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UNIVERSIDADE ESTADUAL PAULISTA
"JÚLIO DE MESQUITA FILHO"
Campus de São José do Rio Preto

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**Revisão taxonômica e análise cladística dos gêneros de tarântulas arborícolas
Psalmopoeus Pocock, 1985 e *Tapinauchenius* Ausserer, 1871 (Araneae:
Theraphosidae: Aviculariinae).**

São José do Rio Preto
2018

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Dissertação apresentada como parte dos requisitos para obtenção do título de Mestre em Biologia Animal, junto ao Programa de Pós-Graduação em Biologia Animal, do Instituto de Biociências, Letras e Ciências Exatas da Universidade Estadual Paulista “Júlio de Mesquita Filho”, Câmpus de São José do Rio Preto.

Orientador: Prof. Dr. Rogério Bertani.

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Revisão taxonômica e análise cladística dos gêneros de tarântulas arborícolas *Psalmopoeus* Pocock, 1985 e *Tapinauchenius* Ausserer, 1871 (Araneae: Theraphosidae: Aviculariinae) / Yeimy Lizeth Cifuentes Gil. -- São José do Rio Preto, 2018
132 f. : il.

Orientador: Rogério Bertani

Dissertação (mestrado) – Universidade Estadual Paulista “Júlio de Mesquita Filho”, Instituto de Biociências, Letras e Ciências Exatas

1. Ecologia animal. 2. Aranha. 3. Biologia – Classificação. I. Universidade Estadual Paulista “Júlio de Mesquita Filho”. Instituto de Biociências, Letras e Ciências Exatas. II. Título.

CDU – 595.4

Ficha catalográfica elaborada pela Biblioteca do IBILCE
UNESP - Câmpus de São José do Rio Preto

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Financiadora: CNPq

Comissão Examinadora

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São José do Rio Preto
22 de Fevereiro 2018

Aos três pilares da minha vida: meus pais Víctor Cifuentes e Leonor Gil, e à minha irmã Mariana Cifuentes, minhas forças e esperança.

AGRADECIMENTOS

Aos meus pais Víctor e Leonor, principal exemplo, motor e fonte de inspiração, meu apoio e companhia durante todos os caminhos da minha vida e minha irmã Mariana que ainda na distância estão presentes como luz no caminho. Aos meus irmãos Alexander e Omar, pelo apoio durante estes anos.

Também quero agradecer profundamente ao professor Rogerio Bertani, por ter aberto as portas de seu laboratório, por permitir-me ser sua estudante, pela paciência, confiança e apoio; ao Carlos Perafán e Juan Pablo Botero pelas orientações durante a elaboração do trabalho, conselhos, apoio, mas, principalmente, pela amizade.

A Rick West, que doou grande parte dos espécimes, contribuindo de grande maneira ao desenvolvimento do projeto; ao Laboratório de Ecologia e Evolução do Instituto Butantan, o lugar que me acolheu durante estes dois anos; à agencia financiadora CNPq pelo processo [190543/2015-9] e ao Programa PEC-PG, por incentivar o estudo de estudos de pós-graduação para estudantes latino-americanos. Aos curadores das coleções, que gentilmente enviaram os espécimes utilizados no presente trabalho e ao Laboratório de Biologia Celular do Instituto Butantan pelo uso do Microscópio de Varredura.

Quero agradecer às almas bonitas da minha vida e aos meus amigos que encontrei pelo caminho: Ao Aramys, pela sua ajuda com correções de português e amizade, e aos meus companheiros de laboratório Pedro, Caroline, Irene e André, pelo apoio e amizade; às minhas irmãs no Brasil: Maita, Mariana, Gineth, Elisa, pelas risadas, piadas, conselhos e amizade, por fazer cargas leves e momentos felizes. Ao “tico” Arturo e ao Danilo, aqueles que me receberam como em casa em São José do Rio Preto, pelas conversações, risadas e amizade. Ao Brad Zamft, pelo conselho, palavra, abraço, pelo apoio, por estar sempre presente ainda em tempos de distância. Igualmente ao Mathias Weibel, Dani Martinez e Dani Espejo grandes amigos na distância, aqueles que tem sido um suporte constante, sempre presentes.

Finalmente agradeço todas aquelas pessoas que me apoiaram e contribuíram neste processo de formação. Obrigada.

“Exploration is in our nature. We began as wanderers, and we are wanderers still. We have lingered long enough on the shores of the cosmic ocean. We are ready at last to set sail for the stars.”

Carl Sagan

RESUMO

Os gêneros *Psalmopoeus* Pocock, 1895 e *Tapinauchenius* Ausserer, 1871 são revisados, e a maioria das espécies são redescritas, chaves taxonômicas para a identificação de espécies são propostas e mapas de distribuição são apresentados. *Tapinauchenius* é composto pelas espécies: *Tapinauchenius plumipes* (C. L. Koch, 1842), *Tapinauchenius latipes* L. Koch, 1875 e *Tapinauchenius sanctivincenti* (Walckenaer, 1837). *Tapinauchenius cupreus* Schmidt & Bauer, 1996 é sinonimizada com *Tapinauchenius latipes*, e *Tapinauchenius brunneus* Schmidt, 1995 e *Tapinauchenius gigas* Caporiacco, 1954 são consideradas sinônimos-júniors de *Tapinauchenius plumipes*. *Tapinauchenius concolor* (Caporiacco, 1947) é considerada “nomem dubium”. *Tapinauchenius elenae* Schmidt, 1994 e *Tapinauchenius subcaeruleus* Bauer & Antonelli, 1997 são transferidas para *Psalmopoeus* e as novas combinações *Psalmopoeus elenae* (Schmidt, 1994) n. comb., e *Psalmopoeus subcaeruleus* (Bauer & Antonelli, 1997) n. comb. são estabelecidas. *Psalmopoeus* é composto por 14 espécies: *Psalmopoeus cambridgei* Pocock, 1895, *Psalmopoeus ecclesiasticus* Pocock, 1903, *Psalmopoeus emeraldus* Pocock, 1903, *Psalmopoeus intermedius* Chamberlin, 1940, *Psalmopoeus irminia* Saager, 1994, *Psalmopoeus langenbucheri* Schmidt, Bullmer & Thierer-Lutz, 2006, *Psalmopoeus plantaris* Pocock, 1903, *Psalmopoeus pulcher* Petrunkevitch, 1925, *Psalmopoeus reduncus* (Karsch, 1880), *Psalmopoeus victori* Mendoza, 2014, *Psalmopoeus elenae* (Schmidt, 1994) n. comb, *Psalmopoeus subcaeruleus* (Bauer & Antonelli, 1997) n. comb, e duas espécies novas: *Psalmopoeus* sp. nov 1 e *Psalmopoeus* sp. nov 2. Foi efetuada análise cladística com 45 táxons e 84 caracteres utilizando o programa TNT, com pesos iguais (L= 180, Ci 41, Ri= 67) e com pesagem implícita (K weight = 4.909, L= 184, Ci=41, Ri= 66). As duas metodologias usadas recuperaram *Tapinauchenius* e *Psalmopoeus* como monofiléticos e grupos irmãos dentro de Aviculariinae.

Palavras chave: Tarântulas neotropicais, Psalmopoeinae, Selenocosmiinae, órgão estridulatorio, sistemática.

ABSTRACT

The arboreal tarantula genera *Psalmopoeus* Pocock, 1895 and *Tapinauchenius* Ausserer, 1871 are taxonomically reviewed, the majority of the species are redescribed, taxonomic keys are proposed for species identification and maps with distribution of the species are presented. *Tapinauchenius* has three valid species: *Tapinauchenius plumipes* (C. L. Koch, 1842), *Tapinauchenius latipes* L. Koch, 1875 and *Tapinauchenius sanctivincenti* (Walckenaer, 1837). *Tapinauchenius cupreus* Schmitt & Bauer, 1996 is synonymized with *Tapinauchenius latipes*, and *Tapinauchenius brunneus* Schmidt, 1995 and *Tapinauchenius gigas* Caporiacco, 1954 are considered junior-synonyms of *Tapinauchenius plumipes*. *Tapinauchenius concolor* (Caporiacco, 1947) is considered “nomen dubium”. *Tapinauchenius elenae* Schmidt, 1994 and *Tapinauchenius subcaeruleus* Bauer & Antonelli, 1997 are transferred to *Psalmopoeus* making the new combinations *Psalmopoeus elenae* (Schmidt, 1994) n. comb., and *Psalmopoeus subcaeruleus* (Bauer & Antonelli, 1997) n. comb., respectively. *Psalmopoeus* is composed of 14 species: *Psalmopoeus cambridgei* Pocock, 1895, *Psalmopoeus ecclesiasticus* Pocock, 1903, *Psalmopoeus emeraldus* Pocock, 1903, *Psalmopoeus intermedius* Chamberli, 1940, *Psalmopoeus irminia* Saager, 1994, *Psalmopoeus langenbucheri* Schmidt, Bullmer & Thierer-Lutz, 2006, *Psalmopoeus plantaris* Pocock, 1903, *Psalmopoeus pulcher* Petrunkevitch, 1925, *Psalmopoeus reduncus* (Karsch, 1880), *Psalmopoeus victori* Mendoza, 2014, *Psalmopoeus elenae* (Schmidt, 1994) n. comb, *Psalmopoeus subcaeruleus* (Bauer & Antonelli, 1997) n. comb, two of them newly described: *Psalmopoeus* sp. nov 1 and *Psalmopoeus* sp. nov 2. Cladistic analyses for 45 taxa and 84 characters were carried out with TNT program, with equal weights (L= 180, Ci 41, Ri= 67) and under implied weighting (K weight = 4.909, L= 184, Ci=41, Ri= 66). The two used methodologies recovered *Tapinauchenius* and *Psalmopoeus* as monophyletics and as sister groups inside Aviculariinae.

Key words: neotropical tarantulas, Psalmopoeinae, Selenocosmiinae, stridulatory organ, systematics.

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Taxonomic revision and cladistic analysis of the arboreal tarantula genera *Psalmopoeus* Pocock, 1985 and *Tapinauchenius* Ausserer, 1871 (Araneae: Theraphosidae: Aviculariinae).

(Manuscript formatted for the journal Zootaxa)

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Introduction

Theraphosidae Thorell, 1869, is the most specious mygalomorph family. To date, it is composed by 144 genera and 962 species of tarantulas (World Spider Catalog, 2018), distributed in all continents except Antarctica and well represented in tropical and subtropical regions. According to Raven (1985), it is composed by eight subfamilies: Thrigmopoeinae, Ornithoctoninae, Eumenophorinae, Harpactirinae, Selenocosmiinae, Ischnocolinae, Aviculariinae and Theraphosinae, the last three with their core distribution in the New World.

The aviculariines are mainly arboreal tarantulas that have been receiving considerable taxonomic and biological attention recently (West et al., 2008; Fukushima & Bertani, 2017; Bertani, 2012). The more recent revisions and cladistics analyses of some genera based on morphological characters had determined that the subfamily is composed by two african genera (*Heteroscodra* Pocock, 1899 and *Stromatopelma* Karsch, 1881), and ten New World genera (*Antillena* Fukushima & Bertani, 2017, *Avicularia* Lamarck, 1818, *Caribena* Fukushima & Bertani, 2017, *Ephebopus* Simon, 1892, *Iridopelma* Pocock, 1901, *Pachistopelma* Pocock, 1901, *Psalmopoeus* Pocock 1985, *Tapinauchenius* Ausserer, 1871, *Typhochlaena* C. L. Koch, 1850, *Ybirapora* Fukushima & Bertani, 2017 (Fukushima & Bertani, 2017; Bertani, 2012; West et al., 2008).

Despite all efforts in understanding the relationship among aviculariine genera, the position of *Psalmopoeus* in theraphosid subfamilies has been ambiguous (Raven, 1985; Sann & Schmidt, 2008). *Psalmopoeus* was erected in Selenocosmiidae by Pocock (1895). Posteriorly, Pocock (1901) considered that *Psalmopoeus* as well as *Epebopus*, *Pachistopelma* and *Iridopelma* should belong in the group Avicularieae of Simon (1892), which had at that moment only the genera *Tapinauchenius* and *Avicularia*. In Roewer's catalog (1942) *Psalmopoeus* and *Tapinauchenius* were retained in Aviculariinae.

Raven (1985) transferred *Psalmopoeus* from Aviculariinae to Selenocosmiinae, an Asian and Australian theraphosid subfamily, due to the presence of a maxillary lyra, and absence of urticating hairs on the opisthosoma. Sann & Schmidt (2008) proposed a new subfamily Sinurticantinae for *Psalmopoeus* and *Tapinauchenius*, based on the incongruence of some characters with Selenocosmiinae, such as the presence of tibial apophysis (which lack in adult males of Selenocosmiinae (West et al. 2012)), neotropical distribution, ecology (selenocosmiines have semi-arboreal habits whereas *Psalmopoeus* and *Tapinauchenius* live in trees and shrubs), and morphology of copulatory palpal bulb, a structure more similar to those in males of aviculariines. The proposal was, however, considered as "nomen nudum" by not complying with the zoological nomenclature rules (World Spider Catalog, 2018). Posteriorly, Schmidt (2010) modified the subfamily name to Psalmopoeinae but did not present a phylogenetic analysis to justify the new group. West et al. (2008) conducted a cladistic analysis of *Epebopus* species and included representatives of seven of the eight Theraphosidae subfamilies recognized by Raven (1985) as outgroups. They concluded that *Psalmopoeus* and *Tapinauchenius* should be included in the Aviculariinae, and the "maxillary lyra character" was regarded as a homoplasy with the Selenocosmiinae (West et al. 2008). More recent revisions and cladistic analyses including Aviculariinae genera support this hypothesis (Fukushima & Bertani, 2017; Bertani, 2012) and consider *Psalmopoeus* as a sister group of *Tapinauchenius*, sharing the characters "presence of lateral directed hairs on legs of males", and the general morphology of copulatory structures of males (Fukushima & Bertani, 2017; West et al., 2008) as apomorphies. The species of both genera are very similar morphologically, differing mainly by the presence of a conspicuous maxillary lyra in *Psalmopoeus*. Nonetheless, some species of *Tapinauchenius* have an intermediate state of this character, hindering the establishment of boundaries of the genera, and suggesting that *Psalmopoeus* and *Tapinauchenius* can be synonymous (West et al. 2008).

A recent molecular phylogenetic hypothesis of relationship of Theraphosidae subfamilies, propose Aviculariinae as possible paraphyletic group, with a clade formed by *Avicularia*, *Ybirapora* and *Caribena* separated from *Psalmopoeus* and *Tapinauchenius* that form a sister-clade with Schismatothelinae (Lüddecke *et al.* 2017). This supports Samm & Schmidt (2008) proposal of a new subfamily Psalmopoeinae; nonetheless, the hypothesis requires additional evaluation (Lüddecke *et al.* 2017). This study also suggests that the african aviculariines *Heteroscodra* and *Stromatopelma* forms a strongly supported clade named Stromatopelminae, which is the sister group of the african Harpactirinae (Lüddecke *et al.* 2017).

Historic of the genera *Tapinauchenius* and *Psalmopoeus*.

Genus *Tapinauchenius* Ausserer, 1871.

Ausserer (1871) erected his new genus *Tapinauchenius* Ausserer, 1871 based on *Mygale plumipes* C. L. Koch, 1842 from Suriname, a male described in general terms as a very hairy limbs specimen with male genitalia having long, slender and mildly curved embolus (C.L. Koch, 1842). C. L. Koch (1850) described the genus *Eurypelma* C. L. Koch, 1850 and transferred to it several species formerly described in *Mygale* Latreille, 1802, including *M. plumipes*. Ausserer (1871) described *Tapinauchenius* genus as having dense and entire scopulae in tarsi and metatarsi, eyes of the first row larger than those of the second row, and anterior median eyes at least two times lateral anterior eyes.

Becker (1879) described *Avicularia deborri* Becker, 1879 with male and female from Paramaribo, Surinam. The species was diagnosed by the well-developed scopulae, anterior row of eyes almost in a line and the anterior median eyes larger than the others.

A few years after (Ausserer 1875), a new species, *T. latipes* L. Koch, 1875, was described from Puerto Cabello, Venezuela with a male specimen.

Simon (1886) revised *A. deborri* and synonymized it with *T. plumipes*.

Some years after, Simon (1891) described two species from United States, *Tapinauchenius caerulescens* Simon, 1891 and *Tapinauchenius texensis* Simon, 1891; and, one year after (Simon, 1892), transferred *Mygale sancti-vincentii* (Walckenaer, 1837) described with a female from “Nouveau-Monde”, Saint Vincent Island, to *Tapinauchenius*.

Schiapelli and Gerschman (1945) described the female of *T. latipes*, from Chacaito, Caracas, Venezuela.

More than fifty years after, Caporiacco (1954) described *T. gigas* Caporiacco, 1954 with females from French Guiana.

More recently, three *Tapinauchenius* species were described by Schmidt (1994c, 1995), *Tapinauchenius eleneae* Schmidt, 1994 with a female specimen from Ecuador (and posteriorly in the same year described the male (Schmidt 1994c)); *Tapinauchenius brunneus* Schmidt, 1995 with a male from Mato Grosso, Brazil; and *Tapinauchenius purpureus* Schmidt (1995) with male and female specimens from French Guiana. Schmidt described also the male of *Tapinauchenius gigas* (Schmidt 1994a).

Smith (1995) considered *T. caerulescens* and *T. texensis* nomina dubia, due to the descriptions based on immature specimens with dubious localities. Furthermore, the holotypes are lost (Smith 1995). Schmidt and Bauer (1996) described *T. cupreus* Schmidt & Bauer, 1996 with female and male specimens from Ecuador; and Bauer and Antonelli (1997) described *T. subcaeruleus* Bauer & Antonelli, 1996 with a female from the same country.

West *et al.* (2008) reviewed *Epebopus* Simon, 1892, transferred *Epebopus violaceus* Mello-Leitão (1930) to *Tapinauchenius* and considered it senior-synonym of *T. purpureus*.

Bertani (2012) transferred *Pachystopelma concolor* Caporiacco (1947), described with an immature specimen, to *Tapinauchenius*.

Currently, *Tapinauchenius* is composed by 10 species, distributed in Brazil, Guyana, Ecuador, French Guiana, Saint Vincent, Suriname, and Venezuela (World Spider Catalog, 2018).

Genus *Psalmopoeus* Pocock, 1895.

Psalmopoeus was described with *Psalmopoeus cambridgei* Pocock, 1895 as type species, based on a female specimen from "The East Indies" (Pocock, 1895). The main features of the genus were the scopulae and hairs of the legs well developed, metatarsus of leg III scopulate to the base, complete scopulae in tarsus IV, chelicera with external scopulae having few spiniform setae, and stridulatory organ described as a single serie of rods (Pocock, 1895). It was included in the new family Selenocosmiidae of Pocock, 1895 (Selenocosmiiae tribe in Avicularinae, Simon 1889) with other eight genera from the Old World. The main diagnostic characteristic of the new family was the possession of a stridulating organ formed by thick setae

on inner side of maxillae and spiniform series of hairs or spicules in lower half of ventral side of chelicera (Pocock 1895).

In the following year, F. O. Pickard-Cambridge (1896) described *Santaremia longipes* F. O. Pickard-Cambridge, 1896 with a female. Posteriorly (F. O. Pickard-Cambridge 1899), he noticed that this species has a stridulatory organ as some specimens from Trinidad determined by him as *P. cambridgei*. He also perceived and suggested that the origin of the female of *P. cambridgei* described by Pocock (1895) probably was mistaken and the real provenance of this species was "The West Indies" as the material of Trinidad that he reviewed. He also described the male of the species.

Simon (1903) transferred *Tapinauchenius reduncus* Karsch, 1880, described with male and female from Costa Rica, to *Psalmopoeus*, due to the presence of a stridulatory organ. In the same year Pocock (1903) described *Psalmopoeus emeraldus* Pocock, 1903 and *P. plantaris* Pocock, 1903 from Colombia, with females; and *Psalmopoeus ecclesiasticus* Pocock, 1903 from Ecuador, with male and female.

Strand (1907) described *Psalmopoeus affinis* Strand, 1907 from "The West Indies" with two females.

Petrunkevitch (1925) described two more species, *Psalmopoeus rufus* Petrunkevitch, 1925 and *Psalmopoeus pulcher* Petrunkevitch, 1925, both from Panamá, with a female and a male, respectively.

Another panamenian species was described by Chamberlin (1940), *Psalmopoeus intermedius* Chamberlin, 1940, based on a female specimen.

Saager (1994) described *Psalmopoeus irminia* Saager, 1994 with male and female from the Guyana State in Venezuela, and Schmidt, Bullmer, & Thierer-Lutz (2006) described *Psalmopoeus langensbucheri* Schmidt, Bullmer, & Thierer-Lutz, 2006 with male and female from north of Venezuela.

Witt (1996) described *Psalmopoeus maya* Witt, 1996, with male and female from Belize. However, the species was synonymized with *P. reduncus* by Gabriel (2008) as the description was based in color features and the holotype was unavailable for study.

Mendoza (2014) described the first species of arboreal mexican Theraphosidae, *Psalmopoeus victori* Mendoza, 2014 corresponding to the higher latitude record for

Psalmopoeus genus (Mendoza 2014). This species is very similar to *P. reduncus*, differing slightly in the stridulatory organ structure, copulatory palp bulb shape and sclerotization of spermathecae (Mendoza 2014).

Gabriel (2014) considered *P. affinis* Strand, 1907 a “nomen dubium” due to poor clarity of identity of the species and doubtful collecting location. In the same paper (Gabriel 2014) he considered *P. rufus* as junior-synonym of *P. pulcher* as the holotype of *P. rufus* corresponds to an immature specimen with same pattern of stridulatory organ as in *P. pulcher*.

To date, *Psalmopoeus* genus contains 14 species, distributed in the Caribbean (Trinidad), Central America (Costa Rica, Panama), North and South America (Mexico, Brazil, Colombia, Ecuador and Venezuela) (World Spider Catalog, 2018).

Considering the taxonomic problematic of *Psalmopoeus* and *Tapinauchenius*, the aim of this work is to review taxonomically the species of the two genera and to propose a phylogenetic hypothesis for their species.

Materials and Methods

All measurements are in millimeters and were obtained with a Mitutoyo digital caliper with an error of 0.005 mm, rounded up to two significant decimals, for large measurements. A Leica LAS Montage and LAS 3D module mounted on a Leica M205C dissecting microscope were used for image capture and measurements of other small structures. Legs and palp measurements were taken from dorsal view of the left side and leg spines description and cuspules were also taken from the left limbs. Photomicrographs were obtained with a Scanning Electron Microscope SEM FEI Quanta 250. Abbreviations: (ALE) anterior lateral eyes, (AME) anterior median eyes, (PLE) posterior lateral eyes, (PLS) posterior lateral spinnerets, (PME) posterior median eyes, (PMS) posterior median spinnerets, (ITC) Inferior tarsal claw, (STC) superior tarsal claws.

Specimens from the following institutions were examined:

AMNH= American Museum of Natural history, New York; BMNH= The Natural History Museum, London; CASENT= California Academy of Science Museum of Entomology, San Francisco; ICN-UNAL= Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá; INPA= Instituto Nacional de Pesquisas da Amazônia, Manaus; LEEV= Laboratório de Ecologia e Evolução, Instituto Butantan, São Paulo; MCP-PUCRS= Museu de Ciências da

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