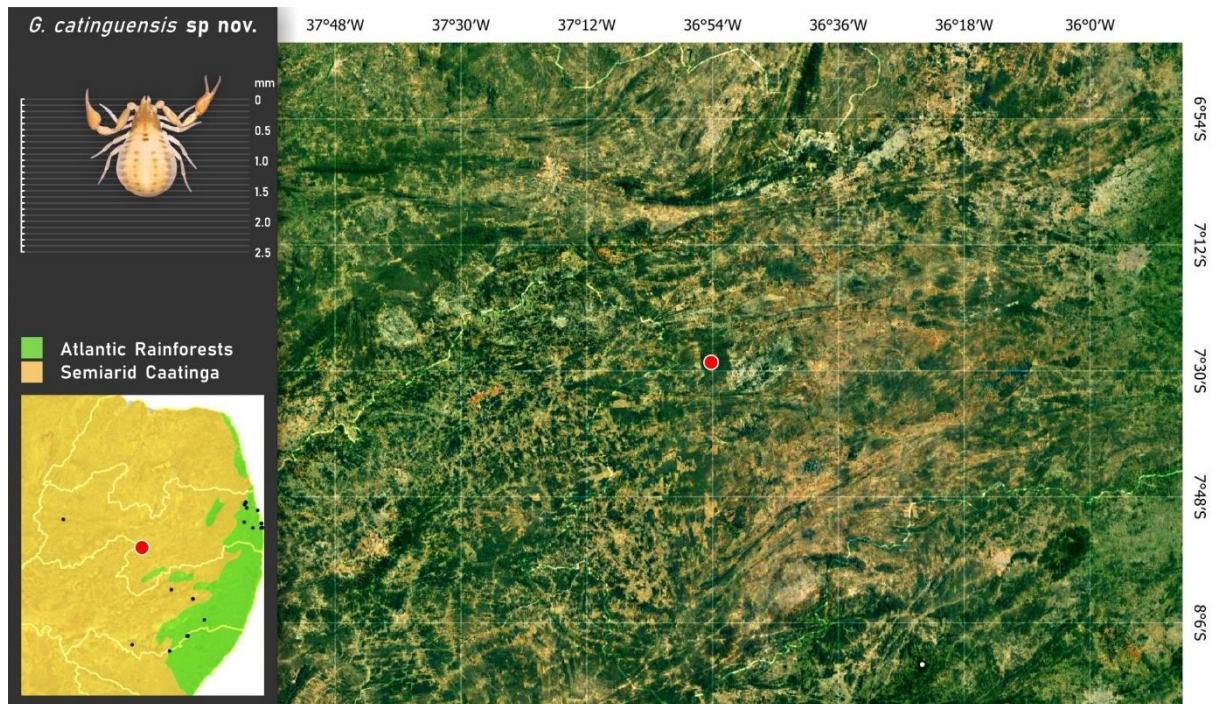


**Figure 24.** *G. calon* sp. nov. Coded description Coxal region and Legs: A. Coxa of pedipalp and I-IV. B. Legs I, IV.

|             |          |        |    |          |           |       |   |          |           |        |   |          |         |        |   |           |         |        |   |
|-------------|----------|--------|----|----------|-----------|-------|---|----------|-----------|--------|---|----------|---------|--------|---|-----------|---------|--------|---|
| OPISTHOSOMA | Tergites | plm    | 0  | Tergites | darkspots | T IX  | 7 | Tergites | darkspots | TdVII  | 1 | Tergites | bridges | TbVII  | 7 | Sternites | bridges | S VIII | 6 |
|             |          | scl    | 0  |          |           | T X   | 5 |          |           | TdVIII | 1 |          |         | TbVIII | 1 |           |         | S IX   | 2 |
|             |          | td     | 1  |          |           | T XI  | 8 |          |           | TdIX   | 0 |          |         | TbIX   | 0 |           |         | S X    | 4 |
|             |          | T I    | 2  |          |           | A     | 0 |          |           | TdX    | 0 |          |         | TbX    | 0 |           |         | S XI   | 1 |
|             |          | T II   | 4  |          |           | tdsp  | 0 |          |           | TdXI   | 0 |          |         | TbXI   | 0 |           |         |        |   |
|             |          | T III  | 8  |          |           | TdI   | 0 |          |           | TbI    | 0 |          |         | S II   | 1 |           |         |        |   |
|             |          | T IV   | 10 |          |           | TdII  | 0 |          |           | TbII   | 1 |          |         | S III  | 3 |           |         |        |   |
|             |          | T V    | 7  |          |           | TdIII | 1 |          |           | TbIII  | 2 |          |         | S IV   | 2 |           |         |        |   |
|             |          | T VI   | 9  |          |           | TdIV  | 0 |          |           | TbIV   | 3 |          |         | S V    | 1 |           |         |        |   |
|             |          | T VII  | 6  |          |           | TdV   | 1 |          |           | TbV    | 3 |          |         | S VI   | 0 |           |         |        |   |
|             |          | T VIII | 7  |          |           | TdVI  | 1 |          |           | TbVI   | 1 |          |         | S VII  | 5 |           |         |        |   |



**Figure 25.** *G. calon* sp. nov. Coded description Tergites and Sternites: Tergites I–XI with chaetotaxy, lyrifissures and color intensity spots, dorsal view, schematic and in color.



**Figure 26.** *G. caatinguensis* sp. nov.: Habitus, size and distribution.

#### 3.3.3.4 *Geogarypus caatinguensis* Oliveira-Neto and Zeppelini sp. nov.

Figures 4, 6, 7, 9, 10, 26–30; Table 2, 3; Appendix 1

**Material examined.** Holotype: (UEPB–CRFS–PB003) BRAZIL, Paraíba, São José dos Cordeiros, Private Natural Patrimony Reserve Fazenda Almas, 7°28'45.00"S, 36°54'18.00"W, 675m ASL, December 2011, Seasonally dry tropical forest, Caatinga, Col. Ferreira AS.

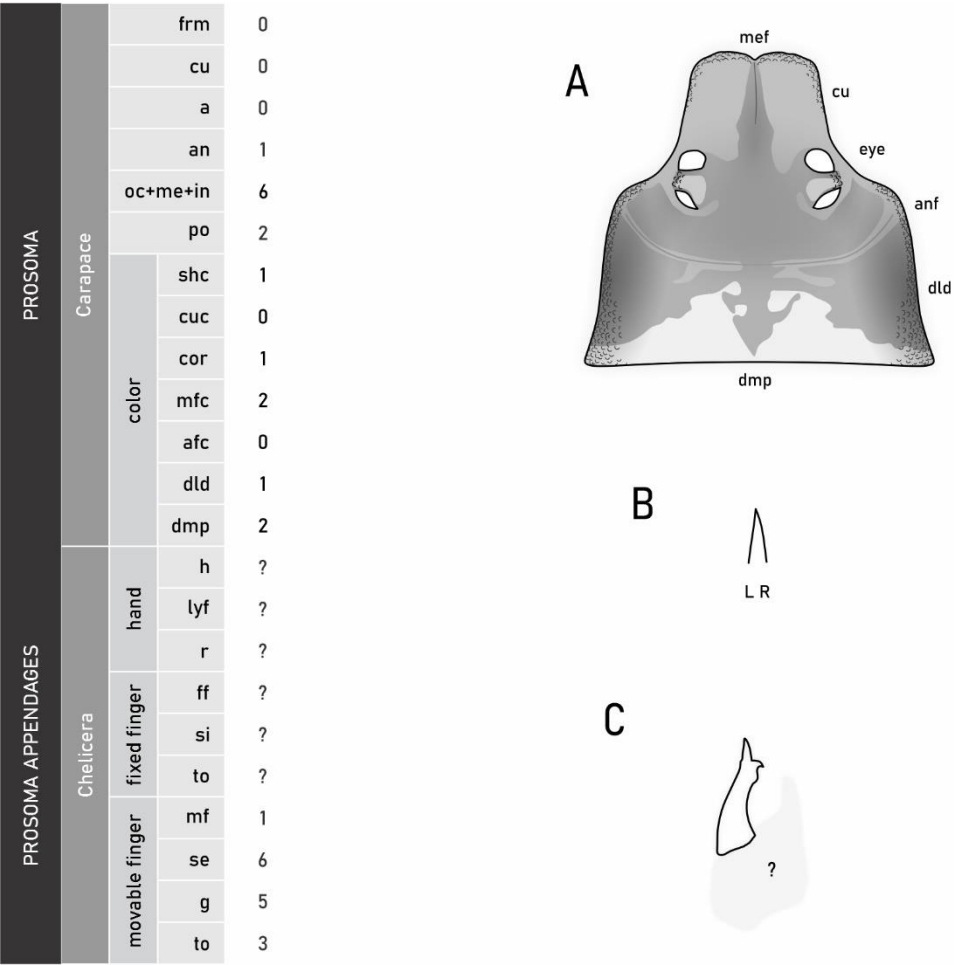
**Etymology.** This species is named after the Caatinga forest, a semi-arid vegetation which is predominant where this species is endemic.

**Distribution.** Northeastern Brazil (Caatinga) (Fig. 26). *G. caatinguensis* sp. nov. is the rarest among the species described in these study, it is known only from the Type locality, likely to be endemic to the state of Paraíba. Despite the efforts to sample the area, the species has only been recorded once, just two individuals, an adult male and a female nymph. Due to the extreme seasonality of the raining regime of the Caatinga, the species possibly presents high seasonality and habitat displacement to survive the harsh conditions in the Brazilian Caatinga.

**Diagnosis.** *G. caatinguensis* sp. nov. can be easily recognized by the presence of: Pedipalpal femur total chaetae: 40(6); Fixed finger total chaetae: 47 3(9) + 30(10) + 3+3(14) + 8(15); Movable finger without *pns*; Coxa I–IV total chaetae: 4(16), 7(16), 9(16), 16(16); Leg IV tarsus total chaetae: 23(18a); Tergites III, IX, X total chaetae: 12(6), 15(6), 14(6); Sternite V total chaetae: 10(21); Leg IV femur + patella ratio: 3.0x. Leg IV tarsus ratio: 2.2x.

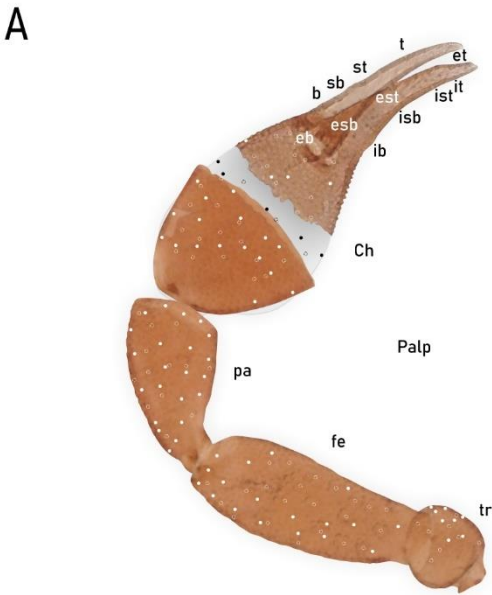
**Coded Description.** Figs. 6, 27–30 and Appendix 1.

**Remarks.** This species is distinguished from other species by presenting pls on both sides of the fixed finger, the fingers are smaller than the hand, just like *G. cuyabanus*, the two species still share the same number of sclerites on the pleoral membrane but differ in different aspects, *G. caatinguensis* **sp. nov.** has 3 *pns* type 11 on the mobile finger, while *G. cuyabanus* has no *pns*, in addition, despite having the same number of darkspots (37) the tone and general appearance of the coloration is totally different, as well, total body chaetotaxy.



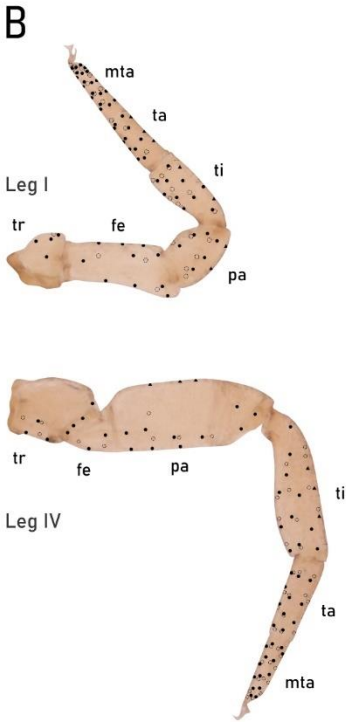
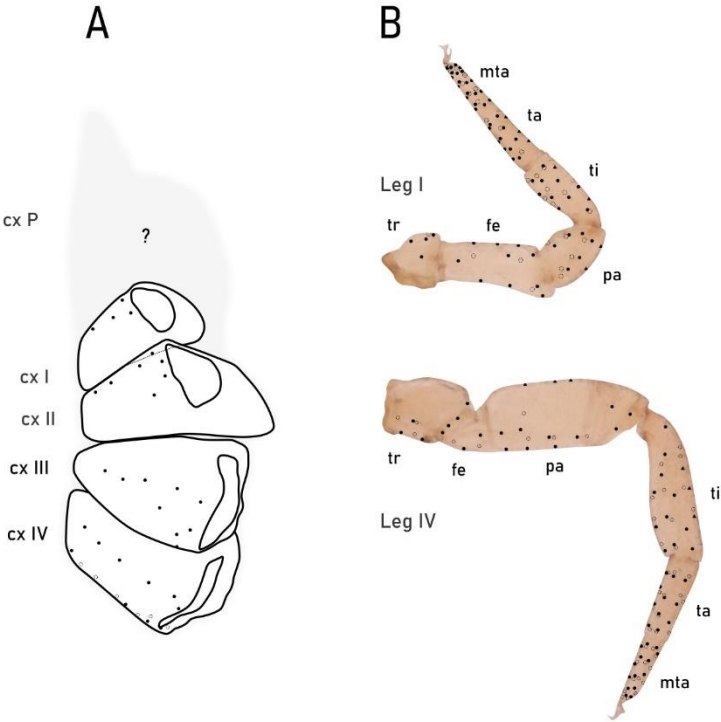
**Figure 27.** *G. caatinguensis* **sp. nov.** Coded description: Carapace and Chelicera: Carapace with chaetotaxy and color intensity spots, dorsal view.; Male galea.; Chelicera with chaetotaxy.

| PROSOMA APPENDAGES |  |  |      |    |
|--------------------|--|--|------|----|
| Pedipalp           |  |  |      |    |
|                    |  |  |      |    |
| hand               |  |  | tr   | 9  |
|                    |  |  | fe   | 11 |
|                    |  |  | pa   | 7  |
|                    |  |  | h    | 9  |
|                    |  |  | hfrm | 0  |
|                    |  |  | ff   | 13 |
| fixed finger       |  |  | to   | 6  |
|                    |  |  | dis  | 0  |
|                    |  |  | pro  | 0  |
|                    |  |  | vd   | 0  |
| movable finger     |  |  | mf   | 9  |
|                    |  |  | to   | 7  |
|                    |  |  | dis  | 0  |
|                    |  |  | pro  | 0  |
|                    |  |  | vd   | 0  |



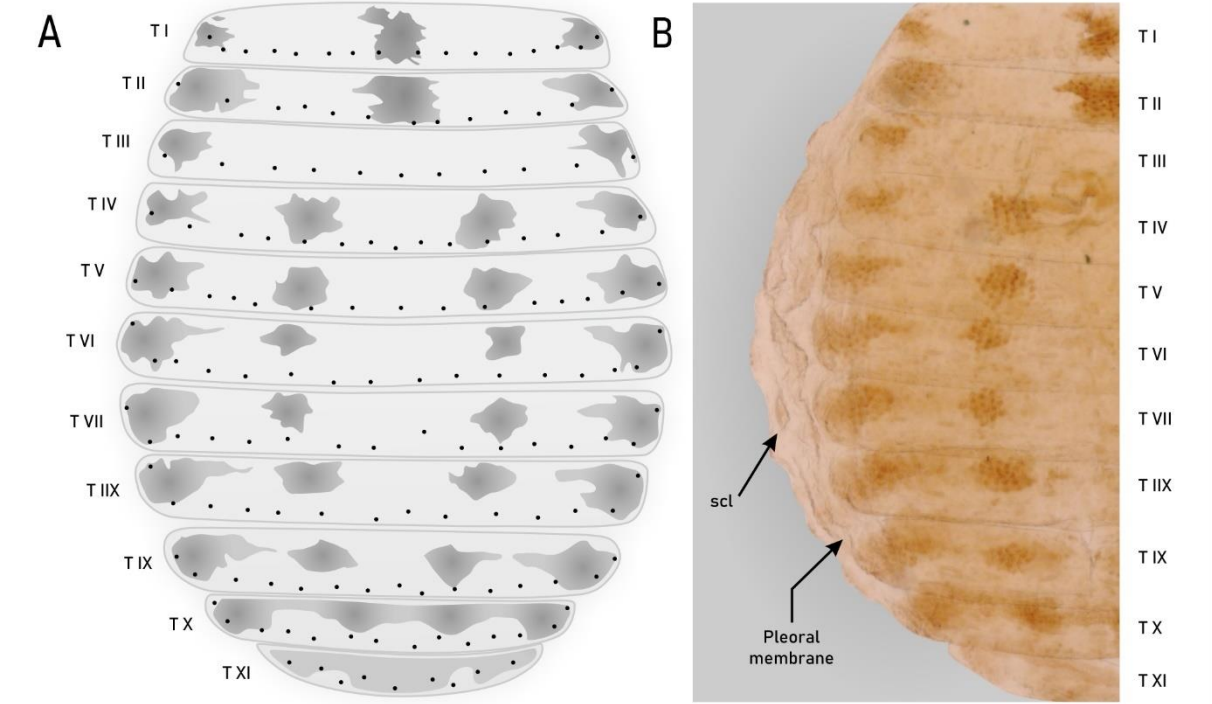
**Figure 28.** *G. caatinguensis* sp. nov. Coded description Pedipalp: Pedipalp with chaetotaxy pattern and color.

| PROSOMA APPENDAGES |        |  |        |    |
|--------------------|--------|--|--------|----|
| Legs               |        |  |        |    |
|                    |        |  |        |    |
| Coxal Region       |        |  | cx P   | ?  |
|                    |        |  | cx I   | 9  |
|                    |        |  | cx II  | 7  |
|                    |        |  | cx III | 11 |
|                    |        |  | cx IV  | 13 |
|                    | leg I  |  | tr     | 5  |
|                    |        |  | fe     | 0  |
|                    |        |  | pa     | 7  |
|                    |        |  | ti     | 2  |
|                    |        |  | ta     | 7  |
|                    |        |  | mta    | 4  |
|                    |        |  | clw    | 0  |
|                    |        |  | arr    | 0  |
|                    | leg IV |  | tr     | 3  |
|                    |        |  | fe     | 1  |
|                    |        |  | pa     | 1  |
|                    |        |  | ti     | 0  |
|                    |        |  | ta     | 12 |
|                    |        |  | mta    | 2  |
|                    |        |  | clw    | 0  |
|                    |        |  | arr    | 0  |

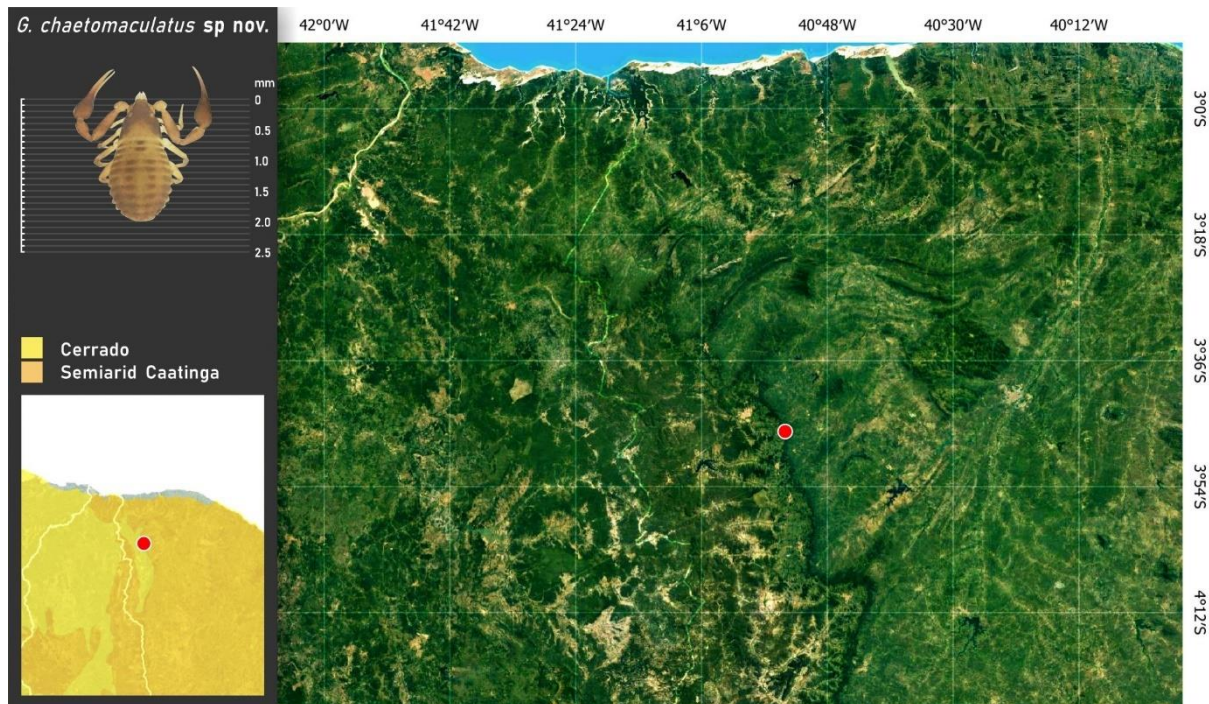


**Figure 29.** *G. caatinguensis* sp. nov. Coded description Coxal region and Legs. A. Coxa of pedipalp and I-IV. B. Legs I, IV.

|             |          |        |    |          |           |       |    |          |           |        |   |           |         |        |    |           |        |   |
|-------------|----------|--------|----|----------|-----------|-------|----|----------|-----------|--------|---|-----------|---------|--------|----|-----------|--------|---|
| OPISTHOSOMA | Tergites | plm    | 0  | Tergites | darkspots | T IX  | 11 | Tergites | darkspots | TdVII  | 0 | Tergites  | bridges | TbVII  | 0  | Sternites | S VIII | 7 |
|             |          | scl    | 1  |          |           | T X   | 9  |          |           | TdVIII | 0 |           |         | TbVIII | 0  |           | S IX   | 5 |
|             |          | td     | 0  |          |           | T XI  | 11 |          |           | TdIX   | 1 |           |         | TbIX   | 2  |           | S X    | 0 |
|             |          | T I    | 10 |          |           | A     | 0  |          |           | TdX    | 1 |           |         | TbX    | 6  |           | S XI   | 0 |
|             |          | T II   | 9  |          |           | tdsp  | 1  |          |           | TdXI   | 2 |           |         | TbXI   | 0  |           |        |   |
|             |          | T III  | 10 |          |           | TdI   | 0  |          |           | TbI    | 0 | Sternites |         | S II   | ?  |           |        |   |
|             |          | T IV   | 11 |          |           | TdII  | 0  |          |           | TbII   | 0 |           |         | S III  | 3  |           |        |   |
|             |          | T V    | 11 |          |           | TdIII | 0  |          |           | TbIII  | 0 |           |         | S IV   | 2  |           |        |   |
|             |          | T VI   | 10 |          |           | TdIV  | 0  |          |           | TbIV   | 0 |           |         | S V    | 10 |           |        |   |
|             |          | T VII  | 2  |          |           | TdV   | 0  |          |           | TbV    | 0 |           |         | S VI   | 8  |           |        |   |
|             |          | T VIII | 13 |          |           | TdVI  | 0  |          |           | TbVI   | 0 |           |         | S VII  | 7  |           |        |   |



**Figure 30.** *G. caatinguensis* sp. nov. Coded description Tergites and Sternites: Tergites I–XI with chaetotaxy and color intensity spots, dorsal view. A. schematic and color. B. photograph of the dorsal view of the abdomen showing the arrangement of tergites and sternites, with labels for scl (sclerite) and Pleoral membrane.



**Figure 31.** *G. chaetomaculatus* **sp. nov.**: Habitus, size and distribution.

### 3.3.3.5 *Geogarypus chaetomaculatus* Oliveira-Neto and Zeppelini **sp. nov.**

Figures 4, 6, 8–10, 31–35; Table 2, 3; Appendix 1

**Material examined.** Holotype: (UFPB-PG146) BRAZIL, Ceará, Ubajara, PN de Ubajara - Serra de Ibiapaba, 03°49'11.11"S 40°53'30.30"W, 840m ASL, January 2014, Seasonally dry tropical forest, Caatinga. Col. Sampaio, C; DaSilva, MB; Eugenio, N.

**Etymology.** The species name refers to the darkmarks around the sockets of the chaetae.

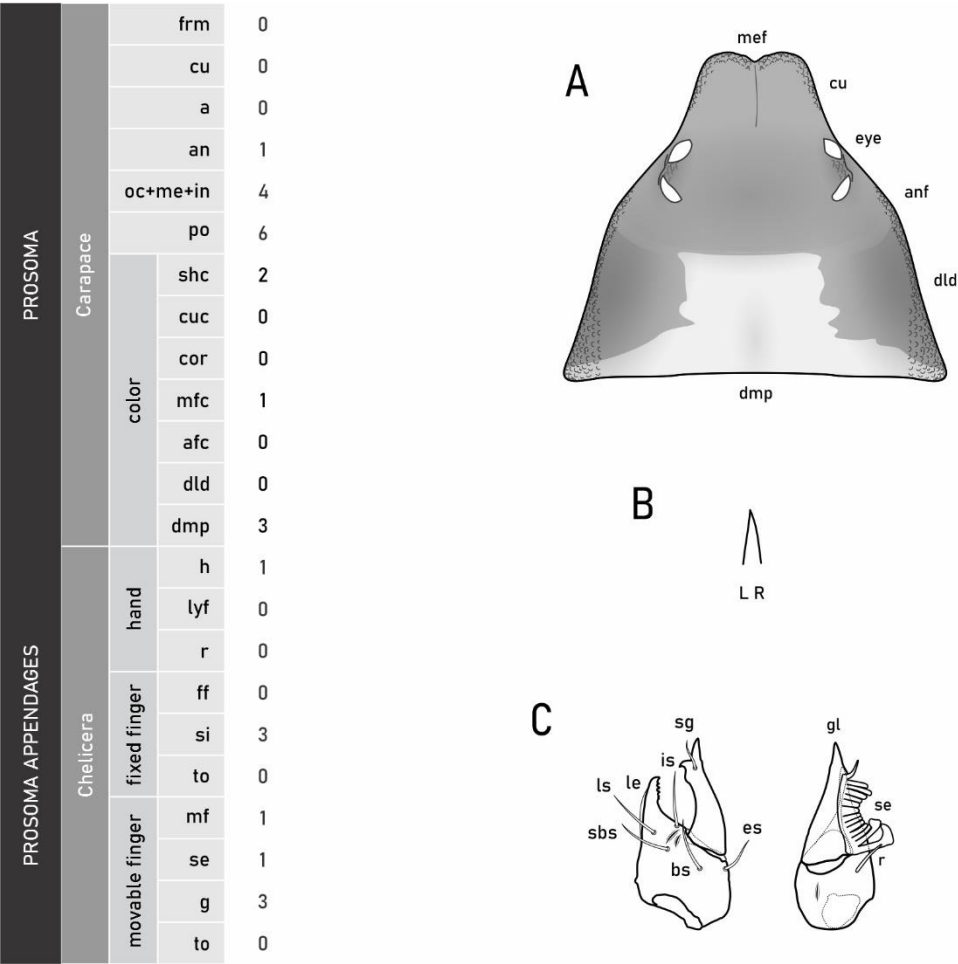
**Distribution.** Northeastern Brazil (Caatinga) (Fig. 31). This species was collected in the Ubajara National Park – Serra de Ibiapaba, ecotone Caatinga and Cerrado. It is not possible to determine whether this species is distributed in the Cerrado.

**Diagnosis.** *G. chaetomaculatus* **sp. nov.** can be easily recognized by the presence of: Pedipalpal femur, patella and hand total chaetae: 32 29(5) + 3(9), 34 27(5) + 7(9), 29 27(5) + 2(10); Tergites I, V, IX and X total chaetae: 10(5), 12(5), 10(5), 6(5); Sternite VIII, IX and X total chaetae: 8(21), 8(21), 6 6(21); Tergites with darkmarks in the chaetal field; Leg I femur ratio: 3.2x; Leg IV trochanter ratio: 2.0x; Leg IV patella ratio: 3.5x.

**Coded Description.** Figs. 6, 32–35 and Appendix 1.

**Remarks.** This species located in the extreme north of the Caatinga presents pedipalpal femur with granular humps, as well as *G. incertus* from French Guiana, the two species have numerous

distinctions, including the number of darkspots, presence of darkmarks in the chaetae positions in tergites IV–X, in addition it has 10 ramis in the female's galea while *G. incertus* has 7 ramis. In terms of morphometry, the two species differ in the ratio of the femur and metatarsus of Leg I, femur with patella and metatarsus of Leg IV.



**Figure 32.** *G. chaetomaculatus* **sp. nov.** Coded description: Carapace and Chelicera: Carapace with chaetotaxy and color intensity spots, dorsal view.; Male galea.; Chelicera with chaetotaxy.

| PROSOMA APPENDAGES |              |      |    |  |
|--------------------|--------------|------|----|--|
| Pedipalp           |              |      |    |  |
|                    |              |      |    |  |
| hand               | fixed finger | tr   | 10 |  |
|                    |              | fe   | 12 |  |
|                    |              | pa   | 14 |  |
|                    |              | h    | 12 |  |
| movable finger     | fixed finger | hfrm | 0  |  |
|                    |              | ff   | 5  |  |
|                    |              | to   | 1  |  |
|                    |              | dis  | 0  |  |
| movable finger     | fixed finger | pro  | 0  |  |
|                    |              | vd   | 0  |  |
|                    |              | mf   | 5  |  |
|                    |              | to   | 0  |  |
| movable finger     | fixed finger | dis  | 0  |  |
|                    |              | pro  | 0  |  |
|                    |              | vd   | 0  |  |

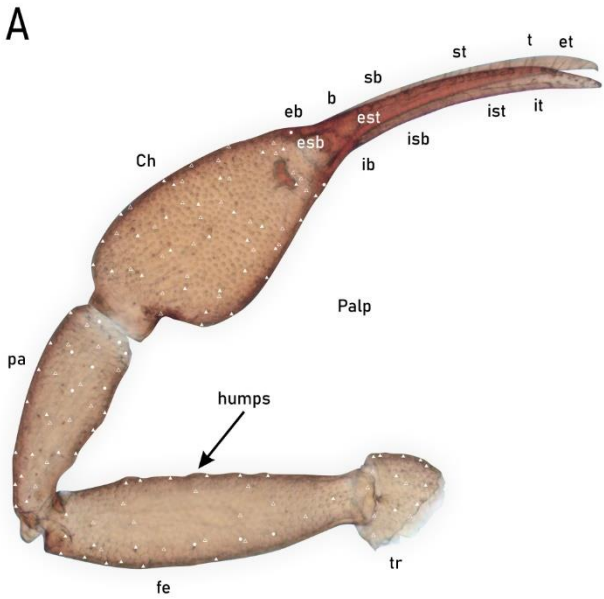
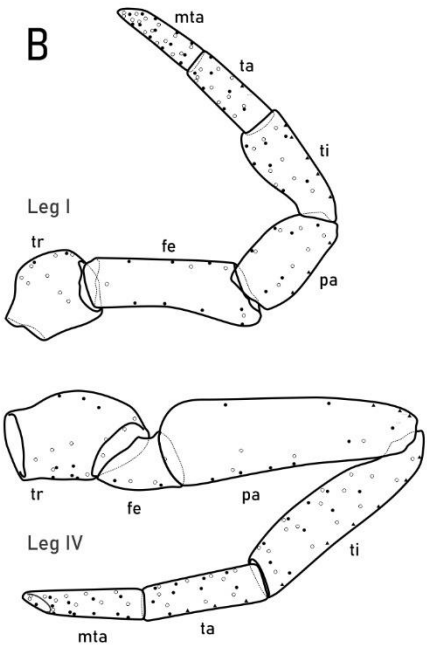
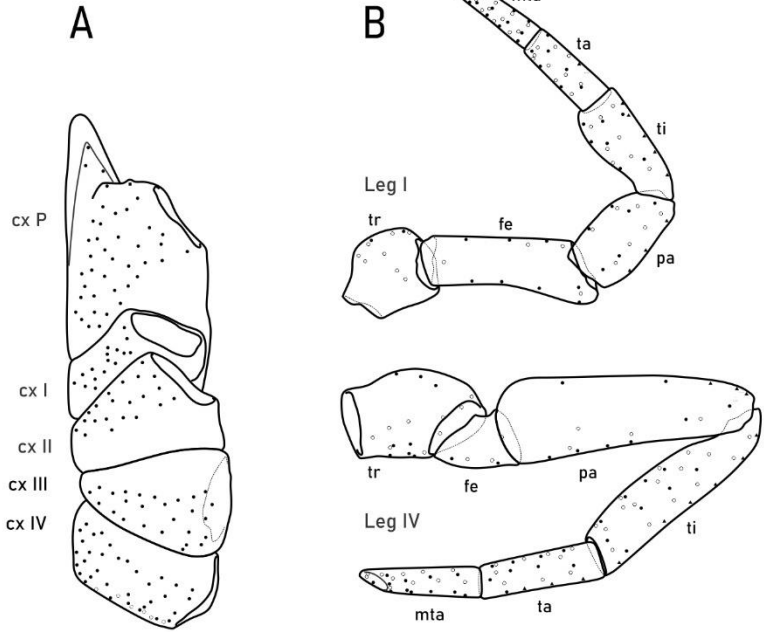
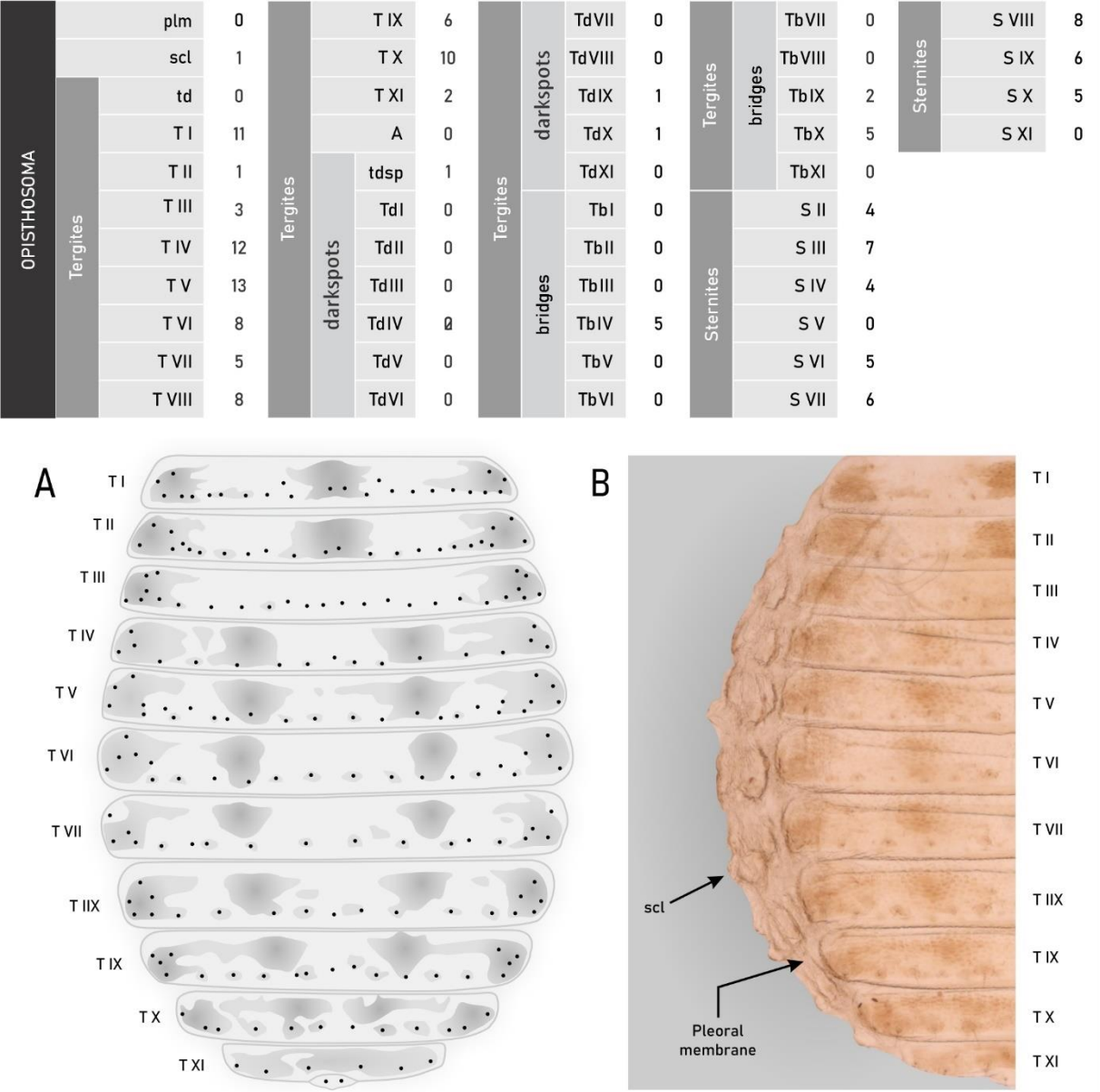


Figure 33. *G. chaetomaculatus* sp. nov. Coded description Pedipalp: Pedipalp with chaetotaxy pattern and color.

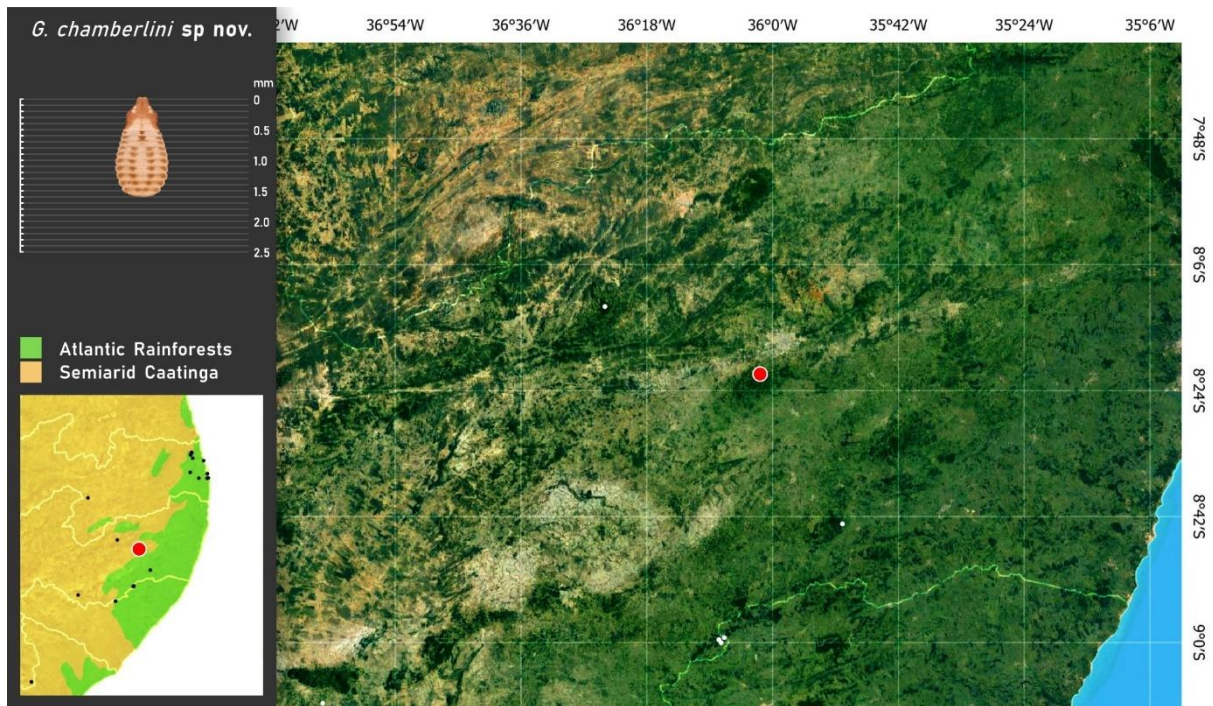
| PROSOMA APPENDAGES |        |        |   |  |
|--------------------|--------|--------|---|--|
| Coxal Region       |        |        |   |  |
|                    |        |        |   |  |
| leg I              | leg I  | cx P   | 3 |  |
|                    |        | cx I   | 4 |  |
|                    |        | cx II  | 6 |  |
|                    |        | cx III | 0 |  |
| leg IV             | leg IV | cx IV  | 7 |  |
|                    |        | tr     | 2 |  |
|                    |        | fe     | 2 |  |
|                    |        | pa     | 6 |  |
| leg I              | leg I  | ti     | 6 |  |
|                    |        | ta     | 0 |  |
|                    |        | mta    | 2 |  |
|                    |        | clw    | 0 |  |
| leg IV             | leg IV | arr    | 0 |  |
|                    |        | tr     | 7 |  |
|                    |        | fe     | 0 |  |
|                    |        | pa     | 0 |  |
| leg IV             | leg IV | ti     | 3 |  |
|                    |        | ta     | 9 |  |
|                    |        | mta    | 4 |  |
|                    |        | clw    | 0 |  |
| leg IV             | leg IV | arr    | 0 |  |



**Figure 34.** *G. chaetomaculatus* **sp. nov.** Coded description Coxal region and Legs. A. Coxa of pedipalp and I-IV. B. Legs I, IV.



**Figure 35.** *G. chaetomaculatus* **sp. nov.** Coded description Tergites and Sternites: Tergites I–XI with chaetotaxy and color intensity spots, dorsal view. A. schematic and color.



**Figure 36.** *G. chamberlini* sp. nov.: Habitus, size and distribution.

### 3.3.3.6 *Geogarypus chamberlini* Oliveira-Neto and Zeppelin *sp. nov.*

Figures 4, 6, 8–10, 36–40; Table 2, 3; Appendix 1

**Material examined.** Holotype: (UFPB–CAP02) BRAZIL, Pernambuco, Caruaru, PNM João Vasconcelos Sobrinho, 08°21'24.78"S 36°1'47.14"W, 850m ASL, October 2011, Seasonally dry tropical forest, Caatinga. Col. DeSouza, AM; Lira, AFA.

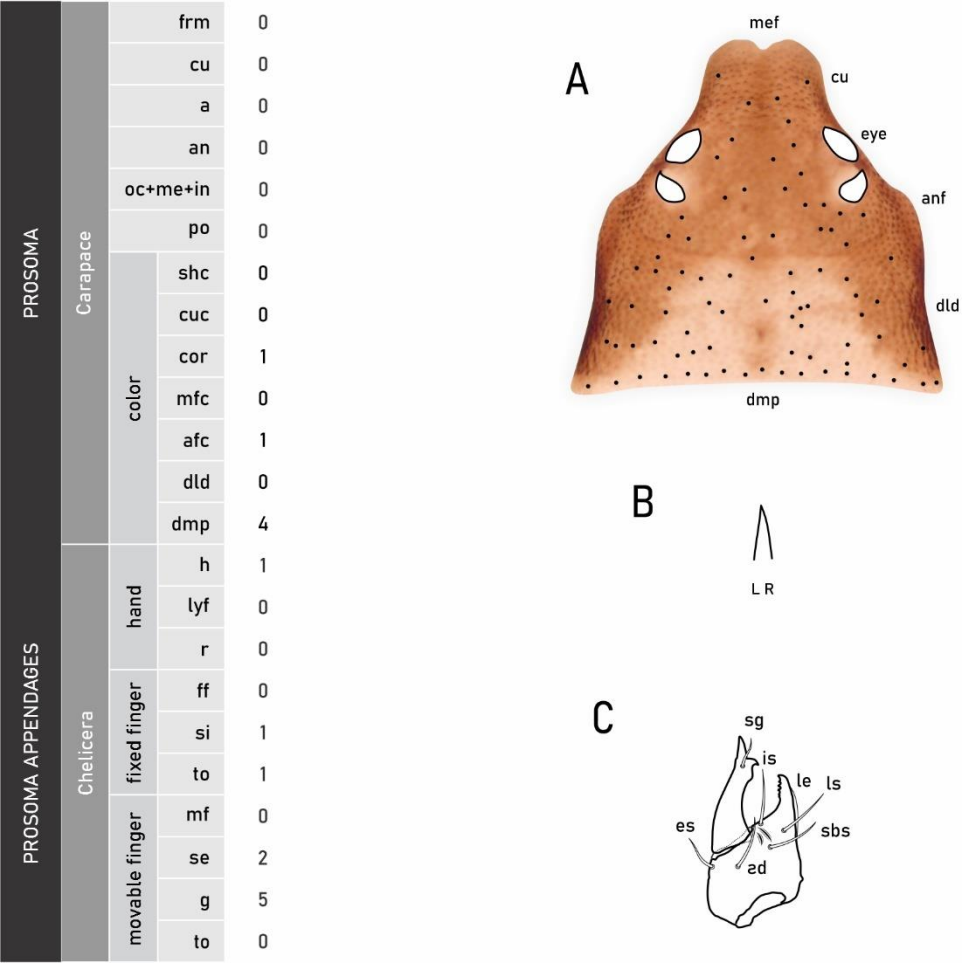
**Etymology.** The species is named after Professor Joseph Conrad Chamberlin (1898–1962), for his incredible contribution to arachnology, the study of Pseudoscorpiones order and the Geogarypydae family. **Distribution.** Brazilian Northeast (Biomes: Atlantic Forest and Caatinga).

**Distribution.** Northeastern Brazil (Caatinga) (Fig. 36). This species was collected in the Municipal Natural Park Professor João Vasconcelos Sobrinho, is an important forest fragment in the Caatinga of the state of Pernambuco, the fragment is located at 850m altitude on the Borborema Plateau.

**Diagnosis.** *G. chamberlini* sp. nov. can be easily recognized by the presence of: Pedipalpal hand total chaetae: 67 48(5) + 17(9) + 2(10); Leg I tibia total chaetae: 25 18(18a) + 7(19); Tergital discs count: 12 on tergites IV–IX; Tergites VIII–X with medial darkmarks.

**Coded Description.** Figs. 6, 37–40 and Appendix 1.

**Remarks.** *G. chamberlini* **sp. nov.** is a very characteristic species, it can be easily distinguished from the species *G. montanus* **sp. nov.**, *G. rajatus* **sp. nov.**, *G. sertanejus* **sp. nov.**, *G. talhadensis* **sp. nov.**, *G. eliptycus* **sp. nov.**, *G. caatinguensis* **sp. nov.**, *G. chaetomaculatus* **sp. nov.**, *G. alagoensis* **sp. nov.**, *G. volkeri* **sp. nov.** and *G. calon* **sp. nov.** for presenting darkmarks on medial region of tergites, the *G. curumim* **sp. nov.**, *G. brescoviti* **sp. nov.** and *G. salimoni* **sp. nov.** has darkmarks medial on tergites, *G. chamberlini* **sp. nov.** differs by having darkmarks only on tergites VIII-X.

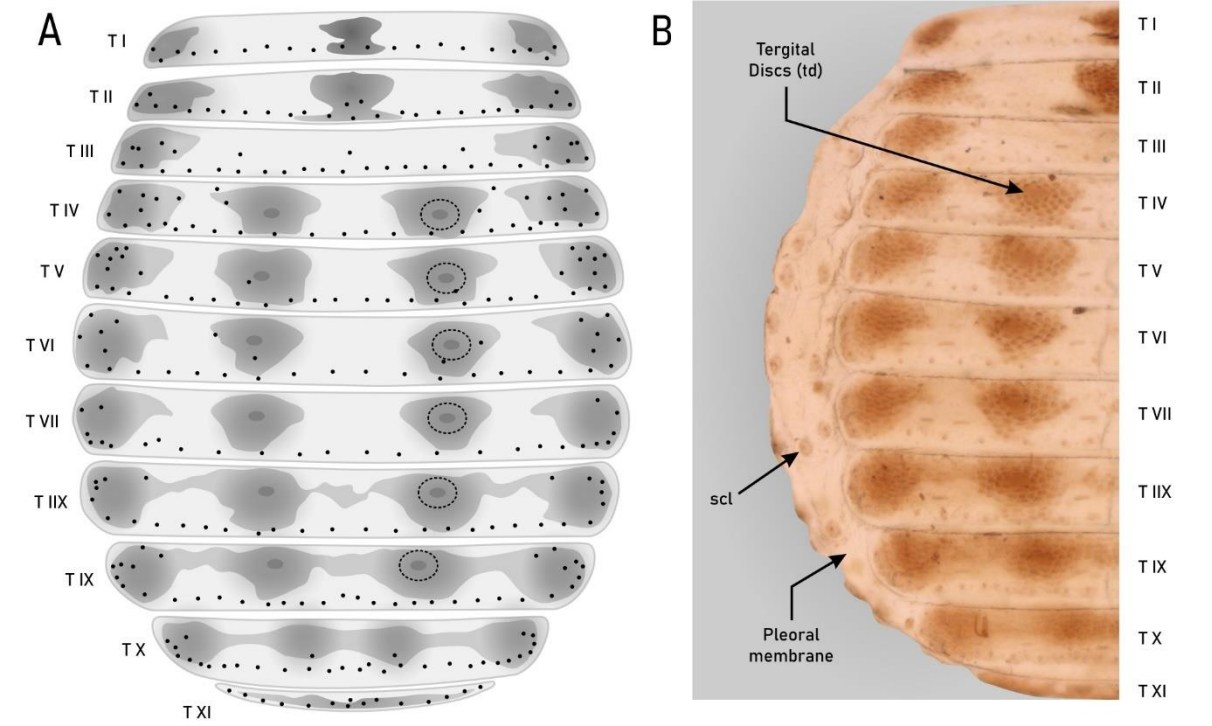


**Figure 37.** *G. chamberlini* **sp. nov.** Coded description Carapace and Chelicera: A. Carapace with chaetotaxy and color intensity spots, dorsal view. B. Male galea. C. Chelicera with chaetotaxy.

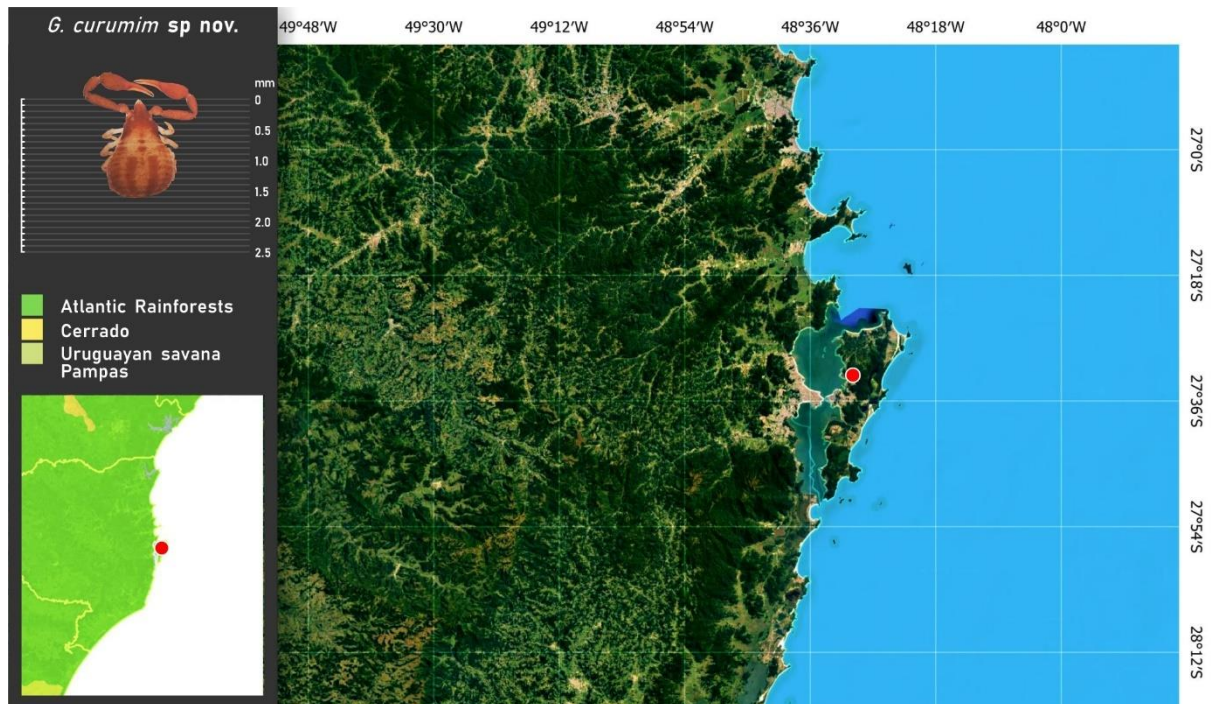


**Figure 39.** *G. chamberlini* sp. nov. Coded description Coxal region and Legs. A. Coxa of pedipalp and I-IV. B. Legs I, IV.

|             |          |        |   |          |           |       |   |          |           |        |   |           |         |        |   |           |        |   |
|-------------|----------|--------|---|----------|-----------|-------|---|----------|-----------|--------|---|-----------|---------|--------|---|-----------|--------|---|
| OPISTHOSOMA | Tergites | plm    | 0 | Tergites | darkspots | T IX  | 2 | Tergites | darkspots | TdVII  | 0 | Tergites  | bridges | TbVII  | 0 | Sternites | S VIII | 0 |
|             |          | scl    | 3 |          |           | T X   | 2 |          |           | TdVIII | 2 |           |         | TbVIII | 5 |           | S IX   | 1 |
|             |          | td     | 2 |          |           | T XI  | 1 |          |           | TdIX   | 1 |           |         | TbIX   | 4 |           | S X    | 0 |
|             |          | T I    | 0 |          |           | A     | 0 |          |           | TdX    | 0 |           |         | TbX    | 3 |           | S XI   | 0 |
|             |          | T II   | 2 |          |           | tdsp  | 1 |          |           | TdXI   | 0 |           |         | TbXI   | 0 |           |        |   |
|             |          | T III  | 0 |          |           | TdI   | 0 |          |           | TbI    | 0 | Sternites |         | S II   | ? |           |        |   |
|             |          | T IV   | 3 |          |           | TdII  | 0 |          |           | TbII   | 0 |           |         | S III  | 5 |           |        |   |
|             |          | T V    | 3 |          |           | TdIII | 0 |          |           | TbIII  | 0 |           |         | S IV   | 2 |           |        |   |
|             |          | T VI   | 3 |          |           | TdIV  | 1 |          |           | TbIV   | 0 |           |         | S V    | 1 |           |        |   |
|             |          | T VII  | 0 |          |           | TdV   | 0 |          |           | TbV    | 0 |           |         | S VI   | 0 |           |        |   |
|             |          | T VIII | 3 |          |           | TdVI  | 0 |          |           | TbVI   | 0 |           |         | S VII  | 3 |           |        |   |



**Figure 40.** *G. chamberlini* sp. nov. Coded description Tergites and Sternites: Tergites I–XI with chaetotaxy and color intensity spots, dorsal view. A. schematic and color.



**Figure 41.** *G. curumim* sp. nov.: Habitus, size and distribution.

### 3.3.3.7 *Geogarypus curumim* Oliveira-Neto and Bichuette sp. nov.

Figures 4, 6, 8–10, 41–45; Table 2, 3; Appendix 1

**Material examined.** Holotype: (UFSCar-LES0017321) BRAZIL, Santa Catarina, Florianópolis, Gruta das Pedras Grandes, 27°32'19.2"S 48°29'55.8"W, 6m ASL, May 2016, Semideciduous Seasonal Forest, Atlantic Rainforest. Col. Bichuette, ME & Gallão, JE. (Cave).

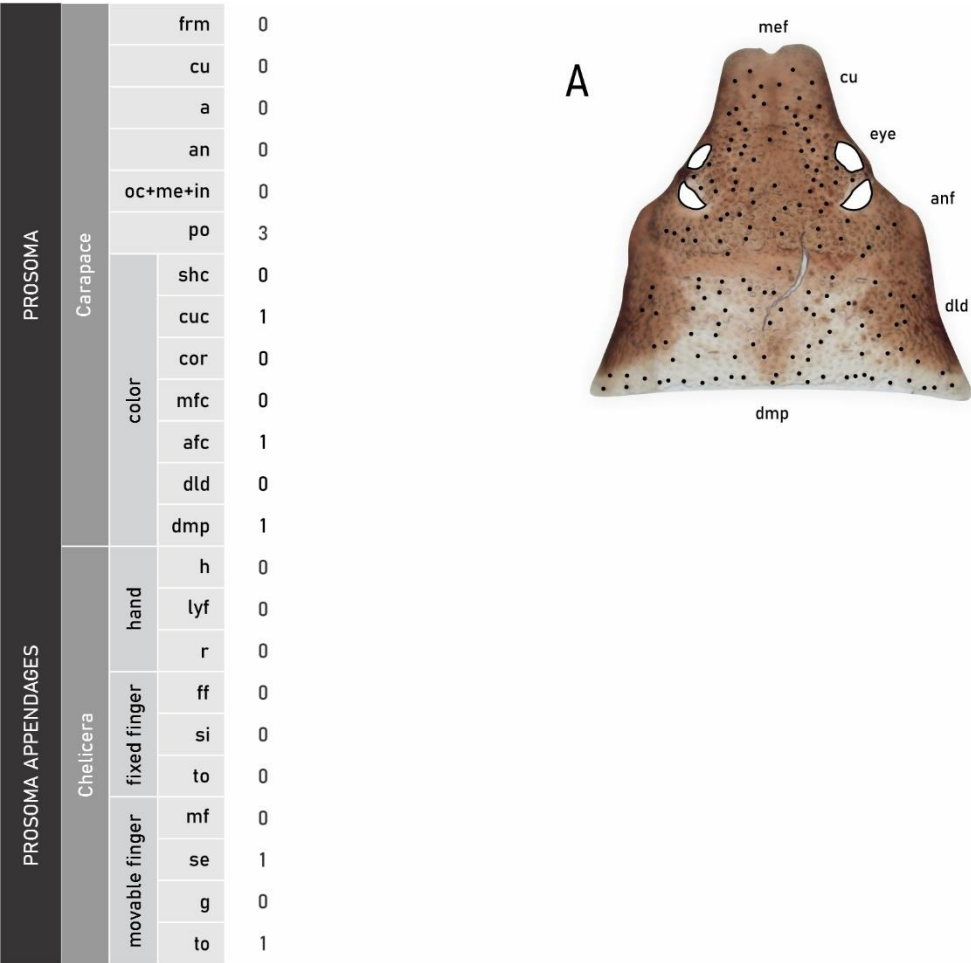
**Etymology.** Curumim is a Tupi word, a Brazilian indigenous language which translates as young.

**Distribution.** Brazilian Southern (Atlantic Rainforest) (Fig. 41). This species was collected in a unique habitat in the state of Rio Grande do Sul. It was found at the entrance to Gruta das Pedras Grandes, cave located on Santa Catarina Island, in the municipality of Florianópolis. The island is continental, quite urbanized and closely connected to the mainland by roads.

**Diagnosis.** *G. curumim* sp. nov. can be easily recognized by the presence of: Leg I trochanter total chaetae: 4(18a); Leg IV metatarsus total chaetae: 22 19(18a) + 2(18c) + 1(19); Total darkspots and darkmarks: 39 darkspots + 5 darkmarks; Absence of darkspot or darkmark on middle Tergite V; 2(20) + 2+2(21); Sternite XI total chaetae: 2(20) + 2+2(21); Leg I patella ratio: 1.2x.

**Coded Description.** Figs. 6, 42–45 and Appendix 1.

**Remarks.** The *G. curumim* **sp. nov.** is a very peculiar specimen, it has a unique darkspot distribution pattern, with solid and very wide darkspots, just like *G. formosum* from the Atlantic Forest of the state of Rio de Janeiro, the two species are possibly related, the description original *G. formosum* Melo-Leitão 1937 lacks comparative information, the tone of the pedipalp and carapace of *G. curumim* **sp. nov.** is very close to that described by Melo-Leitão 1937, it was described as blackish, the species differ in terms of the total number of darkspots, *G. curumim* **sp. nov.** has 40 while *G. formosum* has 42, in addition, *G. curumim* **sp. nov.** still presents darkmarks in the VII-X tergites.



**Figure 42.** *G. curumim* **sp. nov.** Coded description Carapace and Chelicera: A. Carapace with chaetotaxy and color intensity spots, dorsal view. B. Male galea. C. Chelicera with chaetotaxy.

| PROSOMA APPENDAGES |          |                |      |   |
|--------------------|----------|----------------|------|---|
| Pedipalp           |          |                |      |   |
| PROSOMA APPENDAGES | Pedipalp | hand           | tr   | 7 |
|                    |          |                | fe   | 6 |
|                    |          |                | pa   | 0 |
|                    |          |                | h    | 7 |
|                    |          | fixed finger   | hfrm | 0 |
|                    |          |                | ff   | 9 |
|                    |          |                | to   | 0 |
|                    |          |                | dis  | 0 |
|                    |          |                | pro  | 0 |
|                    |          | movable finger | vd   | 0 |
|                    |          |                | mf   | 6 |
|                    |          |                | to   | 0 |
|                    |          |                | dis  | 0 |
|                    |          |                | pro  | 0 |
|                    |          |                | vd   | 0 |

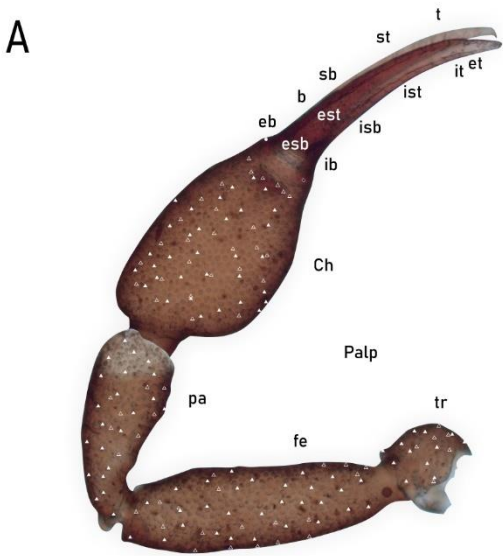
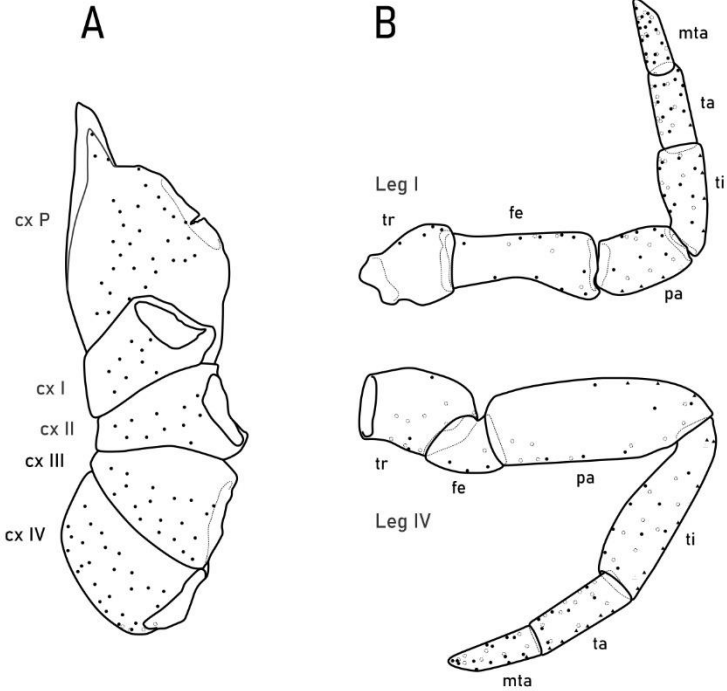


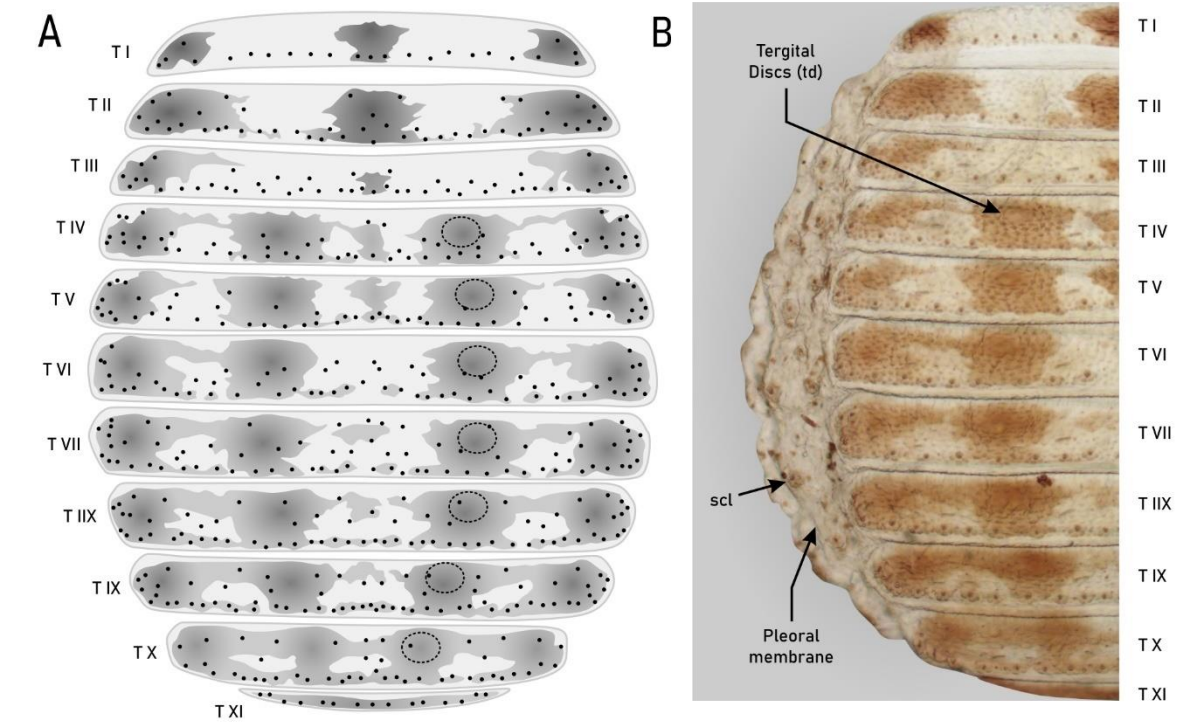
Figure 43. *G. curumim* sp. nov. Coded description Pedipalp: Pedipalp with chaetotaxy pattern and color.

| PROSOMA APPENDAGES |      |         |        |   |
|--------------------|------|---------|--------|---|
| Coxal Region       |      |         |        |   |
| PROSOMA APPENDAGES | Legs | leg I   | cx P   | 7 |
|                    |      |         | cx I   | 0 |
|                    |      |         | cx II  | 5 |
|                    |      |         | cx III | 1 |
|                    |      |         | cx IV  | 3 |
|                    |      | leg II  | tr     | 6 |
|                    |      |         | fe     | 6 |
|                    |      |         | pa     | 1 |
|                    |      |         | ti     | 5 |
|                    |      |         | ta     | 3 |
|                    |      | leg III | mta    | 1 |
|                    |      |         | clw    | 0 |
|                    |      |         | arr    | 0 |
|                    |      |         | tr     | 4 |
|                    |      | leg IV  | fe     | 1 |
|                    |      |         | pa     | 3 |
|                    |      |         | ti     | 1 |
|                    |      |         | ta     | 7 |
|                    |      |         | mta    | 9 |
|                    |      |         | clw    | 0 |
|                    |      |         | arr    | 0 |

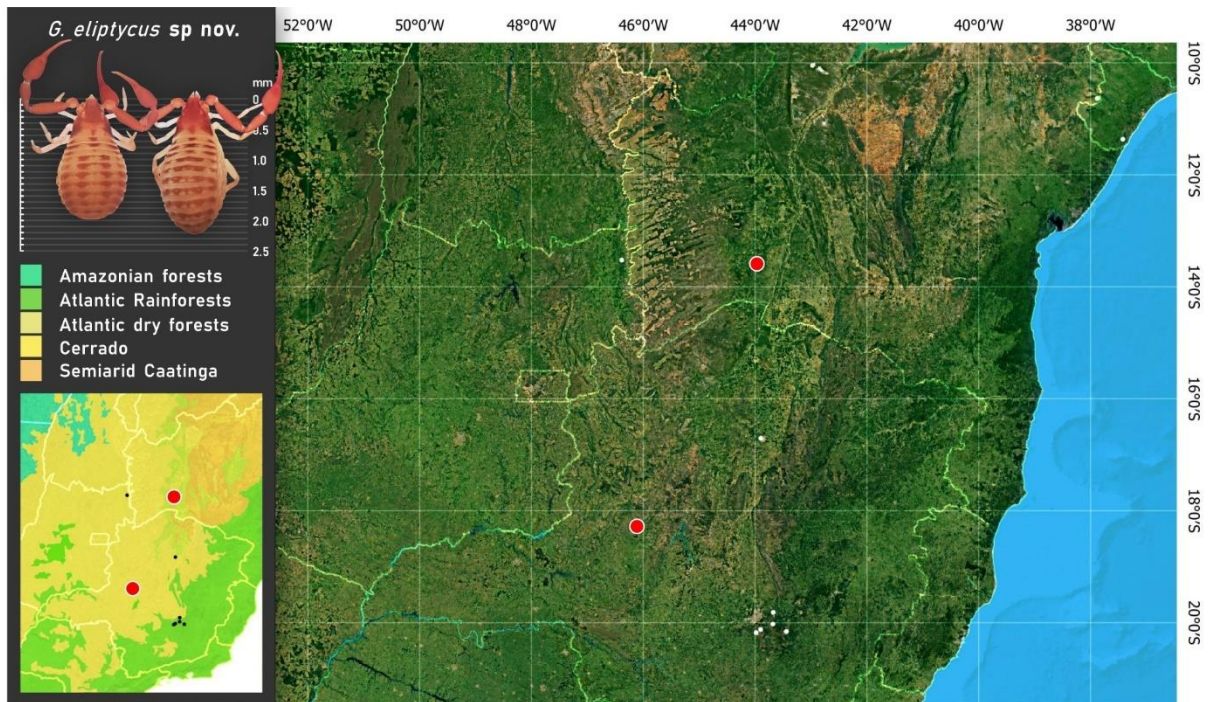


**Figure 44.** *G. curumim* sp. nov. Coded description Coxal region and Legs. A. Coxa of pedipalp and I-IV. B. Legs I, IV.

|             |          |        |   |          |           |       |   |          |           |        |   |          |         |        |   |           |        |   |
|-------------|----------|--------|---|----------|-----------|-------|---|----------|-----------|--------|---|----------|---------|--------|---|-----------|--------|---|
| OPISTHOSOMA | Tergites | plm    | 0 | Tergites | darkspots | T IX  | 1 | Tergites | darkspots | TdVII  | 2 | Tergites | bridges | TbVII  | 2 | Sternites | S VIII | 3 |
|             |          | scl    | 5 |          |           | T X   | 1 |          |           | TdVIII | 2 |          |         | TbVIII | 9 |           |        | 4 |
|             |          | td     | 1 |          |           | T XI  | 0 |          |           | TdIX   | 1 |          |         | TbIX   | 7 |           |        | 3 |
|             |          | T I    | 2 |          |           | A     | 0 |          |           | TdX    | 0 |          |         | TbX    | 8 |           |        | 3 |
|             |          | T II   | 3 |          |           | tdsp  | 5 |          |           | TdXI   | 0 |          |         | TbXI   | 0 |           |        | 3 |
|             |          | T III  | 5 |          |           | TdI   | 0 |          |           | TbI    | 0 |          |         | S II   | ? |           |        |   |
|             |          | T IV   | 2 |          |           | TdII  | 0 |          |           | TbII   | 0 |          |         | S III  | 1 |           |        |   |
|             |          | T V    | 6 |          |           | TdIII | 1 |          |           | TbIII  | 1 |          |         | S IV   | 3 |           |        |   |
|             |          | T VI   | 1 |          |           | TdIV  | 0 |          |           | TbIV   | 3 |          |         | S V    | 4 |           |        |   |
|             |          | T VII  | 0 |          |           | TdV   | 2 |          |           | TbV    | 7 |          |         | S VI   | 0 |           |        |   |
|             |          | T VIII | 0 |          |           | TdVI  | 2 |          |           | TbVI   | 3 |          |         | S VII  | 0 |           |        |   |



**Figure 45.** *G. curumim* sp. nov. Coded description Tergites and Sternites: Tergites I–XI with chaetotaxy and color intensity spots, dorsal view. A. schematic and color.



**Figure 46.** *G. eliptycus* sp. nov.: Habitus, size and distribution

### 3.3.3.8 *Geogarypus eliptycus* Oliveira-Neto and Bichuette **sp. nov.**

Figures 4, 6, 8–10, 46–50; Table 2, 3; Appendix 1

**Material examined.** Holotype: (UFSCar–LES005741) BRAZIL, Minas Gerais, Presidente Olegário, Lapa da fazenda São Bernardo, 18°16'36.88"S, 46°06'45.71"O, 776m ASL, September 2013, Tropical Savanna, Brazilian Cerrado. Col. Bichuette, ME & Zepon, (Cave).

Paratype (UFSCar–LES005748) BRAZIL, Minas Gerais, Presidente Olegário, Lapa da fazenda São Bernardo, 18°16'36.88"S, 46°06'45.71"O, 776m ASL, June 2014, Tropical Savanna, Brazilian Cerrado. Col. Bichuette, ME & Zepon. (Cave).

Paratype (UFSCar–LES005750) BRAZIL, Minas Gerais, Presidente Olegário, Lapa da fazenda São Bernardo, 18°16'36.88"S, 46°06'45.71"O, 776m ASL, June 2014, Tropical Savanna, Brazilian Cerrado. Col. Bichuette, ME & Zepon. (Cave).

Paratype (UFSCar–LES0017540) BRAZIL, Bahia, Carinhanha, Grana Bem Bom, 13°35'03.3"S, 43°57'51.2"W, 689m ASL, November 2015, Tropical Savanna, Brazilian Cerrado, Atlantic dry forests. Col. Bichuette, ME & Gallão, JE. (Cave).

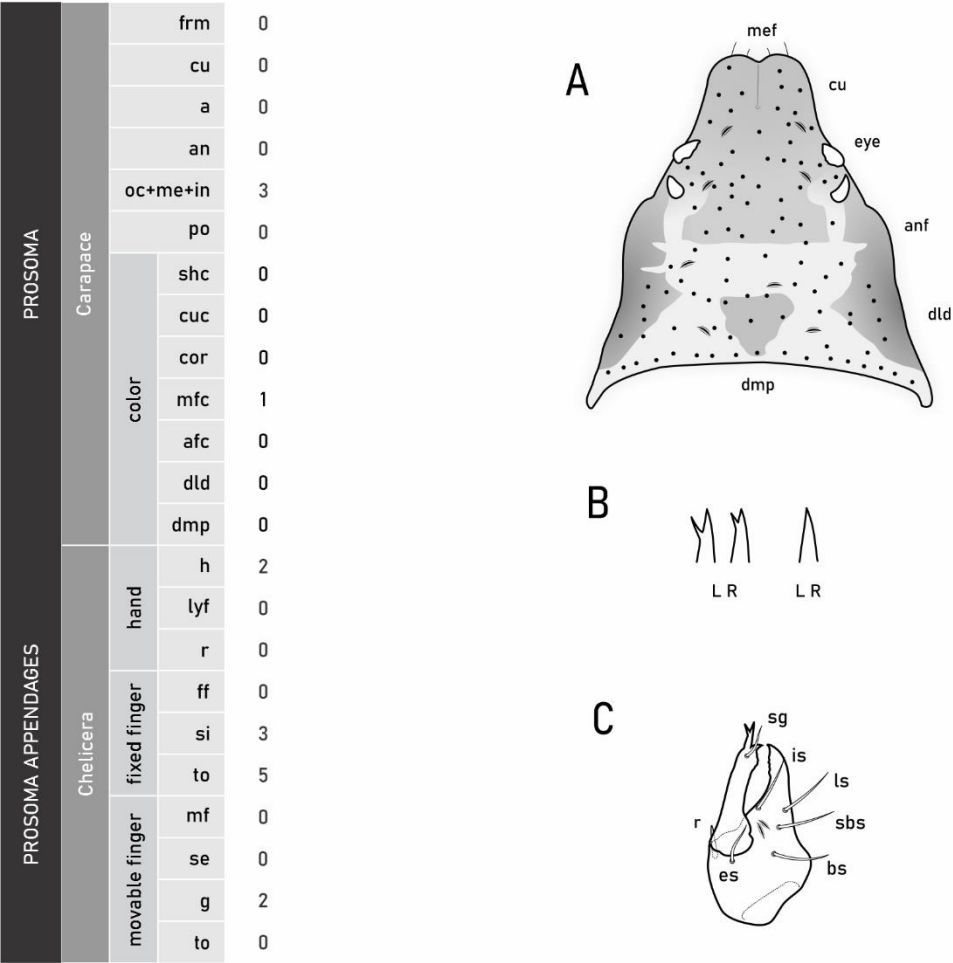
**Etymology.** The name of the species refers to the extremely elliptical shaped opisthosoma.

**Distribution.** Southeastern, Central and Northeastern Brazil (Cerrado and Atlantic dry forest) (Fig. 46). This is the first species recorded in the central region of Brazil, and it is the second

most widespread species in Brazilian territory, occurring in the states of Minas Gerais and Bahia. This species was recorded at the entrance of caves in both states.

**Diagnosis.** *G. eliptycus* **sp. nov.** can be easily recognized by the presence of: Pedipalpal fixed finger total chaetae: 106 8(9) + 80(10) + 7(14) + 8(15); Leg I tarsus total chaetae: 27(18a); Leg IV tibia and tarsus total chaetae: 40 28(18a) + 12(19), 35 29(18a) + 6(19); Tergites IV and V total darkspots: 3 continuous, 2 discrete; Tergites IV and V pattern bridges.

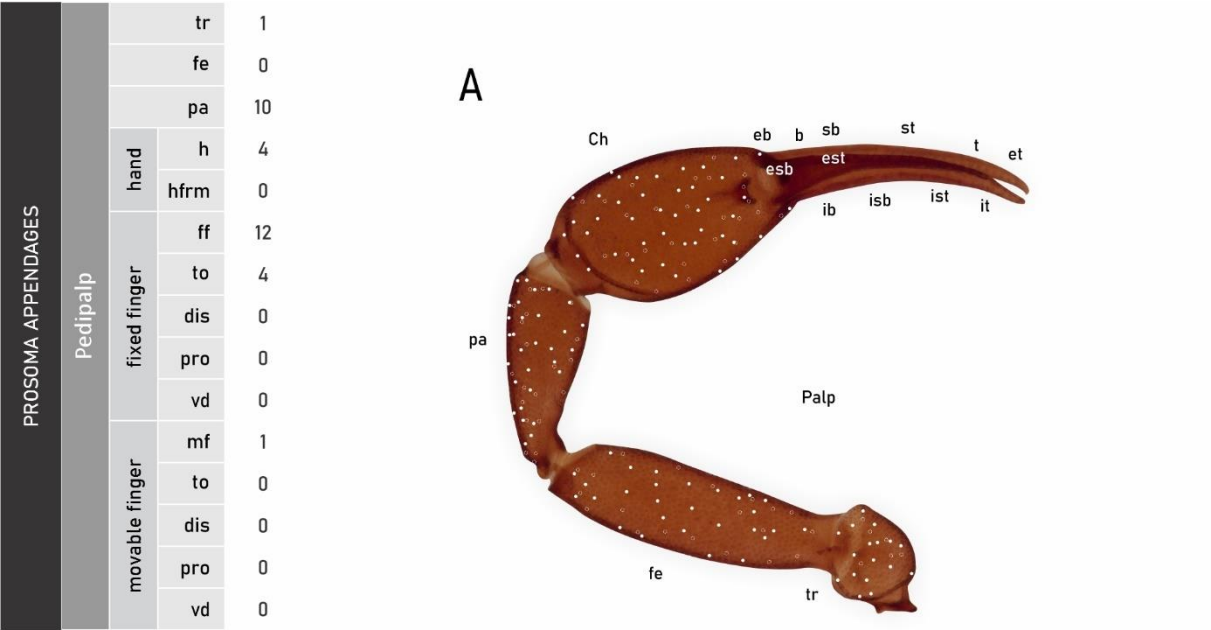
**Coded Description.** Figs. 6, 47–50 and Appendix 1.



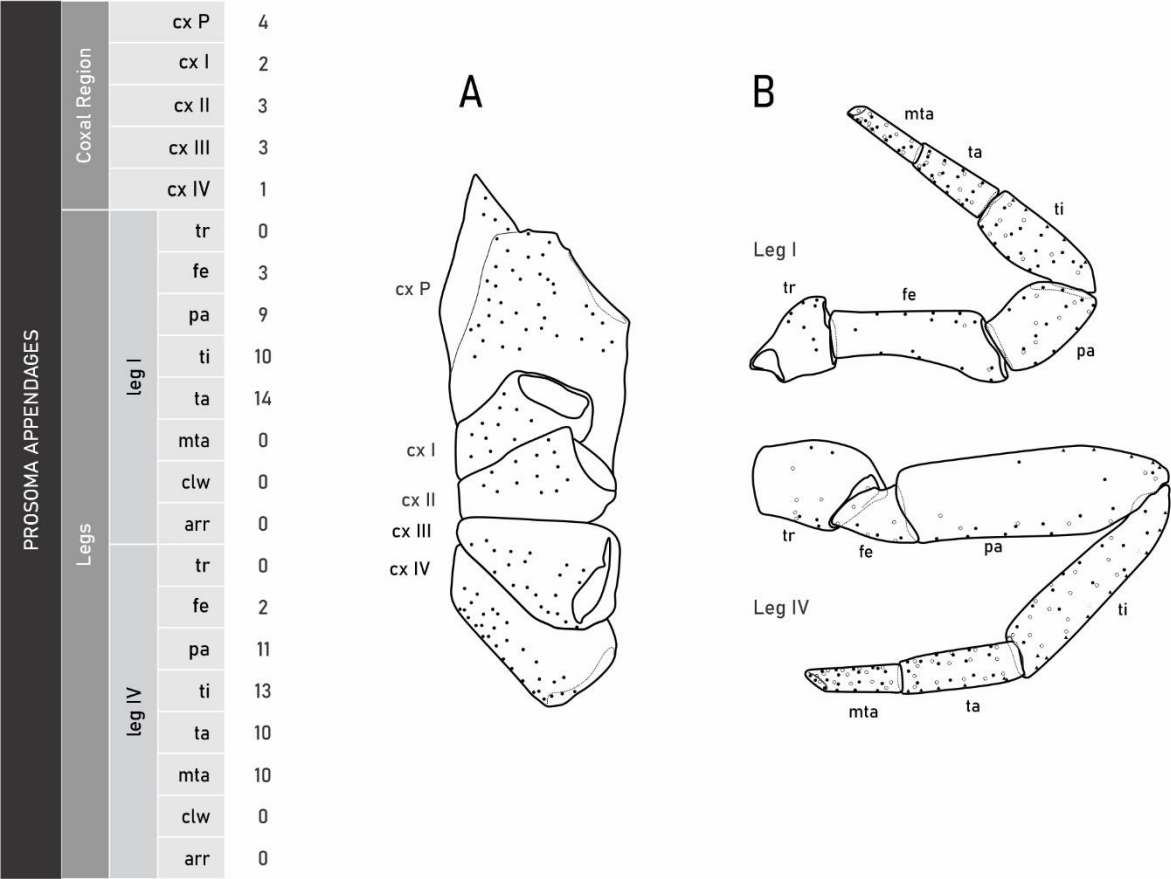
**Figure 47.** *G. eliptycus* **sp. nov.** Coded description: Carapace and Chelicera: Carapace with chaetotaxy and color intensity spots, dorsal view.; Male galea.; Chelicera with chaetotaxy.

**Remarks.** *G. eliptycus* **sp. nov.** is one of the largest species found in Brazil. It is the only species with 8 pls on the fixed finger and has a very characteristic color in IV-V tergites. This species is distinguished from the species described in this study as follows: *G. alagoensis* **sp. nov.**, *G. salimoni* **sp. nov.**, *G. sergipensis* **sp. nov.**, *G. brescoviti* **sp. nov.**, *G. chaetomaculatus* **sp. nov.**, *G. caatinguensis* **sp. nov.**, *G. montanus* **sp. nov.** and *G. chamberlini* **sp. nov.**, as it has *pnso* type 13,

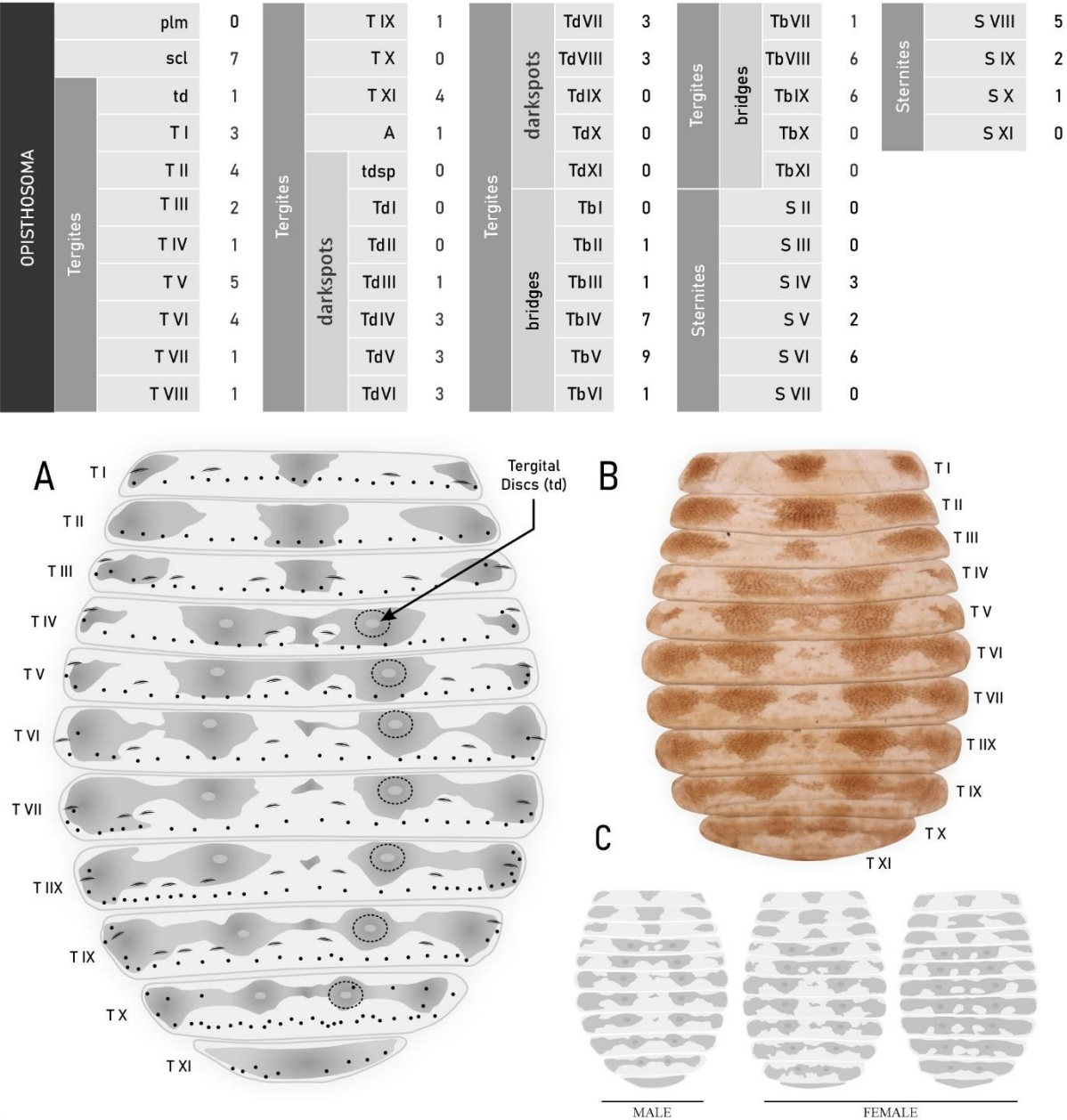
of the species with *pns* type 13 *G. eliptycus* **sp. nov.** is distinguished from *G. calon* **sp. nov.**, *G. volkeri* **sp. nov.**, *G. sertanejus* **sp. nov.**, *G. rajatus* **sp. nov.** and *G. curumim* **sp. nov.** for not having chaetae type 19 on the tarsi of leg I, from *G. talhadensis* **sp. nov.** the *G. eliptycus* **sp. nov.** can be distinguished through the chaetotaxy of the pedipalpal coxa, number of sclerites and pattern of bridges.



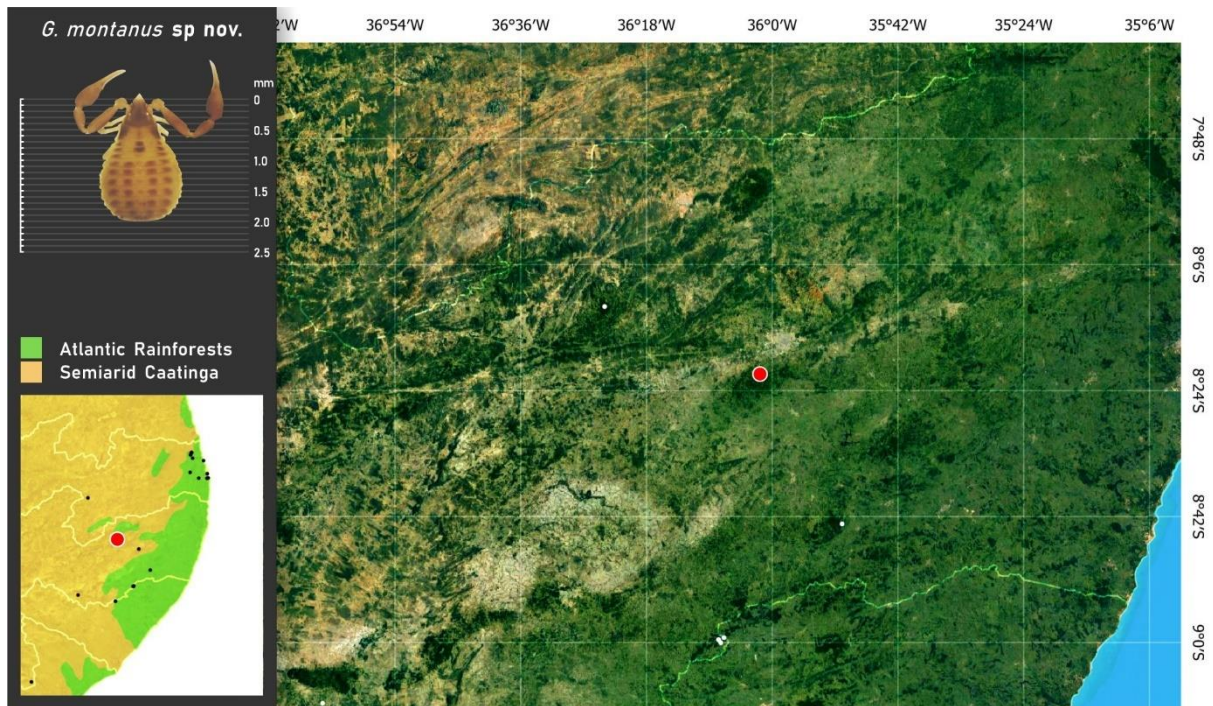
**Figure 48.** *G. eliptycus* **sp. nov.** Coded description Pedipalp: Pedipalp with chaetotaxy pattern and color.



**Figure 49.** *G. eliptycus* **sp. nov.** Coded description Coxal region and Legs: A. Coxa of pedipalp and I-IV. B. Legs I, IV.



**Figure 50.** *G. eliptycus* sp. nov. Coded description Tergites and Sternites: Tergites I–XI with chaetotaxy, lyrifissures and color intensity spots, dorsal view, schematic and in color.



**Figure 51.** *G. montanus* sp. nov.: Habitus, size and distribution.

#### 3.3.3.9 *Geogarypus montanus* Oliveira-Neto and Zeppelini sp. nov.

Figures 4, 6, 8–10, 51–55; Table 1–3; Appendix 1

**Material examined.** Holotype: (UFPB-BMD01A) BRAZIL, Pernambuco, Brejo da Madre de Deus, RPPN Fazenda Bitury, 08°11'59.77"S, 36°23'59.71"W, 1050m ASL, July 2016, Seasonally dry tropical forest, Caatinga. Col. DeSouza, AM; Saraiva, NEV; Pozzi, PH; Araujo-da-Silva, LP.

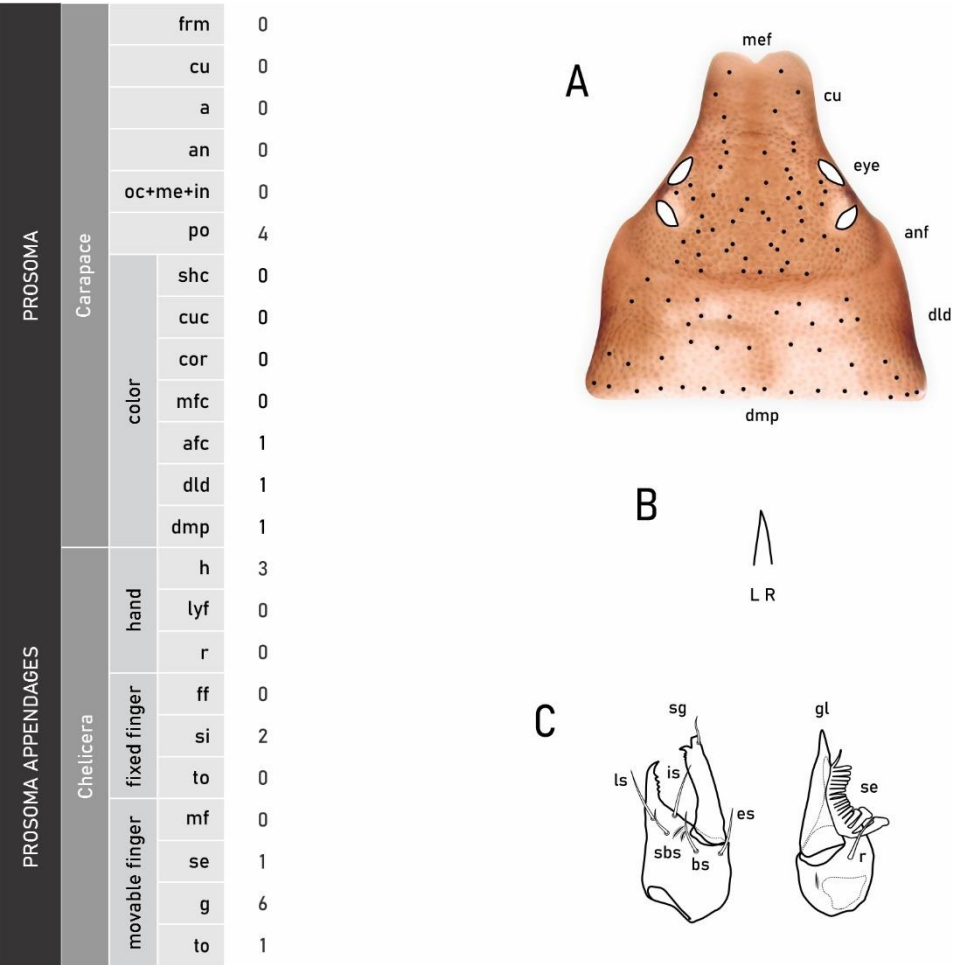
**Etymology.** The name of this species refers to the fact that it was collected in the highest highland rainforest among the species collected in northeastern Brazil.

**Distribution.** Northeastern Brazil (Caatinga) (Fig. 51). The *G. montanus* sp. nov. has been found only in a single location in the highland rainforest in the Caatinga of northeastern Brazil, at an altitude of 1,050m. This site, the Private Natural Heritage Reserve Fazenda Bituri It is an important conservation area located in the ecotone between the Caatinga and the Atlantic Rainforest.

**Diagnosis.** *G. montanus* sp. nov. can be easily recognized by the presence of: Pedipalpal hand total chaetae: 64 41(5) + 21(9) + 2(10); Pedipalpal movable finger total chaetae: 64 60(10) + 4(15); Tergite II total darkspots: 3 continuous; Tergites I-X pattern of bridges.

**Coded Description.** Figs. 6, 52–55 and Appendix 1.

**Remarks.** This species is the only one that has medial darkspots on tergites III–X that do not have *pnso* on the mobile finger. This species has the highest elevation record among the species from northeastern Brazil, being collected at 1050m in a humid forest enclave of the Caatinga in the state of Pernambuco.



**Figure 52.** *G. montanus* sp. nov. Coded description: Carapace and Chelicera: Carapace with chaetotaxy and color intensity spots, dorsal view.; Male galea.; Chelicera with chaetotaxy.

| PROSOMA APPENDAGES |              |      |     |    |
|--------------------|--------------|------|-----|----|
| Pedipalp           |              |      | tr  | 4  |
|                    |              |      | fe  | 1  |
|                    |              |      | pa  | 5  |
| hand               | h            | hfrm | h   | 14 |
|                    |              |      | ff  | 0  |
|                    | fixed finger | vd   | to  | 4  |
|                    |              |      | dis | 5  |
|                    |              |      | pro | 0  |
|                    |              |      | vd  | 0  |
| movable finger     | mf           | vd   | to  | 11 |
|                    |              |      | dis | 2  |
|                    |              |      | pro | 0  |
|                    |              |      | vd  | 0  |

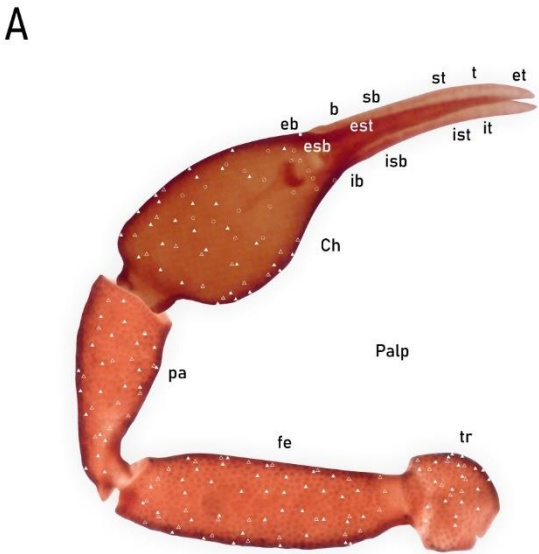
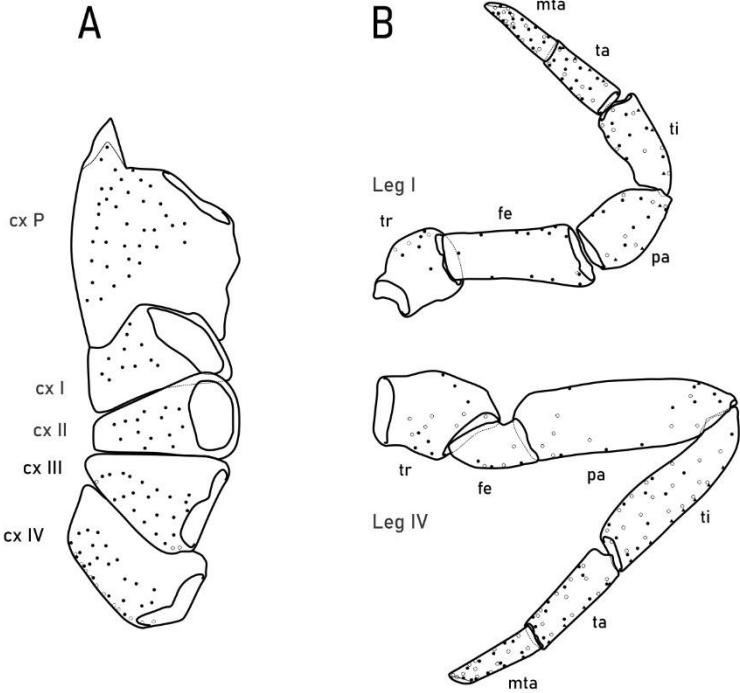
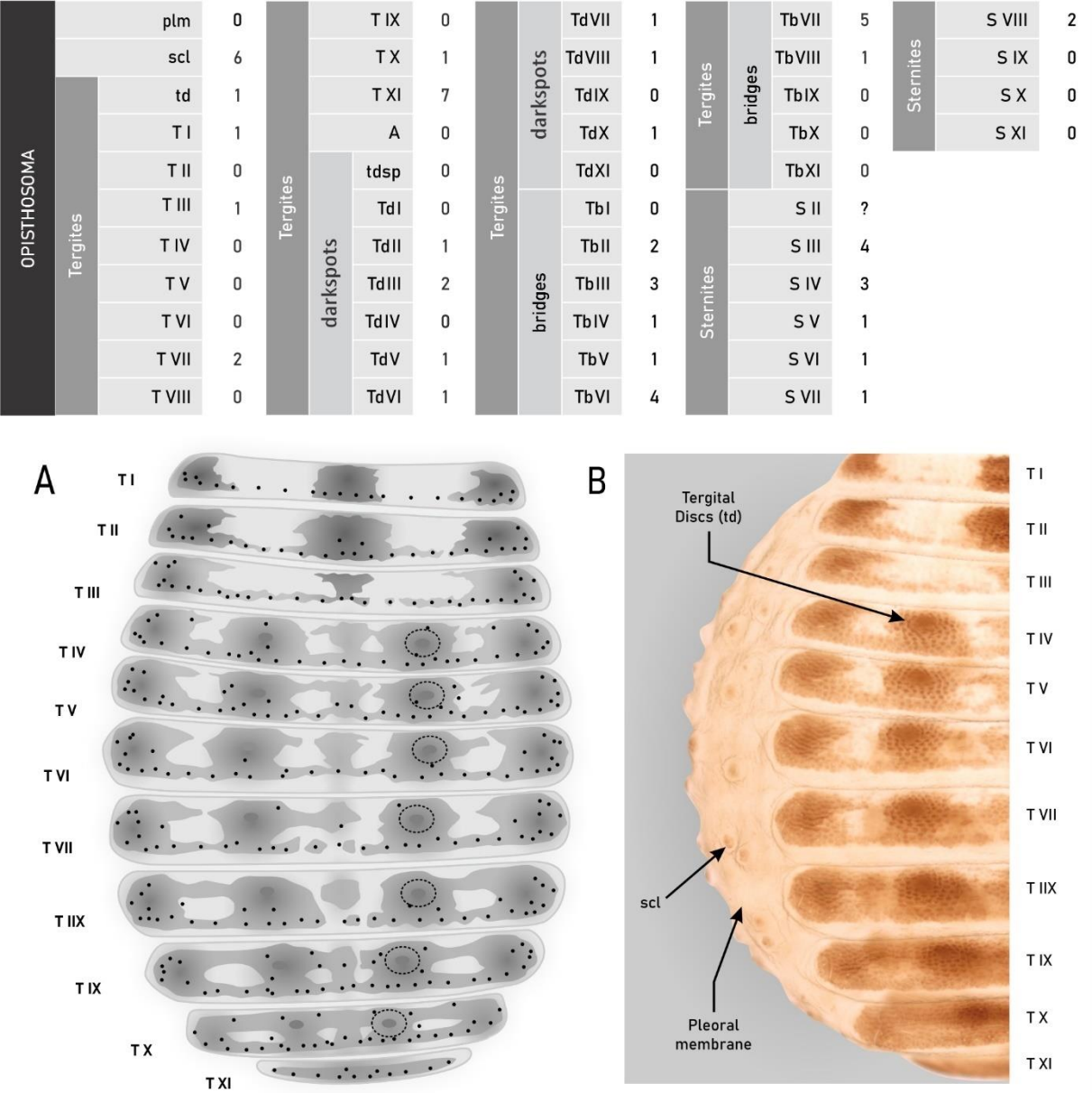


Figure 53. *G. eliptycus* sp. nov. Coded description Pedipalp: Pedipalp with chaetotaxy pattern and color.

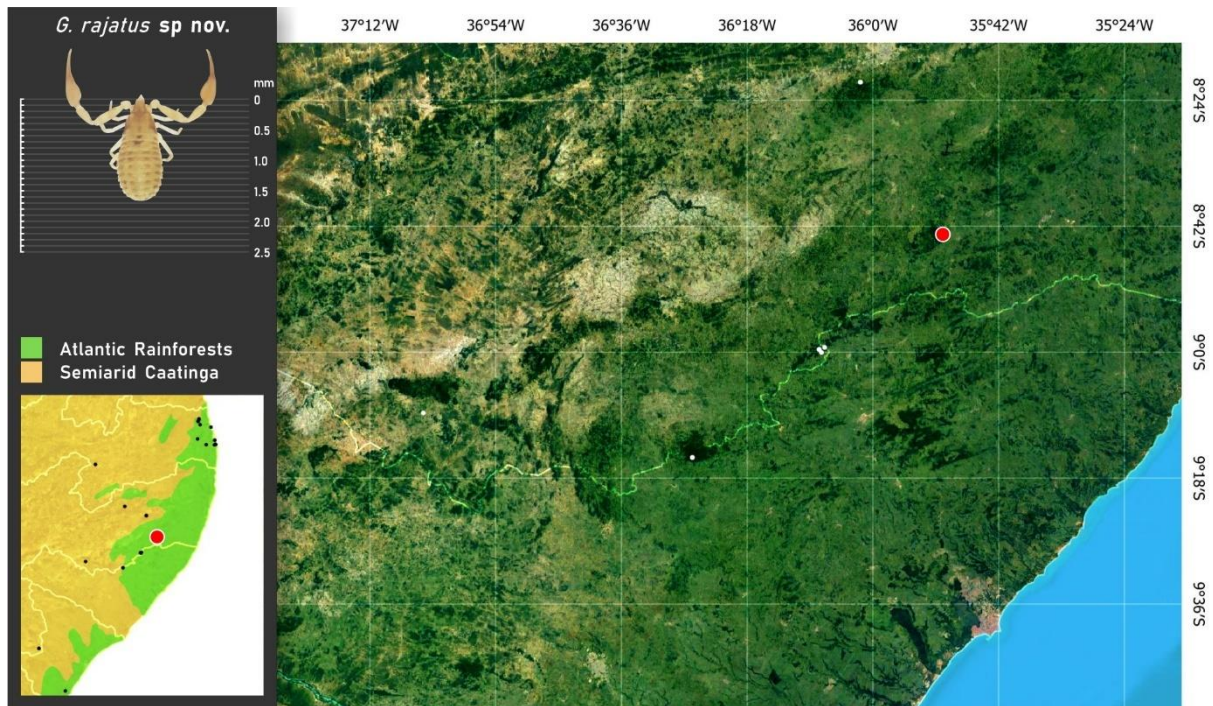
| PROSOMA APPENDAGES |        |    |        |    |
|--------------------|--------|----|--------|----|
| Coxal Region       |        |    | cx P   | 0  |
|                    |        |    | cx I   | 2  |
|                    |        |    | cx II  | 2  |
|                    |        |    | cx III | 4  |
|                    |        |    | cx IV  | 4  |
| Legs               | leg I  | tr | tr     | 0  |
|                    |        |    | fe     | 1  |
|                    |        |    | pa     | 2  |
|                    |        |    | ti     | 1  |
|                    |        |    | ta     | 9  |
|                    |        |    | mta    | 5  |
|                    |        |    | clw    | 0  |
|                    |        |    | arr    | 0  |
|                    | leg IV | tr | tr     | 1  |
|                    |        |    | fe     | 2  |
|                    |        |    | pa     | 2  |
|                    |        |    | ti     | 10 |
|                    |        |    | ta     | 0  |
|                    |        |    | mta    | 6  |
|                    |        |    | clw    | 0  |
|                    |        |    | arr    | 0  |



**Figure 54.** *G. montanus* sp. nov. Coded description Coxal region and Legs: A. Coxa of pedipalp and I-IV. B. Legs I, IV.



**Figure 55.** *G. montanus* sp. nov. Coded description Tergites and Sternites: Tergites I–XI with chaetotaxy, lyrifissures and color intensity spots, dorsal view, schematic and in color.



**Figure 56.** *G. rajatus* sp. nov.: Habitus, size and distribution.

#### 3.3.3.10 *Geogarypus rajatus* Oliveira-Neto and Zeppelini sp. nov.

Figures 4, 6, 8–10, 56–60; Table 2, 3; Appendix 1

**Material examined.** Holotype: (UFPB-AR0044) BRAZIL, Pernambuco, Jaqueira, RPPN Frei Caneco – Mata do Quengo, 8°21'24.78"S 36°1'47.14"W, 482m ASL, August 2011, Semideciduous Seasonal Forest, Atlantic Rainforest. Col. DaSilva, MB; DeSouza, AM; Araujo-da-Silva, LP.

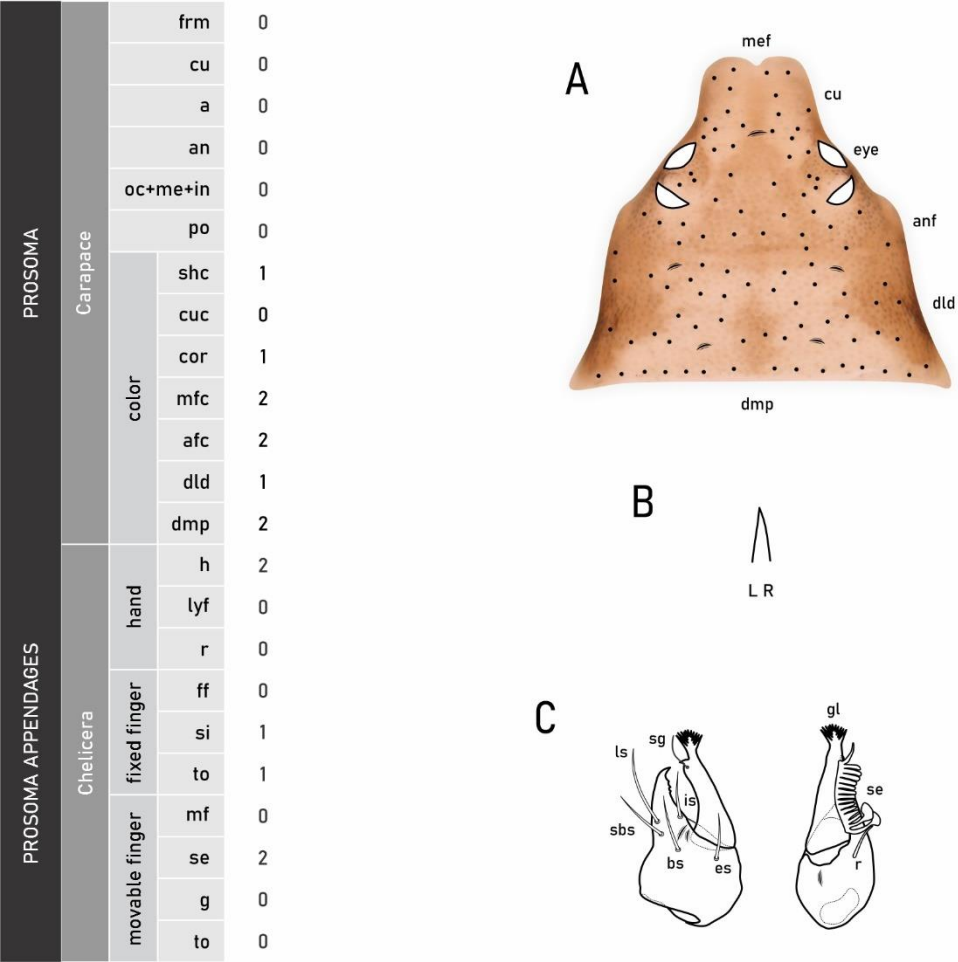
**Etymology.** The species name refers to the characteristic coloration of the carapace and tergites, resembling striped camouflage.

**Distribution.** Northeastern Brazil (Atlantic Forest) (Fig. 56). This specimen is endemic to the Atlantic rainforests of Pernambuco State, the specimen was collected in Private Natural Heritage Reserve Frei Caneco - Mata do Quengo.

**Diagnosis.** *G. rajatus* sp. nov. can be easily recognized by the presence of: Pedipalpal trochanter total chaetae: 32(5); Leg IV patella and tibia total chaetae: 25 17(18a) + 8(19), 46 26(18a) + 20(19); Pleural membrane without sclerites and total chaetae: 34(5). Chela with pedicel ratio: 3.6x.

**Coded Description.** Figs. 6, 57–60 and Appendix 1.

**Remarks.** The *G. rajatus* **sp. nov.** can be easily distinguished from other species as it is the only Brazilian species with 45 dakspots that does not have sclerites in the pleural membrane and tergital discs.



**Figure 57.** *G. rajatus* **sp. nov.** Coded description: Carapace and Chelicera: Carapace with chaetotaxy and color intensity spots, dorsal view.; Male galea.; Chelicera with chaetotaxy.

| PROSOMA APPENDAGES |              |      |    |    |
|--------------------|--------------|------|----|----|
| Pedipalp           |              |      | tr | 11 |
|                    |              |      | fe | 1  |
|                    |              |      | pa | 9  |
| hand               | fixed finger | h    | 2  |    |
|                    |              | hfrm | 0  |    |
|                    |              | ff   | 7  |    |
|                    |              | to   | 0  |    |
| movable finger     | dis          | dis  | 0  |    |
|                    |              | pro  | 0  |    |
|                    |              | vd   | 0  |    |
|                    |              | mf   | 7  |    |
|                    | to           | to   | 0  |    |
|                    |              | dis  | 0  |    |
|                    |              | pro  | 0  |    |
|                    |              | vd   | 0  |    |

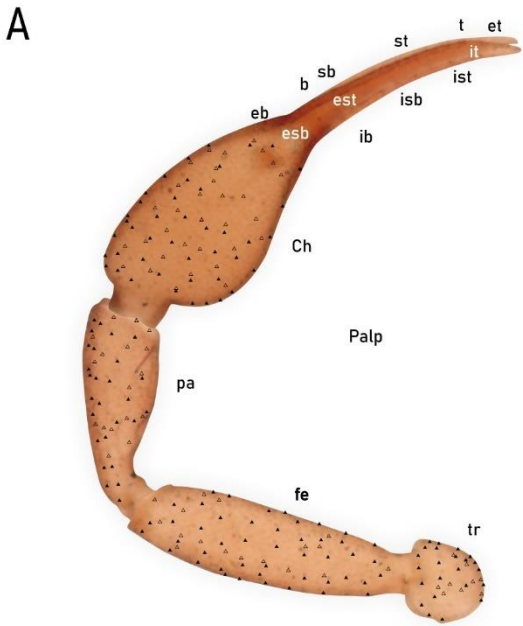
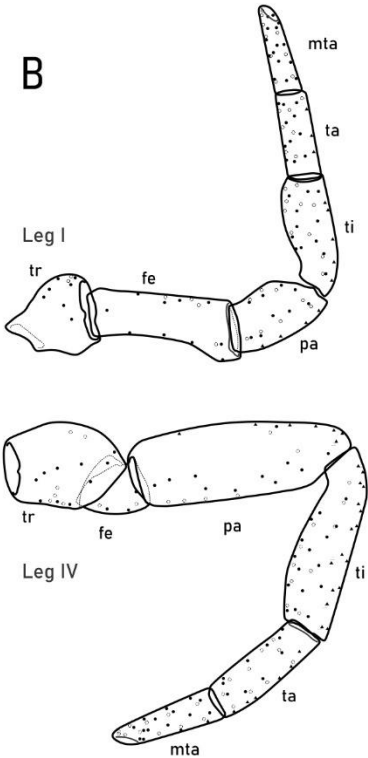
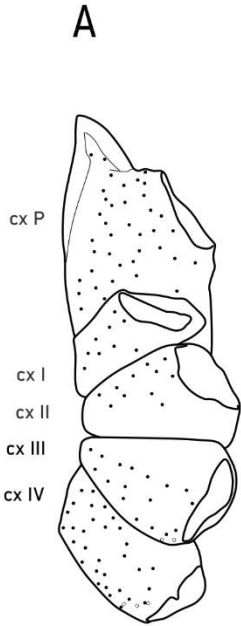


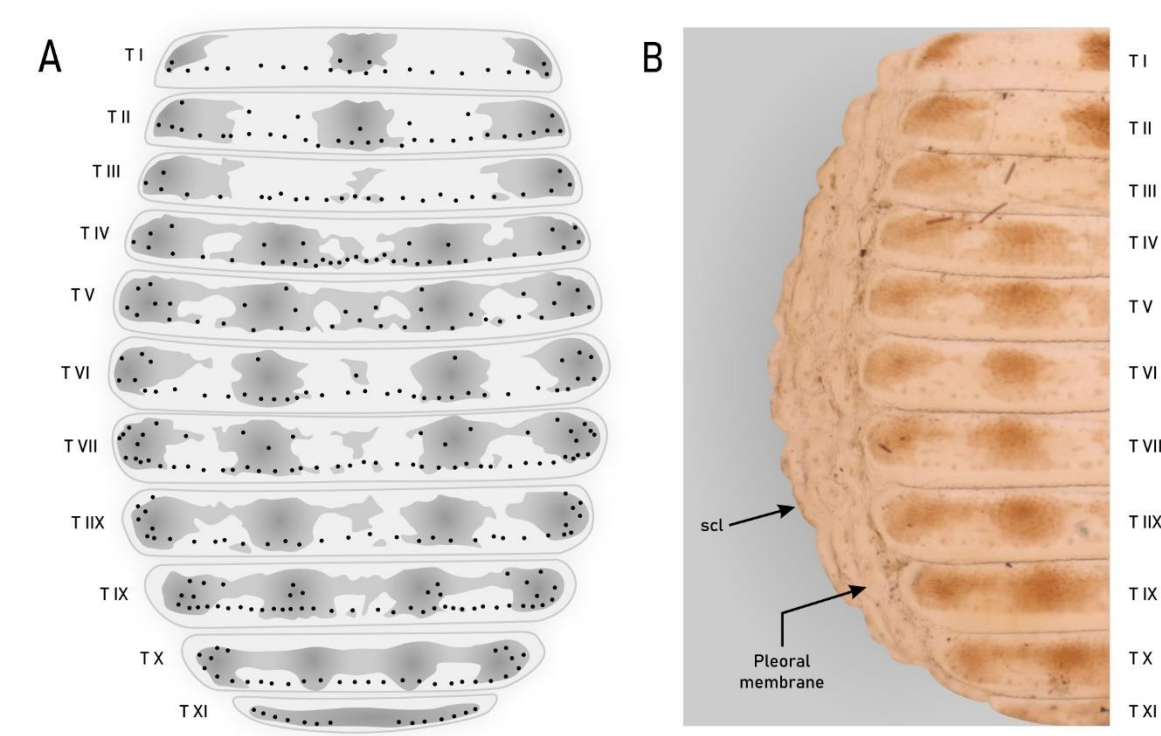
Figure 58. *G. rajatus* sp. nov. Coded description Pedipalp: Pedipalp with chaetotaxy pattern and color.

| PROSOMA APPENDAGES |    |              |   |
|--------------------|----|--------------|---|
| Legs               |    | Coxal Region |   |
| leg I              |    | cx P         | 2 |
|                    |    | cx I         | 0 |
|                    |    | cx II        | 5 |
|                    |    | cx III       | 1 |
|                    |    | cx IV        | 5 |
|                    |    | tr           | 1 |
|                    |    | fe           | 1 |
|                    |    | pa           | 0 |
|                    |    | ti           | 0 |
|                    |    | ta           | 4 |
|                    |    | mta          | 6 |
|                    |    | clw          | 0 |
|                    |    | arr          | 0 |
|                    |    | leg IV       |   |
| fe                 | 0  |              |   |
| pa                 | 12 |              |   |
| ti                 | 14 |              |   |
| ta                 | 6  |              |   |
| mta                | 0  |              |   |
| clw                | 0  |              |   |
| arr                | 0  |              |   |

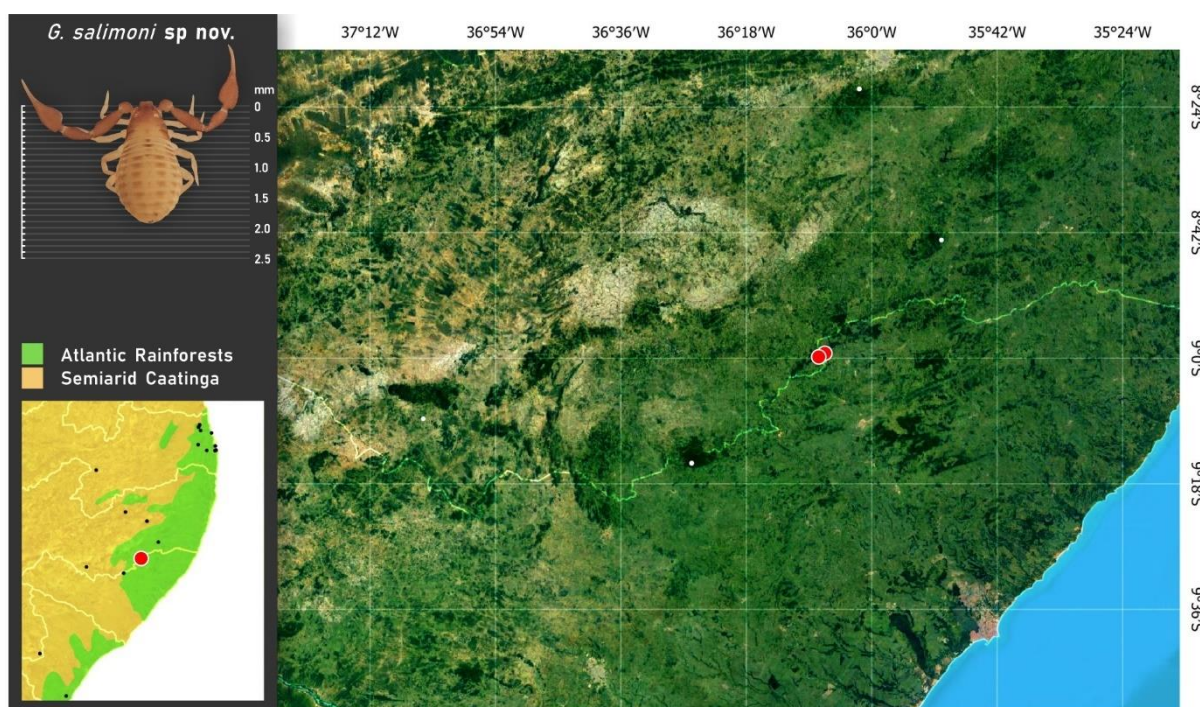


**Figure 59.** *G. rajatus* sp. nov. Coded description Coxal region and Legs: A. Coxa of pedipalp and I-IV. B. Legs I, IV.

|             |          |        |    |          |           |       |   |          |           |        |   |          |           |        |   |           |        |   |
|-------------|----------|--------|----|----------|-----------|-------|---|----------|-----------|--------|---|----------|-----------|--------|---|-----------|--------|---|
| OPISTHOSOMA | Tergites | plm    | 0  | Tergites | darkspots | T IX  | 0 | Tergites | darkspots | TdVII  | 3 | Tergites | bridges   | TbVII  | 1 | Sternites | S VIII | 4 |
|             |          | scl    | 11 |          |           | T X   | 0 |          |           | TdVIII | 1 |          |           | TbVIII | 7 |           | S IX   | 3 |
|             |          | td     | 0  |          |           | T XI  | 3 |          |           | TdIX   | 0 |          |           | TbIX   | 0 |           | S X    | 2 |
|             |          | T I    | 4  |          |           | A     | 0 |          |           | TdX    | 0 |          |           | TbX    | 0 |           | S XI   | 0 |
|             |          | T II   | 5  |          |           | tdsp  | 0 |          |           | TdXI   | 0 |          |           | TbXI   | 0 |           |        |   |
|             |          | T III  | 4  |          |           | TdI   | 0 |          |           | TbI    | 0 |          | Sternites | S II   | ? |           |        |   |
|             |          | T IV   | 2  |          |           | TdII  | 0 |          |           | TbII   | 0 |          |           | S III  | 1 |           |        |   |
|             |          | T V    | 1  |          |           | TdIII | 1 |          |           | TbIII  | 1 |          |           | S IV   | 5 |           |        |   |
|             |          | T VI   | 2  |          |           | TdIV  | 0 |          |           | TbIV   | 1 |          |           | S V    | 5 |           |        |   |
|             |          | T VII  | 0  |          |           | TdV   | 1 |          |           | TbV    | 4 |          |           | S VI   | 1 |           |        |   |
|             |          | T VIII | 2  |          |           | TdVI  | 3 |          |           | TbVI   | 1 |          |           | S VII  | 4 |           |        |   |



**Figure 60.** *G. rajatus* sp. nov. Coded description Tergites and Sternites: Tergites I–XI with chaetotaxy, lyrifissures and color intensity spots, dorsal view, schematic and in color.



**Figure 61.** *G. salimoni* sp. nov.: Habitus, size and distribution.

### 3.3.3.11 *Geogarypus salimoni* Oliveira-Neto and Zeppelini sp. nov.

Figures 4, 6, 8–10, 61–65; Table 2, 3; Appendix 1

**Material examined.** Holotype: (UFPB–AR00361) BRAZIL, Alagoas, São José da Laje, Usina Serra Grande – Mata do Brejo, 09°0'3.42"S, 36°7'21.89"W, 413m ASL, February 2012, Semideciduous Seasonal Forest, Atlantic Rainforest. Col. DeSouza, AM.

Paratype (UFPB–AR00391) BRAZIL, Alagoas, São José da Laje, Usina Serra Grande – Mata de Maria Maior, 08°59'36.92"S, 36°07'40.97"W, 435m ASL, February 2012, Semideciduous Seasonal Forest, Atlantic Rainforest. Col. DeSouza, AM; DaSilva, MB; Pozzi, PHS.

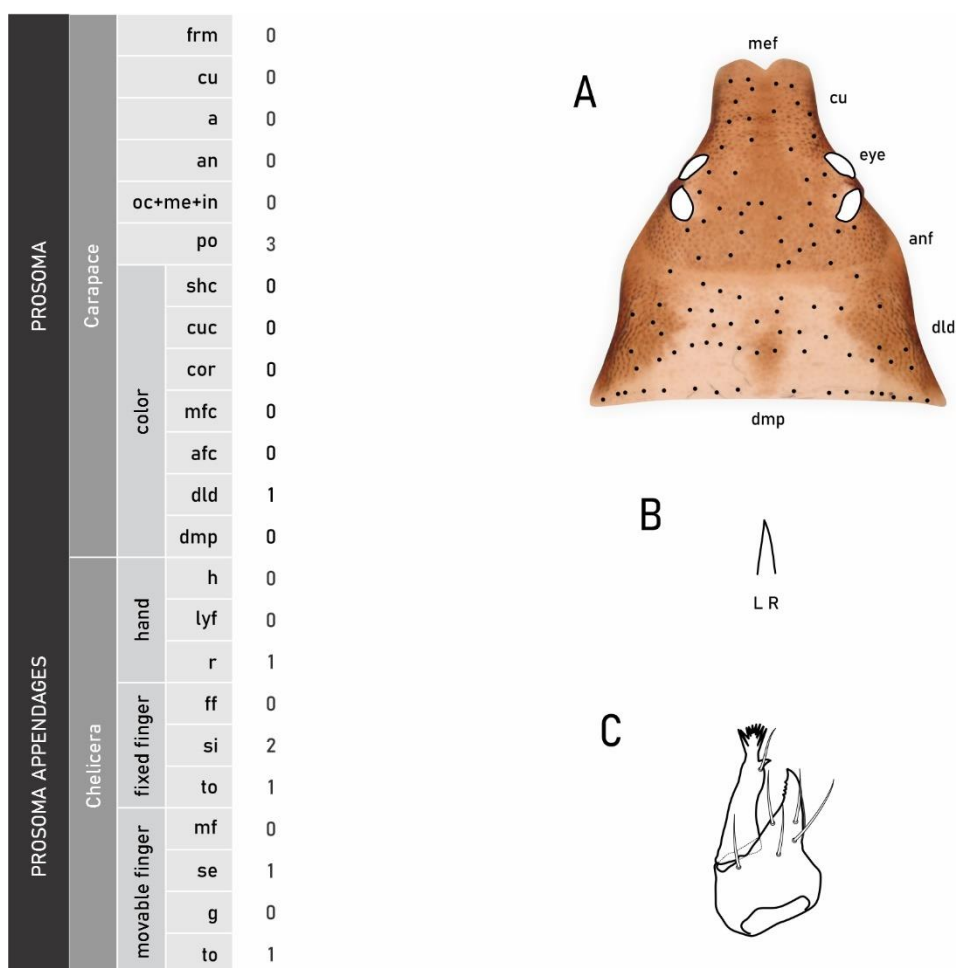
**Etymology.** The species is after Prof. Dr. Kleber Ibrain Salimon, for being a great defender of science and always making scientific progress possible.

**Distribution.** (Fig. 61) Northeastern Brazil (Atlantic Forest). This specimen is endemic to the Atlantic Forest of the state of Alagoas, being found only in the municipality of São José da Laje, more specifically in Mata de Maria Maior.

**Diagnosis.** *G. salimoni* sp. nov. can be easily recognized by the presence of: Chelicera with long blade in rallum; Leg I tarsus total chaetae: 19(18a); Leg IV femur, tibia and tarsus total chaetae: 8(18a), 38 18(18a) + 20(19), 27 16(18a) + 11(19); Tergites total darkspots: 38 darkspots + 7 darkmarks; Sternite XI total chaetae: 4(20).

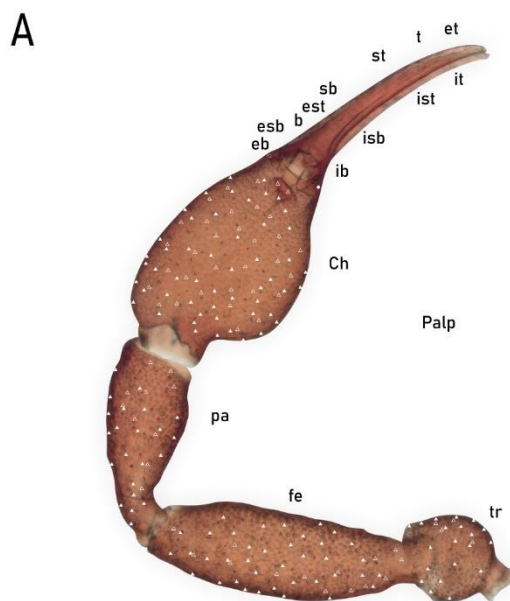
**Coded Description.** Figs. 6, 62–65 and Appendix 1.

**Remarks.** (see *G. alagoensis* **sp. nov.** and *G. volkeri* **sp. nov.** remarks) This specie shares the same distribution as the *G. alagoensis* **sp. nov.** and *G. volkeri* **sp. nov.** species, and can be easily distinguished from the *G. volkeri* **sp. nov.** and *G. alagoensis* **sp. nov.** by the shape of the rallum, long exclusively in *G. salimoni* **sp. nov.**, the chaetotaxy of the chelicera hand is different for the three species, *G. salimoni* **sp. nov.** has: 5(8), while *G. alagoensis* **sp. nov.** has: 5 1(7) + 4(8) and *G. volkeri* **sp. nov.** has: 5 3(7) + 2(8). Furthermore, *G. salimoni* **sp. nov.** have 14 tergital discs on Tergites IV–X, while *G. alagoensis* **sp. nov.** without tergital discs and *G. volkeri* **sp. nov.** have 4 tergital disc on Tergites IV–V.



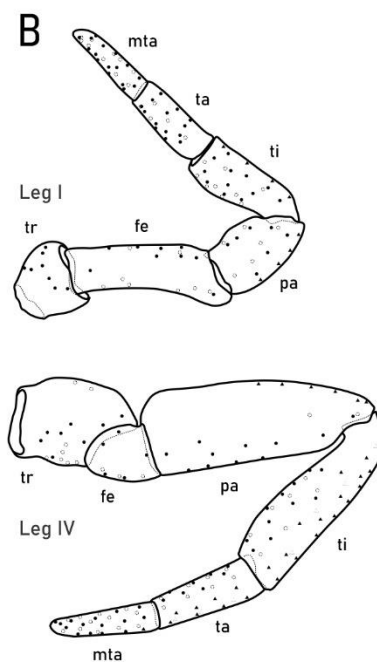
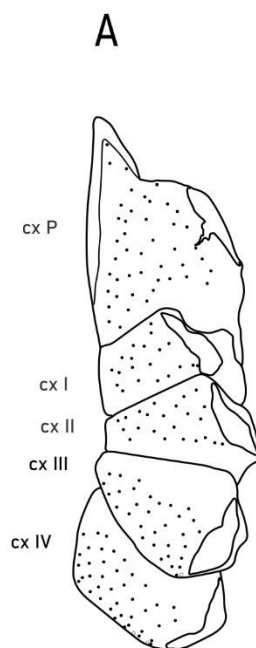
**Figure 62.** *G. salimoni* **sp. nov.** Coded description: Carapace and Chelicera: Carapace with chaetotaxy and color intensity spots, dorsal view.; Male galea.; Chelicera with chaetotaxy.

| PROSOMA APPENDAGES | Pedipalp | hand           | tr   | 2 |
|--------------------|----------|----------------|------|---|
|                    |          |                | fe   | 4 |
|                    |          |                | pa   | 4 |
|                    |          |                | h    | 0 |
|                    |          | fixed finger   | hfrm | 0 |
|                    |          |                | ff   | 3 |
|                    |          |                | to   | 0 |
|                    |          |                | dis  | 0 |
|                    |          |                | pro  | 0 |
|                    |          |                | vd   | 0 |
|                    |          | movable finger | mf   | 0 |
|                    |          |                | to   | 4 |
|                    |          |                | dis  | 0 |
|                    |          |                | pro  | 0 |
|                    |          |                | vd   | 0 |



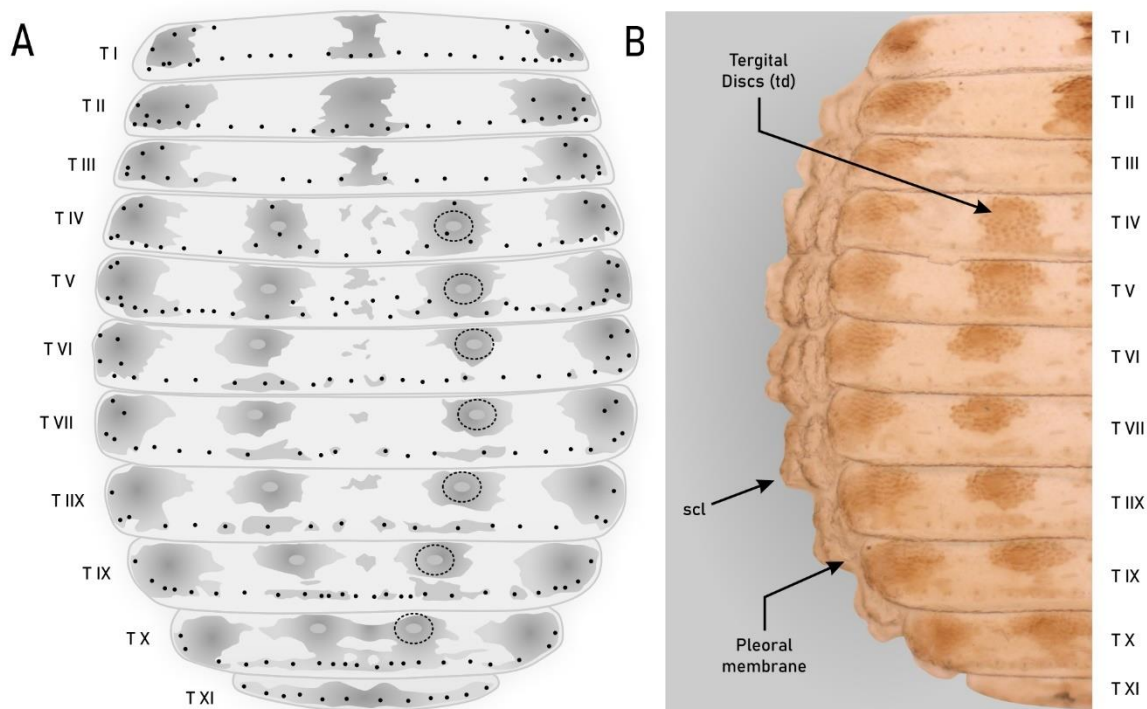
**Figure 63.** *G. salimoni* sp. nov. Coded description Pedipalp: Pedipalp with chaetotaxy pattern and color.

| PROSOMA APPENDAGES | Coxal Region | Legs   | cx P   | 9  |
|--------------------|--------------|--------|--------|----|
|                    |              |        | cx I   | 6  |
|                    |              |        | cx II  | 0  |
|                    |              |        | cx III | 6  |
|                    |              |        | cx IV  | 8  |
|                    | leg I        | tr     | tr     | 0  |
|                    |              |        | fe     | 5  |
|                    |              |        | pa     | 1  |
|                    |              |        | ti     | 8  |
|                    |              |        | ta     | 13 |
|                    |              | mta    | mta    | 1  |
|                    |              |        | clw    | 0  |
|                    |              |        | arr    | 0  |
|                    |              |        | tr     | 2  |
|                    |              |        | fe     | 4  |
|                    |              |        | pa     | 6  |
|                    |              | leg IV | ti     | 11 |
|                    |              |        | ta     | 11 |
|                    |              |        | mta    | 2  |
|                    |              |        | clw    | 0  |
|                    |              |        | arr    | 0  |

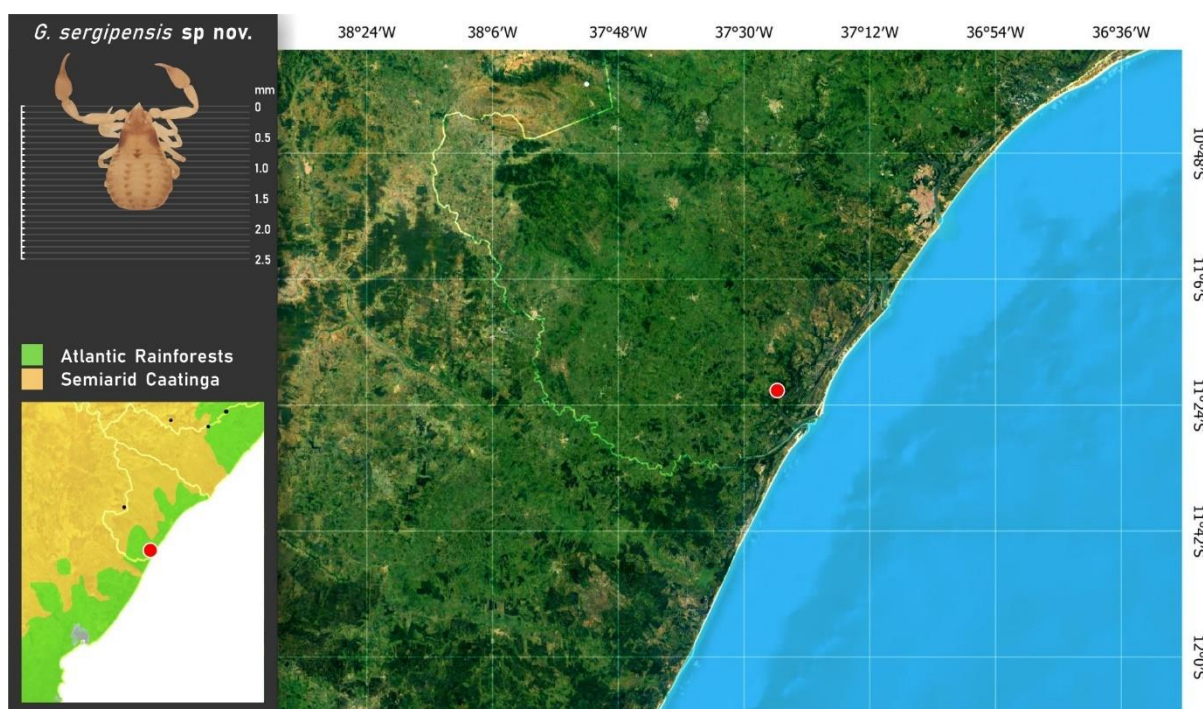


**Figure 64.** *G. salimoni* sp. nov. Coded description Coxal region and Legs: A. Coxa of pedipalp and I-IV. B. Legs I, IV.

|             |          |        |   |          |           |       |   |          |           |        |   |          |           |        |   |           |        |   |
|-------------|----------|--------|---|----------|-----------|-------|---|----------|-----------|--------|---|----------|-----------|--------|---|-----------|--------|---|
| OPISTHOSOMA | Tergites | plm    | 0 | Tergites | darkspots | T IX  | 0 | Tergites | darkspots | TdVII  | 0 | Tergites | bridges   | TbVII  | 3 | Sternites | S VIII | 4 |
|             |          | scl    | 9 |          |           | T X   | 4 |          |           | TdVIII | 0 |          |           | TbVIII | 2 |           | S IX   | 1 |
|             |          | td     | 1 |          |           | T XI  | 6 |          |           | TdIX   | 2 |          |           | TbIX   | 3 |           | S X    | 0 |
|             |          | T I    | 5 |          |           | A     | 1 |          |           | TdX    | 1 |          |           | TbX    | 2 |           | S XI   | 2 |
|             |          | T II   | 0 |          |           | tdsp  | 4 |          |           | TdXI   | 0 |          |           | TbXI   | 0 |           |        |   |
|             |          | T III  | 0 |          |           | TdI   | 0 |          |           | TbI    | 0 |          | Sternites | S II   | ? |           |        |   |
|             |          | T IV   | 6 |          |           | TdII  | 0 |          | bridges   | TbII   | 0 |          |           | S III  | 2 |           |        |   |
|             |          | T V    | 0 |          |           | TdIII | 1 |          |           | TbIII  | 1 |          |           | S IV   | 1 |           |        |   |
|             |          | T VI   | 0 |          |           | TdIV  | 1 |          |           | TbIV   | 2 |          |           | S V    | 3 |           |        |   |
|             |          | T VII  | 3 |          |           | TdV   | 0 |          |           | TbV    | 5 |          |           | S VI   | 0 |           |        |   |
|             |          | T VIII | 0 |          |           | TdVI  | 0 |          |           | TbVI   | 2 |          |           | S VII  | 4 |           |        |   |



**Figure 65.** *G. salimoni* sp. nov. Coded description Tergites and Sternites: Tergites I–XI with chaetotaxy, lyrifissures and color intensity spots, dorsal view, schematic and in color.



**Figure 66.** *G. sergipensis* sp. nov.: Habitus, size and distribution.

### 3.3.3.12 *Geogarypus sergipensis* Oliveira-Neto and Zeppelini sp. nov.

Figures 4, 6, 7, 9, 10, 66–70; Table 2, 3; Appendix 1

**Material examined.** Holotype: (UFPB–no code) BRAZIL, Sergipe, Santa Luzia do Itanhy, RPPN Mata do Castro, 11°21'52.89"S 37°25'16.54"W, 86m ASL, August 2015, Semideciduous Seasonal Forest, Atlantic Rainforest. Col. no collectors.

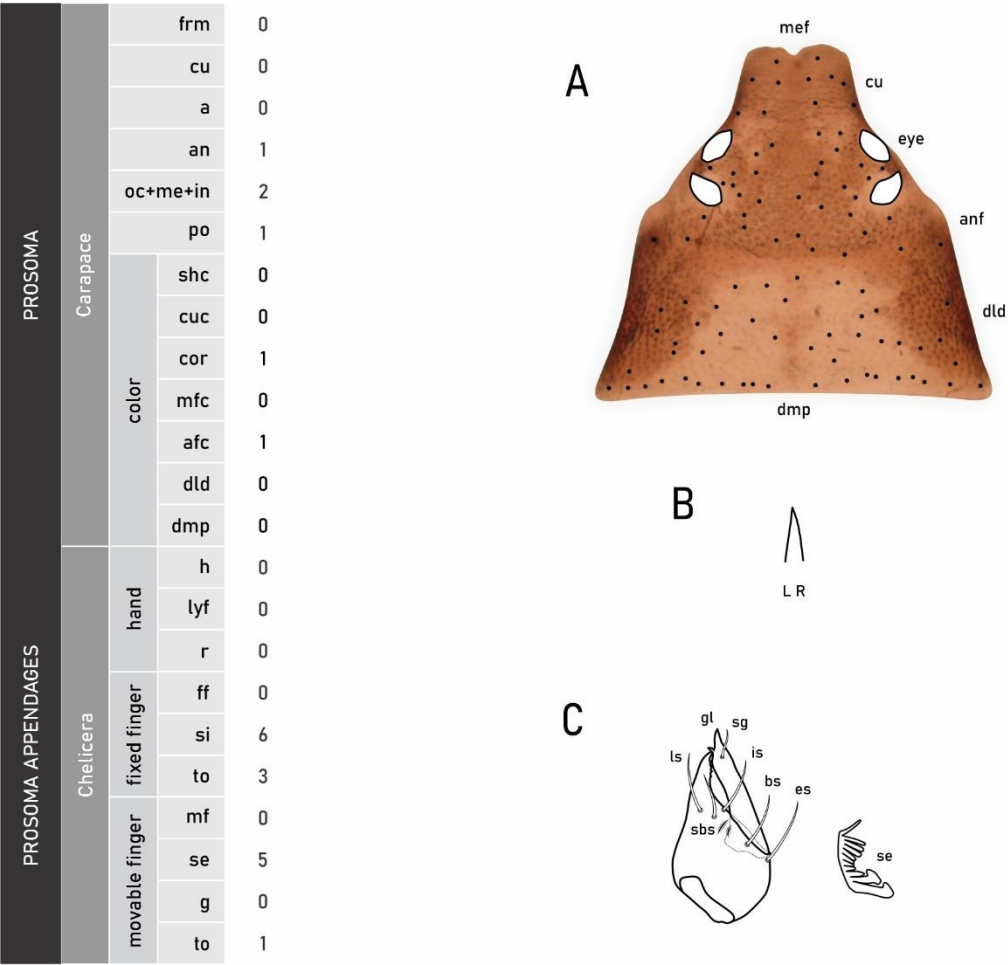
**Etymology.** The species name refers to the Brazilian state of the specimens examined was found.

**Distribution.** Northeastern Brazil (Atlantic Forest) (Fig. 66). This species is endemic to the Atlantic Forests of Sergipe State. The specimen was collected in Private Natural Heritage Reserve Mata do Castro, located on the banks of the Castro River. Mata do Castro is an important remnant of the Atlantic Forest in the region south the São Francisco River.

**Diagnosis.** *G. sergipensis* sp. nov. can be easily recognized by the presence of: Serrula interna with 6 blades; Pedipalpal coxa total chaetae: 25 19+5(16) + 1(17); Coxa II total chaetae: 7(16); Tergite X total chaetae: 10(6); Leg I tibia ratio: 2.0x; Leg I metatarsus ratio: 2.2x; Leg IV tibia ratio: 2.8x.

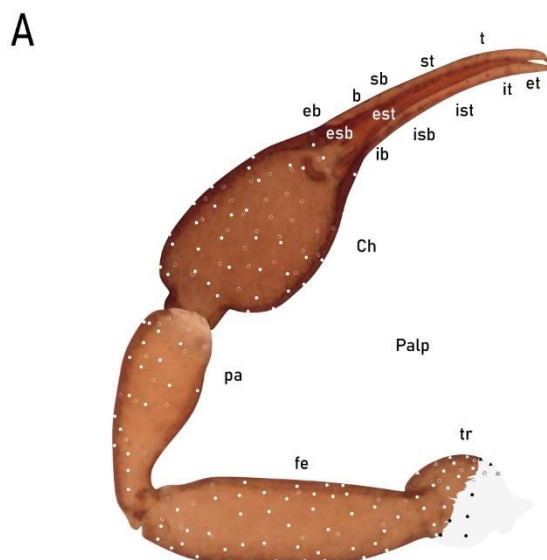
**Coded Description.** Figs. 6, 67–70 and Appendix 1.

**Remarks.** This species, like *G. calon* **sp. nov.**, is endemic to the Atlantic Forest closest to the coast, on opposite sides of the São Francisco River. The two species have a certain similarity in terms of carapace coloration, but in the general context the two species have different chaeta types in the anterior region of the carapace. *G. sergipensis* **sp. nov.** has: 2(2) + 2(4) while *G. calon* **sp. nov.** has: 4 2(1) + 2(3). In addition, the chaeta type covering the Tergites is different, being type 6 for *G. sergipensis* **sp. nov.** and type 5 for *G. calon* **sp. nov.**.



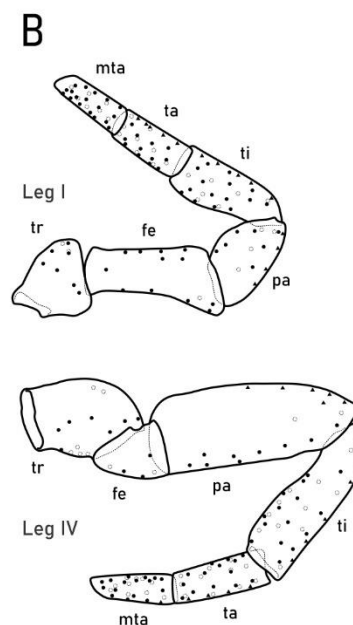
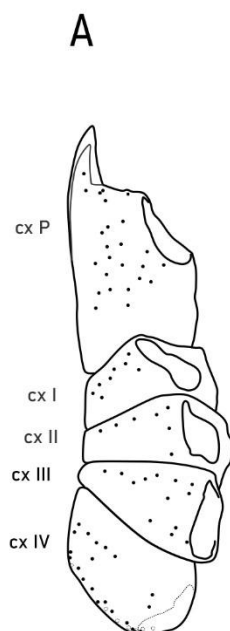
**Figure 67.** *G. sergipensis* **sp. nov.** Coded description: Carapace and Chelicera: Carapace with chaetotaxy and color intensity spots, dorsal view.; Male galea.; Chelicera with chaetotaxy.

| PROSOMA APPENDAGES | Pedipalp | hand           | tr   | 3 |
|--------------------|----------|----------------|------|---|
|                    |          |                | fe   | 2 |
|                    |          |                | pa   | 2 |
|                    |          | fixed finger   | h    | 6 |
|                    |          |                | hfrm | 0 |
|                    |          |                | ff   | 1 |
|                    |          | movable finger | to   | 0 |
|                    |          |                | dis  | 0 |
|                    |          |                | pro  | 0 |
|                    |          |                | vd   | 0 |
|                    |          |                | mf   | 3 |
|                    |          |                | to   | 5 |
|                    |          |                | dis  | 0 |
|                    |          |                | pro  | 0 |
|                    |          |                | vd   | 0 |



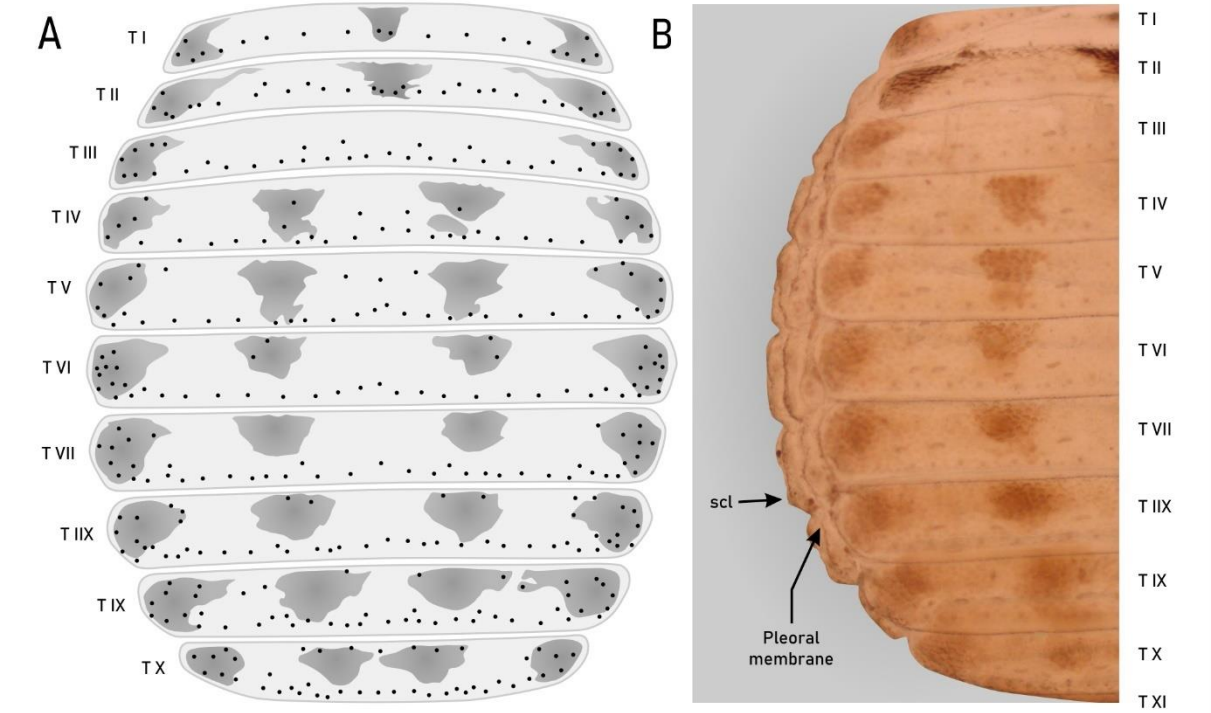
**Figure 68.** *G. sergipensis* sp. nov. Coded description Pedipalp: Pedipalp with chaetotaxy pattern and color.

| PROSOMA APPENDAGES | Coxal Region |        | cx P   | 11 |
|--------------------|--------------|--------|--------|----|
|                    |              |        | cx I   | 1  |
|                    |              |        | cx II  | 7  |
|                    |              |        | cx III | 10 |
|                    |              |        | cx IV  | 0  |
|                    | Legs         | leg I  | tr     | 1  |
|                    |              |        | fe     | 0  |
|                    |              |        | pa     | 11 |
|                    |              |        | ti     | 0  |
|                    |              |        | ta     | 10 |
|                    |              | leg II | mta    | 0  |
|                    |              |        | clw    | 0  |
|                    |              |        | arr    | 0  |
|                    |              | leg IV | tr     | 0  |
|                    |              |        | fe     | 0  |
|                    |              |        | pa     | 0  |
|                    |              |        | ti     | 4  |
|                    |              |        | ta     | 2  |
|                    |              |        | mta    | 3  |
|                    |              |        | clw    | 0  |
|                    |              |        | arr    | 0  |

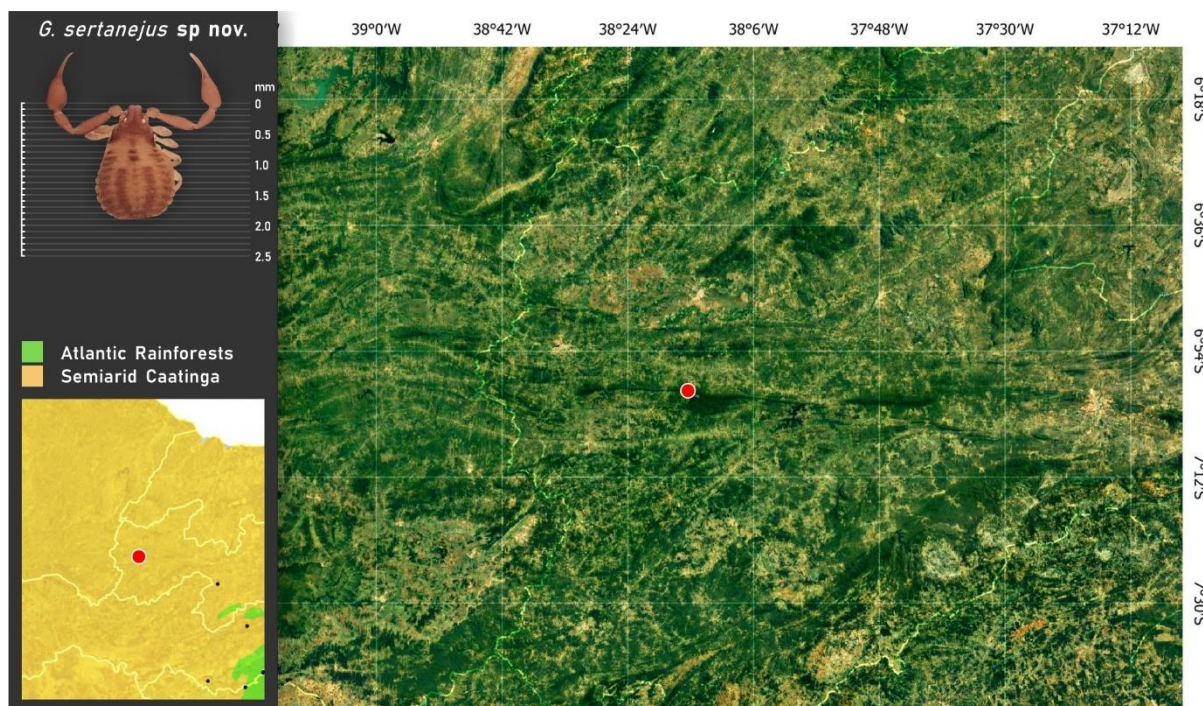


**Figure 69.** *G. sergipensis* sp. nov. Coded description Coxal region and Legs: A. Coxa of pedipalp and I-IV. B. Legs I, IV.

|             |          |        |    |          |           |       |    |          |           |        |   |          |           |        |   |           |        |   |
|-------------|----------|--------|----|----------|-----------|-------|----|----------|-----------|--------|---|----------|-----------|--------|---|-----------|--------|---|
| OPISTHOSOMA | Tergites | plm    | 0  | Tergites | darkspots | T IX  | 8  | Tergites | darkspots | TdVII  | 0 | Tergites | bridges   | TbVII  | 0 | Sternites | S VIII | 0 |
|             |          | scl    | 2  |          |           | T X   | 6  |          |           | TdVIII | 0 |          |           | TbVIII | 0 |           | S IX   | 1 |
|             |          | td     | 0  |          |           | T XI  | 12 |          |           | TdIX   | 2 |          |           | TbIX   | 1 |           | S X    | 2 |
|             |          | T I    | 1  |          |           | A     | 0  |          |           | TdX    | 2 |          |           | TbX    | 4 |           | S XI   | 0 |
|             |          | T II   | 6  |          |           | tdsp  | 1  |          |           | TdXI   | 0 |          |           | TbXI   | 0 |           |        |   |
|             |          | T III  | 6  |          | darkspots | TdI   | 0  |          | bridges   | TbI    | 0 |          | Sternites | S II   | 2 |           |        |   |
|             |          | T IV   | 7  |          |           | TdII  | 0  |          |           | TbII   | 0 |          |           | S III  | 0 |           |        |   |
|             |          | T V    | 8  |          |           | TdIII | 0  |          |           | TbIII  | 0 |          |           | S IV   | 4 |           |        |   |
|             |          | T VI   | 11 |          |           | TdIV  | 1  |          |           | TbIV   | 0 |          |           | S V    | 7 |           |        |   |
|             |          | T VII  | 8  |          |           | TdV   | 0  |          |           | TbV    | 0 |          |           | S VI   | 3 |           |        |   |
|             |          | T VIII | 9  |          |           | TdVI  | 0  |          |           | TbVI   | 0 |          |           | S VII  | 1 |           |        |   |



**Figure 70.** *G. sergipensis* sp. nov. Coded description Tergites and Sternites: Tergites I–XI with chaetotaxy, lyrifissures and color intensity spots, dorsal view, schematic and in color.



**Figure 71.** *G. sertanejus* sp. nov.: Habitus, size and distribution.

### 3.3.3.13 *Geogarypus sertanejus* Oliveira-Neto and Zeppelini sp. nov.

Figures 4, 6, 8–10, 71–75; Table 2, 3; Appendix 1

**Material examined.** Holotype: (UFPB-ES099) BRAZIL, Paraíba, São José da Lagoa Tapada, State Park Serra de Santa Catarina, 06°59'36.55"S, 38°15'24.60"W, 730m ASL, April 2015, Seasonally dry tropical forest (Arboreal Caatinga), Caatinga. Col. DaSilva, MB.

**Etymology.** The name of this species is a tribute to the “sertanejo” people, who are traditional inhabitants in the semi-arid region of the Northeastern Brazil, mainly the Caatinga and the Agreste, and which is characterized by its deep connection with nature, the name “sertanejo” is synonymous with resilience and hard work, representing those who seek subsistence in the challenging environment of the Caatinga.

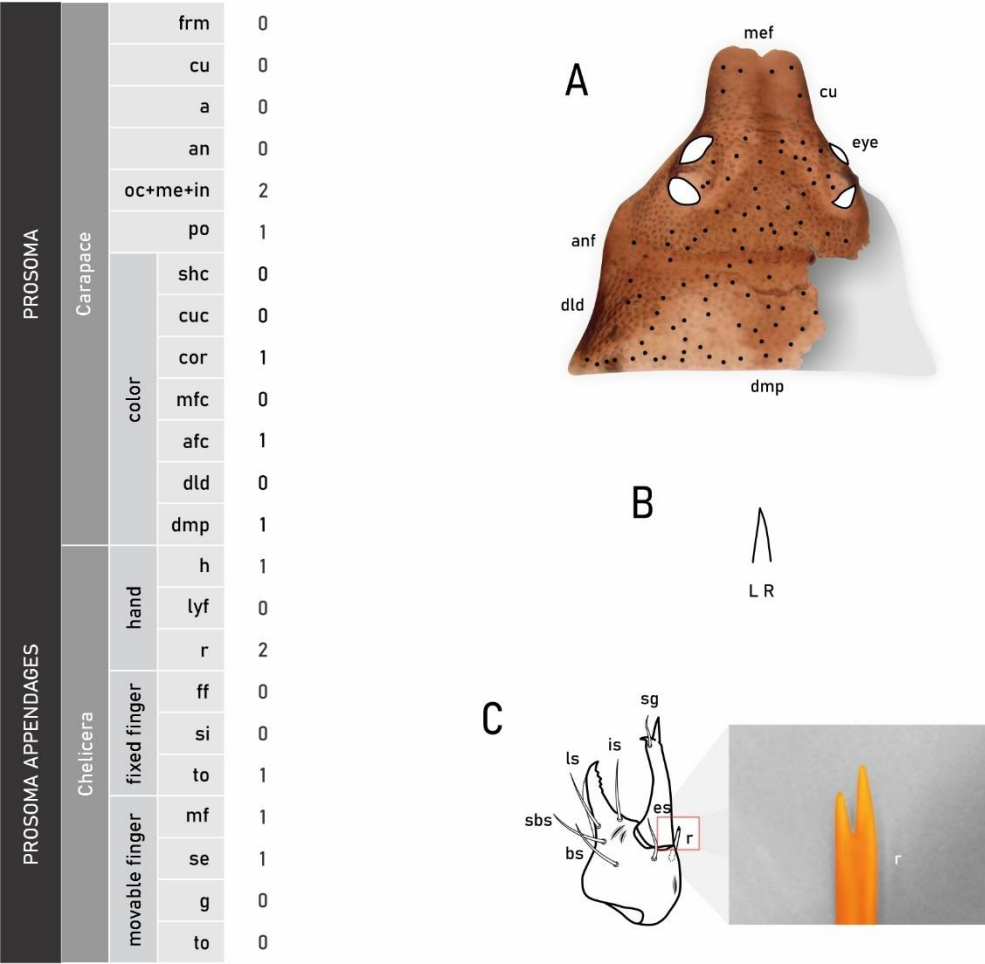
**Distribution.** Northeastern Brazil (Caatinga) (Fig. 71). This species has the most inland distribution within the Brazilian Caatinga. It was collected in the Serra de Santa Catarina State Park, an important enclave of humid forest in the Caatinga of Paraíba State, at an altitude of 730m. The Serra de Santa Catarina presents vegetation of shrubby Caatinga, arboreal-shrubby Caatinga and arboreal Caatinga, with a small proportion of Atlantic Forest interspersed within the predominant Caatinga landscape.

**Diagnosis.** *G. sertanejus* sp. nov. can be easily recognized by the presence of: Chelicera with bifurcated blade in rallum; Pedipalpal patella and hand total chaetae: 21(6), 56 24(5) + 30(9) +

2(10); Leg I patella and tibia total chaetae: 11(18a), 17 12(18a) + 5(19); Leg IV femur and patella total chaetae: 3(18a), 29 23(18a) + 6(19); Tergite I, III-VII, IX, X; 40(6), 34(6), 37(6), 46(6), 43(6), 54(6), 39(6), 31(6); Tergite I and II total chaetae: 3 continuous and 3 continuous. Sternite X total chaetae: 18(21).

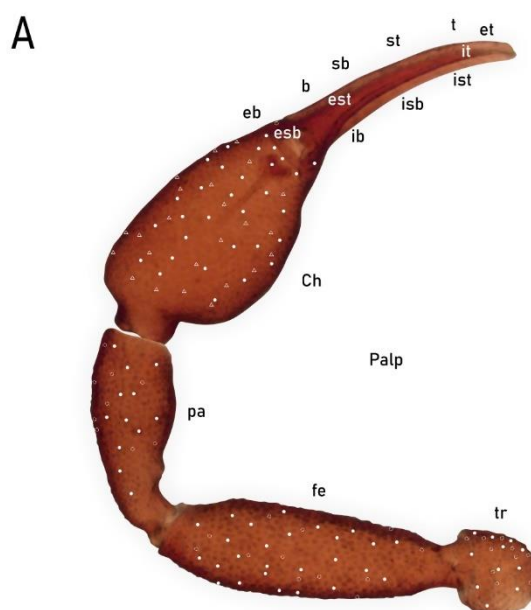
**Coded Description.** Figs. 6, 72–75 and Appendix 1.

**Remarks.** *G. sertanejus* **sp. nov.** have a unique rallum shape, it is the first Geogarypidae with a bifurcated rallum, a characteristic never observed in the genus *Afrogarypus* and *Geogarypus*, the undescribed new genus 1 from Brazil presents individuals with two blades in the rallum [unpublished data], a fact also never observed before for the Family.



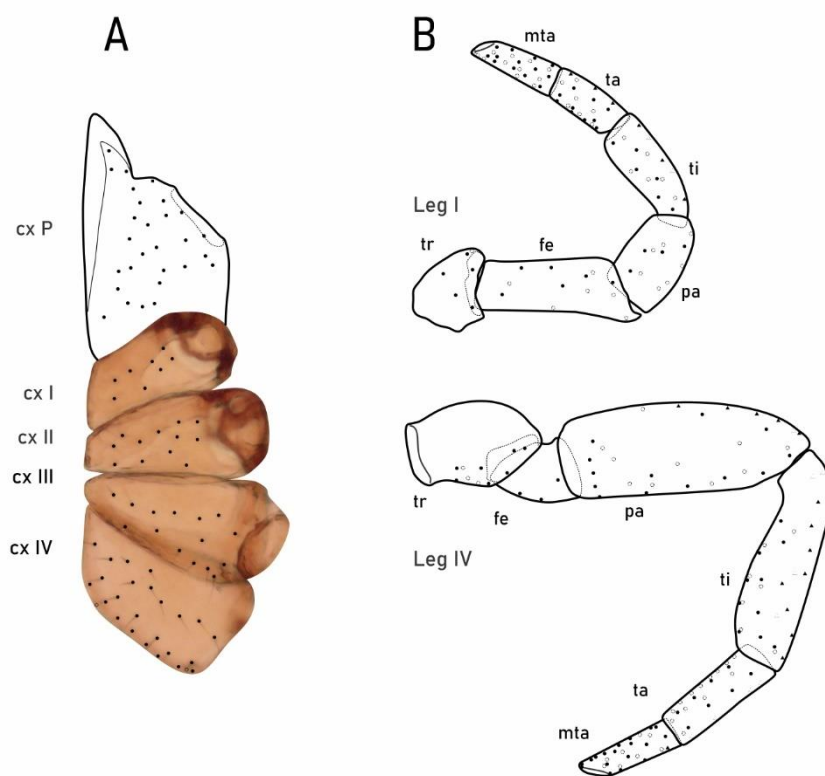
**Figure 72.** *G. sertanejus* **sp. nov.** Coded description: Carapace and Chelicera: A. Carapace with chaetotaxy and color intensity spots, dorsal view.; B. Male galea.; C. Chelicera with chaetotaxy, structure detail shows is rallum bifurcated.

| PROSOMA APPENDAGES | Pedipalp | hand           | tr   | 0  |
|--------------------|----------|----------------|------|----|
|                    |          |                | fe   | 0  |
|                    |          |                | pa   | 12 |
|                    |          |                | h    | 12 |
|                    |          | fixed finger   | hfrm | 0  |
|                    |          |                | ff   | 0  |
|                    |          |                | to   | 1  |
|                    |          |                | dis  | 0  |
|                    |          |                | pro  | 0  |
|                    |          |                | vd   | 0  |
|                    |          | movable finger | mf   | 13 |
|                    |          |                | to   | 3  |
|                    |          |                | dis  | 0  |
|                    |          |                | pro  | 0  |
|                    |          |                | vd   | 0  |



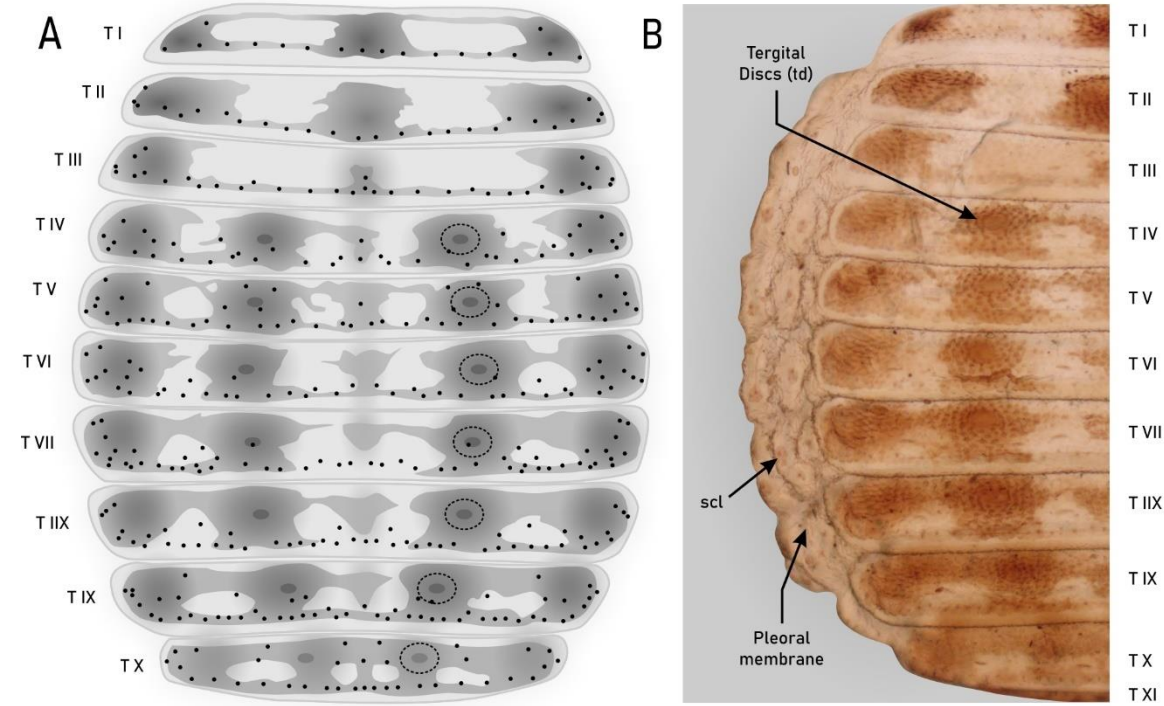
**Figure 73.** *G. sertanejus* sp. nov. Coded description Pedipalp: Pedipalp with chaetotaxy pattern and color.

| PROSOMA APPENDAGES | Coxal Region |  | leg I | leg IV | cx P   | 1  |  |
|--------------------|--------------|--|-------|--------|--------|----|--|
|                    |              |  |       |        | cx I   | 1  |  |
|                    |              |  |       |        | cx II  | 4  |  |
|                    |              |  |       |        | cx III | 8  |  |
|                    |              |  |       |        | cx IV  | 9  |  |
|                    | Legs         |  |       |        | tr     | 3  |  |
|                    |              |  |       |        | fe     | 2  |  |
|                    |              |  |       |        | pa     | 13 |  |
|                    |              |  |       |        | ti     | 11 |  |
|                    |              |  |       |        | ta     | 5  |  |
|                    |              |  |       |        | mta    | 0  |  |
|                    |              |  |       |        | clw    | 0  |  |
|                    |              |  |       |        | arr    | 0  |  |
|                    |              |  |       |        | tr     | 3  |  |
|                    |              |  |       |        | fe     | 5  |  |
|                    |              |  |       |        | pa     | 13 |  |
|                    |              |  |       |        | ti     | 2  |  |
|                    |              |  |       |        | ta     | 8  |  |
|                    |              |  |       |        | mta    | 0  |  |
|                    |              |  |       |        | clw    | 0  |  |
|                    |              |  |       |        | arr    | 0  |  |

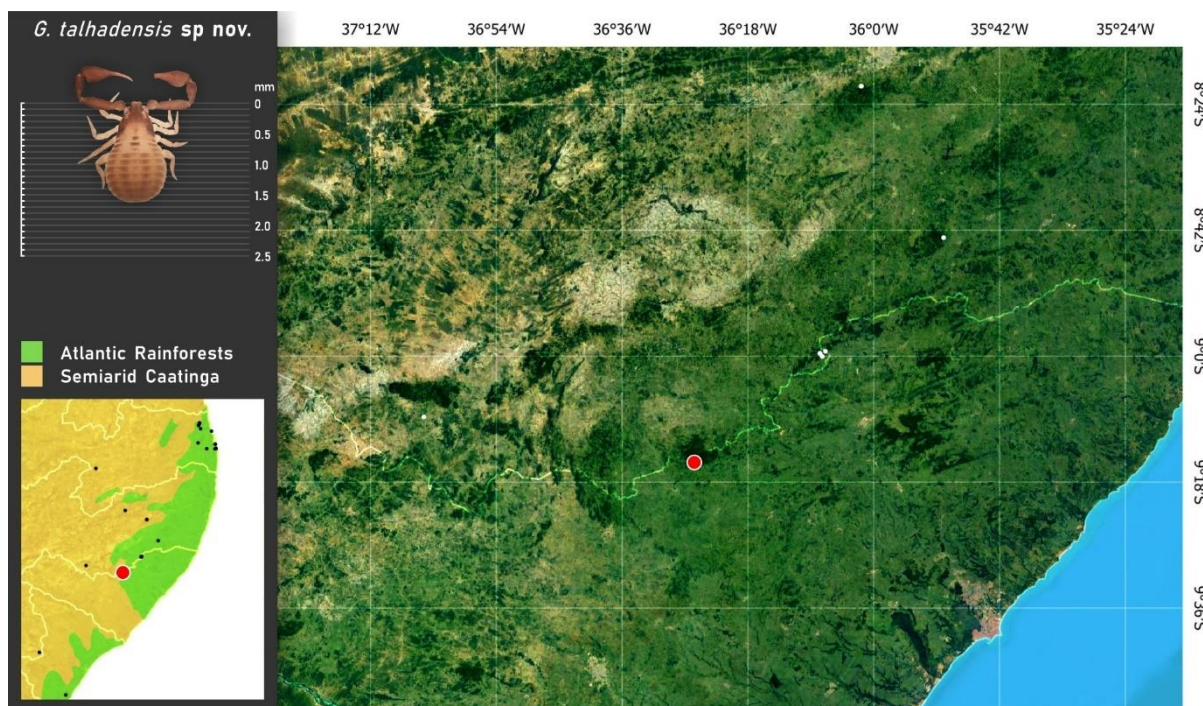


**Figure 74.** *G. sertanejus* sp. nov. Coded description Coxal region and Legs: A. Coxa of pedipalp and I-IV. B. Legs I, IV.

|             |          |        |    |          |           |       |    |          |           |        |   |          |           |        |   |           |        |   |
|-------------|----------|--------|----|----------|-----------|-------|----|----------|-----------|--------|---|----------|-----------|--------|---|-----------|--------|---|
| OPISTHOSOMA | Tergites | plm    | 0  | Tergites | darkspots | T IX  | 10 | Tergites | darkspots | TdVII  | 1 | Tergites | bridges   | TbVII  | 4 | Sternites | S VIII | 5 |
|             |          | scl    | 2  |          |           | T X   | 8  |          |           | TdVIII | 1 |          |           | TbVIII | 8 |           | S IX   | 0 |
|             |          | td     | 1  |          |           | T XI  | 9  |          |           | TdIX   | 0 |          |           | TbIX   | 0 |           | S X    | 4 |
|             |          | T I    | 8  |          |           | A     | 0  |          |           | TdX    | 0 |          |           | TbX    | 0 |           | S XI   | 1 |
|             |          | T II   | 8  |          |           | tdsp  | 0  |          |           | TdXI   | 0 |          |           | TbXI   | 0 |           |        |   |
|             |          | T III  | 9  |          |           | TdI   | 1  |          |           | TbI    | 2 |          | Sternites | S II   | 3 |           |        |   |
|             |          | T IV   | 9  |          |           | TdII  | 1  |          |           | TbII   | 2 |          |           | S III  | 0 |           |        |   |
|             |          | T V    | 10 |          |           | TdIII | 2  |          |           | TbIII  | 3 |          |           | S IV   | 0 |           |        |   |
|             |          | T VI   | 13 |          |           | TdIV  | 0  |          |           | TbIV   | 4 |          |           | S V    | 9 |           |        |   |
|             |          | T VII  | 10 |          |           | TdV   | 1  |          |           | TbV    | 2 |          |           | S VI   | 2 |           |        |   |
|             |          | T VIII | 12 |          |           | TdVI  | 1  |          |           | TbVI   | 5 |          |           | S VII  | 2 |           |        |   |



**Figure 75.** *G. sertanejus* sp. nov. Coded description Tergites and Sternites: Tergites I–XI with chaetotaxy, lyrifissures and color intensity spots, dorsal view, schematic and in color.



**Figure 76.** *G. talhadensis* sp. nov.: Habitus, size and distribution.

#### 3.3.3.14 *Geogarypus talhadensis* Oliveira-Neto and Zeppelini sp. nov.

Figures 4–6, 8–10, 76–80; Table 2, 3; Appendix 1

**Material examined.** Holotype: (UEPB–CRFS–AL002) BRAZIL, Alagoas, Quebrangulo, REBio Pedra Talhada, 9°15'3.83"S, 36°25'50.77"W, 720m ASL, December 2023, Semideciduous Seasonal Forest, Atlantic Rainforest. Col. Oliveira-Neto M.

(UEPB–CRFS–AL001) BRAZIL, Alagoas, Quebrangulo, REBio Pedra Talhada, 9°15'3.83"S, 36°25'50.77"W, 720m ASL, December 2023, Semideciduous Seasonal Forest, Atlantic Rainforest. Col. Oliveira-Neto M. (ninf)

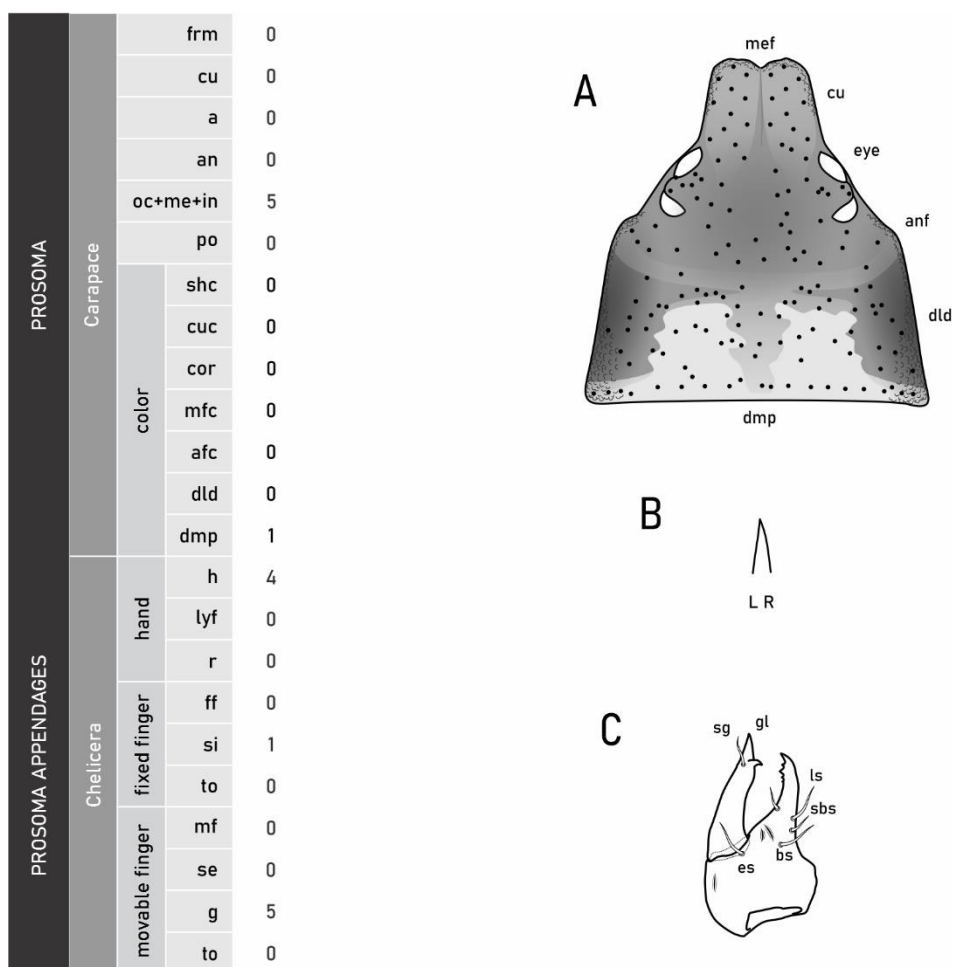
**Etymology.** The name of this species is a tribute to the Pedra Talhada Biological Reserve, one of the largest and important reserves in the northern portion of the Atlantic Rainforest.

**Distribution.** Northeastern Brazil (Atlantic Forest) (Fig. 76). This species was collected in one of the most significant highland rainforests in northeastern Brazil, located between the states of Pernambuco and Alagoas. The Pedra Talhada Biological Reserve is renowned for its high number of endemic species. The *G. talhadensis* sp. nov. was recorded at an elevation of 730m.

**Diagnosis.** *G. talhadensis* sp. nov. can be easily recognized by the presence of: Chelicera hand total chaetae: 5(7); Pedipalpal trochanter and patella total chaetae: 10(5), 33 7(5) + 26(9); Pedipalpal coxa total chaetae: 26 22+3(16) + 1(17); Tergites VI–V pattern of bridges.

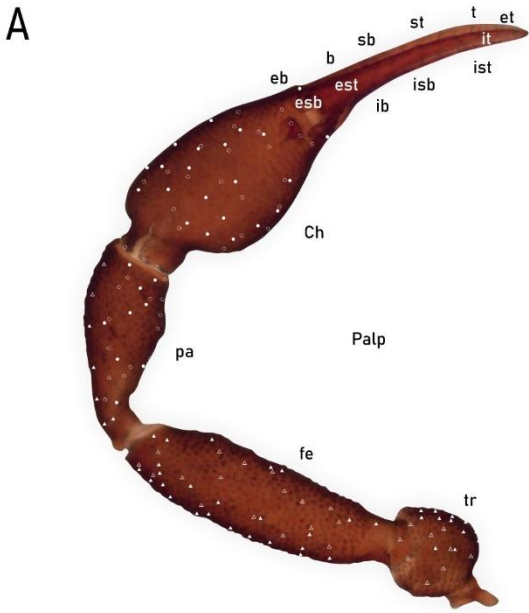
**Coded Description.** Figs. 6, 77–80 and Appendix 1.

**Remarks.** This species has a very characteristic color pattern, with intense bridges on tergites IV–X, the chaetae count of Pedipalp trochanter is quite low, among the species with 45 darkspots, in addition only the trochanter and femur of the pedipalp have only chaetae type 5, on the patella this species has a tiny number of chaeta type 5 and a predominance of chaetae type 9.



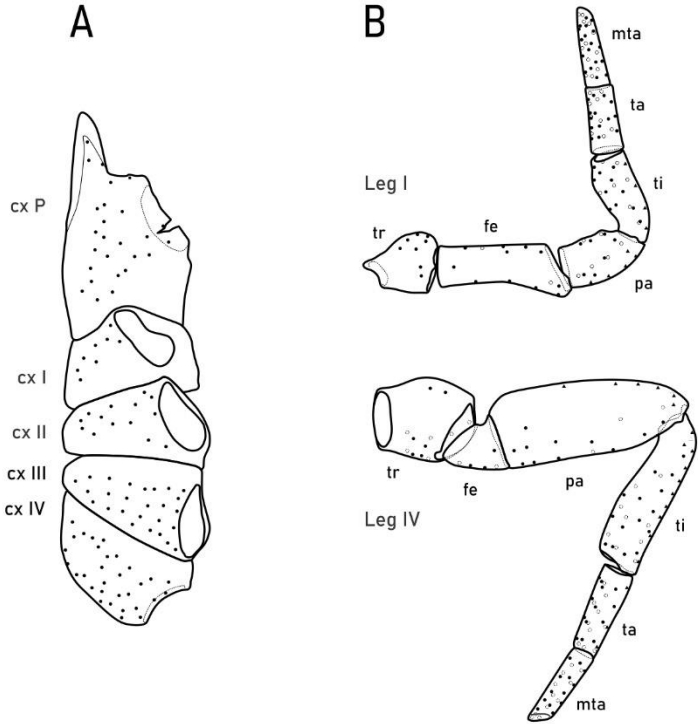
**Figure 77.** *G. talhadensis* sp. nov. Coded description: Carapace and Chelicera: Carapace with chaetotaxy and color intensity spots, dorsal view.; Male galea.; Chelicera with chaetotaxy.

| PROSOMA APPENDAGES |          |                |      |    |
|--------------------|----------|----------------|------|----|
| Pedipalp           |          |                |      |    |
| PROSOMA APPENDAGES | Pedipalp | hand           | tr   | 12 |
|                    |          |                | fe   | 10 |
|                    |          |                | pa   | 13 |
|                    |          |                | h    | 11 |
|                    |          | fixed finger   | hfrm | 0  |
|                    |          |                | ff   | 0  |
|                    |          |                | to   | 1  |
|                    |          |                | dis  | 0  |
|                    |          |                | pro  | 0  |
|                    |          |                | vd   | 0  |
|                    |          | movable finger | mf   | 4  |
|                    |          |                | to   | 1  |
|                    |          |                | dis  | 0  |
|                    |          |                | pro  | 0  |
|                    |          |                | vd   | 0  |



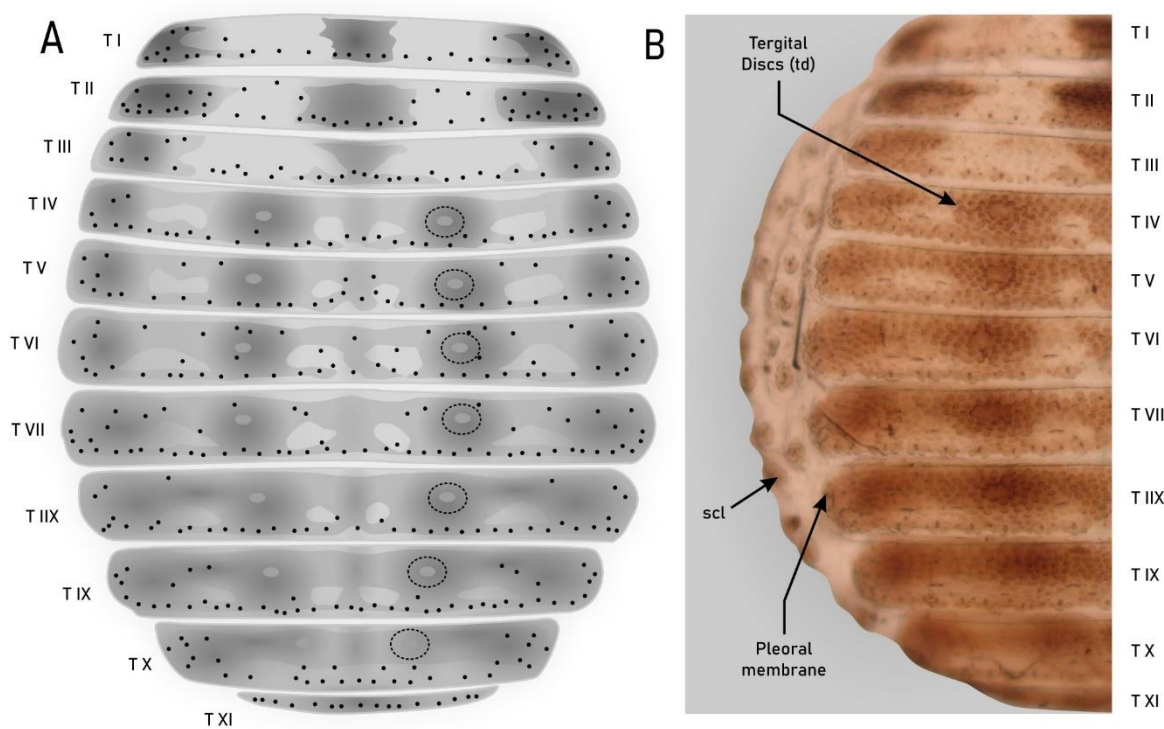
**Figure 78.** *G. talhadensis* sp. nov. Coded description Pedipalp: Pedipalp with chaetotaxy pattern and color.

| PROSOMA APPENDAGES |              |        |        |    |
|--------------------|--------------|--------|--------|----|
| Coxal Region       |              |        |        |    |
| PROSOMA APPENDAGES | Coxal Region | leg I  | cx P   | 10 |
|                    |              |        | cx I   | 1  |
|                    |              |        | cx II  | 2  |
|                    |              |        | cx III | 0  |
|                    |              |        | cx IV  | 1  |
|                    | Legs         | leg I  | tr     | 0  |
|                    |              |        | fe     | 0  |
|                    |              |        | pa     | 4  |
|                    |              |        | ti     | 4  |
|                    |              |        | ta     | 11 |
|                    |              | leg II | mta    | 3  |
|                    |              |        | clw    | 0  |
|                    |              |        | arr    | 0  |
|                    |              | leg IV | tr     | 4  |
|                    |              |        | fe     | 0  |
|                    |              |        | pa     | 8  |
|                    |              |        | ti     | 9  |
|                    |              |        | ta     | 5  |
|                    |              |        | mta    | 5  |
|                    |              |        | clw    | 0  |
|                    |              |        | arr    | 0  |

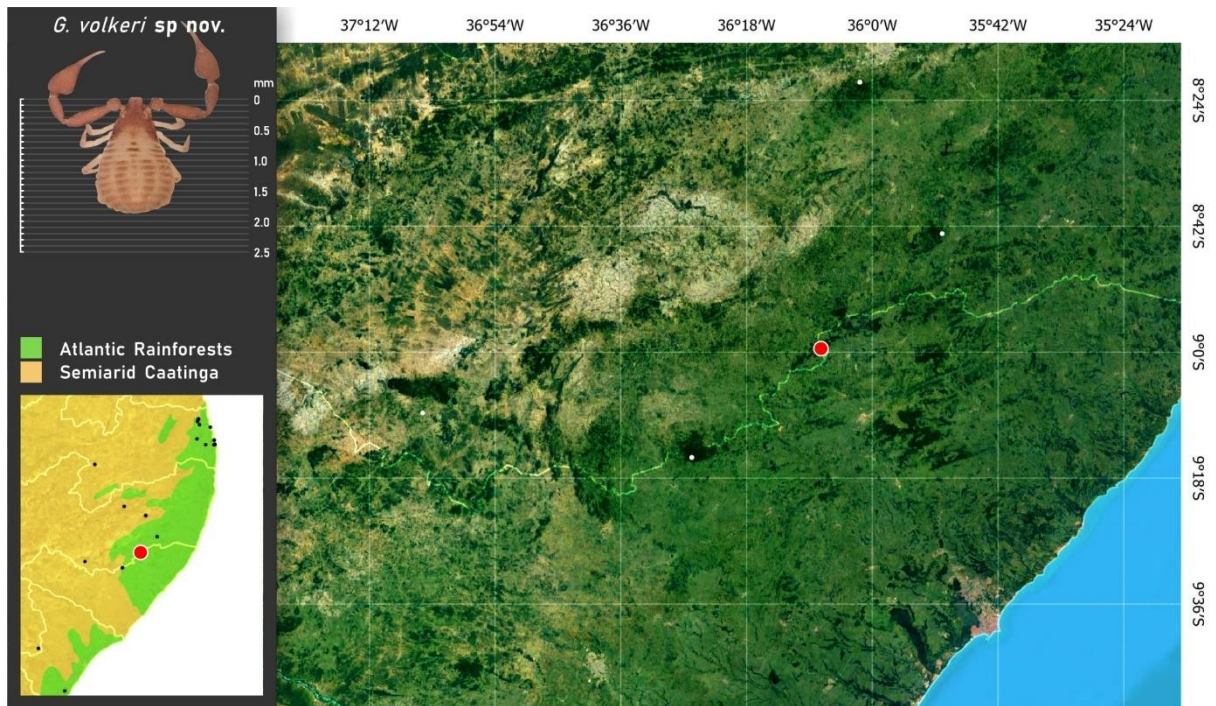


**Figure 79.** *G. talhadensis* sp. nov. Coded description Coxal region and Legs: A. Coxa of pedipalp and I-IV. B. Legs I, IV.

|             |          |        |   |          |           |       |   |          |           |        |    |           |         |        |   |           |        |   |
|-------------|----------|--------|---|----------|-----------|-------|---|----------|-----------|--------|----|-----------|---------|--------|---|-----------|--------|---|
| OPISTHOSOMA | Tergites | plm    | 0 | Tergites | darkspots | T IX  | 0 | Tergites | darkspots | TdVII  | 1  | Tergites  | bridges | TbVII  | 9 | Sternites | S VIII | 1 |
|             |          | scl    | 4 |          |           | T X   | 1 |          |           | TdVIII | 1  |           |         | TbVIII | 1 |           | S IX   | 0 |
|             |          | td     | 1 |          |           | T XI  | 5 |          |           | TdIX   | 0  |           |         | TbIX   | 0 |           | S X    | 1 |
|             |          | T I    | 1 |          |           | A     | 0 |          |           | TdX    | 0  |           |         | TbX    | 0 |           | S XI   | 0 |
|             |          | T II   | 2 |          |           | tdsp  | 0 |          |           | TdXI   | 0  |           |         | TbXI   | 0 |           |        |   |
|             |          | T III  | 1 |          |           | TdI   | 0 |          |           | TbI    | 1  | Sternites |         | S II   | ? |           |        |   |
|             |          | T IV   | 5 |          |           | TdII  | 0 |          |           | TbII   | 1  |           |         | S III  | 0 |           |        |   |
|             |          | T V    | 2 |          |           | TdIII | 1 |          |           | TbIII  | 2  |           |         | S IV   | 1 |           |        |   |
|             |          | T VI   | 6 |          |           | TdIV  | 0 |          |           | TbIV   | 8  |           |         | S V    | 0 |           |        |   |
|             |          | T VII  | 2 |          |           | TdV   | 1 |          |           | TbV    | 10 |           |         | S VI   | 1 |           |        |   |
|             |          | T VIII | 5 |          |           | TdVI  | 1 |          |           | TbVI   | 8  |           |         | S VII  | 0 |           |        |   |



**Figure 80.** *G. talhadensis* sp. nov. Coded description Tergites and Sternites: Tergites I–XI with chaetotaxy, lyrifissures and color intensity spots, dorsal view, schematic and in color.



**Figure 81.** *G. volkeri* sp. nov.: Habitus, size and distribution.

#### 3.3.3.15 *Geogarypus volkeri* Oliveira-Neto and Zeppelini sp. nov.

Figures 4, 6, 8–10, 81–85; Table 2, 3; Appendix 1

**Material examined.** Holotype: (UFPB-AR0039III) BRAZIL, Alagoas, São José da Laje, Usina Serra Grande – Mata de Maria Maior, 08°59'36.92"S, 36°07'40.97"W, 435m ASL, February 2012, Semideciduous Seasonal Forest, Atlantic Rainforest. Col. DeSouza, AM; DaSilva, MB; Pozzi, PHS.

Paratype (UFPB-AR0039II) BRAZIL, Alagoas, São José da Laje, Usina Serra Grande – Mata de Maria Maior, 08°59'36.92"S, 36°07'40.97"W, 435m ASL, February 2012, Semideciduous Seasonal Forest, Atlantic Rainforest. Col. DeSouza, AM; DaSilva, MB; Pozzi, PHS.

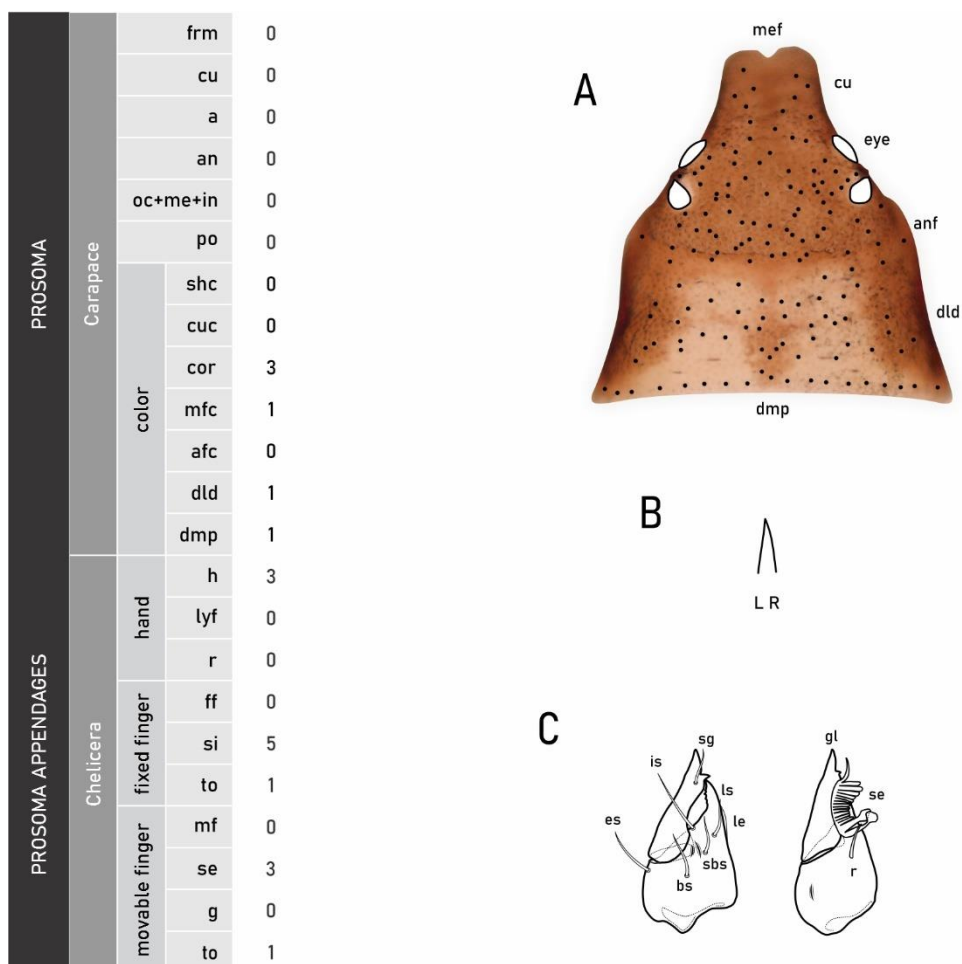
**Etymology.** The species is named after brilliant arachnologist Volker Mahnert (1943–2018) from Muséum d'Histoire Naturelle, for the important studies with the Brazilian fauna of Pseudoscorpiones, which served as a foundation and inspiration for Brazilian researchers of that generation.

**Distribution.** (Fig. 81) Northeastern Brazil (Atlantic Forest). This specimen is endemic to the Atlantic Forest of the state of Alagoas, being found only in the municipality of São José da Laje, more specifically in Mata de Maria Maior.

**Diagnosis.** *G. volkeri* **sp. nov.** can be easily recognized by the presence of: Coxa IV total chaetae: 45(16); Leg I tibia total chaetae: 26 20(18a) + 6(19); Pleural membrane with 40 sclerites; Tergital discs count: 4 on tergites IV–V.

**Coded Description.** (Figs. 6, 82–85 and Appendix 1).

**Remarks.** (see *G. alagoensis* **sp. nov.** and *G. salimoni* **sp. nov.** remarks) This specie shares the same distribution as the *G. alagoensis* **sp. nov.** and *G. volkeri* **sp. nov.** species, and can be easily distinguished through the number of blades in serrula externa, type of plns and bridges of Tergite X, while *G. volkeri* **sp. nov.** has 17 blades, *pnso* type 13 and 5 continuous darkspots, the *G. alagoensis* **sp. nov.** has 13 blades, *pnso* type 12 and 3 continuous darkspots + 2 discrete, *G. salimoni* **sp. nov.** has 15 blades, *pnso* type 12 and 4 continuous darkspots.



**Figure 82.** *G. volkeri* **sp. nov.** Coded description: Carapace and Chelicera: Carapace with chaetotaxy and color intensity spots, dorsal view.; Male galea.; Chelicera with chaetotaxy.

| PROSOMA APPENDAGES |                |      |    |  |
|--------------------|----------------|------|----|--|
| Pedipalp           |                |      |    |  |
|                    |                |      |    |  |
| hand               | fixed finger   | tr   | 8  |  |
|                    |                | fe   | 3  |  |
|                    |                | pa   | 1  |  |
|                    |                | h    | 10 |  |
|                    |                | hfrm | 0  |  |
| movable finger     | fixed finger   | ff   | 0  |  |
|                    |                | to   | 0  |  |
|                    |                | dis  | 0  |  |
|                    |                | pro  | 0  |  |
|                    |                | vd   | 0  |  |
|                    | movable finger | mf   | 2  |  |
|                    |                | to   | 3  |  |
|                    |                | dis  | 0  |  |
|                    |                | pro  | 0  |  |
|                    |                | vd   | 0  |  |

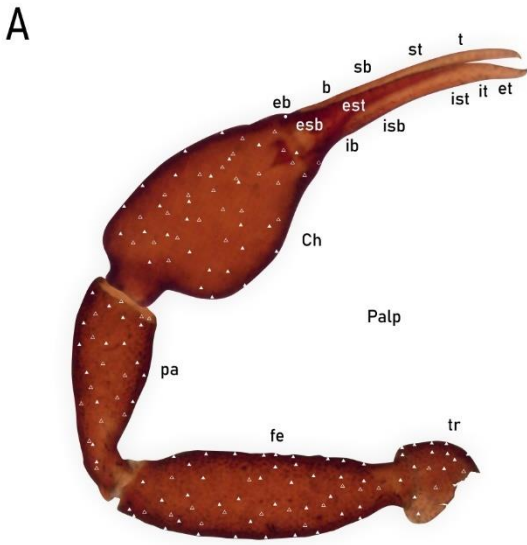
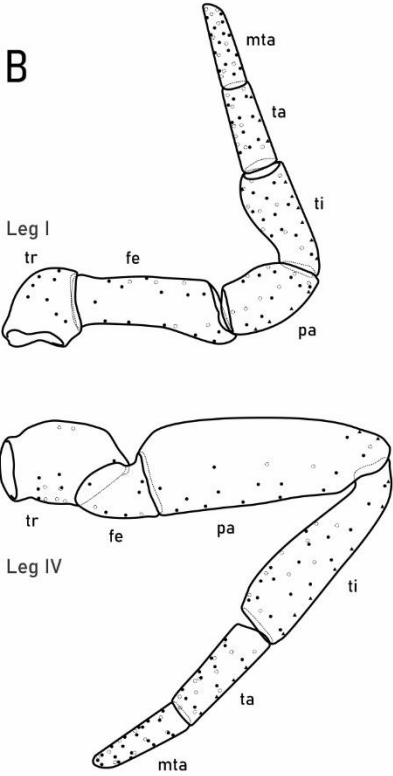
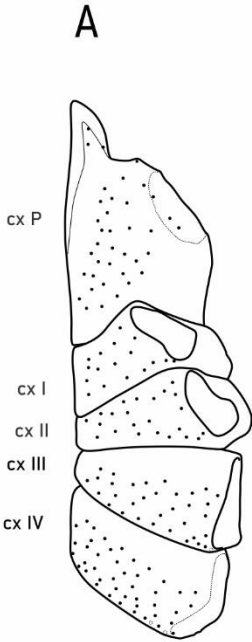


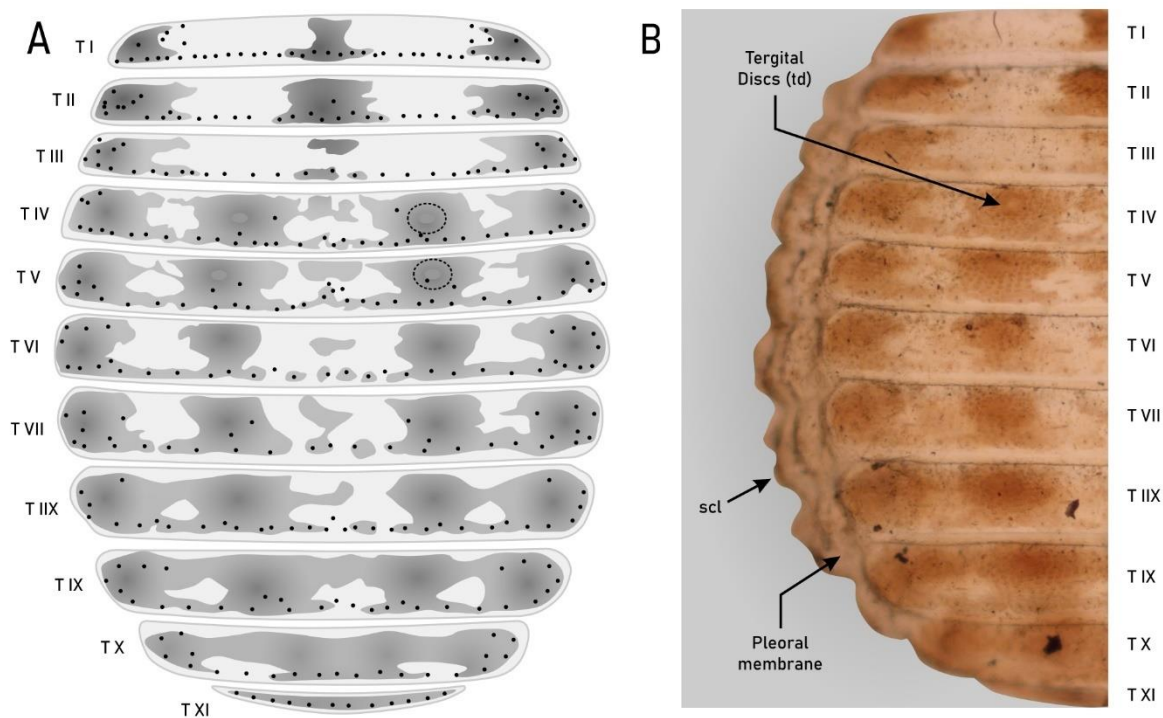
Figure 83. *G. volkeri* sp. nov. Coded description Pedipalp: Pedipalp with chaetotaxy pattern and color.

| PROSOMA APPENDAGES |        |        |    |  |
|--------------------|--------|--------|----|--|
| Legs               |        |        |    |  |
|                    |        |        |    |  |
| Coxal Region       | leg I  | cx P   | 0  |  |
|                    |        | cx I   | 5  |  |
|                    |        | cx II  | 0  |  |
|                    |        | cx III | 7  |  |
|                    |        | cx IV  | 11 |  |
| Legs               | leg I  | tr     | 0  |  |
|                    |        | fe     | 4  |  |
|                    |        | pa     | 0  |  |
|                    |        | ti     | 9  |  |
|                    |        | ta     | 2  |  |
|                    | leg IV | mta    | 0  |  |
|                    |        | clw    | 0  |  |
|                    |        | arr    | 0  |  |
|                    |        | tr     | 0  |  |
|                    |        | fe     | 3  |  |
|                    |        | pa     | 4  |  |
|                    |        | ti     | 5  |  |
|                    |        | ta     | 0  |  |
|                    |        | mta    | 1  |  |
|                    |        | clw    | 0  |  |
|                    |        | arr    | 0  |  |

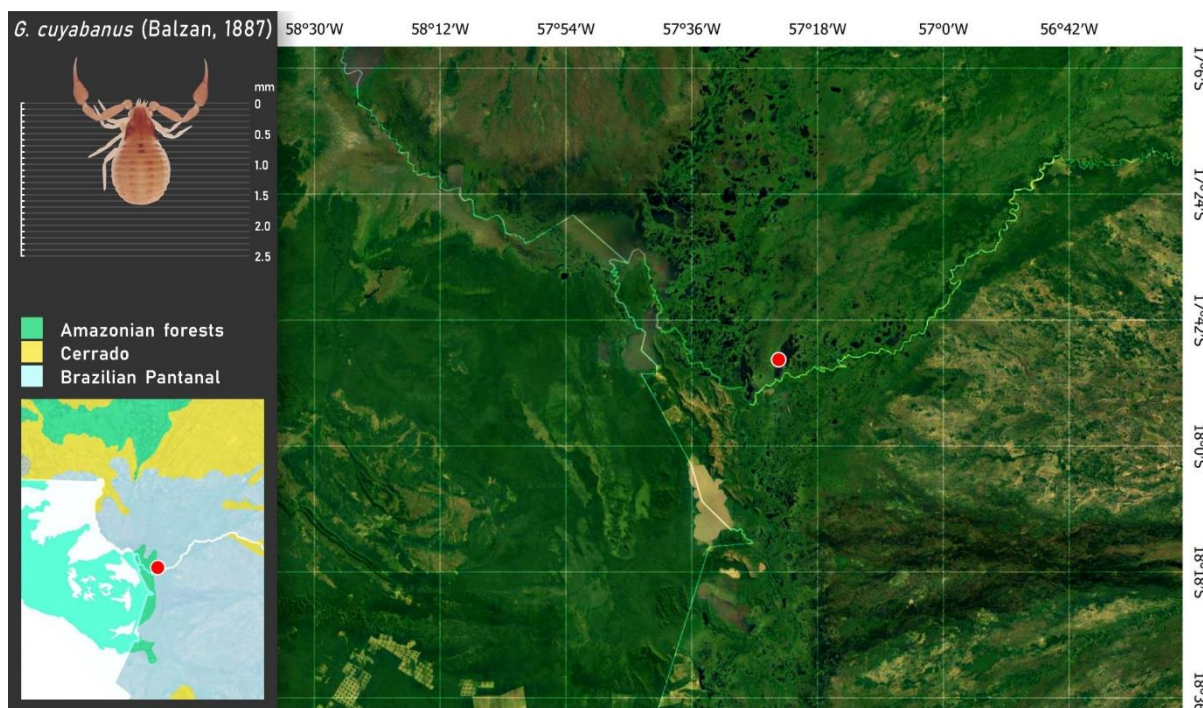


**Figure 84.** *G. volkeri* sp. nov. Coded description Coxal region and Legs: A. Coxa of pedipalp and I-IV. B. Legs I, IV.

|             |          |        |    |          |           |       |   |          |           |        |   |          |           |        |   |           |        |   |
|-------------|----------|--------|----|----------|-----------|-------|---|----------|-----------|--------|---|----------|-----------|--------|---|-----------|--------|---|
| OPISTHOSOMA | Tergites | plm    | 0  | Tergites | darkspots | T IX  | 4 | Tergites | darkspots | TdVII  | 3 | Tergites | bridges   | TbVII  | 6 | Sternites | S VIII | 0 |
|             |          | scl    | 10 |          |           | T X   | 0 |          |           | TdVIII | 3 |          |           | TbVIII | 3 |           | S IX   | 0 |
|             |          | td     | 3  |          |           | T XI  | 0 |          |           | TdIX   | 0 |          |           | TbIX   | 0 |           | S X    | 1 |
|             |          | T I    | 3  |          |           | A     | 1 |          |           | TdX    | 0 |          |           | TbX    | 0 |           | S XI   | 0 |
|             |          | T II   | 0  |          |           | tdsp  | 0 |          |           | TdXI   | 0 |          |           | TbXI   | 0 |           |        |   |
|             |          | T III  | 0  |          |           | TdI   | 0 |          |           | TbI    | 0 |          | Sternites | S II   | ? |           |        |   |
|             |          | T IV   | 0  |          |           | TdII  | 0 |          |           | TbII   | 1 |          |           | S III  | 6 |           |        |   |
|             |          | T V    | 0  |          |           | TdIII | 1 |          |           | TbIII  | 2 |          |           | S IV   | 3 |           |        |   |
|             |          | T VI   | 5  |          |           | TdIV  | 0 |          |           | TbIV   | 1 |          |           | S V    | 6 |           |        |   |
|             |          | T VII  | 4  |          |           | TdV   | 1 |          |           | TbV    | 1 |          |           | S VI   | 2 |           |        |   |
|             |          | T VIII | 4  |          |           | TdVI  | 3 |          |           | TbVI   | 6 |          |           | S VII  | 0 |           |        |   |



**Figure 85.** *G. volkeri* sp. nov. Coded description Tergites and Sternites: Tergites I–XI with chaetotaxy, lyrifissures and color intensity spots, dorsal view, schematic and in color.



**Figure 86.** *G. cuyabanus* (Balzan, 1887). Habitus, size and distribution.

#### 3.3.3.16 *Geogarypus cuyabanus* (Balzan, 1887)

Figures 4, 5–7, 9, 86–90; Table 2, 3; Appendix 1

**New records.** (UFMT-1002) BRAZIL, Mato Grosso, Poconé, National Park of Pantanal Matogrossense, 17°46'18.9"S 57°23'52.2"W, 98m ASL, December 2012, Flooded Steppe Savanna, Brazilian Pantanal. Jonas E. Gallão, *leg.*

(UFMT-992) BRAZIL, Mato Grosso, Poconé, PN do Pantanal Matogrossense, 17°46'18.9"S 57°23'52.2"W, 98m ASL, December 2012, Flooded Steppe Savanna, Brazilian Pantanal. Jonas E. Gallão, *leg.*

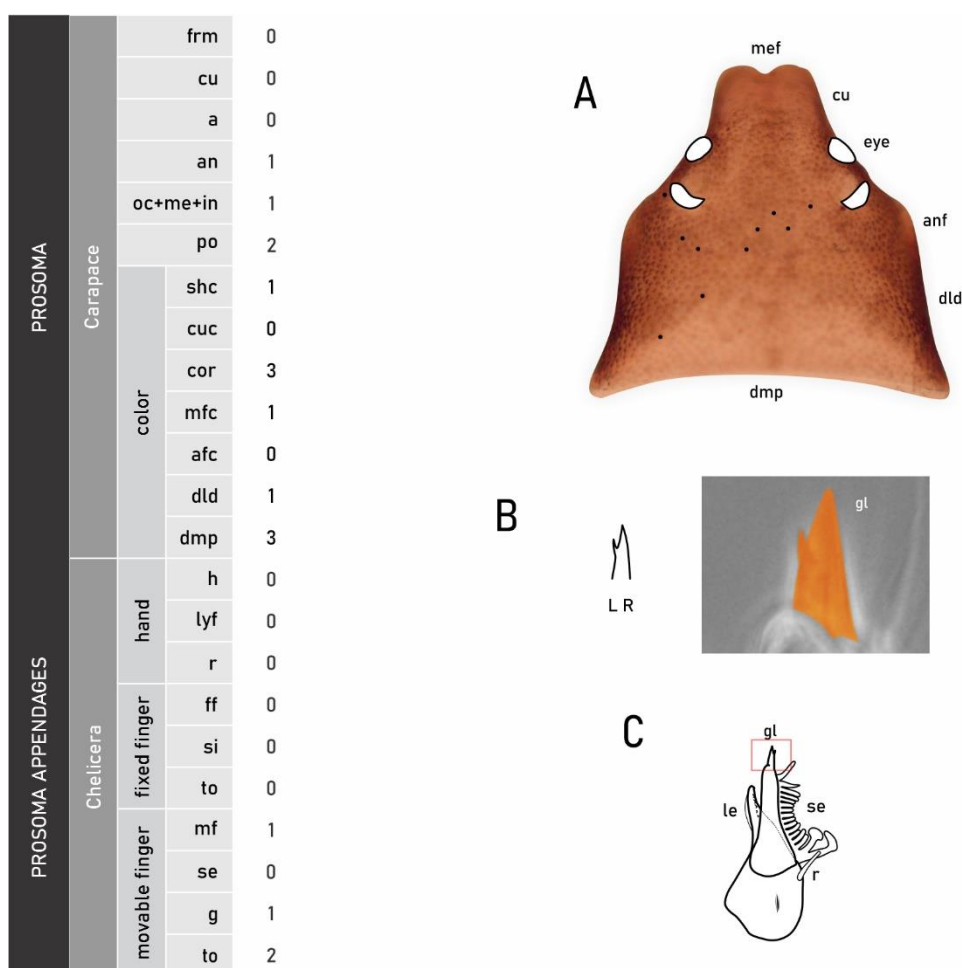
**Distribution.** Central-West Brazil and Paraguay (Pantanal) (Fig. 86). This species is endemic to steppe savannah flooded in Pantanal. We believe that this species may also occur in the portion of the Pantanal that extends into Paraguay. The known distribution of this species to date is exclusively in the southern portion of the State of Mato Grosso. Our new record is from within the Pantanal Mato-Grossense National Park.

**Diagnosis complementary.** (see original description in Balzan, 1887) *G. cuyabanus* can be easily recognized by the presence of: Carapace anterior region total chaetae: 4 2(2) + 2(4); Male galea coniform with one spinule; Pedipalpal movable finger total chaetae: 54 50(10) + 4(15); Coxa II total chaetae: 9(16); Leg I femur, patella end tibia total chaetae: 8(18a), 13(18a), 20(18a); Leg IV

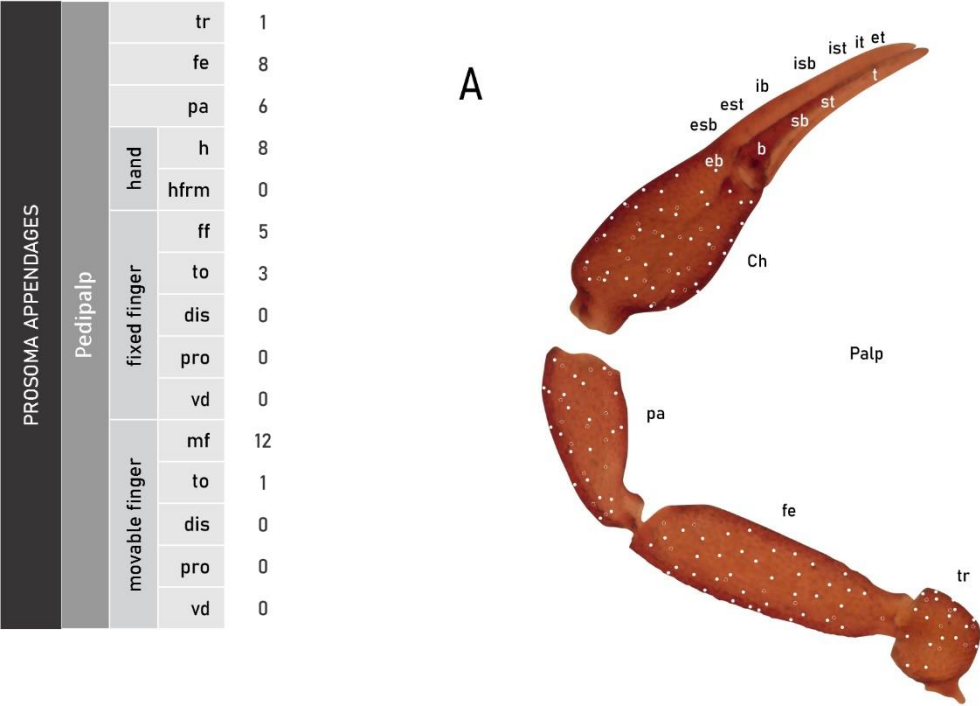
trochanter, patella, tibia and tarsus total chaetae: 9(18a); 22(18a), 28(18a), 22(18a); Tergites color soft orange, Tergites medial line predominantly depigmented.

**Coded complementary description.** (Figs. 6, 87–90 and Appendix 1).

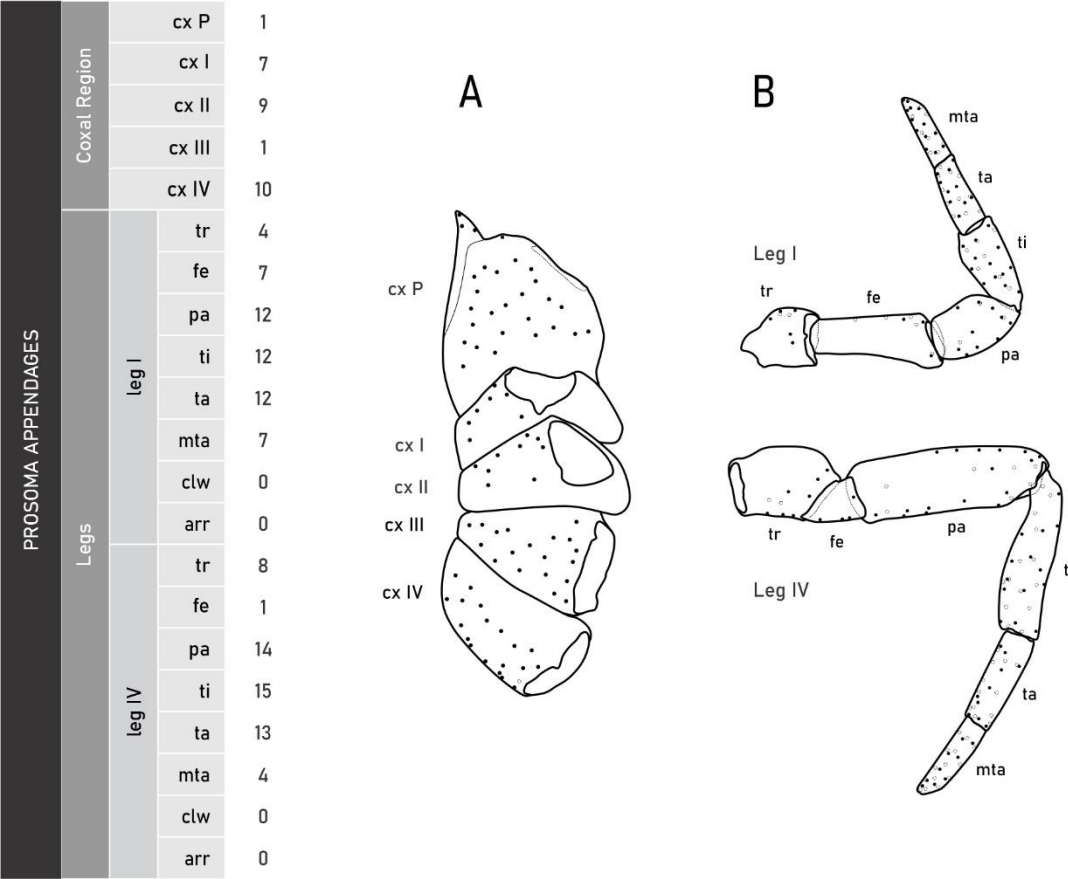
**Remarks.** It was observed that the description of the holotype (see Balzan, 1887) despite the low amount of comparative data matches perfectly with the coded specimen, presenting high morphometric similarity, despite the difference in size between the two specimens. In this study, only a diagnosis and complementary description to the original description are necessary, adding the information revealed through the coding, such as the complete chaetotaxy of the morphological units, with the different chaeta types and coloration pattern.



**Figure 87.** *G. cuyabanus* Balzan, 1887. Coded complementary description: Carapace and Chelicera: Carapace with chaetotaxy and color intensity spots, dorsal view.; Male galea.; Chelicera with chaetotaxy.

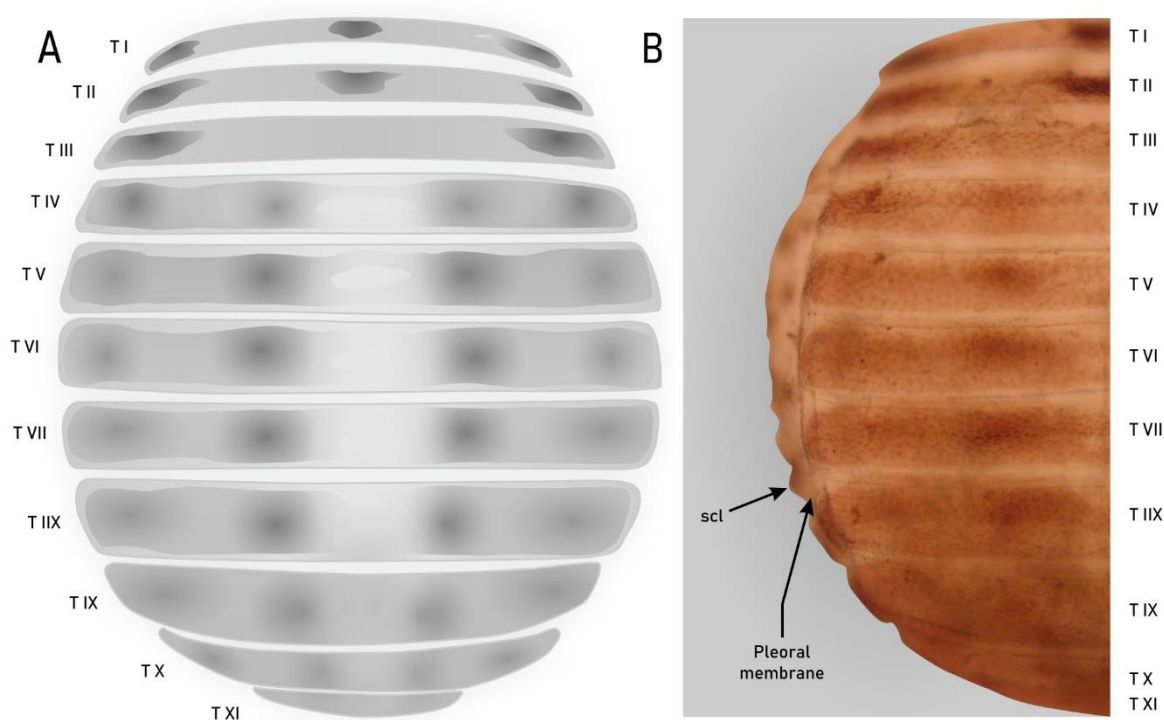


**Figure 88.** *G. cuyabanus* Balzan, 1887. Coded complementary description Pedipalp: Pedipalp with chaetotaxy pattern and color.

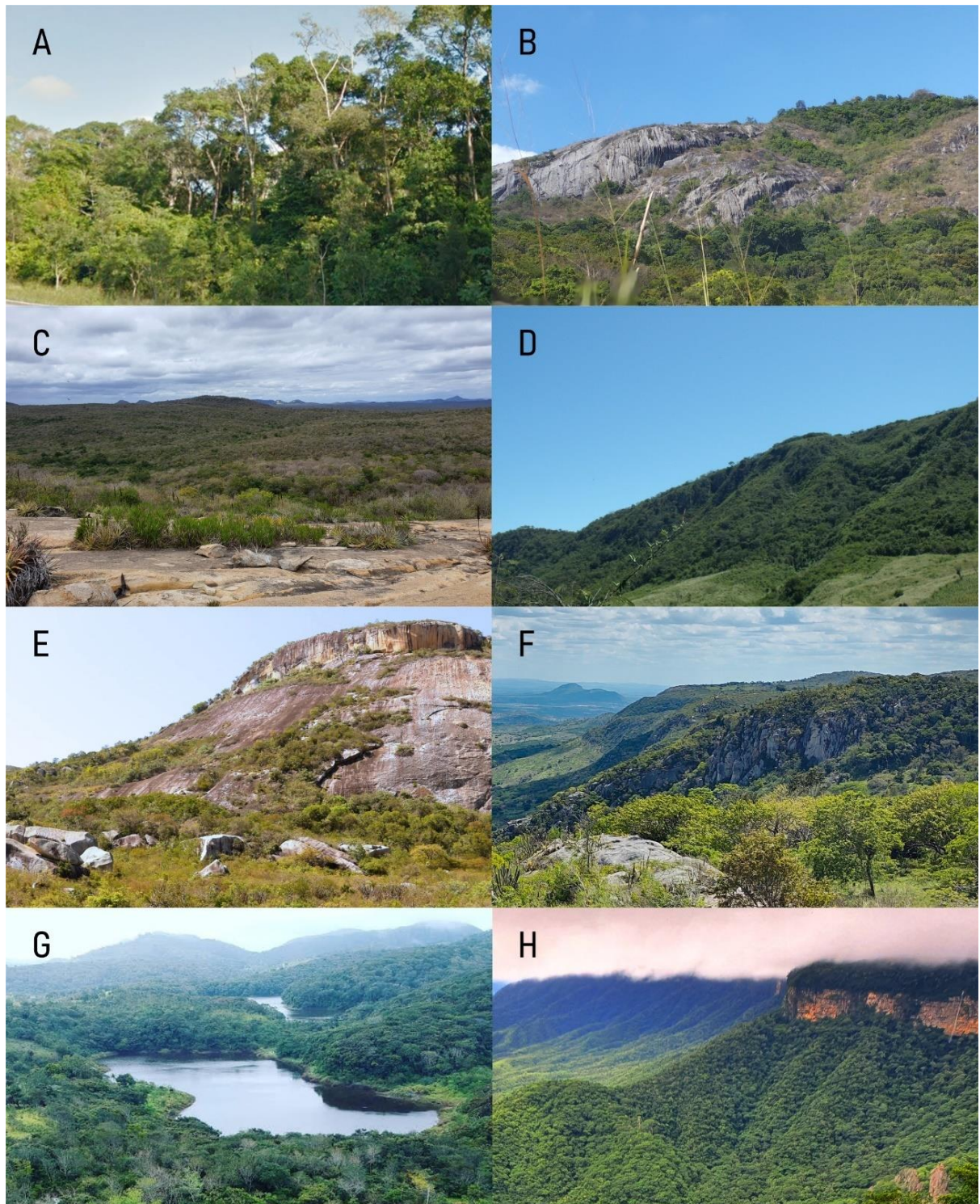


**Figure 89.** *G. cuyabanus* Balzan, 1887. Coded complementary description Coxal region and Legs: A. Coxa of pedipalp and I-IV. B. Legs I, IV.

|             |          |        |    |          |           |       |    |          |           |        |   |          |           |        |    |           |        |   |
|-------------|----------|--------|----|----------|-----------|-------|----|----------|-----------|--------|---|----------|-----------|--------|----|-----------|--------|---|
| OPISTHOSOMA | Tergites | plm    | 0  | Tergites | darkspots | T IX  | 9  | Tergites | darkspots | TdVII  | 2 | Tergites | bridges   | TbVII  | 8  | Sternites | S VIII | 1 |
|             |          | scl    | 1  |          |           | T X   | 7  |          |           | TdVIII | 2 |          |           | TbVIII | 10 |           | S IX   | 1 |
|             |          | td     | 0  |          |           | T XI  | 10 |          |           | TdIX   | 1 |          |           | TbIX   | 8  |           | S X    | 3 |
|             |          | T I    | 7  |          |           | A     | 0  |          |           | TdX    | 1 |          |           | TbX    | 9  |           | S XI   | 0 |
|             |          | T II   | 7  |          |           | tdsp  | 1  |          |           | TdXI   | 0 |          |           | TbXI   | 0  |           |        |   |
|             |          | T III  | 7  |          |           | TdI   | 0  |          |           | TbI    | 0 |          | Sternites | S II   | ?  |           |        |   |
|             |          | T IV   | 8  |          |           | TdII  | 0  |          | bridges   | TbII   | 0 |          |           | S III  | 2  |           |        |   |
|             |          | T V    | 9  |          |           | TdIII | 0  |          |           | TbIII  | 0 |          |           | S IV   | 1  |           |        |   |
|             |          | T VI   | 12 |          |           | TdIV  | 2  |          |           | TbIV   | 6 |          |           | S V    | 0  |           |        |   |
|             |          | T VII  | 9  |          |           | TdV   | 2  |          |           | TbV    | 8 |          |           | S VI   | 1  |           |        |   |
|             |          | T VIII | 10 |          |           | TdVI  | 2  |          |           | TbVI   | 7 |          |           | S VII  | 3  |           |        |   |



**Figure 90.** *G. cuyabanus* Balzan, 1887. Coded complementary description Tergites and Sternites: Tergites I-XI with chaetotaxy, lyrifissures and color intensity spots, dorsal view, schematic and in color.



**Figure 91.** Different phytophysionomies in which species of the genus *Geogarypus* were collected in Northeastern Brazil. A. Usina São João (PB). B. REBio Pedra Talhada (AL/PE). C. RPPN Fazenda Almas (PB). D. PE Serra de Santa Catarina (PB). E. RPPN Fazenda Bitury (PE). F. Serra do Comunaty (PE). G. PNM João Vasconcelos Sobrinho (PE). H. Serra de Ibiapaba (CE).

## 4 Discussion

### 4.1 Coded Description

For groups with exhaustively explored chaetotaxy, the chaetae bank from SEM images is an indispensable tool (Cipola et al., 2020; de Lima et al., 2022; Lukić et al., 2010; Zeppelini et al., 2022, 2024; Zhang & Deharveng, 2015). In addition to eliminating ambiguity regarding the description of the chaetae itself, the bank can be added to, modified and corrected (Zeppelini et al., 2024). In traditional taxonomy, the chaetotaxy of pseudoscorpions focuses primarily on the trichobothria of the chela, anterior and posterior chaetae of the carapace and certain tactile chaeta. For the Geogarypidae family, the presence of three types of chaeta is recognized: the pls sensory structures, the smooth and clavate chaeta. In this study we listed 21 different types of chaeta and sensory structures (Fig. 6), highlighting the *pnso*, never observed, on average a single species has 17 different types, the total number of chaetae can vary between 1200-2600 in the species described in this study.

The number of species described annually, for the order Pseudoscorpiones, in the last 5 years is approximately 75 species (World Pseudoscorpiones Catalog, 2022), the Geogarypidae family represents only 1.33% of the species described annually. We describe 60% of the total species described annually in a single study, which highlights the ability of codified description to accelerate the rate of description of neglected taxa without reducing the complexity of taxonomic description.

### 4.2 Borborema Highland Rainforests Hotspot

The Atlantic Forest (Af) is one of the largest and most diverse tropical forests on the planet (Mittermeier et al., 2005), The Af was considered one of the five priority hotspots for protection, due to its biological richness and endemism (Mittermeier et al., 2005; Myers et al., 2000), having more than 50% of Brazilian threatened species and 38% of Brazilian species are endemic to Af (MMA/ICMBio, 2018).

The Brazilian Caatinga (Caa) is characterized by strong seasonality, most áreas typically receiving less than 500-800 mm of annual rainfall, the vegetation is heterogeneous, almost all is xerophilic, with 9% of rainforests on humidity islands amidst the semiarid vegetation, mainly in the ecotone “agreste” between the Caa and Af (Nimer, 1972; Ab'Saber 1977; Olson et al., 2001; Sá et al., 2003, 2004). Humidity islands are remnants of the ancestral rainforest cover resulting from the interconnection between the Amazon and Atlantic Forest during the Paleogene (Morley 2000; Nimer, 1972; Ab'Saber 1977; Olson et al., 2001; Sá et al., 2003, 2004).

The predominant distribution in northeastern Brazil of the Geogarypidae family in the Highland Rainforest of the Borborema plateau corroborates the well-established hypothesis of the refuge theory (Ab'sáber, 1992; De Medeiros and Cestaro, 2019), where Pleistocene climate change and cycles of connections between rainforests, followed by periods of isolation (Auler et al., 2004; Auler and Smart, 2001; Behling et al., 2000; Costa, 2003; De Oliveira et al., 1999; Edwin O. Willis, 1992; Fouquet et al., 2012; Pellegrino et al., 2011; Wang et al., 2004). shaped the distribution of species that occupied the ancient rainforest that covered the dry diagonal during the Pleistocene Speciated in periods of isolation forming this incredible endemic fauna (Rizzini, 1977; Silva and Casteleti, 2003).

The Borborema plateau is a hotspot for the Geogarypidae family, with a large number of endemic species found there, of the genus *Geogarypus* e *New. Gen1*. The vast majority of Brazilian species occur in the ecotone Af/Caa on north of the São Francisco River in the states of Pernambuco, Paraíba, Alagoas, Ceara and Rio Grande do Norte (Tab. 3 and Figs. 9, 10), in different phytophysiognomies (Fig. 91). Considering the biogeographic complexity previously exposed and the lack of knowledge about practically all other families, the Brazilian northeast could easily exceed half the number of described species.

#### 4.3 Brazilian Geogarypidae color pattern

Despite being considered variable, the coloration of the family presents a certain intraspecific constancy regarding the total number of darkspots. (Mahnert, 1979). No Brazilian species varies in terms of the total number of darkspots of the same species and there are few different species in Brazil with the same number of darkspots (Fig. 4). The species described in this study presented two types of intraspecific variation, regarding the hue in individuals from different locations (*G. calon* **sp. nov.** and undescribed new genus 1 *mf3*) and the intensity of bridges in adult individuals of different ages and from the same location (*G. calon* **sp. nov.** and *G. elipticus* **sp. nov.** Figs. 21, 46, 50).

The total count of darkspots is an excellent tool for delimiting Brazilian species and the detailed description of bridges is essential for separating cryptic and pseudocryptic species. Such as, for example, the species *G. Gollumi*, *G. nordestinus* **sp. n.** and *G. elipticus* **sp. n.** that have the same number of dark spots in the tergites (45) and differ in terms of coloration, in the proportion between the lateral dark spots of the tergites IV and V in relation to the tergite I (see *G. elipticus* **sp. n.** dark spots proportion of tergites IV, V and I in colors on Fig. 50) and bridges. Darkmarks are present in some species, they can be seen in the medial position of the tergites or related to chaetotaxy, darkmarks are still something misunderstood, observing this characteristic in different species around the world can bring clarity regarding darkmarks.

Vast majority of current Geogarypids species (*Afrogarypus*, *Geogarypus*, undescribed new genus 1 and undescribed new genus 2) have 7-8 darkspots on submedial line and 10 darkspots on lateral line. Understanding the full complexity that permeates the colors of the Geogarypidae family still lacks fundamental data, especially regarding the understanding of variations. There is also another line of spots in addition to the medial, submedial and lateral lines, present exclusively in species belonging to undescribed new genus 3, which has not yet been described (Unpublished Data).

**Table 4.** Brazilian Geogarypidae species records in caves. *Geogarypus* species records, new species, new morfotypes and Undescribed genus 1 morfotypes in subterranean habitats. States abbreviation: BA – Bahia; GO – Goiás; MG – Minas Gerais; PA – Pará; PE – Pernambuco; RS – Rio Grande do Sul.

| species                                   | state | county              | cave                             | colectors                                                              |
|-------------------------------------------|-------|---------------------|----------------------------------|------------------------------------------------------------------------|
| <i>G. curumim</i> sp. nov.                | SC    | Florianópolis       | Gru. das Pedras Grandes          | Bichuette, ME & Gallão, JE.                                            |
| <i>G. eliptycus</i> sp. nov.              | MG    | Presidente Olegário | Lapa da Fazenda São Bernardo and | Bichuette, ME & Zepon, T.                                              |
|                                           | BA    | Carinhanha          | Gru. Bem Bom                     | Bichuette, ME & Gallão JE                                              |
| <i>G. gollum</i> Bedoya-Roque et al, 2023 | PE    | Catimbau-Buíque     | Cav. Meu Rei                     | Barbier, E.                                                            |
| <i>G. mf1</i>                             | PA    | Altamira            | Abrigo Assurini                  | Bichuette, ME; Gallão, JE; Monteiro-Neto, D; Pedroso, DR.              |
| <i>G. mf2</i>                             | GO    | São Domingos        | Lapa do Angélica                 | Bichuette, ME; Monteiro-Neto, D; Gallão, JE; Simões, LB.               |
| <i>G. mf3</i>                             | MG    | Montes Claros       | Lapa do Ninho                    | Zepon, T; Gallão, JE; von Schimonsky, DM.                              |
| Undescribed genus 1 <i>mf1</i>            | MG    | Rio Acima           | Cav. AP                          | Brito, RA.; Zampaulo R.                                                |
| Undescribed genus 1 <i>mf2</i>            | MG    | Catas Altas         | Cav. FZ-94                       | DaFonseca, RF; Mendes, LR                                              |
| Undescribed genus 1 <i>mf3</i>            | MG    | Nova Lima           | Cav. SERR and Cav. CPMT          | Brito, RA.; Zampaulo R.                                                |
| Undescribed genus 1 <i>mf4</i>            | BA    | Carinhanha          | Gru. Bem Bom                     | Gallão JE.; Bolfarini M.; Rosendo M.; Moreira R.                       |
| Undescribed genus 1 <i>mf5</i>            | MG    | Caeté               | Gru. da Piedade                  | Emerich, L; Araujo, M; Micaela, M; Fonseca, RF; Rosado, T; Fonseca, T. |
| Undescribed genus 1 <i>mf6</i>            | BA    | Paripiranga         | Cav. do Alto do Morro da Candeia | Gallão J.; Bolfarini M.; Rosendo M.; Moreira R.                        |

#### 4.4 Caves Species

Of the total of 22,623 caves registered in Brazil, around 314 caves have records of some pseudoscorpion in the literature. (CECAV, 2021; Gallão and Bichuette, 2018; Schimonsky and Bichuette, 2019). That is, less than 2% of Brazilian caves have any records, and a tiny fraction of these records are from the Geogarypidae family. We listed 12 records, among species already known, described in this study and new morphotypes that are in the process of description, of the genus *Geogarypus* and undescribed new genus 1 (Tab. 4). It is worth highlighting the evident rarity of records for the family in general, as demonstrated in this study (see 3Results), records of this family in subterranean habitats are quite scarce. The species described in this study were recorded in the photic region of the caves, therefore they are troglophiles, the species *G. eliptycus* **sp. nov.** and undescribed new genus 1 *mf3* were found in more than one cavity, *G. eliptycus* **sp. nov.** was collected in caves in the states of Minas Gerais and Bahia.



**Figure 92.** Extreme fragmentation of the Atlantic Forest in the wild ecotone between the Caatinga and the Atlantic Rainforest. A. Records of Geogarypidae species in the Borborema

hotspot. B. The main threat to the species is the suppression of habitats and the increase in fragmentation in northeastern Brazil.

#### 4.5 Conservation

The Atlantic Forest currently have around 8.5% of the original vegetation remains in fragments larger than 100 hectares (Fundação SOS Mata Atlântica e INPE, 2020), the extreme fragmentation of the Atlantic Forest (Fig. 92) is a reflect the successive impacts resulting from different cycles of natural resource exploitation led to a drastic reduction in natural vegetation cover (Ribeiro et al., 2009; Tabarelli et al., 2012). The large number of endemic species that we found in the fragments above the São Francisco River is not surprising, given that the Atlantic Forest was considered one of the five priority hotspots for protection, due to its biological richness and endemism (Mittermeier et al., 2005; Myers et al., 2000), having more than 50% of Brazilian threatened species and 38% of Brazilian species are endemic to Atlantic Forest (MMA/ICMBio, 2018). We believe that there are still many species to be described living in the areas of exception and islands of humidity in northeastern Brazil. The main threat to these species is the continued suppression of original vegetation.

#### 5 Conclusion

- a. The application of the coded description method in the genus *Geogarypus* demonstrated the potential to drastically accelerate the rate of species description, considerably increasing the number of species in this neglected genus in a few months. In addition to the sharp curve in the rate of species description, the coded description provided an increase in the level of morphological information complexity. It was also possible to reveal new structures never observed before, as well as revealing all the chaetotaxy complexity of the appendages.
- b. The color classification system used in this study allows all species to be individualized. By observing each Tergite individually, certain aspects that make up the pattern of each species become clear, such as the presence/absence of a certain darkspot or darkmark, as well as the pattern and shape of the bridges. The hue itself of each species was disregarded, since some species may vary in hue but never in the total quantity of darkspots. The bridge pattern remains constant in individuals of the same species from distant locations. For certain females, the bridges may present an accentuation in intensity, but the species pattern is still maintained.
- c. It is possible to assume that the total number of species in Brazil is still not close to reality, the review of the Geogarypidae family revealed several species, three times higher than the number of species described until then. This incredible diversity now known was deposited

in fauna collections, this should apply to the vast majority families in Brazil, most of the species still await description, which reflects the lack of studies and the fact that the order has been historically neglected.

- d. The main threat to endemic species in northeastern Brazil is the suppression of native vegetation, which is already extremely fragmented in the northern portion of the Atlantic Rainforest, above the São Francisco River. Recent exploration cycles in the areas of exception and islands of humidity in the Atlantic Forest and Caatinga ecotone, the current lack of connection between the fragments and reduced size raise an alert regarding the conservation of this incredible endemic diversity.

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**APPENDIX 1** The following list of characters is presented in a sequence from the prossoma and appendages of the opisthosomal segments. It is a perfect match of Table 1 and is also represented by an individualized table in each species description plate. This list presents the observed conditions of each character included in our study, a total of 107 morphological characters and 646 different conditions are listed.

## PROSOMA

### Carapace

#### shield

##### shield format (sfrm):

- 0 – strongly sub-triangular.
- 1 – different format.

##### cucullus format (cu):

- 0 – snout-like; long.
- 1 – different format.

##### eyes (a):

- 0 – 4; same size.
- 1 – 4; anterior short.

##### anterior edge total chaetae (an):

- 0 – 4 2(1) + 2(3).
- 1 – 4 2(2) + 2(4).

##### central carapace total chaetae (oc + me + in):

- 0 – 80–90(5).
- 1 – 80–90(6).
- 2 – 90–100(6).
- 3 – 130–140(5).
- 4 – 60–70(5).
- 5 – 100(5) + 2(6).
- 6 – 55(6)

##### posterior edge total chaetae (po):

- 0 – 16–18(5).
- 1 – 17–18(6).
- 2 – 13–16(6).
- 3 – 15(5).
- 4 – 14(5).
- 5 – 12(5).
- 6 – 10(5).
- 7 – 19–20(6).

#### color

##### shield color (shc):

- 0 – uniformly red-brown to light-brown.
- 1 – uniformly brown to light-brown.
- 2 – uniformly light-brown.

##### cucullus color (cuc):

- 0 – light-brown.
- 1 – red-brown.

##### ocular region color (cor):

- 0 – red-brown

- 1 – brown with light marks on ayes
- 2 – red-brown with dark line on eyes.
- 3 – light-brown

##### color medial furrow (cmf):

- 0 – red-brown
- 1 – light-brown
- 2 – brown

##### color anterior furrow (caf):

- 0 – light-brown
- 1 – red-brown
- 2 – brown

##### darkspots lateral-dorsal (dld):

- 0 – blackened
- 1 – red-brown

##### darkspot medial posterior (dmp):

- 0 – red-brown; discrete.
- 1 – red-brown; continuous.
- 2 – brown; continuous
- 3 – light-brown; indefinite
- 4 – red-brown; indefinite

## Appendages

### Chelicera

#### hand

##### hand total chaetae (h):

- 0 – 5 5(8).
- 1 – 5 1(7) + 4(8).
- 2 – 5 2(7) + 3(8).
- 3 – 5 3(7) + 2(8).
- 4 – 5 5(7).
- ? – no data.

##### lyrifissure dorsal + ventral (lyf d + v):

- 0 – 2+1.
- ? – no data.

##### rallum blades (r):

- 0 – 1 blade pointed; short.
- 1 – 1 blade pointed; long.
- 2 – 1 blade bifurcated.
- ? – no data.

#### fixed finger

**setae fixed finger (ff):**

0 – 0.  
? – no data.

**serrula interna blades (serr int):**

0 – 10 blades.  
1 – 12 blades.  
2 – 13 blades.  
3 – 11 blades.  
4 – 9 blades.  
5 – 8 blades.  
6 – 6 blades.  
? – no data.

**tooth:**

0 – 5 distinct teeth.  
1 – 4 distinct teeth.  
2 – 6 distinct teeth.  
3 – 3 distinct teeth.  
? – no data.

**movable finger****setae (mf):**

0 – 1 (11).  
1 – 1 1(8); distal.

**serrula externa (serr ext):**

0 – 14 blades.  
1 – 15 blades.  
2 – 16 blades.  
3 – 17 blades.  
4 – 13 blades.  
5 – 11 blades.  
? – no data.

**galea male; female (g):**

0 – coniform; 9 distal rami.  
1 – coniform with 1 spinule; 9 distal rami.  
2 – coniform with 1 spinule; 8 distal rami.  
3 – coniform; 10 distal rami.  
4 – coniform with 3 spinules; 9 distal rami.  
5 – coniform; no data.  
6 – no data; 9 distal rami.

**tooth:**

0 – 2 small subapical teeth.  
1 – 1 small subapical tooth.  
2 – 0 small subapical teeth.  
? – no data.

**Pedipalp****setae trochanter (tr):**

0 – 21 21(6).  
1 – 23 23(6).  
2 – 24 24(5).  
3 – 28 28(6).  
4 – 28 28(5).  
5 – 21 21(5).  
6 – 18 18(6).  
7 – 18 18(5).  
8 – 17 17(5).  
9 – 16 16(6).

10 – 15 15(5).  
11 – 32 32(5).  
12 – 10 10(5).

**setae femur (fe):**

0 – 48 48(6).  
1 – 63 63(5).  
2 – 54 54(6).  
3 – 54 54(5).  
4 – 52 52(5).  
5 – 49 49(6).  
6 – 48 48(5).  
7 – 46 46(5).  
8 – 45 45(6).  
9 – 43 43(5).  
10 – 42 42(5).  
11 – 40 40(6).  
12 – 32 29(5) + 3(9).

**setae patella (pa):**

0 – 30 30(5).  
1 – 29 29(5).  
2 – 29 29(6).  
3 – 28 28(5).  
4 – 32 32(5).  
5 – 35 35(5).  
6 – 35 35(6).  
7 – 35 35(9).  
8 – 39 39(6).  
9 – 46 46(5).  
10 – 50 50(6).  
11 – 56 56(6).  
12 – 21 21(6).  
13 – 33 7(5) + 26(9).  
14 – 34 27(5) + 7(9).

**hand****setae (h):**

0 – 87 85(5) + 2(10).  
1 – 77 75(5) + 2(10).  
2 – 77 75(6) + 2(10).  
3 – 75 73(9) + 2(10).  
4 – 72 70(6) + 2(10).  
5 – 68 66(6) + 2(10).  
6 – 66 64(6) + 2(10).  
7 – 63 61(5) + 2(10).  
8 – 57 55(9) + 2(10).  
9 – 56 54(9) + 2(10).  
10 – 54 52(5) + 2(10).  
11 – 44 42(9) + 2(10).  
12 – 29 27(5) + 2(10).  
13 – 56 24(5) + 30(9) + 2(10).  
14 – 64 41(5) + 21(9) + 2(10).  
15 – 67 48(5) + 17(9) + 2(10).

**hand format (hfrm):**

0 – simple.  
1 – different format.

**fixed finger****fixed finger total chaetae (ff):**

0 – 71 60(10) + 3(14) + 8(15).  
1 – 72 60(10) + 4(14) + 8(15).  
2 – 92 80(10) + 4(14) + 8(15).  
3 – 92 80(10) + 2(14) + 8(15).  
4 – 93 80(10) + 5(14) + 8(15).

5 – 75 5(5) + 60(10) + 2(14) + 8(15).  
 6 – 71 60(10) + 3(14) + 8(15).  
 7 – 66 7(6) + 48(10) + 3(14) + 8(15).  
 8 – 62 50(10) + 4(14) + 8(15).  
 9 – 58 50(10) + ?(14) + 8(15).  
 10 – 47 35(10) + 4(14) + 8(15).  
 11 – 42 30(10) + 4(14) + 8(15).  
 12 – 106 8(9) + 80(10) + 7(14) + 8(15).  
 13 – 47 3(9) + 30(10) + 3+3(14) + 8(15).

**tooth:**

0 – 25 teeth; heterodentate.  
 1 – 30 teeth; heterodentate.  
 2 – 34 teeth; heterodentate.  
 3 – 29 teeth; heterodentate.  
 4 – 27 teeth; heterodentate.  
 5 – 26 teeth; heterodentate.  
 6 – 23 teeth; heterodentate.  
 7 – 22 teeth; heterodentate.

**tooth distal (dist):**

0 – conic acuminate.  
 1 – different format.

**tooth proximal (prox):**

0 – conic acuminate.  
 1 – different format.

**venom ducts (vd):**

0 – short.  
 1 – different format.

**movable finger**

**movable finger total chaetae (mf):**

0 – 65 60(10) + 1(12) + 4(15).  
 1 – 60 55(10) + 1(13) + 4(15).  
 2 – 65 60(10) + 1(13) + 4(15).  
 3 – 66 60(10) + 2(11) + 4(15).  
 4 – 58 53(10) + 1(13) + 4(15).  
 5 – 50 45(10) + 1(12) + 4(15).  
 6 – 48 43(10) + 1(13) + 4(15).  
 7 – 43 38(10) + 1(13) + 4(15).  
 8 – 35 30(10) + 1(13) + 4(15).  
 9 – 29 22(10) + 3(11) + 4(15).  
 10 – 30 25(10) + 1(12) + 4(15).  
 11 – 64 60(10) + 4(12).  
 12 – 54 50(10) + 4(12).  
 13 – 55 50(10) + 1(13) + 4(15).

**tooth:**

0 – 25 teeth.  
 1 – 21 teeth.  
 2 – 20 teeth.  
 3 – 22 teeth.  
 4 – 18 teeth.  
 5 – 17 teeth.  
 6 – 16 teeth.  
 7 – 14 teeth.

**tooth distal (dist):**

0 – triangular acuminate.  
 1 – different format.

**tooth proximal (prox):**

0 – rounded.  
 1 – different format.

**venom ducts (vd):**

0 – short.  
 1 – different format.

**Coxal region**

**pedipalp coxa total chaetae (cx P):**

0 – 38 34+3(16) + 1(17)  
 1 – 29 25+3(16) + 1(17)  
 2 – 38 30+2(16) + 1(17)  
 3 – 41 37+3(16) + 1(17)  
 4 – 41 36+4(16) + 1(17)  
 5 – 39 35+3(16) + 1(17)  
 6 – 33 28+4(16) + 1(17)  
 7 – 32 28+3(16) + 1(17)  
 8 – 31 27+3(16) + 1(17)  
 9 – 45 41+3(16) + 1(17)  
 10 – 26 22+3(16) + 1(17)  
 11 – 25 19+5(16) + 1(17)  
 ? – no data.

**coxa I total chaetae (cx I):**

0 – 9 9(16).  
 1 – 8 8(16).  
 2 – 11 11(16).  
 3 – 14 14(16).  
 4 – 16 16(16).  
 5 – 17 17(16).  
 6 – 20 20(16).  
 7 – 7 7(16).  
 8 – 6 6(16).  
 9 – 4 4(16).

**coxa II total chaetae (cx II):**

0 – 23 23(16).  
 1 – 18 18(16).  
 2 – 14 14(16).  
 3 – 13 13(16).  
 4 – 12 12(16).  
 5 – 11 11(16).  
 6 – 21 21(16).  
 7 – 7 7(19).  
 8 – 8 8(16).  
 9 – 9 9(16).

**coxa III total chaetae (cx III):**

0 – 26 26(16).  
 1 – 19 19(16).  
 2 – 20 20(16).  
 3 – 21 21(16).  
 4 – 24 24(16).  
 5 – 31 31(16).  
 6 – 33 33(16).  
 7 – 34 34(16).  
 8 – 15 15(16).  
 9 – 14 14(16).  
 10 – 13 13(16).  
 11 – 9 9(19).

**coxa IV total chaetae (cx IV):**

0 – 28 28(16).  
 1 – 31 31(16).  
 2 – 29 29(16).  
 3 – 30 30(16).

4 – 33 33(16).  
 5 – 34 34(16).  
 6 – 37 37(16).  
 7 – 40 40(16).  
 8 – 42 42(16).  
 9 – 26 26(16).  
 10 – 20 20(16).  
 11 – 45 45(16).  
 12 – 46 46(16).  
 13 – 16 16(16).

## Legs

### leg I

#### trochanter total chaetae (tr):

0 – 8 8(18a).  
 1 – 9 9(18a).  
 2 – 10 10(18a).  
 3 – 6 6(18a).  
 4 – 7 7(18a).  
 5 – 5 5(18a).  
 6 – 4 4(18a).

#### femur total chaetae (fe):

0 – 13 13(18a).  
 1 – 14 14(18a).  
 2 – 12 12(18a).  
 3 – 16 16(18a).  
 4 – 18 18(18a).  
 5 – 17 17(18a).  
 6 – 15 15(18a).  
 7 – 8 8(18a).

#### patella total chaetae (pa):

0 – 21 17(18a) + 4(19).  
 1 – 17 13(18a) + 4(19).  
 2 – 17 14(18a) + 3(19).  
 3 – 18 14(18a) + 4(19).  
 4 – 18 13(18a) + 5(19).  
 5 – 19 15(18a) + 4(19).  
 6 – 16 13(18a) + 3(19).  
 7 – 14 12(18a) + 2(19).  
 8 – 13 12(18a) + 1(19).  
 9 – 20 20(18a).  
 10 – 18 18(18a).  
 11 – 15 15(18a).  
 12 – 13 13(18a).  
 13 – 11 11(18a).

#### tibia total chaetae (ti):

0 – 27 22(18a) + 5(19).  
 1 – 19 16(18a) + 3(19).  
 2 – 23 19(18a) + 4(19).  
 3 – 23 18(18a) + 5(19).  
 4 – 22 18(18a) + 4(19).  
 5 – 21 17(18a) + 4(19).  
 6 – 20 15(18a) + 5(19).  
 7 – 25 18(18a) + 7(19).  
 8 – 25 21(18a) + 4(19).  
 9 – 26 20(18a) + 6(19).  
 10 – 29 24(18a) + 5(19).  
 11 – 17 12(18a) + 5(19).  
 12 – 20 20(18a).

#### tarsus total chaetae (ta):

0 – 19 17(18a) + 2(19).  
 1 – 22 18(18a) + 4(19).

2 – 22 19(18a) + 3(19).  
 3 – 22 21(18a) + 1(19).  
 4 – 21 18(18a) + 3(19).  
 5 – 20 17(18a) + 3(19).  
 6 – 19 17(18a) + 2(19).  
 7 – 18 14(18a) + 4(19).  
 8 – 17 14(18a) + 3(19).  
 9 – 24 20(18a) + 4(19).  
 10 – 26 21(18a) + 5(19).  
 11 – 23 23(18a).  
 12 – 21 21(18a).  
 13 – 19 19(18a).  
 14 – 27 27(18a).

#### metatarsus total chaetae (mta):

0 – 25 23(18a) + 2(18c).  
 1 – 26 24(18a) + 2(18c).  
 2 – 28 26(18a) + 2(18c).  
 3 – 30 28(18a) + 2(18c).  
 4 – 33 31(18a) + 2(18c).  
 5 – 29 27(18a) + 2(18c).  
 6 – 24 22(18a) + 2(18c).  
 7 – 22 20(18a) + 2(18c).  
 8 – 30 27(18a) + 2(18c) + 1(19).  
 9 – 24 20(18a) + 1(18b) + 2(18c) + 1(19).

#### claw (clw):

0 – simple.  
 1 – different format.

#### arolium (arr):

0 – slightly longer than claws.  
 1 – different format.

### leg IV

#### trochanter total chaetae (tr):

0 – 13 13(18a).  
 1 – 14 14(18a).  
 2 – 16 16(18a).  
 3 – 10 10(18a).  
 4 – 12 12(18a).  
 5 – 11 11(18a).  
 6 – 12 12(18a).  
 7 – 17 17(18a).  
 8 – 9 9(18a).

#### femur total chaetae (fe):

0 – 5 5(18a).  
 1 – 4 4(18a).  
 2 – 6 6(18a).  
 3 – 7 7(18a).  
 4 – 8 8(18a).  
 5 – 3 3(18a).

#### patela total chaetae (pa):

0 – 17 12(18a) + 5(19).  
 1 – 17 14(18a) + 3(19).  
 2 – 18 17(18a) + 1(19).  
 3 – 18 15(18a) + 3(19).  
 4 – 19 17(18a) + 2(19).  
 5 – 19 16(18a) + 3(19).  
 6 – 19 13(18a) + 6(19).  
 7 – 20 17(18a) + 3(19).  
 8 – 21 14(18a) + 7(19).  
 9 – 21 19(18a) + 2(18).  
 10 – 22 17(18a) + 5(19).

11 – 24 19(18a) + 5(19).  
 12 – 25 17(18a) + 8(19).  
 13 – 29 23(18a) + 6(19).  
 14 – 22 22(18a).

**tibia total chaetae (ti):**

0 – 26 22(18a) + 4(19).  
 1 – 27 17(18a) + 10(19).  
 2 – 29 17(18a) + 12(19).  
 3 – 31 25(18a) + 6(19).  
 4 – 31 26(18a) + 5(19).  
 5 – 33 26(18a) + 7(19).  
 6 – 33 25(18a) + 8(19).  
 7 – 35 28(18a) + 7(19).  
 8 – 35 26(18a) + 9(19).  
 9 – 35 24(18a) + 11(19).  
 10 – 37 30(18a) + 7(19).  
 11 – 38 18(18a) + 20(19).  
 12 – 39 19(18a) + 10(19).  
 13 – 40 28(18a) + 12(19).  
 14 – 46 26(18a) + 20(19).  
 15 – 28 28(18a).

**tarsos total chaetae (ta):**

0 – 27 23(18a) + 4(19).  
 1 – 28 23(18a) + 5(19).  
 2 – 29 25(18a) + 4(19).  
 3 – 29 24(18a) + 5(19).  
 4 – 29 22(18a) + 7(19).  
 5 – 26 23(18a) + 3(19).  
 6 – 26 20(18a) + 6(19).

7 – 24 18(18a) + 6(19).  
 8 – 25 21(18a) + 4(19).  
 9 – 21 18(18a) + 3(19).  
 10 – 35 29(18a) + 6(19).  
 11 – 27 16(18a) + 11(19).  
 12 – 23 23(18a).  
 13 – 22 22(18a).

**metatarsos total chaetae (mta):**

0 – 27 24(18a) + 2(18c) + 1(19).  
 1 – 29 27(18a) + 2(18c).  
 2 – 28 26(18a) + 2(18c).  
 3 – 27 25(18a) + 2(18c).  
 4 – 23 21(18a) + 2(18c).  
 5 – 24 22(18a) + 2(18c).  
 6 – 26 34(18a) + 2(18c).  
 7 – 27 23(18a) + 2(18c) + 2(19).  
 8 – 30 26(18a) + 2(18c) + 2(19).  
 9 – 22 19(18a) + 2(18c) + 1(19).  
 10 – 32 30(18a) + 2(18c).

**claw (clw):**

0 – simple.  
 1 – different format.

**arolium (arr):**

0 – slightly longer than claws.  
 1 – different format.

## OPISTHOSOMA

**total sclerites (scl):**

0 – 12 sclerites.  
 1 – 16 sclerites.  
 2 – 18 sclerites.  
 3 – 23 sclerites.  
 4 – 27 sclerites.  
 5 – 28 sclerites.  
 6 – 29 sclerites.  
 7 – 30 sclerites.  
 8 – 33 sclerites.  
 9 – 38 sclerites.  
 10 – 40 sclerites.  
 11 – 0 sclerites.

## Tergites

**tergital discs (td):**

0 – without.  
 1 – 14; T IV–X.  
 2 – 12; T IV–IX  
 3 – 4; T IV–V.

**tergite I total chaetae (T I):**

0 – 16 16(5).  
 1 – 14 14(5).  
 2 – 18 18(5).  
 3 – 19 19(5).  
 4 – 17 17(5).  
 5 – 16 16(5).  
 6 – 15 15(5).

7 – 18 18(6).  
 8 – 40 40(6).  
 9 – 14 14(6).  
 10 – 13 13(6).  
 11 – 10 10(5).

**tergite II total chaetae (T II):**

0 – 14 14(5).  
 1 – 12 12(5).  
 2 – 15 15(5).  
 3 – 16 16(5).  
 4 – 18 18(5).  
 5 – 17 17(5).  
 6 – 16 16(6).  
 7 – 20 20(6).  
 8 – 42 42(6).  
 9 – 12 12(6).

**tergite III total chaetae (T III):**

0 – 16 16(5).  
 1 – 14 14(5).  
 2 – 18 18(5).  
 3 – 12 12(5).  
 4 – 15 15(5).  
 5 – 19 19(5).  
 6 – 17 17(6).  
 7 – 24 24(6).  
 8 – 31 31(5).  
 9 – 34 34(6).  
 10 – 12 12(6).

**tergite IV total chaetae (T IV):**

0 – 18 18(5).  
 1 – 20 20(5).  
 2 – 21 21(5).  
 3 – 17 17(5).  
 4 – 16 16(5).  
 5 – 15 15(5).  
 6 – 14 14(5).  
 7 – 20 20(6).  
 8 – 24 24(6).  
 9 – 37 37(6).  
 10 – 38 38(5).  
 11 – 14 14(6).  
 12 – 12 12(5).

**tergite V total chaetae (T V):**

0 – 18 18(5).  
 1 – 19 19(5).  
 2 – 17 17(5).  
 3 – 21 21(5).  
 4 – 22 22(5).  
 5 – 23 23(5).  
 6 – 24 24(5).  
 7 – 43 43(5).  
 8 – 20 20(6).  
 9 – 26 26(6).  
 10 – 46 46(6).  
 11 – 17 17(6).  
 12 – 14 14(5).  
 13 – 12 12(5).

**tergite VI total chaetae (T VI):**

0 – 18 18(5).  
 1 – 22 22(5).  
 2 – 20 20(5).  
 3 – 23 23(5).  
 4 – 24 24(5).  
 5 – 17 17(5).  
 6 – 16 16(5).  
 7 – 14 14(5).  
 8 – 10 10(5).  
 9 – 36 36(5).  
 10 – 17 17(6).  
 11 – 22 22(6).  
 12 – 26 26(6).  
 13 – 43 43(6).

**tergite VII total chaetae (T VII):**

0 – 20 20(5).  
 1 – 22 22(5).  
 2 – 18 18(5).  
 3 – 16 16(5).  
 4 – 15 15(5).  
 5 – 10 10(5).  
 6 – 35 35(5).  
 7 – 18 18(6).  
 8 – 20 20(6).  
 9 – 28 28(6).  
 10 – 54 54(6).

**tergite VIII total chaetae (T VIII):**

0 – 20 20(5).  
 1 – 24 24(5).  
 2 – 21 21(5).  
 3 – 19 19(5).  
 4 – 18 18(5).  
 5 – 17 17(5).

6 – 15 15(5).  
 7 – 37 37(5).  
 8 – 10 10(5).  
 9 – 20 20(6).  
 10 – 26 26(6).  
 12 – 53 53(6).  
 13 – 15 15(6).

**tergite IX total chaetae (T IX):**

0 – 18 18(5).  
 1 – 20 20(5).  
 2 – 21 21(5).  
 3 – 22 22(5).  
 4 – 17 17(5).  
 5 – 14 14(5).  
 6 – 10 10(5).  
 7 – 34 34(5).  
 8 – 18 18(6).  
 9 – 27 27(6).  
 10 – 39 39(6).  
 11 – 15 15(6).

**tergite X total chaetae (T X):**

0 – 16 16(5).  
 1 – 15 15(5).  
 2 – 20 20(5).  
 3 – 12 12(5).  
 4 – 13 13(5).  
 5 – 35 35(5).  
 6 – 18 18(6).  
 7 – 20 20(6).  
 8 – 31 31(6).  
 9 – 14 14(6).  
 10 – 6 6(5).

**tergite XI total chaetae (T XI):**

0 – 10 10(5).  
 1 – 12 12(5).  
 2 – 6 6(5).  
 3 – 15 15(5).  
 4 – 16 16(5).  
 5 – 14 14(5).  
 6 – 9 9(5).  
 7 – 22 22(5).  
 8 – 36 36(5).  
 9 – 15 15(6).  
 10 – 14 14(6).  
 11 – 12 12(6).  
 12 – 10 10(6).

**Anal plate total chaetae (A):**

0 – 2 2(23).  
 1 – 2 2(5)

**color****total darkspots (tdsp):**

0 – 45 darkspots.  
 1 – 37 darkspots.  
 2 – 38 darkspots.  
 3 – 37 darkspots + 8 darkmarks.  
 4 – 38 darkspots + 7 darkmarks.  
 5 – 39 darkspots + 5 darkmarks.

**tergite I total darkspots (T I):**

0 – 3 discrete.  
 1 – 3 continuous.

**tergite II total darkspots (T II):**

0 – 3 discrete.  
1 – 3 continuous.

**tergite III total darkspots (T III):**

0 – 2 discrete.  
1 – 3 discrete.  
2 – 3 continuous.

**tergite IV total darkspots (T IV):**

0 – 5 continuous.  
1 – 4 discrete.  
2 – 4 continuous.  
3 – 3 continuous + 2 discrete.

**tergite V total darkspots (T V):**

0 – 4 discrete.  
1 – 5 continuous.  
2 – 4 continuous.  
3 – 3 continuous + 2 discrete.

**tergite VI total darkspots (T VI):**

0 – 4 discrete.  
1 – 5 continuous.  
2 – 4 continuous.  
3 – 4 continuous, 1 discrete.

**tergite VII total darkspots (T VII):**

0 – 4 discrete.  
1 – 5 continuous.  
2 – 4 continuous.  
3 – 4 continuous, 1 discrete.

**tergite VIII total darkspots (VIII):**

0 – 4 discrete.  
1 – 5 continuous.  
2 – 4 continuous.  
3 – 4 continuous, 1 discrete.

**tergite IX total darkspots (T IX):**

0 – 5 continuous.  
1 – 4 continuous.  
2 – 4 discrete.

**tergite X total darkspots (T X):**

0 – 5 continuous.  
1 – 4 continuous.  
2 – 4 discrete.  
3 – 3 continuous, 2 discrete.

**tergite XI total darkspots (T XI):**

0 – 1 continuous.  
1 – 4 discrete.  
2 – 4 continuous.

**tergite I total bridges (T I):**

0 – M 0 L.  
1 – M 0 – L.  
2 – M = 0 = L.

**tergite II total bridges (T II):**

0 – M 0 L.  
1 – M 0 – L.  
2 – M \_ 0 \_ L.

**tergite III total bridges (T III):**

0 – 0 0 L.  
1 – M 0 L.  
2 – M 0 – L.  
3 – M \_ 0 \_ L.  
4 – 1 0 L.

**tergite IV total bridges (T IV):**

0 – 0 S L.  
1 – M = S = L.  
2 – 1 S L.  
3 – M – S – L.  
4 – M – S \_ L.  
5 – 0 S = L.  
6 – 0 = S ■ L.  
7 – M ■ S L.  
8 – M ■ S ■ L.

**tergite V total bridges (T V):**

0 – 0 S L.  
1 – M = S = L.  
2 – M = S \_ L.  
3 – M – S – L.  
4 – M = S – L.  
5 – 1 S L.  
6 – 1 – S L.  
7 – 0 – S – L.  
8 – 0 S – L.  
9 – 0 = S ■ L.  
10 – M ■ S L.  
11 – M ■ S ■ L.

**tergite VI total bridges (T VI):**

0 – 0 S L.  
1 – M S – L.  
2 – 1 S L.  
3 – 1 S – L.  
4 – M = S = L.  
5 – M \_ S = L.  
6 – M S \_ L.  
7 – 0 = S ■ L.  
8 – M ■ S ■ L.

**tergite VII total bridges (T VII):**

0 – 0 S L.  
1 – M S – L.  
2 – 1 S – L.  
3 – 1 S L.  
4 – M – S = L.  
5 – M = S = L.  
6 – M S \_ L.  
7 – M – S ■ L.  
8 – 0 = S ■ L.  
9 – M ■ S ■ L.

**tergite VIII total bridges (T VIII):**

0 – 0 S L.  
1 – M ■ S ■ L.  
2 – 1 S L.  
3 – M S = L.  
4 – 1 – S = L.  
5 – 1 – S – L.  
6 – M S – L.

7 - M - S - L.  
 8 - M - S  L.  
 9 - 1  S  L.  
 10 - 0  S  L.

#### tergite IX total bridges (T IX):

0 - M  S  L.  
 1 - 0 S L.  
 2 - 0 S - L.  
 3 - 1 S L.  
 4 - 1 - S - L.  
 5 - 1 = S = L.  
 6 - M - S  L.  
 7 - 1  S  L.  
 8 - 0  S  L.

#### tergite X total bridges (T X):

0 - M  S  L.  
 1 - M - S L.  
 2 - 1 = S L.  
 3 - 1 - S - L.  
 4 - 0 S L.  
 5 - 0 S - L.  
 6 - 0 - S - L.  
 7 - 1 = S  L.  
 8 - 1  S  L.  
 9 - 0  S  L.

#### tergite XI total bridges (T XI):

0 - M.  
 1 - different combination.

### Sternites

#### sternite II total chaetae (S II):

0 - 18 18(21).  
 1 - 14 14(21).  
 2 - 13 13(21).  
 3 - 10 10(21).  
 4 - 8 8(21).  
 ? - no data.

#### sternite III total chaetae (S III):

0 - 16 16(21).  
 1 - 18 18(21).  
 2 - 15 15(21).  
 3 - 12 12(21).  
 4 - 32 32(21).  
 5 - 24 24(21).  
 6 - 20 20(21).  
 7 - 14 14(21).  
 ? - no data.

#### sternite IV total chaetae (S IV):

0 - 16 16(21).  
 1 - 14 14(21).  
 2 - 12 12(21).  
 3 - 20 20(21).  
 4 - 18 18(21).  
 5 - 13 13(21).  
 ? - no data.

#### sternite V total chaetae (S V):

0 - 16 16(21).  
 1 - 22 22(21).  
 2 - 28 28(21).

3 - 30 30(21).  
 4 - 25 25(21).  
 5 - 24 24(21).  
 6 - 26 26(21).  
 7 - 21 21(21).  
 8 - 18 18(21).  
 9 - 14 14(21).  
 10 - 10 10(21).

#### sternite VI total chaetae (S VI):

0 - 24 24(21).  
 1 - 22 22(21).  
 2 - 20 20(21).  
 3 - 23 23(21).  
 5 - 18 18(21).  
 6 - 26 26(21).  
 7 - 30 30(21).  
 8 - 14 14(21).

#### sternite VII total chaetae (S VII):

0 - 22 22(21).  
 1 - 18 18(21).  
 2 - 24 24(21).  
 3 - 16 16(21).  
 4 - 26 26(21).  
 5 - 27 27(21).  
 6 - 14 14(21).  
 7 - 12 12(21).

#### sternite VIII total chaeta (S VIII):

0 - 16 16(21).  
 1 - 14 14(21).  
 2 - 20 20(21).  
 3 - 22 22(21).  
 4 - 18 18(21).  
 5 - 24 24(21).  
 6 - 28 28(21).  
 7 - 10 10(21).  
 8 - 8 8(21).

#### sternite IX total chaeta (S IX):

0 - 16 16(21).  
 1 - 14 14(21).  
 2 - 20 20(21).  
 3 - 13 13(21).  
 4 - 12 12(21).  
 5 - 10 10(21).  
 6 - 8 8(21).

#### sternite X total chaeta (S X):

0 - 10 10(21).  
 1 - 12 12(21).  
 2 - 9 9(21).  
 3 - 8 8(21).  
 4 - 18 18(21).  
 5 - 6 6(21).

#### sternite XI total chaeta (S XI):

0 - 2 2(20).  
 1 - 0.  
 2 - 4 4(20).  
 3 - 6 2(20) + 2+2(21).