# Chapter 4
# Arboreal Tarantulas and Their Allies: Aviculariinae and Psalmopoeinae

**Yeimy Cifuentes and Carlos Perafán**

**Abstract** The Aviculariinae spiders *sensu lato* are known as the American arboreal tarantulas. They are characterized mainly by having legs with few or no spines, laterally extended tarsal and metatarsal scopulae, resulting in a spatulate appearance of the appendices, absence of spiniform setae on the prolateral maxillae, females with completely separated spermathecae, males with palpal bulb with subtegulum not extended, and long and thin embolus without keels (except *Antillena*). Some Aviculariinae, together with all Theraphosinae, are the only spiders that evolutionarily acquired urticating setae as a defense mechanism. The primary mechanism for releasing the urticating setae in Theraphosinae is by the friction of the legs with the abdomen, which throws the urticating setae into the air, in contrast, in most Aviculariinae the releasing mechanism occurs by direct contact. The Aviculariinae tarantulas have received considerable taxonomic and biological attention and the validity as a monophyletic group has been discussed extensively. Some phylogenetic studies suggest at least two subfamilies for the American arboreal tarantulas and their kin: Aviculariinae and Psalmopoeinae. Likewise, the phylogenetic relationships of these groups have been questioned, linking these tarantulas more closely with African or American taxa. Taxonomy, systematics and some aspects of its natural history, behavioral and distribution are addressed in this chapter.

---

Y. Cifuentes (✉)
Instituto de Biociências, Letras e Ciências Exatas, Universidade Estadual Paulista "Júlio de Mesquita Filho" (IBILCE-UNESP), São José do Rio Preto, São Paulo, Brazil

Laboratório de Ecologia e Evolução (LEEV), Instituto Butantan, São Paulo, Brazil

C. Perafán
Departamento de Ecología y Biología Evolutiva, Instituto de Investigaciones Biológicas Clemente Estable (IIBCE), Montevideo, Uruguay

Entomología, Facultad de Ciencias, UDELAR, Montevideo, Uruguay

F. Pérez-Miles (ed.), *New World Tarantulas*, Zoological Monographs 6,
https://doi.org/10.1007/978-3-030-48644-0_4

## 4.1 Introduction

In a broad sense, the Aviculariinae spiders are considered as the group of arboreal theraphosids of the Neotropics (Fig. 4.1), represented by species of a variety of sizes and colors; some even have metallic-color patterns. The group is traditionally known as the bird-eating spiders. These curious habits have been documented for centuries. The first documented observation of an aviculariine eating a bird is attributed to the naturalist and scientific illustrator Maria Sibylla Merian (1705), who published in

**Fig. 4.1** Aviculariinae arboreal spider *habitus*. (**a**, **b**) *Antillena rickwesti*, (**a**) male, (**b**) female. (**c**, **d**) *Caribena versicolor*, (**c**) juvenile, (**d**) female. (**e**) *Avicularia avicularia*, female. (**f**) *Avicularia minatrix,* female. (Photos: courtesy of Rick West)

*Metamorphosis Insectorium Surinamensis* the representation of an arboreal tarantula feeding on a hummingbird (Fukushima and Bertani 2017). According to Madame Merian, these spiders surprise small birds that are in their nests, and suck their blood with avidity. The illustration and description initially was controversial and considered as a senseless idea, but it was probably the story that Lamarck (1818) took into account for naming these spiders as *Avicularia*, referring to the fact that these tarantulas prey on birds ("*avis*" in Latin) (Fukushima and Bertani 2017).

Aviculariinae *sensu lato* can be distinguished morphologically from the other theraphosids primarily by having legs with few or no spines, and laterally extended tarsal and metatarsal scopulae, resulting in a spatulate appearance of the appendices (Fig. 4.2). Other additional features presented are: the absence of spiniform setae on the prolateral maxillae, females with completely separated spermathecae, males with palpal bulb with subtegulum not extended, and long and thin embolus without keels (except *Antillena* Bertani, Huff and Fukushima 2017) (Raven 1985; Fukushima and Bertani 2017).

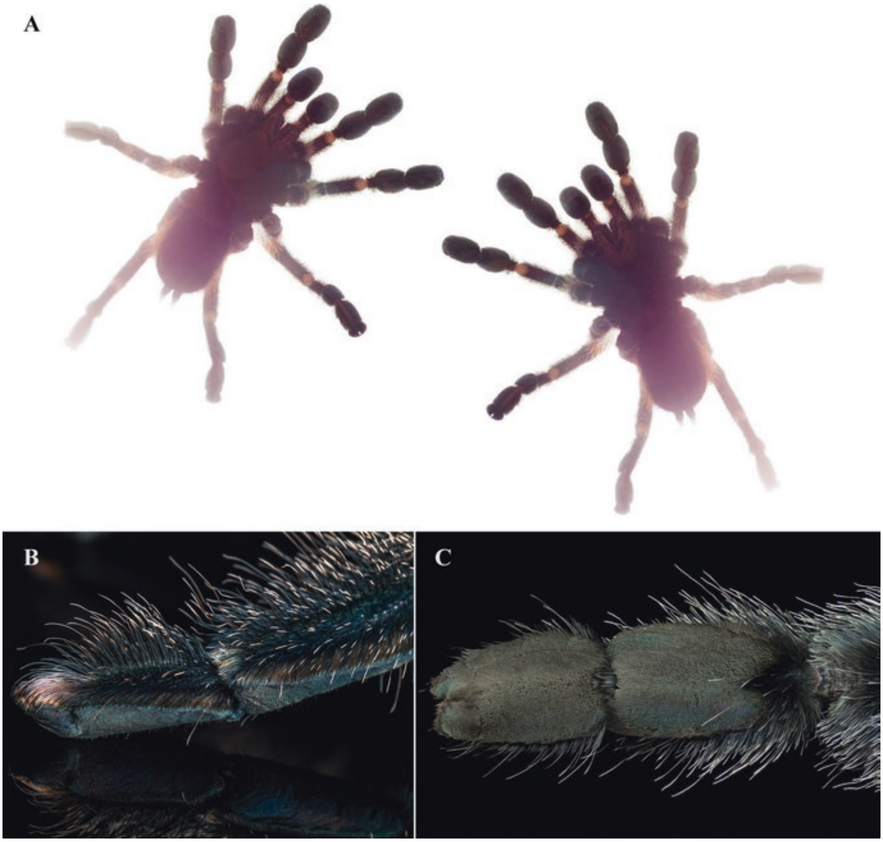


**Fig. 4.2** Tarsal and metatarsal scopulae, and claw tufts in Neotropical arboreal tarantulas. (**a**) *Caribena versicolor*, ventral view. (**b**, **c**) Detail of the adhesive pads in *Avicularia* sp., (**b**) Lateral view, (**c**) Ventral view. (Photos: courtesy of Julian Kamzol)

### 4.1.1 *Aviculariinae*

The taxonomic history of the aviculariines goes back to the first arachnological studies, beginning with the first system of spider classification proposed by the Baron Walckenaer (1802), who used the term "*Mygale*" (a nonscientific name) to distinguish the "*mineuses*" and "*aviculaires*" spiders (where it included species with two pairs of book lungs and paraxial chelicerae) from the other spiders. The name *Mygale* was subsequently used by Latreille (1802) to designate a spider genus, where he described the most mygalomorph spiders known until then. Later, Olivier (1811) following Walckenaer's system adopted the genus *Mygale* separated from *Aranea*, but he restricted *Mygale* to "*les Araignées mineuses*," excluding all the other *Mygale* species or "*les Araignées aviculaires*," which he referred to *Aranea* (Thorell 1870). Then, Lamarck (1818) followed the Olivier proposal, but for "*les Araignées aviculaires*" proposed a separated genus, *Avicularia* Lamarck, 1818; at this time *Avicularia* included three species, *A. canceridea* (Latreille 1806), *A. blondii* (Latreille 1804), and *A. fasciata* (Latreille 1804) (Fukushima and Bertani 2017). Several years later, Latreille (1802) named *Ctenize* to "*les Araignées mineuses*," and in opposition to Olivier (1811) and Lamarck (1818) gave to "*les Araignées aviculaires*" the name *Mygale*, which was unavailable later (Thorell 1870), because it is a junior homonym of a mammal genus described by Cuvier (1800).

Simon (1892) in his famous work "Histoire naturelle des Araignées" established a classification for the order Araneae where he proposed two suborders "Araneae theraphosae" and "Araneae verae." The first was composed of the Mesothelae and mygalomorph spiders, and divided into Liphistiidae, Aviculariidae, and Atypidae. At the same time, he configured some subfamilies, one of them the Aviculariinae subfamily (which corresponds currently to the family Theraphosidae Thorell, 1869) divided into 10 groups. One of these groups was named Avicularieae, which was composed by two genera, *Avicularia* and *Tapinauchenius* Ausserer, 1871. Additionally, Simon (1892) synonymized *Typhochlaena* C.L. Koch, 1850 with *Avicularia*. Afterwards, Pocock (1901) included *Ephebopus* Simon, 1892, *Psalmopoeus* Pocock, 1895, *Pachistopelma* Pocock, 1901, and *Iridopelma* Pocock, 1901 into Avicularieae, and also suggested the inclusion of the African genera *Scodra* Becker, 1879 (currently *Stromatopelma* Karsch, 1881) and *Heteroscodra* Pocock, 1899 (Pocock 1901). Soon after, Simon (1903) following Pocock (1901) included the African genera mentioned, transferred *Ephebopus* to Phoneyuseae (currently part of Eumenophorinae), and synonymized *Iridopelma* with *Avicularia*. Sometime later, Mello-Leitao (1923) considered only American genera as valid taxa within the "Avicularias" group, added *Ancylochiros* Mello-Leitao, 1920, revalidated *Typhochlaena,* and synonymized *Iridopelma* with this genus. Finally, Roewer (1942) used for his catalog the taxonomic category of subfamily for spiders Avicularieae, additionally transferred *Heteroscodra* and *Scodra* back to this group, included the genera *Avicuscodra* Strand, 1908 (currently *Avicularia*), synonymized *Typhochlaena* with *Avicularia* again, transferred *Ancylochiros* to Ischnocolinae subfamily and *Ephebopus* to Eumenophoriinae subfamily.

It is well known that in 1985 Raven performed the first taxonomic revision and phylogenetic analysis of the infraorder Mygalomorphae based on morphological characters and without cladistics software. Within his results, Raven (1985) established *Avicularia*, *Iridopelma*, *Pachistopelma*, and *Tapinauchenius* genera as the Aviculariinae subfamily. Likewise, he transferred *Ephebopus* to Theraphosinae; *Stramatopelma* and *Heteroscodra* to Eumenophorinae; and *Psalmopoeus* to Selenocosmiinae. Raven (1985) considered the following characteristics as diagnostic of the Aviculariinae subfamily: presence of a spinose process between the lobes of the male palpal tarsus (except *Tapinauchenius*), tarsi broad as or broader than the metatarsi, and legs with few spines or absent. Lucas et al. (1991) described the male of *E. murinus* and, based on the possession of a sinuous embolus without keels, together with the characters used by Raven (1985), transferred *Ephebopus* to Aviculariinae. Additionally, they noted that males of both *Ephebopus* and *Tapinauchenius* lacked the spinose process on the palpal tarsi, but considered the wide tarsal pads, elongated embolus, and absence of spines on the legs as synapomorphies of Aviculariinae, allowing as a consequence the inclusion of these genera within the subfamily (West et al. 2008).

The first approximation to the study of the phylogenetic relationships into the Aviculariinae subfamily was carried out by West et al. (2008), with the taxonomic review and cladistic analysis of *Ephebopus*. Aviculariinae was considered as a monophyletic group which includes various lineages, supported by the presence of a “well-developed scopulae” that extends laterally on tarsi and metatarsi, mainly those of legs I and II (with parallelism in *Poecilotheria*: Selenocosmiinae subfamily). According to West et al. (2008), Aviculariinae includes two West African genera, *Stromatopelma* and *Heteroscodra*, and the New World genera *Avicularia*, *Ephebopus*, *Iridopelma*, *Pachistopelma*, *Psalmopoeus*, and *Tapinauchenius*. This composition is in complete harmony with Pocock’s (1901) previous proposal. However, according to their cladogram obtained, the conformation of two subfamilies could be inferred: one of them composed by *Avicularia*, *Heteroscodra*, *Iridopelma*, *Pachistopelma*, and *Stromatopelma*, and the other by *Ephebopus*, *Psalmopoeus*, and *Tapinauchenius* (Fig. 4.3a; West et al. 2008: Fig. 9).

Bertani (2012) performed the taxonomic review of the genera *Iridopelma*, *Pachistopelma*, and *Typhochlaena,* revalidating again this last problematic genus. His results recovered Aviculariinae as a paraphyletic group in the majority of obtained trees, with a clade (*Ephebopus* (*Psalmopoeus* + *Tapinauchenius*)) as sister group of *Pelinobius* (Eumenophorinae) + *Phlogiellus* (Selenocosmiinae); and another clade composed by *Avicularia*, *Heteroscodra*, *Iridopelma*, *Typhochlaena*, *Pachistopelma*, and *Stromatopelma*, as sister group of *Encyocratella* (Stromatopelminae), *Haplopelma* (Ornithoctoninae), and *Poecilotheria* (Selenocosmiinae) (Fig. 4.3b; Bertani 2012: Figs. 177, 178). The author mentioned the possibility of changes in the Aviculariinae composition, which could be supported with the revision of other genera such as *Avicularia* and *Psalmopoeus* and additional information of the outgroups (Bertani 2012).

The genus *Avicularia* was recently revised by Fukushima and Bertani (2017), who also described three new genera in Aviculariinae: *Antillena*, *Caribena,* and

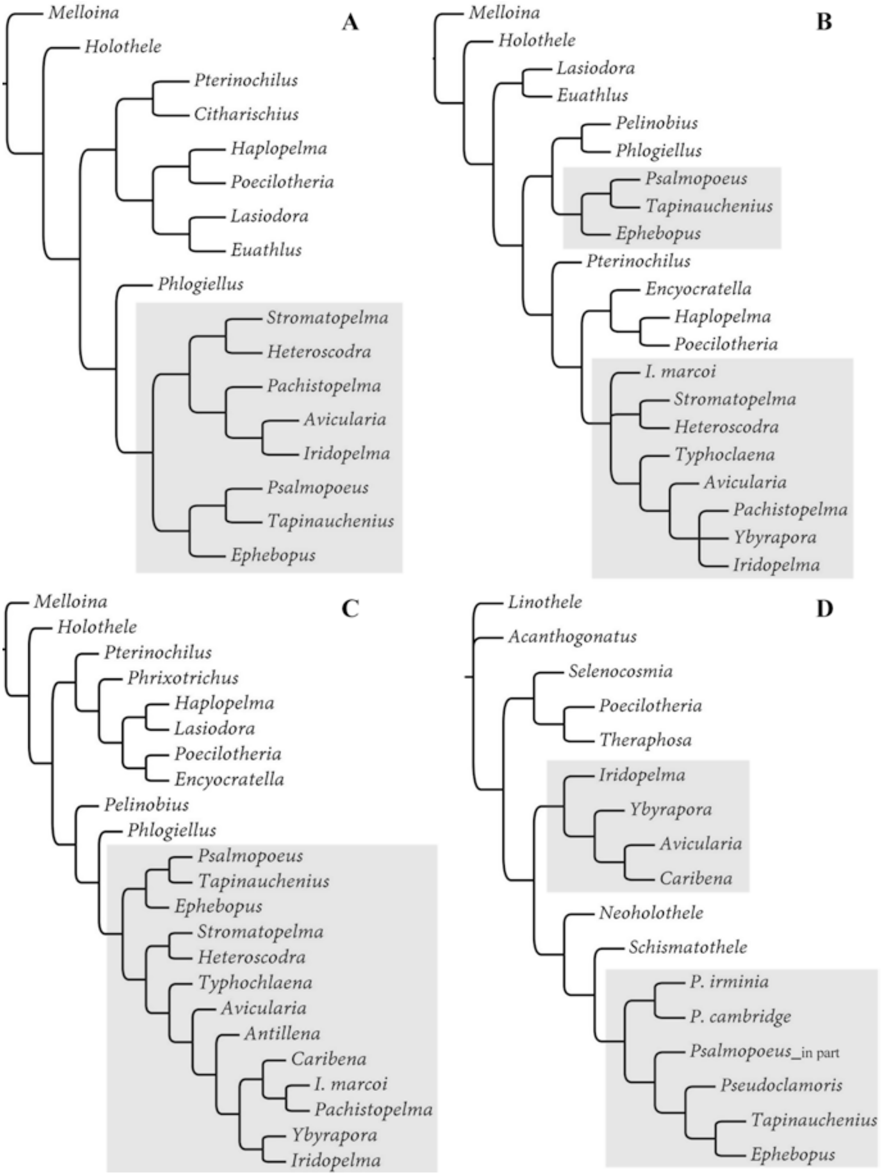


**Fig. 4.3** Preferred phylogenetic hypothesis of the arboreal tarantulas and their allies. (**a**) West et al. (2008). (**b**) Bertani (2012). (**c**) Fukushima and Bertani (2017). (**d**) Hüsser (2018)

*Ybyrapora*. They stated the monophyly of the subfamily, agreeing with West et al. (2008) and based on the following homoplastic characters: presence of well-developed scopulae on tarsi, and metatarsi very extended laterally. According to Fukushima and Bertani (2017), Aviculariinae is composed of: *Antillena, Avicularia*, *Caribena*, *Ephebopus*, *Heteroscodra*, *Iridopelma*, *Pachistopelma*, *Psalmopoeus*, *Stromatopelma*, *Tapinauchenius*, *Typhochlaena*, and *Ybyrapora*. The clade (*Ephebopus* (*Psalmopoeus* + *Tapinauchenius*)) was retrieved as sister group to all the remaining Aviculariinae (Fig. 4.3c; Fukushima and Bertani 2017: Fig. 325).

The monophyly and the relationships within Aviculariinae have been extensively debated in the last decade, and the classification of the node (*Ephebopus* (*Psalmopoeus* + *Tapinauchenius*)) has been controversial (West et al. 2008; Bertani 2012, Fukushima and Bertani 2017; Foley et al. 2019). Recent phylogenetic analyses with molecular data consider this clade out of Aviculariinae, as another subfamily Psalmopoeinae (Foley et al. 2019; Hüsser 2018; Lüddecke et al. 2018; Turner et al. 2018). The cladograms obtained by Hüsser (2018), Lüddecke et al. (2018), and Turner et al. (2018) recover the clade composed by Aviculariinae taxa as the sister group of a clade composed by Schismatothelinae + Psalmopoeinae (Fig. 4.3d). Additionally, Foley et al. (2019) recover the same evidence from transcriptome data: Aviculariinae as sister group of Schismatothelinae + Psalmopoeinae.

### *4.1.2 Psalmopoeinae*

The genus *Psalmopoeus* Pocock, 1895 has had a controversial history of changes between Theraphosidae subfamilies. Initially, Pocock (1901), followed by other authors, allocated *Psalmopoeus* in Aviculariinae, but later Raven (1985) transferred it to Selenocosmiinae, based on the presence of numerous bacilliform setae in the prolateral surface of the maxillae (lyriform organ) (Fig. 4.4a). Samm and Schmidt (2008) proposed the Sinurticantinae subfamily, composed by *Psalmopoeus* and *Tapinauchenius*, based on the absence of urticating setae, presence of male tibial apophysis bipartite, and differences on the copulatory palpal bulbs regarding Selenocosmiinae males. However, Sinurticantinae was considered an invalid nomenclatural proposal because no type genus was specified and none corresponded with the "subfamily" name. Then, Schmidt (2010) modified the subfamily name to Psalmopoeinae, but did not present a phylogenetic analysis to justify the new group, although he endorsed the nature of the group by the lacking abdominal urticating setae, morphology of the tibial apophysis and palpal bulb, as well as other aspects such the Neotropical distribution. Additionally, Schmidt (2010) proposed that *Psalmopoeus* and *Tapinauchenius* are more closely related phylogenetically with Aviculariinae. This last proposal did not have a place in the academic community, perhaps due to the lack of a robust phylogenetic analysis, the fact that the absence of urticating setae would not be enough to create a subfamily, and in some sense this would be far from solving the group's taxonomic problems.

On the other hand, *Ephebopus* also has been a theraphosid genus that has had a very uncertain taxonomic position over the decades. Summarized, first, *Ephebopus* was included in the Selenocosmieae by Simon (1892), and then it was transferred variously to the Avicularieae (Pocock 1901), Phoneyuseae (Simon 1903), back to Aviculariinae (Mello-Leitão 1923), Eumenophorinae (Roewer 1942), Theraphosinae

**Fig. 4.4** Stridulatory organ in Psalmopoeinae. (**a**, **b**) *Psalmopoeus cambridgei*, (**a**) Maxillary lyra, composed by one row of thick bristles, (**b**) Base of chelicerae, ventral view. (**c**, **d**) *Pseudoclamoris gigas*, (**c**) Maxillary lyra, composed by a group of slender bristles, (**d**) Base of chelicerae, ventral view. White arrows point to the rows of filiform setae strikers

(Raven 1985), again to Aviculariinae (Lucas et al. 1991; West et al. 2008; Fukushima and Bertani 2017), and recently in Psalmopoeinae (Hüsser 2018).

Cladistic analyses carried out by West et al. (2008), Bertani (2012), and Fukushima and Bertani (2017) considered *Ephebopus*, *Tapinauchenius*, and *Psalmopoeus* as Aviculariinae genera. However, other studies validate the inclusion of *Psalmopoeus* and *Tapinauchenius*, and recently *Ephebopus*, into Psalmopoeinae subfamily (Lüddecke et al. 2018; Turner et al. 2018; Hüsser 2018). Recently molecular analyses of Theraphosidae have supported the hypothesis that Psalmopoeinae is closely related to Schismatothelinae, forming the clade sister of Aviculariinae. Lüddecke et al. (2018) and Turner et al. (2018) suggest (*Psalmopoeus* + *Tapinauchenius*) as the sister group of Schismatothelinae, and paraphyletic with respect to Aviculariinae. Lüddecke et al. (2018) also discussed the position of the two African genera *Stromatopelma* and *Heteroscodra*, transferred out of Aviculariinae, and proposed Stromatopelmatinae as the sister group of Harpactirinae, with a phylogenetic analysis strongly supported.

A phylogenetic study focused on *Tapinauchenius* and *Psalmopoeus* based on morphological and molecular data, conducted by Hüsser (2018), suggests Psalmopoeinae as a paraphyletic group (=morphological data) or monophyletic group (=molecular data), including *Ephebopus*, *Tapinauchenius*, *Psalmopoeus*, and a new genus described *Pseudoclamoris* (Fig. 4.3d; Hüsser 2018: Figs. 16–17). The obtained tree with morphological data recovered *Psalmopoeus* as the sister group of (*Tapinauchenius* (*Ephebopus* (*Pseudoclamoris* + Aviculariinae))), while with molecular data recovered the clade (Psalmopoeinae + Schismatothelinae) as sister group of Aviculariinae, as follow (Aviculariinae (Schismatothelinae (*Psalmopoeus* (*Pseudoclamoris* (*Ephebopus* + *Tapinauchenius*))))) (Hüsser 2018). The last tree recovered *Psalmopoeus* as paraphyletic group. Cifuentes (2018) in a taxonomic revision and cladistic analysis of *Psalmopoeus* and *Tapinauchenius,* based on morphological characters, recovered the clade (*Ephebopus* (*Tapinauchenius* + *Psalmopoeus*)) as monophyletic, related as the sister group of the Aviculariinae. Both genera *Tapinauchenius* and *Psalmopoeus* were recovered as monophyletic; nevertheless, no Schismatothelinae taxa were included in the analysis (Cifuentes 2018).

Traditionally, several authors have highlighted the taxonomic difficulties of Theraphosidae and the problems to delimit species, because of its great morphological homogeneity (Raven 1990, Bertani 2000; Perafán and Pérez-Miles 2014); Aviculariinae is no exception. Therefore, deep taxonomic studies and additional molecular analyses are necessary in order to know the identity of the species and attain better resolution of the relationships inside this group. *Tapinauchenius* and *Psalmopoeus* have variety and stability in some characters (sexual characters, setae of the legs, morphology of the maxillae lyra, and strikers) that permit the identification of groups and species. The addition of those characters in cladistic analyses will therefore attempt to better resolve the trees and improve the comparison with earlier hypotheses (Cifuentes 2018).

The validity of Psalmopoeinae as a monophyletic subfamily, as well as the phylogenetic relationships within the group are still questionable. However, we have preferred to maintain the two proposed subfamilies within the group of Neotropical arboreal tarantulas and their kin, according to the recent molecular evidence, for taxonomic treatment within this chapter: Aviculariinae and Psalmopoeinae.

## 4.2 Taxonomy

### *4.2.1* Aviculariinae Simon, 1892

**Type species:** *Avicularia avicularia* (Linnaeus, 1758).

**Genera included:** *Antillena* Bertani, Huff and Fukushima, 2017, *Avicularia* Lamarck, 1818, *Caribena* Fukushima and Bertani, 2017, *Iridopelma* Pocock, 1901, *Pachistopelma* Pocock, 1901, *Typhochlaena* C.L. Koch, 1850 and *Ybyrapora* Fukushima and Bertani, 2017.

*Note:* recent molecular study carried out by Lüddecke et al. (2018) considered *Stromatopelma* and *Heteroscodra,* distributed in West and Central Africa, out of Aviculariinae, composing the family Stromatopelminae together with *Encyocratella*. Foley et al. (2019), Hüsser (2018), and Lüddecke et al. (2018) recovered *Ephebopus*,

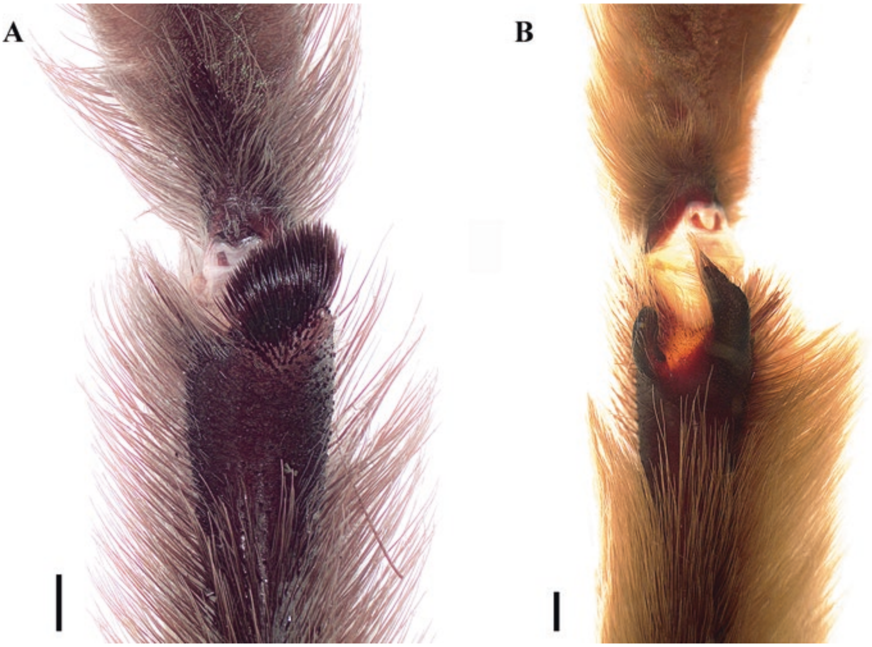


**Fig. 4.5** Male tibial apophysis in Aviculariinae and Psalmopoeinae, ventral view. (**a**) *Avicularia* sp. (**b**) *Psalmopoeus* sp.

*Psalmopoeus* and *Tapinauchenius* in a clade closely related to Schismatothelinae before with the rest of the Aviculariinae taxa.

**Diagnosis:** Aviculariinae subfamily can be recognized by the conjunction of the following characters: legs without spines; scopulae in tarsus and metatarsus laterally extended, mainly on anterior legs, giving a spatulate appearance (Fig. 4.2); absence of spiniform setae on prolateral maxillae and presence of abdominal urticating setae type II (most species, absent in adult females of both *I. marcoi* Bertani, 2012 and *Pachistopelma*). Females with spermathecae long and completely separated. Males with tibia I with a spinose spur (Fig. 4.5a) (except *Typhochlaena, Ybyrapora* and some *Avicularia,* in which it's lacking), and palpal bulb with subtegulum not extended, and embolus long and thin without keels (except *Antillena*) (Bertani 2012; Fukushima and Bertani 2017).

**Distribution:** Southern Mexico, Central America, some Caribbean islands, and northern and central South America.

### Taxonomic Key for the New World Aviculariinae

(Based on Bertani 2012; Fukushima and Bertani 2017)

1. Adults with sternum as long as wide, truncated behind; posterior lateral spinnerets with domed, short distal article. Males without both tibial spur and spiniform process on the cymbium (Bertani 2012: Figs. 1–28) .......................*Typhochlaena*

– Sternum longer than wide; posterior lateral spinnerets with digitiform distal article. Males with tibial spur and spiniform process on the cymbium ............................................................................................................2

2. Anterior row of eyes straight or slightly procurved. Females with abdomen dorso-ventrally flattened and without urticating setae (Bertani 2012: Figs. 29–80) ..........................................................................................*Pachistopelma*

– Anterior row of eyes strongly procurved. Females with abdomen not flattened and with urticating setae type II (Fukushima and Bertani 2017: Figs. 13, 15–17) ........................................................................................................3

3. Spermathecae very short and broad, with distal half strongly sclerotized (Fukushima and Bertani 2017: Fig. 284). Male palpal bulb with very flattened embolus and well-developed keels (Fukushima and Bertani 2017: Figs. 285–288) ...................................................................................................... *Antillena*

– Spermathecae long, not strongly sclerotized. Male palpal bulb lacking keels ...........................................................................................................4

4. Urticating setae type II very slender on a conspicuous patch on abdomen dorsum (Fukushima and Bertani 2017: Figs. 18, 254) ........................................*Caribena*

– Urticating setae type II stout spread over most abdominal area (Fukushima and Bertani 2017: Figs. 15–17, 302–304.) ...................................................5

5. Spermathecae lacking an accentuated outwards curvature medially, with distal portion far from the base (Fukushima and Bertani 2017: Fig. 14). Male withtibial spur on legs I and II (Bertani 2012: Figs. 85, 86) ..............................*Iridopelma*

– Spermathecae with an accentuated outwards curvature medially (Fukushima and Bertani 2017: Fig. 21). Males lacking tibial apophysis on leg II .............6

6. Spermathecae virtually non-sclerotized (Fukushima and Bertani 2017: Figs. 257–259). Male cymbium with or without a process on retrolateral lobe, tibial spur on leg I absent (Fukushima and Bertani 2017: Fig. 308) (southeastern and part of northeastern Brazil) .......................................................................*Ybyrapora*

– Spermathecae with a well-sclerotized area (Fukushima and Bertani 2017: Fig. 21). Male cymbium with or without a process on retrolateral lobe, tibial spur on leg I well-developed or tibia with a discrete elevation covered by a cluster of setae on apical portion (Fukushima and Bertani 2017: Figs. 309–311) (México, Central America and South America) ..............................*Avicularia*

### *Antillena* Bertani, Huff and Fukushima, 2017

**Type species:** *Antillena rickwesti* (Bertani and Huff, 2013)

**Species included:** *Antillena rickwesti*

**Diagnosis:** *Antillena* females can be distinguished by having two very short, broad, and apically sclerotized spermathecae (Fukushima and Bertani 2017:

Fig. 284), and by spiniform setae in prolateral and/or retrolateral side of coxae I–IV. Males differ by the copulatory palpal bulb with embolus very flattened and with keels (Fukushima and Bertani 2017: Figs. 285–288). Additionally, males are characterized by abdominal leaf pattern coloration (Fukushima and Bertani 2017: Fig. 294) (Fukushima and Bertani 2017).

**Distribution:** Dominican Republic (Bertani and Huff, 2013)

### *Avicularia* Lamarck, 1818

**Type species:** *Avicularia avicularia* (Linnaeus, 1758)

**Species included:** *Avicularia avicularia*, *Avicularia caei* Fukushima and Bertani, 2017, *Avicularia glauca* Simon, 1891, *Avicularia hirschii* Bullmer, Thierer-Lutz and Schmidt, 2006, *Avicularia juruensis* Mello-Leitão, 1923, *Avicularia lynnae* Fukushima and Bertani, 2017, *Avicularia merianae* Fukushima and Bertani, 2017, *Avicularia minatrix* Pocock, 1903, *Avicularia purpurea* Kirk, 1990, *Avicularia rufa* Schiapelli Gerschman, 1945, and *Avicularia taunayi* (Mello-Leitão, 1920), and *Avicularia variegata* F. O. Pickard-Cambridge, 1896.

**Diagnosis:** *Avicularia* can be distinguished from some Aviculariinae, except *Caribena*, *Iridopelma*, *Typhochlaena*, and *Ybyrapora*, by having the anterior row of eyes procurved (Fukushima and Bertani 2017). It can be recognized from those groups by the following: from *Caribena* by stout urticating setae on abdomen dorsum and rounded process of cymbium (Fukushima and Bertani 2017: Figs. 15–17, 307); from *Iridopelma* males by lacking tibial apophysis on tibiae II and females by spermathecae long with accentuated medial curvature directed outward (Fukushima and Bertani 2017: Fig. 21); from *Typhochlaena* by digitiform apical article in PLS (Fukushima and Bertani 2017: Fig. 10); and from *Ybyrapora* by the sclerotized spermathecae in females and the presence of developed tibial apophysis in males (Fukushima and Bertani 2017: Figs. 309–311), except *A. minatrix*, *A. lynnae*, *A. caei*, and *A hirschii*. Males of these species can be differentiated from *Y. diversipes* by the embolus less curved in frontal view (Fukushima and Bertani 2017: Fig. 30), from *Y. sooretama* and *Y. gamba* by the presence of a well-developed process on cymbium (Fukushima and Bertani 2017: Fig. 307), except *A. minatrix*; *A. minatrix* can be distinguished from the last *Ybyrapora* species mentioned by the abdomen coloration, dorsum black with orange spots on its side (Fukushima and Bertani 2017: Fig. 89).

**Distribution:** Mexico; Central America: Costa Rica, Panama; South America: Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname, Trinidad and Tobago and Venezuela. In Brazil, it occurs in the states of Roraima, Amapá, Amazonas, Pará, Maranhão, Tocantins, Acre, western Bahia, Rondônia, Mato Grosso, Goiás, Minas Gerais, São Paulo, and The Distrito Federal (Fukushima and Bertani 2017).

### *Caribena* Fukushima and Bertani, 2017

**Type species:** *Caribena laeta* (C. L. Koch, 1842)

**Species included:** *Caribena laeta*, and *Caribena versicolor* (Walckenaer, 1837).

**Diagnosis:** *Caribena* species are characterized by the presence of a conspicuous abdominal patch of type II urticating setae, setae long and slender (more than 1 mm long and less than 0.009 mm wide) (Fukushima and Bertani 2017: Figs. 18, 243, 241, 254). Additionally, males have a sharp spiniform process in the retrolateral lobe of cymbium (Fukushima and Bertani 2017: Fig. 306) (Fukushima and Bertani 2017).

**Distribution:** Puerto Rico, the U. S. Virgin Island, and Martinique (Fukushima and Bertani 2017).

### *Iridopelma* Pocock, 1901

**Type species:** *Iridopelma hirsutum* Pocock, 1901

**Species included:** *Iridopelma hirsutum*, *Iridopelma katiae* Bertani, 2012, *Iridopelma marcoi* Bertani, 2012, *Iridopelma oliverai* Bertani, 2012, *Iridopelma vanini* Bertani, 2012 and *Iridopelma zorodes* (Mello-Leitao, 1926).

**Diagnosis:** *Iridopelma* males are characterized by having tibial spurs on leg I and II (Bertani 2012: Figs. 85, 86) and females by having the anterior row of eyes strong procurved (Fukushima and Bertani 2017: Fig. 13). The last characteristic is shared with *Avicularia* and *Typhochlaena*, but it can be recognized from those genera, respectively, by having spermathecae lacking accentuated curvature (Fukushima and Bertani 2017: Fig. 14), and by the distal PLS segment digitiform (Fukushima and Bertani 2017: Fig. 10) (Bertani 2012).

**Distribution:** Northeastern Brazil, from the state of Bahia, northwards, and some records for states of Para and Tocantins (Bertani 2012).

### *Pachistopelma* Pocock, 1901

**Type species:** *Pachistopelma rufonigrum* Pocock, 1901

**Species included:** *Pachistopelma bromelicola* Bertani, 2012, and *Pachistopelma rufonigrum*.

**Diagnosis:** *Pachistopelma* differs from those of other aviculariines by having the anterior row of eyes straight or slightly procurved (Bertani 2012: Fig. 37).

*Note*: It is worth noting that the characteristic of anterior row of eyes straight or slightly procurved is shared with *Ephebopus*, *Tapinauchenius,* and *Psalmopoeus* genera (Psalmopoeinae). However, *Pachistopelma* can be recognized from those genera by having legs aspinose, abdominal urticating setae (except in mature female), males with a spinose spur on tibia I, and females with abdomen dorso-ventral flattened (Bertani 2012: Fig. 34) and paired long spermathecae with slight curvature medially, without any constriction (Bertani 2012: Figs. 58–65) (Bertani 2012). **Distribution:** Northeastern Brazil, from the state of Rio Grande do Norte to state of Bahia, mostly in the coastal region (Bertani 2012).

### *Typhochlaena* C. L. Koch, 1850

**Type species:** *Typhochalena seladonia* (C.L. Koch 1841)

**Species included:** *Typhochalena amma* Bertani, 2012, *Typhochalena costae* Bertani, 2012, *Typhochalena curumin* Bertani, 2012, *Typhochalena seladonia*, and *Typhochalena paschoali* Bertani, 2012.

**Diagnosis:** *Typhochlaena* can be differentiated from other aviculariines by the short, domed apical segment of PLS (Bertani 2012: Fig. 21), and adults with a sternum as long as wide, truncated behind (Bertani 2012: Fig. 20). They are characterized by small sizes. Additionally, males lack tibial spurs and spiniform process in the cymbium (Bertani 2012).

**Distribution:** Brazil: Northeastern, part of Central-West (Tocantins state), and part of southeastern (Espirito Santo state) (Bertani 2012).

*Ybyrapora* **Fukushima and Bertani, 2017**

**Type species:** *Ybyrapora sooretama* (Bertani and Fukushima 2009).

**Species included:** *Ybyrapora diversipes* (C.L. Koch 1842), *Ybyrapora gamba* (Bertani and Fukushima 2009), and *Ybyrapora sooretama*.

**Diagnosis:** *Ybyrapora* species can be distinguished from some aviculariine by having an anterior row of eyes procurved; a characteristic that is shared with *Avicularia*, *Caribena*, *Iridopelma*, and *Typhochlaena*. It can be distinguished from *Avicularia* by the presence of virtually non-sclerotized spermathecae in females (Fukushima and Bertani 2017: Figs. 257–259), while males differ by lacking developed tibial apophysis (Fukushima and Bertani 2017: Fig. 308), except from *A. minatrix*, *A. lynnae*, *A. caei*, and *A hirschii*. Males of *Y. diversipes* can be differentiated from those four species by the presence of a very long embolus, strongly curved in the frontal view (Fukushima and Bertani 2017: Fig. 278); *Y. sooretama* and *Y. gamba* differ from those of *A. lynnae, A. caei*, and *A. hirschii* by lack a well-developed process on cymbium (Fukushima and Bertani 2017: Fig. 305); *Ybyrapora* males can be distinguished from *A. minatrix* by the presence of a single red or dark longitudinal stripe on the abdomen dorsum (Fukushima and Bertani 2017: Fig. 297). *Ybyrapora* can be distinguished from *Caribena* by the presence of stout urticating setae on the abdomen dorsum in both males and females, and the absence of a sharp process with thin setae on the retrolateral lobe of the cymbium in males; from *Iridopelma* by males lacking a tibial apophysis on tibiae II and females by the presence of a long spermathecae medially curved and directed outwards; and from *Typhochlaena* by the presence of a digitiform apical article in PLS (Fukushima and Bertani 2017).

**Distribution:** Brazil, from Bahia to southern Rio de Janeiro (Fukushima and Bertani 2017).

### *4.2.2* Psalmopoeinae Samm and Schmidt (2008)

**Type species:** *Psalmopoeus cambridgei* Pocock, 1895

**Genera included:** *Ephebopus* Simon, 1892*, Psalmopoeus* Pocock, 1895, *Pseudoclamoris* Hüsser, 2018, and *Tapinauchenius* Ausserer, 1871 (Fig. 4.6).

**Diagnosis:** Males and females of Psalmopoeinae can be distinguished from the majority of Theraphosidae subfamilies, except Aviculariinae, by the scopulae in

**Fig. 4.6** Psalmopoeinae spiders *habitus*. (**a**) *Ephebopus murinus*, male. (**b**) *Ephepobus cyanognathus*, female. (**c**) *Pseudoclamoris gigas*, female. (**d**) *Tapinauchenius polybtes*, female. (**e**, **f**) *Psalmopoeus ecclesiasticus*, (**e**) juvenil, (**f**) female. (Photos: **a**–**d** courtesy of Rick West; **e**–**f** Carlos Perafán)

tarsus and metatarsus laterally extended, giving a spatulate appearance. They differ from most Aviculariinae species by the absence of abdominal urticating setae; urticating setae only present in palpal femur of *Ephebopus*. Also, by the anterior row of eyes straight (except from *Pachistopelma)*. Additionally, *Psalmopoeus*,

**Fig. 4.7** (**a**) *Psalmopoeus ecclesiasticus*, showing the long lateral setae in the legs. (**b**) *Psalmopoeus cambridgei*, dorsal view of palp and leg I, showing the group of smooth short setae. Arrows point to the lateral setae and the group of smooth short setae in legs

*Tapinauchenius*, and *Pseudoclamoris* males can be distinguished by the long covering setae laterally directed in their legs (Fig. 4.7a) and tibial apophysis composed by two branches (Fig. 4.5b) (Hüsser 2018).

**Distribution:** Mexico; Central America: Belize, Costa Rica and Panama, Caribbean islands: Saint Vincent Island, Saint Lucia island, Union island, The Grenadines, Trinidad and Tobago islands and South America: Brazil, Colombia, Ecuador, French Guiana, Peru, and Venezuela (World Spider Catalog 2020; West 1983).

### Taxonomic Key for Psalmopoeinae

1. Presence of a patch of urticating setae (type V) on prolateral distal palpal femora (West et al. 2008: Figs. 19–20; Fukushima and Bertani 2017: Fig. 4) ..................................................................................................*Ephebopus*
   - Absence of a patch of urticating setae on femora ..........................................2
2. Stridulatory setae forming a lyriform organ on prolateral maxillae (Fig. 4.4a, c; Fukushima and Bertani 2017: Fig. 11) ..............................................................3
   - Stridulatory setae absent on maxillae .......................................*Tapinauchenius*
3. Thick bristles on the maxillary lyra disposed in one row (Fig. 4.4a; Fukushima and Bertani 2017: Fig. 11) .............................................................*Psalmopoeus*

4. Slender bristles on the maxillary lyra arranged in an oval patch, composed by several rows of slender setae (Fig. 4.4c; Hüsser 2018: Fig. 2) ..........................................................................................*Pseudoclamoris*

*Ephebopus* **Simon, 1892**

**Type species:** *Ephebopus murinus* (Walckenaer, 1837)

**Species included:** *Ephebopus cyanognathus* West and Marshall, 2000, *Ephebopus foliatus* West, Marshall, Fukushima and Bertani, 2008, *Ephebopus murinus*, *Ephebopus rufescens* West and Marshall, 2000, and *Ephebopus uatuman* Lucas, Silva and Bertani, 1992.

**Diagnosis:** *Ephebopus* can be distinguished from all Theraphosidae genera by the presence of a patch of urticating setae (type V) on prolateral distal palpal femora (West et al. 2008: Figs. 19–20; Fukushima and Bertani 2017: Fig. 4).

**Distribution:** Northeastern and Central Brazilian Amazon, French Guiana, Southern Suriname, and Southwestern Guyana (West et al. 2008).

*Psalmopoeus* **Pocock, 1895**

**Type species:** *Psalmopoeus cambridgei* Pocock, 1895

**Species included:** *Psalmopoeus cambridgei*, *Psalmopoeus ecclesiasticus* Pocock, 1903, *Psalmopoeus emeraldus* Pocock, 1903, *Psalmopoeus intermedius* Chamberlin, 1940, *Psalmopoeus irminia* Saager, 1994, *Psalmopoeus langenbucheri* Schmidt, Bullmer and Thierer-Lutz, 2006, *Psalmopoeus plantaris* Pocock, 1903, *Psalmopoeus pulcher* Petrunkevitch, 1925, *Psalmopoeus reduncus* (Karsch, 1880), and *Psalmopoeus victori* Mendoza, 2014.

**Diagnosis:** The species of *Psalmopoeus* can be distinguished by the presence of a lyriform organ composed by one row of thick bristles on prolateral maxillae in conjunction with a row of long filiform setae strikers on the base of chelicerae (Fig. 4.4a, b). Additionally, *Psalmopoeus* have a group of short and smooth hair on the retrolateral side of the palpal trochanter and femur, and on prolateral and retrolateral sides of trochanter and femur of leg I (Fig. 4.7b) (Absent in *Tapinauchenius* and *Pseudoclamoris*) (Cifuentes 2018).

**Distribution:** Mexico; Central America: Belize to Panama; Caribbean: Trinidad and Tobago islands; South America: Colombia, Ecuador, Venezuela, Guyana, and Brazil.

*Pseudoclamoris* **Hüsser, 2018**

**Type species:** *Pseudoclamoris gigas* (Caporiacco, 1954)

**Species included:** *Pseudoclamoris elenae* (Schmidt, 1994), *Pseudoclamoris gigas*, and *Pseudoclamoris burgessi* Hüsser, 2018.

**Diagnosis:** *Pseudoclamoris* species resemble *Psalmopoeus* genus by the presence of a lyriform organ on prolateral maxillae. However, *Pseudoclamoris* can be distinguished by having an oval maxillary lyra composed by several rows of slender setae (thick bristles on *Psalmopoeus*) (Fig. 4.4c). Additionally, females have

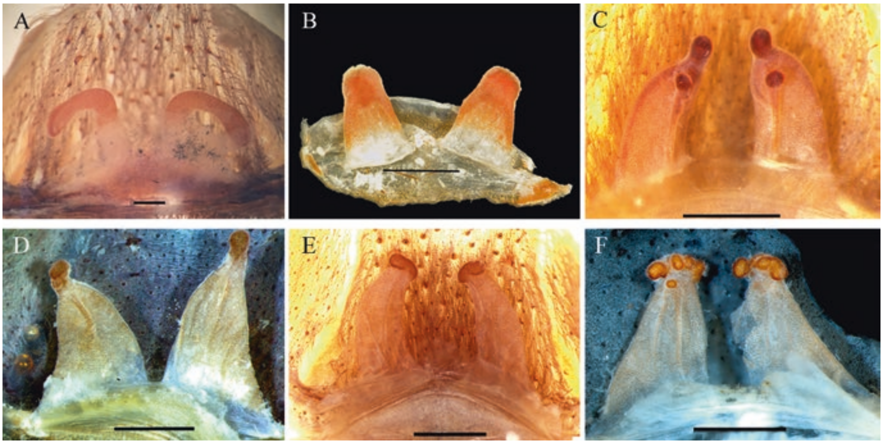


**Fig. 4.8** Morphology of the female's spermatheca in *Avicularia* and Psalmopoeinae. (**a**) *Avicularia* sp. (**b**) *Ephebopus rufescens*. (**c**) *Psalmopoeus irminia.* (**d**) *Tapinauchenius polybotes*. (**e**) *Pseudoclamoris gigas*. (**f**) *Pseudoclamoris elenae* (Photos: **a**, **c**–**f** Yeimy Cifuentes; **b** courtesy of Rick West)

spermathecae with one subsegmented apical lobule (Fig. 4.8e) or with multiple apical lobules (Fig. 4.8f).

**Distribution:** Colombia, Ecuador, Brazil, Peru, and French Guiana.

*Tapinauchenius* **Ausserer, 1871**

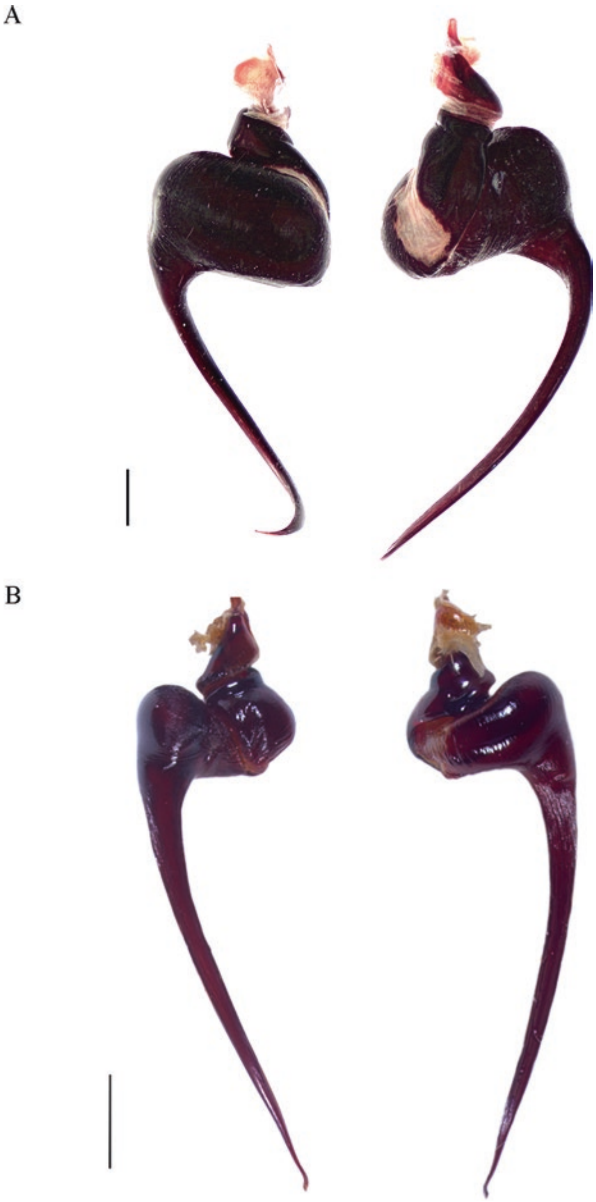
**Type species:** *Tapinauchenius plumipes* (C. L. Koch, 1842)

**Species included:** *Tapinauchenius brunneus* Schmidt, 1995, *Tapinauchenius concolor* (Caporiacco, 1947), *Tapinauchenius cupreus* Schmidt and Bauer, 1996, *Tapinauchenius latipes* L. Koch, 1875, *Tapinauchenius plumipes* (C. L. Koch, 1842), *Tapinauchenius polybotes* Hüsser, 2018, *Tapinauchenius rasti* Hüsser, 2018, *Tapinauchenius sanctivincenti* (Walckenaer, 1837), and *Tapinauchenius violaceus* (Mello-Leitão, 1930).

**Diagnosis:** *Tapinauchenius* can be distinguished from *Ephebopus* by lack urticating setae, and from *Psalmopoeus* and *Pseudoclamoris* by the absence of a maxillary lyra. Additionally, males have palpal bulb embolus with an apical constriction, small and curved ventrally tip (Fig. 4.9b) (except in *T. cupreus*), and known females have spermathecae with one apical lobule (Fig. 4.8d) (Cifuentes 2018).

**Distribution:** Caribbean: Saint Vincent island, Saint Lucia island, Union island, Trinidad and Tobago island; South America: Colombia, Ecuador, Venezuela, Guyana, Suriname, French Guiana, and Brazil.

**Fig. 4.9** Morphology of copulatory palpal bulb in Aviculariinae and Psalmopoeinae. (**a**) *Avicularia* sp. (**b**) *Tapinauchenius plumipes*



## 4.3 Distribution and Natural History

One of the most important and conspicuous characteristics in the arboreal tarantulas is the presence of very well-developed claw tufts and scopulae on the tarsi and metatarsi. These structures participate in the adhesion mechanisms, transcendental in predatory and locomotory function, which facilitate the climbing and descending ability on vertical surfaces. Likewise, claw tufts and scopulae played an important role in the arboreal spiders' evolution, maybe because it was involved in the colonization from the ground to vegetation (Pérez-Miles et al. 2015). On the other hand, most aviculariines species possess urticating setae as a defense mechanism, an evolutionary novelty that appeared only in tarantulas of the New World. A detailed analysis of function and morphology of adhesive setae and urticating setae is found in the Chapters 12 and 9, respectively.

The majority of Neotropical arboreal aviculariine species present an outstanding ontogenetic differentiation in the coloration patterns. Usually, juveniles present abdominal patterns of longitudinal and/or transverse stripes, with striking colors, while in adults these patterns tend to disappear and black, bluish, and reddish colors are predominant. There is also sexual dimorphism in the coloration of mature individuals (Figs 4.1a–d). However, contrary to most aviculariines, ontogenetic changes are not known in species of *Typhochlaena* (Bertani 2012). The ontogenetic and sexual differences in color contributed in the past to erroneous descriptions of different species, because the coloration patterns were used before sexual structures as valid characters to separate species. This has brought difficulties for the current taxonomy and the consequent long list of synonymized species.

Aviculariinae species inhabit predominantly tropical lowland wet forest. *Avicularia* is distributed in the tropical areas of the Americas, from Costa Rica to Bolivia and Brazil, although there are also some unofficial records from southern Mexico (Fukushima and Bertani 2017). In addition to their arboreal habits, usually they make their silk retreats on vegetation but they also tend to use the human structures for establishing their retreats. These habits can change throughout their life development, as is known for many tarantulas. Stradling (1994) reported that *A. avicularia,* in a population closely related to human settlements in Trinidad, use leaves of herbaceous plants, tree barks, branches of tree trunks for their silk retreats, and that the juveniles in first instars use leaves of low growing plants.

*Avicularia* has type II abdominal urticating setae which present a peculiar defense mechanism. These setae are transferred by direct contact when the spider is disturbed, from the abdomen against the target (Bertani and Marques 1996), and are not expelled into the air, as in the majority of Theraphosinae (except *Kankuamo* Perafán, Galvis and Gutiérrez 2016). Urticating setae type II and VII (present in *Kankuamo*) have a different shape and size in relation to other urticating setae; they are thicker and heavier than the slender setae of theraphosines, preventing them from being carried by the air (Cooke et al. 1972; Bertani and Marques 1996; Perafán et al. 2016). A particularity of the urticating setae type II is the basal localization of the penetrating tip being very close to the supporting stalk, which gives it a special release mechanism: In contact, the urticating setae pivots on its stalk, so that the apical end moves away from the target, while the basal penetration tip instead lodges into the target as the stalk releases (see Bertani and Marques 1996: Fig. 3). However, there is a curious exception observed in *C. versicolor*, whereby it has urticating setae type II but its releasing mechanism is similar to theraphosines. According to Bertani et al. (2003), this constitutes a case of convergence between aviculariines and theraphosines. The type II urticating setae of *C. versicolor* are slender, similar to Theraphosinae urticating setae, and this morphology facilitates to said setae to go airborne.

*Iridopelma*, *Pachistopelma*, and *Typhochalena* are principally distributed in Atlantic forests, Restinga, and Caatinga areas of north and northeastern of Brazil. The majority of *Iridopelma* species live in dry open environments (Bertani 2012). These spiders generally build their retreats with two leaves connected with silk, or in a rolled single leaf, although *I. zorodes* and *I. katiae* use bromeliads as a refuge. This change in the habitat has been considered by Bertani (2012) as a derived condition in the group according to its cladistic analysis, which could have occurred due to climatic changes that carried a shift in the vegetation, forming grasslands on rocky and sandy soils, leading to the use of bromeliads and rocks as the available refuges for those spiders (Bertani 2012). Under this same scenario, *Pachistopelma* spp. are strictly associated with bromeliads (Santos et al. 2002, 2004; Dias et al. 2000; Dias and Brescovit 2003, 2004; Bertani 2012), as well some *Avicularia* juveniles that eventually use these refuge plants (Bertani 2012); nonetheless, other aviculariines are uncommon in bromeliads (Bertani 2012).

*Pachistopelma rufonigrum* is a species from Restinga vegetation and apparently strictly-dependent of bromeliads as a resource of water and as a refuge (Bertani 2012; Almeida-Silva et al. 2008), as well as *P. bromelicola*, distributed in the Brazilian Atlantic forest, Restinga, and Caatinga areas (Bertani 2012). *Typhochlaena* species are also found in the Brazilian Atlantic forest, but *T. costae* have been reported in drier environments (Bertani 2012). Some of these species construct silk retreats under loose tree bark, or under low tree leaves (Bertani 2012), and there is evidence that *T. seladonia* and *T. costae* close their shelters with a thin lid (Andre and Hüsser 2018).

*Ephebopus* species are distributed in the Amazonian rainforest, from northeastern and central Brazilian Amazon, French Guiana, southern Suriname, and southwestern Guyana (West et al. 2008). In relation to their shelters, West et al. (2008) described older juvenile and adult *E. murinus* refuges as fossorial channels ending in a blind chamber with a burrow entrance that has a large and elaborate trumpet-shaped turret of silk, in contrast to juveniles that build silk refuges inside terrestrial bromeliads. Other species have been found in retreats in hollow logs and stems, both on and above the ground, in holes and hollows of standing trees, in arboreal termite nests, and in mosses on the sides of shaded rock faces; additionally, they can extend its retreat with tubular silk and camouflage it with soil and vegetative debris (West et al. 2008). Marshall and West (2008) made emphasis in the ontogenetic habitat shift behavior presented by *E. murinus* in a study made in a population in French Guiana. They observed that early instars spiderlings constructed tubular silk refuges in the vegetation above the ground (this correlated with the presence of bromeliads), and the older juveniles and adult females were found in retreats in the ground. They theorized that the ontogenetic habitat shift can be considered as a strategy for avoiding intraspecific competition and cannibalism, but they also suggested that it is possible that the early instars retrieve an ancestry habit (Marshall and West 2008). Retreats of *E. uatuman* and *E. cyanognathus* have been found in damp soil covered by litter and were described as flare-mouth burrows, with the entrance surrounded by a collar of leaves attached by silk and the channel ending in a deep chamber (West et al. 2008). *E. rufescens* was found above the ground (1–4 m) with no evidence of retreats on the soil, and *E. foliatus* has been reported as arboreal (West et al. 2008).

*Ephebopus* represents an exceptional case in the evolution of urticating setae in tarantulas of the New World. It presents an urticating setae patch on the distal prolateral face of palpal femora, composed by setae described as type V (Marshall and Uetz 1990). In contrast to the majority of aviculariines, these setae are released to the air by the movement of the basal segment of the chelicerae against the area of the urticating setae (Lucas et al. 1991; Foelix et al. 2009).

*Psalmopoeus* has a fairly wide Neotropical distribution, inhabiting Amazonian forest from Ecuador, Colombia, Brazil and Venezuela; Andean and Pacific regions from Ecuador and Colombia; dry forest from Andean and Caribbean regions in Colombia; tropical forest of Panama, Costa Rica, Belize, México, and Trinidad and Tobago islands. In addition, they are the only known arboreal tarantulas found in the Andean forest. *Psalmopoeus* is recognized by its arboreal habits and abilities as an opportunistic taxon. Mendoza-M (2014) reported that *P. victori* construct retreats in tree cavities in rainforest of Veracruz, Mexico, from an area that is under pressure from human activities; *P. pulcher* has been reported as opportunistic, adapting an arboreal lifestyle (Gabriel and Sherwood 2018), and has been observed living in environments close to human settlements (personal observations). Records in Colombia indicate that they construct retreats in palm trees, and are associated with dry forest remnants of Caribbean regions (information of museum specimens).

Valerio (1979) recorded *P. reduncus* as an arboreal species, living up to 4 m above the ground, hidden in trunk cavities and bases of palm trees in forested areas in Costa Rica; *P. irminia* was reported in the Paracaima region of the Amazonian area of Brazil at 900 m.a.s.l., predominantly covered by savanna vegetation, in a tubular silk retreats at 1.60 m above into rocky cavities (Bertani et al. 2016). Saager (1994) described this species from the "Gran Sabana" in Venezuela, an area surrounded by tropical forest galleries inside Mahogany and other tree roots, in cavities, lianas, and under tree barks (Saager 1994). *P. ecclesiasticus*is distributed in Colombia and Ecuador, in the biogeographic Chocó region, it has been found in the Pacific foggy forest at 1400 m.a.s.l. from Nariño, Colombia, living over trunks, and juveniles in retreats inside mosses that cover standing trees. This data constitutes the highest altitudinal limit registered for the genus.

*Tapinauchenius* has been reported as opportunistic, even constructing retreats in abandoned human constructions (personal communication with R. Bertani). Apparently, *Pseudoclamoris* species are restricted to the Amazonian rainforest, but information about microhabitats has not been reported.

## 4.4 Conservation

It is widely known that large theraphosids are commonly sold and kept as exotic pets in many countries, due to their exotic beauty, highlighted by their colors, easy maintenance, and long life in captivity. Although, some tarantula dealers act under legal regulations, most of the trade is illegal through animal trafficking (Cifuentes and Perafán personal observations). This activity that is not only used as a lucrative business but also used as scientific traffic. These activities, added to the environmental pressures that all biota of the Earth face due to contamination and reduction of natural habitats, have more than one Aviculariinae species on alert. Unfortunately, we are still far from calculating the full scale of these problems.

Bertani and Fukushima (2009) discussed some traits about the conservation status of the endemic species from Brazilian Atlantic Forest, *Y. diversipes*, *Y. sooretama,* and *Y. gamba*. As expected, the three species are considered as affected, especially by the reduction and fragmentation of their habitat range caused by deforestation in the ecosystems. The Atlantic Forest is one of the most emblematic biogeographic regions of South America, considered as one hotspot of biodiversity and probably the most endangered ecosystem in the planet (Galindo-Leal and Câmara 2003); it is an area of high endemicity, and is considered to house at least 60% of the planet's diversity (Galindo-Leal and Câmara 2003). Bertani and Fukushima (2009) also considered the illegal wildlife trafficking of *Y. diversipes* as one factor that can be affecting the populations; they reported in 2009 that the species was commercialized in Europe, Asia, and United States, with high online sales demand. They consider that, due to the illegal collection, the restricted distributions and the altered habitats, all gravely affecting the populations, the inclusion of these species in the CITES and IUCN threatened list of species should be considered (Bertani and Fukushima 2009).

According to Bertani (2012), some species of *Pachistopelma*, *Iridopelma*, and *Typhochlaena* are very endemic: rare (*Typhochlaena* spp.), specialist (*Pachistopelma* spp. as a result of being strictly bromeliaceous), and scarcely studied (*Iridopelma* are distributed only in threatened areas of Brazilian Atlantic forest, Restinga, and Caatinga). These species can be affected by the reduction of the distribution areas and threatened microhabitats as the bromeliad species of the distribution regions (Bertani 2012).

Wildlife trafficking is one of the most lucrative illegal activities, and it has been reported that only 10% of the captured animals arrive alive to the destination, due to the stress and mistreatment of the animals in the transportation (Caldas et al. 2018). It is considered that the rate of survival of rescued animals, along with the successful reintroduction to their natural habitats, is low or without benefit for the species (Caldas et al. 2018). An extraordinary case was reported by Caldas et al. (2018) where they recorded the study over a case of wildlife trafficking of 52 individuals of *Pachistopelma bromelicola* (Aviculariinae) that were found by the Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA, portuguese acronym) in cruel and poor conditions, transported inside matchboxes and presumably for being sold in Slovakia. Of the 52 individuals found captive, only 22 were alive. During the rehabilitation process 12 of them died and from the remainder, only 4 presented traits of good health (molting). After monitoring the live animals, the researchers realized that some of those spiders presented protuberances "tumor-like" on their opisthosoma, a zoonotic concern for being reintroduced to their natural habitat. Finally, from the total of individuals only 7 (13%) survived (Caldas et al. 2018).

Studies in Aviculariinae and Psalmopoeinae populations are not developed, so the state of the species inside the principal list for animal conservation is generally lacking in information; this information vacuum does not permit the regulation in the use of the natural resources of the region.

## 4.5 Final Considerations

There is an interesting and deep discussion currently about the monophyly of the Neotropical arboreal theraphosids. As it happens widely in the animal world, the evidence suggests that adaptation to arboreal life to be an evolutionary convergence in tarantulas. The latest phylogenetic analyses also suggest a close relationship of these taxa with South American lineages, and each other, rather than with lineages of African or Asian arboreal theraphosids. The evolutionary evidence theorized that the South American theraphosids make up a unique and ancient lineage. Although the growing interest in the study of Neotropical arboreal tarantulas has improved their taxonomic knowledge, there are still few works related to their natural history and there are still many unsolved questions about the ecology and evolution of the urticating setae, as well as the stridulatory structures. Deepening these fields of research will not only expand the knowledge of this fascinating group but also affect the decision-making related to its conservation and the environments it occupies, which are generally just relicts of natural environments.

**Acknowledgments** Special thanks to Rick C. West for his recommendations and corrections, and for his collaboration with the images in Fig. 4.1a–f, 4.6a–d, and 4.8b. Thanks to Julian Kamzol for the images in Fig. 4.2, and Laura Montes de Oca for the help with the edition of the cladograms in Fig. 4.3. We are also thankful to M. Hüsser for the revision of the manuscript and his comments, and to Brad Zamft, for his suggestions and corrections to our English grammar. Y.C. wants to thank the Programa Estudiante-Convenio de Posgraduacão (PEC-PG) from the Brazilian Government, and The Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for the academic fellow process [190543/2015-9].

## References

Almeida-Silva LM, Camacho A, Brescovit AD, Lucas SM, Brazil TK (2008) Redescription and notes on the natural history of the arboreal tarantula *Iridopelma seladonium* (Araneae: Theraphosidae: Aviculariinae). Rev Bras Zool 25:728–736

Andre C, Hüsser M (2018) About trapdoors and bridges- new insights in the little-known ecology and lifestyle of the genus *Typhochlaena* C.L. Koch, 1850. Br Tarantula Soc J 32:3–29

Bertani R (2000) Male palpal bulbs and homologous features in Theraphosinae (Araneae, Theraphosidae). J Arachnol 28:29–42

Bertani R (2012) Revision, cladistic analysis and biogeography of *Typhochlaena* CL Koch, 1859, *Pachistopelma* Pocock, 1901 and *Iridopelma* Pocock, 1901 (Araneae, Theraphosidae, Aviculariinae). ZooKeys 230:1–94

Bertani R, Fukushima CS (2009) Description of two new species of *Avicularia* Lamarck, 1818 and redescription of *Avicularia diversipes* (C.L. Koch, 1842) (Araneae, Theraphosidae, Aviculariinae) three possibly threatened Brazilian species. Zootaxa 2223:25–47

Bertani R, Huff J (2013) *Avicularia rickwesti* sp. nov., a remarkable new species of *Avicularia* (Theraphosidae: Aviculariinae) from Dominican Republic. Zoologia (Curitiba) 30:333–337

Bertani R, Marques OAV (1996) Defensive behaviors in mygalomorph spiders: release of urticating hairs by some Aviculariinae. Zool Anz 234:161–165

Bertani R, Boston T, Evenou Y, Guadanucci JPL (2003) Release of urticating hairs by *Avicularia versicolor* (Walckenaer, 1837) (Araneae, Theraphosidae). Bull Br Arachnol Soc 12:395–398

Bertani R, de Sena SA, Diesel Abegg A, Roncolatto Ortiz F, de Freitas MA (2016) First record of the genus *Psalmopoeus* (Araneae: Theraphosidae) in Brazil. CheckList 12:1–4

Caldas ATM, Dias MA, Peres M (2018) Invertebrate (Araneae: Mygalomorphae) Illegal trade: an ignored side of wildlife trafficking. Am J Zool 1:20–23

Cifuentes Y (2018) Revisão taxonômica e analise cladística dos gêneros de tarântulas arborícolas *Psalmopoeus* Pocock, 1985 e *Tapinauchenius* Ausserer, 1871 (Araneae: Theraphosidae: Aviculariinae). (Unpublished Másters thesis). Universidade Estadual Paulista, Instituto de Biociências, Letras e Ciências Exatas, São José do Rio Preto, São Paulo, Brazil

Cooke JA, Roth VD, Miller FH (1972) The urticating hairs of theraphosid spiders. Am Mus Nov 2498:1–48

Cuvier G (1800) Leçons d'anatomie comparée. Tome I, Baudouin, Paris, p 520

de Mello-Leitão CF (1923) Theraphosideas do Brasil. Revista do Museu Paulista 13:1–438

Dias SC, Brescovit AD (2003) Notes on the behavior of *Pachistopelma rufonigrum* Pocock (Araneae, Theraphosidae, Aviculariinae). Rev Bras Zool 20:13–17

Dias SC, Brescovit AD (2004) Microhabitat selection and co-occurrence of *Pachistopelma rufonigrum* Pocock (Araneae, Theraphosidae) and *Nothroctenus fuxico* sp. nov. (Araneae, Ctenidae) in tank bromeliads from Serra de Itabaiana, Sergipe, Brazil. Rev Bras Zool 21:789–796

Dias SC, Brescovit AD, Santos LT, Couto ECG (2000) Aranhas em bromélias de duas restingas do estado de Sergipe, Brasil. Biologia Geral e Experimental, São Cristóvão 1:22–24

Foelix R, Rast B, Erb B (2009) Palpal urticating hairs in the tarantula *Ephebopus*: fine structure and mechanism of release. J Arachnol 37:292–298

Foley S, Lüddecke T, Chen D-Q, Krehenwinkel H, Kuenzel S, Longhorn SJ, Wendt I, von Wirth V, Taenzler R, Vences M, Piel WH (2019) Tarantula phylogenomics: A robust phylogeny of multiple tarantula lineages inferred from transcriptome data sheds light on the prickly issue of urticating setae evolution. bioRxiv 501262. doi:https://doi.org/10.1101/501262

Fukushima CS, Bertani R (2017) Taxonomic revision and cladistic analysis of *Avicularia* Lamarck, 1818 (Araneae, Theraphosidae, Aviculariinae) with description of three new aviculariine genera. ZooKeys 659(Suppl 1–5):1–185

Gabriel G, Sherwood D (2018) Re-description of the male of *Psalmopoeus pulcher* Petrunkevitch, 1925 with the first description of the female (Araneae: Theraphosidae). Br Tarantula Soc J 33:8–18

Galindo-Leal C, Câmara IG (2003) Atlantic Forest hotspot status: an overview. In: Galindo-Leal C, Câmara IG (eds) The Atlantic Forest of South America: biodiversity status, threats and outlook. CABS and Island Press, Washington, pp 3–11

Hüsser M (2018) A first phylogenetic analysis reveals a new arboreal tarantula genus from South America with description of a new species and two new species of *Tapinauchenius* Ausserer, 1871 (Araneae, Mygalomorphae, Theraphosidae). ZooKeys 784:59–93

Lamarck JB (1818) Classe Séptiéme, Les Arachnides, Les Aranéides ou Arachnides Fileuses, 88–108. In: Histoire naturelle des animaux sans vertèbres. Tome 5, Paris, p 612

Latreille PA (1802) Histoire naturelle, générale et particulière des Crustacés et des Insectes. Paris 3:48–59

Lucas S, da Silva Junior PI, Bertani R (1991) The genus *Ephebopus* Simon, 1892. Description of the male of *Ephebopus murinus* (Walckenaer, 1837), (Araneae, Theraphosiidae, Aviculariinae). Spixiana 14:245–248

Lüddecke T, Krehenwinkel H, Canning G, Glaw F, Longhorn SJ, Tänzler R, Wendt I, Vences M (2018) Discovering the silk road: nuclear and mitochondrial sequence data resolve the phylogenetic relationships among theraphosid spider subfamilies. Mol Phylogenet Evol 119:63–70

Marshall SD, Uetz GW (1990) The pedipalpal brush of *Ephebopus* sp. (Araneae, Theraphosidae): evidence of a new site for urticating hairs. Bull Br Arachnol Soc 8:122–124

Marshall SD, West R (2008) An ontogenetic shift in habitat use by the Neotropical tarantula *Ephebopus murinus* (Araneae, Theraphosidae, Aviculariinae). Arachnology 14:280–284

Mendoza-M JI (2014) *Psalmopoeus victori*, the first arboreal theraphosid spider described for Mexico (Araneae: Theraphosidae: Aviculariinae). Rev Mex Biodivers 85:728–735

Merian MS (1705) Metamorphosis insectorum surinamensium, ofte verandering der urinaamsche insecten; Waar in de Surinaamsche rupsen en wormen met alle des zelfs veranderingen na het leven afgebeeld en beschreeven worden, zynde elk geplaast op die gewassen, bloemen en vruchten, daar sy op gevonden zyn; waar in ookde generatie der kikvorschen, wonderbaare padden, hagedissen, slangen, spinnen en mieren werden ver toond en beschreeven, alles in America na het leven en levensgroote geschildert en beschreeven. Selbstverl, Amsterdam, p 60

Olivier GA (1811) Articles: mygale, oxyope. Encyclopédie méthodique, histoire naturelle, insectes. Paris 8:83–87

Perafán C, Pérez-Miles F (2014) The Andean tarantulas *Euathlus* Ausserer, 1875, *Paraphysa* Simon, 1892 and *Phrixotrichus* Simon, 1889 (Araneae: Theraphosidae): phylogenetic analysis, genera redefinition and new species descriptions. J Nat Hist 48:2389–2418

Perafán C, Galvis W, Gutiérrez M, Pérez-Miles F (2016) *Kankuamo*, a new theraphosid genus from Colombia (Araneae, Mygalomorphae), with a new type of urticating setae and divergent male genitalia. ZooKeys 601:89–109

Pérez-Miles F, Perafán C, Santamaría L (2015) Tarantulas (Araneae: Theraphosidae) use different adhesive pads complementarily during climbing on smooth surfaces: experimental approach in eight arboreal and burrower species. Biol Open 4:643–1648

Pocock RI (1901) Some new and old genera of South American Avicularidae. Ann Mag Nat Hist 8:540–555

Raven RJ (1985) The spider infraorder Mygalomorphae (Araneae): cladistics and systematics. Bull Am Mus Nat Hist 182:1–180

Roewer CF (1942) Katalog der Araneae von 1758 bis 1940. Bremen 1:1040

Saager F (1994) *Psalmopoeus irminia* sp. n., Beschreibung einer neuen Aviculariinae (Theraphosidae, Aviculariinae, genus *Psalmopoeus*) inclusive einem Vergleich mit *Psalmopoeus cambridgei*. Arthropoda 2:59–71

Samm R, Schmidt G (2008) Sinurticantinae subfamilia nov.--eine neue Unterfamilie der Theraphosidae (Araneae). Tarantulas World 140:3–14

Santos RL, Almeida MG, Nunes JV (2002) Notes on the association of *Pachistopelma rufonigrum* Pocock, 1901 (Theraphosidae) with phytotelm bromeliads in eastern Rio Grande do Norte State, NE-Brazil. J Bromeliad Soc 52:122–124

Santos RL, Almeida MG, Tinoco LDS, Martins LB, Maia MG (2004) Biogeography and conservation of the bromeliad tarantula *Pachistopelma rufonigrum* (Araneae, Theraphosidae) in Rio Grande do Norte, Brazil. J Bromeliad Soc 54:153–157

Schmidt G (2010) Psalmopoeinae subfamilia nov. -- eine neue Unterfamilie der Theraphosidae (Araneae). Tarantulas World 142:35–41

Simon E (1892) Histoire naturelle des araignées. Paris Tome 1:1084

Simon E (1903) Histoire naturelle des araignées. Paris Tome 2:1080

Stradling DJ (1994) Distribution and behavioral ecology of an arboreal "tarantula" spider in Trinidad. Biotropica 26:84–97

Thorell T (1870) On European spiders, Part. I. Review of the European genera of spiders. Nova Acta Reg Soc Sci Upsal 7:109–242

Turner SP, Longhorn SJ, Hamilton CA, Gabriel R, Pérez-Miles F, Vogler AP (2018) Re-evaluating conservation priorities of New World tarantulas (Araneae: Theraphosidae) in a molecular framework indicates non monophyly of the genera, *Aphonopelma* and *Brachypelma*. Syst Biodivers 16:89–107

Valerio CE (1979) Arañas terafósidas de Costa Rica (Araneae: Theraphosidae). II. *Psalmopoeus reduncus*, redescripción, distribución y el problema de dispersión en terafósidas. Revista de Biología Tropical 27:301–308

Walckenaer CA (1802) Faune parisienne, Insectes, ou Histoire abrégée des insectes de environs de Paris, classes d'aprés le systême de Fabricius; précédée d'um discours sur les insects em general, pour servir d'introduction à l'étude de l'entomologie. Paris 2:187–250

West RC (1983) An introduction to the tarantulas of Trinidad and Tobago. Living World Magazine. J Trin Tob Field Nat Club 1983–1984:54–58

West RC, Marshall SD, Fukushima CS, Bertani R (2008) Review and cladistic analysis of the Neotropical tarantula genus *Ephebopus* Simon, 1892 (Araneae: Theraphosidae) with notes on the Aviculariinae. Zootaxa 1849:35–58

World Spider Catalog (2020) World Spider Catalog. Version 21.5. Natural History Museum Bern, online at http://wsc.nmbe.ch, accessed on 09/11/20. doi: 10.24436/2