



On the family Fissiphalliidae Martens, 1988, with descriptions of two new Amazonian species (Arachnida: Opiliones: Laniatores)

ANA LÚCIA TOURINHO ¹ & ABEL PÉREZ GONZÁLEZ ²

¹Instituto Nacional de Pesquisas da Amazônia, Coordenação de Pesquisas Ecológicas (CPEC), Avenida André Araújo, 2936, Aleixo, CEP 69011-970, Cx. Postal 478, Manaus, AM, Brasil.

E-mail: amtourinho@gmail.com

²Laboratório de Aracnologia, Museu Nacional, Universidade Federal do Rio de Janeiro. Quinta da Boa Vista s/n, São Cristóvão CEP 20.940-040, Rio de Janeiro, RJ, Brasil. E-mail: abelaracno@gmail.com

Abstract

Two new species of Brazilian Fissiphalliidae are described. *Fissiphallius chicoi* n. sp. from Pará State, Gurupá municipality, whitewater floodplains (várzea), and *Fissiphallius tucupi* n. sp. from Amazonas State, Castanho municipality (paleovárzea). The number of species for this family in the Amazon rainforest increases from one to three. The two new species are closely related to *Fissiphallius martensi* Pinto-da-Rocha, 2004 from Amazonas State, Manaus. Fissiphalliidae and Zalmoxidae show remarkable similarities in somatic and genital morphology. Fissiphalliidae is kept as a family on the basis of its particular shape of the stragulum, but this character should be tested in a phylogenetic framework. A future phylogenetic analysis should determine if Fissiphalliidae is in fact the sister group of Zalmoxidae, or just a junior synonym. A key for identification, a distribution map, and notes on the distribution of the six species of Fissiphalliidae and the biology of the Amazonian species are given.

Key words. Neotropics, Amazonian Rainforest, Amazonian floodplains, Zalmoxidae, taxonomy, BR-319 highway

Introduction

Our knowledge of the diversity, phylogeny and distribution of organisms in Amazonia is still in its infancy (Silva *et al.* 2005). There are still large areas not yet visited by specialists (Nelson *et al.* 1990, Oren & Albuquerque 1991) and several zoological groups in Amazonia have not yet been studied. Some groups of animals were studied by early naturalist explorers, but most of them were analyzed under poor technical conditions and then classified under obsolete systems (see Cunha 1991; Papavero *et al.* 2002a, 2002b;

Röhe in press; Vanzolini 1996). There are still very few recent studies on Amazonian diversity. This region has been less investigated than the southeastern and southern regions of Brazil. Thus its faunistic diversity is less known and underestimated. Therefore it is not surprising that several new species, including mammals, were discovered lately (Van Roosmalen *et al.* 1998, 2000, 2002, 2003; Voss & Silva 2001).

Regarding the order Opiliones, more than 70 percent of the total area of the Amazon basin remains unexplored. The knowledge of most arachnid groups of this region is scanty (Adis 2000, 2002) and particularly our knowledge of the Amazonian Opiliones is sketchy at best. There are only 177 species recorded for Brazilian, Colombian and Peruvian Amazonia (the two new species herein described included). Most of them are known from sites geographically close to metropolitan centers or from localities scattered along the Solimões-Amazonas River and other large rivers, such as the Tocantins and Xingu (Kury & Pinto-da-Rocha 2002).

For people living in other regions or countries, the “inaccessibility” of Amazonia appears to be the main cause for our ignorance of harvestmen diversity. However, we have been systematically identifying material from recent faunal inventories in Amazonia, and noticed that at least 40% of the opilionid species collected near the city of Manaus, easily accessed by car and/or boat, are new taxa (from the nine species collected at Castanho, five are new, see descriptions of biotope and natural history in this paper). The lack of specialists studying the region is the main cause of our ignorance. The most intensively studied area in the Neotropics is the Southeastern Atlantic Forest. Historically most of the work done by specialists and the majority of the important zoological collections were based on that area.

The best examples of the extremely poor knowledge of the harvestmen fauna are found in the Zalmoxidae and related families, which are characterized by the external capsula of their penis developed as a “jack-knife” (*sensu* Kury & Pérez 2002). Despite the huge biodiversity of zalmoxoids in South America [e.g., the “phalangodids” treated by Gonzalez-Sponga (1987) and later transferred to Zalmoxidae by Kury (2003)], there are only three species in two families described for the whole of Amazonia. These are the Zalmoxidae *Ethobunus brasiliensis* (Mello-Leitão, 1941) and *Crosbyella roraima* Goodnight & Goodnight, 1943, and the Fissiphalliidae *Fissiphallius martensi* Pinto-da-Rocha, 2004. Two other possible zalmoxoids from Amazonia are the Peruvian species *Micrisaeus gracillimus* Roewer, 1957 and *Pucallpana pullex* Avram & Soares, 1983. However, the male genitalia of these species remain unknown and their somatic morphology is poorly known. Hence they are currently considered as “Grassatores *incertae sedis*” (Kury 2003).

Two new species of *Fissiphallius* Martens, 1988 were collected in the flooded forests of Gurupá, Pará State (várzea), and at Castanho municipality, Amazonas State (paleovárzea). The study of the Gurupá forests is a component of a larger project on the diversity of Opiliones in flooded areas (várzea) along the Amazonas River, Brazil (named

PróVárzea). The expedition to Castanho was part of a field course in Terrestrial Ecology, part of the post-graduation program of the Instituto Nacional de Pesquisas da Amazônia. These are the fifth and sixth species described in the Fissiphalliidae, and the second and third records of this family for the Amazon rainforest. The two new species are closely related to *Fissiphallius martensi*. The study of their morphology supports the hypothesis of a very close relationship between Fissiphalliidae and Zalmoxidae, as suggested by Kury & Pérez (2002). The new species are herein described and illustrated, the relationship of the two families is discussed on the basis of somatic and genital morphology, a key for identification of the species included in *Fissiphallius* is given, and a map showing the localities of the family is provided. As is the case in numerous other places in Amazonia, the two sites where the new species were collected deserve special attention of governmental institutions for environmental conservation.

Material & methods

All measurements are given in millimeters. The specimens are deposited in the Instituto Nacional de Pesquisas da Amazônia, Manaus (INPA), and Museu Nacional/UFRJ, Rio de Janeiro (MNRJ), both in Brazil.

Martens (1988) referred to the pedipalpal armature as spines. On the other hand, Pinto-da-Rocha (2004) considered them as tubercles with large setae, which makes more sense according to morphology and structural functionality. Pinto-da-Rocha & Kury (2003) and Tourinho & Kury (2003) proposed a similar terminology for tubercles, granules and spines in Laniatores and Eupnoi. Acosta (1989) stated that only projections basally articulated in a socket should be called spines. Yet distinguishing spines, large, rigid hairs and setae by using this terminology is extremely difficult (Acosta *et al.* in press). We are following the terminology of Kury & Pérez (2002), calling tubercles with large setae “setiferous tubercles”. For the armature of the body we follow Kury & Pérez (2002) and Pinto-da-Rocha & Kury (2003). The dorsal hump on the basal segment of the chelicera (= basichelecerite) is called bulla. Terminology of the cuticular armature is far from being universal (Murphree 1988). This problem and its importance for taxonomy and phylogenetics analysis are discussed in Acosta *et al.* (in press).

Terminology of penis structures follows Kury & Pérez (in press). In Fissiphalliidae the ventral lamina of the penis is divided into two parts: rutrum and pergula (Fig. 15). The rutrum was called “ventral immovable finger” by Martens (1988); Kury and Pérez (2002) called it “distal spade-shaped plate”. The pergula was called “basal keeled girdle” by Kury & Pérez (2002) and “rounded median keel” by Pinto-da-Rocha (2004). The glans of the penis in Fissiphalliidae, Zalmoxidae, Icaleptidae and Guasiniidae has a solid bifid plate articulated with the truncus, resembling a closed jackknife. Kury and Pérez (in press) named this structure as stragulum (from the Latin noun *stragulum* = a spread, covering, bed-spread) (Fig. 15). Martens (1988) called the stragulum a “dorsal movable finger”.

Taxonomy**Fissiphalliidae Martens, 1988*****Fissiphallius* Martens, 1988**

Type species. *Fissiphallius sturmi* Martens, 1988 (by original designation).

Included species. *F. chicoi* n. sp., *F. martensi* Pinto-da-Rocha, 2004, *F. spinulatus* Martens, 1988, *F. sturmi* Martens, 1988, *F. sympatricus* Martens, 1988 and *F. tucupi* n. sp.

Distribution. Colombia, Cundinamarca State, Bogota; Brazil, Amazonas State and Pará State. (Fig. 22).

Key to the species of *Fissiphallius*

- 1 Eye mound armed with a single strong sharply pointed medial apophysis (see Pinto da Rocha 2004: fig. 1), tibia II enlarged in the male (see Pinto da Rocha 2004: fig. 4), free sternite IV with strong medial apophysis (see Pinto da Rocha 2004: fig. 2) *F. martensi*
- Eye mound armed with a pair of medial apophyses, tibia II not enlarged in the male, free sternite IV without strong medial apophysis..... 2
- 2 Free sternite IV with a pair of small spiniform apophyses, anal operculum armed with strong spiniform apophysis 3
- Free sternite IV unarmed, anal operculum without strong spiniform apophysis 4
- 3 Free tergites I and II armed with a long spiniform medial apophysis (Figs 2, 4, 8), eye mound armed with two long spiniform apophyses (Fig. 2) *F. tucupi* n. sp.
- Free tergites I and II without strong spiniform medial apophysis (Figs 1, 3, 7), eye mound armed with two short spiniform apophyses (Fig. 1) *F. chicoi* n. sp.
- 4 Free sternite V with a pair of short spiniform apophyses 5
- Free sternite V unarmed (see Martens 1988: fig. 28).....*F. spinulatus*
- 5 Leg IV long (length ratio leg IV / body = 2.6); mesotergal areas markedly larger than carapace region of scutum (see Martens 1988: fig. 30), eye mound armed with two well-developed spiniform apophyses (see Martens 1988: fig. 31 in) *F. sturmi*
- Leg IV short (length ratio leg IV / body = 1.5); mesotergal areas a little larger than carapace region of scutum (see Martens 1988: fig. 32), eye mound with two very small apophyses (see Martens 1988: fig. 33).....*F. sympatricus*

Remark. In order to facilitate identification without dissecting genitalia, only somatic characters are used in this key. Male genitalia may also be used for species identification.

***Fissiphallius chicoi* n. sp.**

Figs 1, 3, 5, 7, 9, 11–12, 16–18, 22

Type material. Male holotype (INPA 159), Brazil, Pará State, Gurupá municipality, São José community, 1.197°S, 51.783°W, Próvarzea, 18.X.2003, Cristina Anne Rheims & Felipe Rego leg. Paratypes: 1 female (INPA 89), 3 females (MNRJ 17814) with the same data as the holotype.

Etymology. The species name is a patronym in honor of Chico Mendes, a Brazilian national hero, symbol of the defense of the Amazonian environment and of rubber worker's rights. Chico was cowardly assassinated in 1988 in Xapuri, Acre State.

Diagnosis. Eye mound armed with one pair of small sharp spiniform aphophysis (Figs 1, 3). Male genitalia clearly different from those of all other congeners. Rutrum with large number of setae irregularly arranged (paired in other species), pergula narrow, without setae. Portion of truncus below pergula very thin and narrower than stragulum (Figs 16–18). Ventral side of truncus, near base of stragulum, with a chitinous structure in the shape of a balcony and armed with three sharp-pointed setae (Figs 17–18), two ventral rows of conic protuberances (similar laterodorsal rows of protuberances present in *F. spinulatus*) (see Martens 1988: figs 17–18). Truncus basis ventrally with other balcony-shaped structure and dorsally with a folded area (Figs 16–18).

Description of male holotype. Measurements. Total length: 3.2 Carapace region of scutum: 1.0 long, 1.2 wide. Scutum: 2.4 long, 2.1 maximum width. Pedipalp: 2.7. Legs: 7.3/5.1/6.2/4.0

Dorsal view. Anterior border of prosoma with one median tubercle and a pair of tubercles on each side (Fig. 1). Spiniform aphophyses of eye mound short (Fig. 3). Scutal areas I–IV with a row of very small tubercles each (almost indiscernible), lateral margin of posterior half of dorsal scutum armed on each side with six sharp-pointed tubercles increasing in length posteriorly (Fig. 1); posterior margin armed with very small tubercles (almost indiscernible). Free tergites I–III armed with sharp-pointed tubercles, the three median and the lateral ones slightly larger than others; free tergite I with 15 tubercles, III with 13, II with 11; the median one always larger than other tubercles (Figs 1, 3, 7).

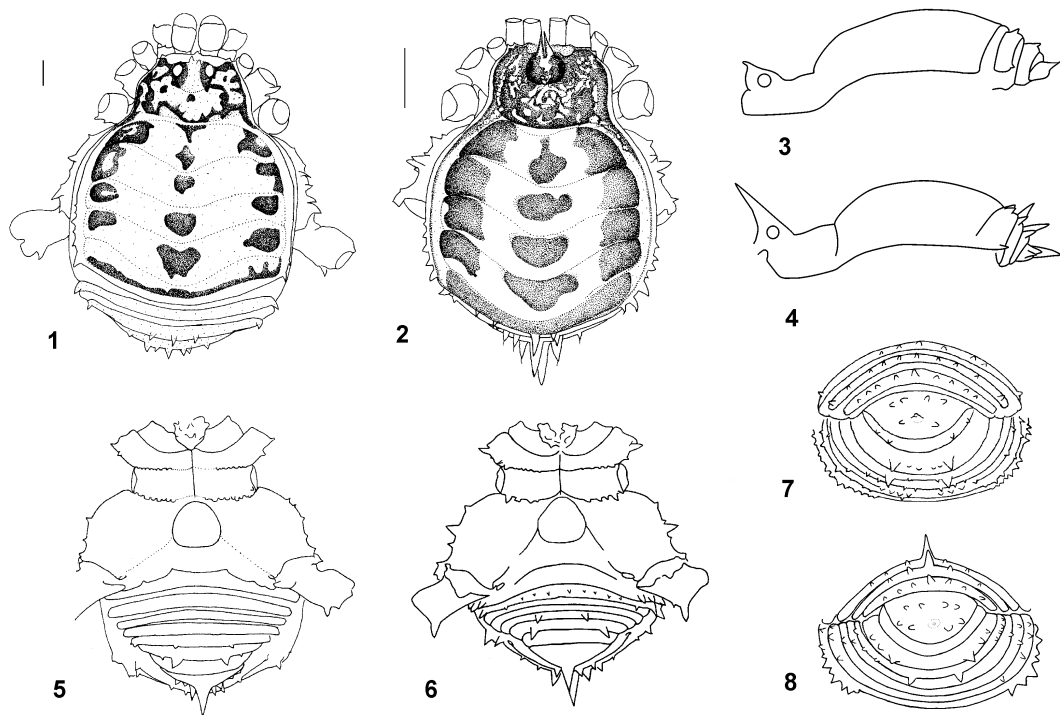
Ventral view. Posterior margin and sternites with tubercles increasing in length laterally, three to five lateral ones visibly larger (Fig. 5). Sternite IV and V with one pair of larger median tubercles (Fig. 5), anal operculum armed with an anterior and a posterior row of tubercles (Fig. 7), median spine of posterior row larger (Figs 5, 7).

Chelicerae. Without remarkable armature. Two tubercles on the basichelicerite, bulla short and well marked. Fingers without teeth.

Pedipalps. Coxa with one ventral tubercle carrying setae and one small dorsal protuberance. Femur ventrally with two basal and one distal setiferous tubercle, one distal setiferous tubercle in the mesal region. Patella mesally with one setiferous tubercle. Tibia mesally and ectally with one row of three setiferous tubercles. Tarsus mesally and ectally with two setiferous tubercles on each side; small setae scattered. Tarsal claw long and

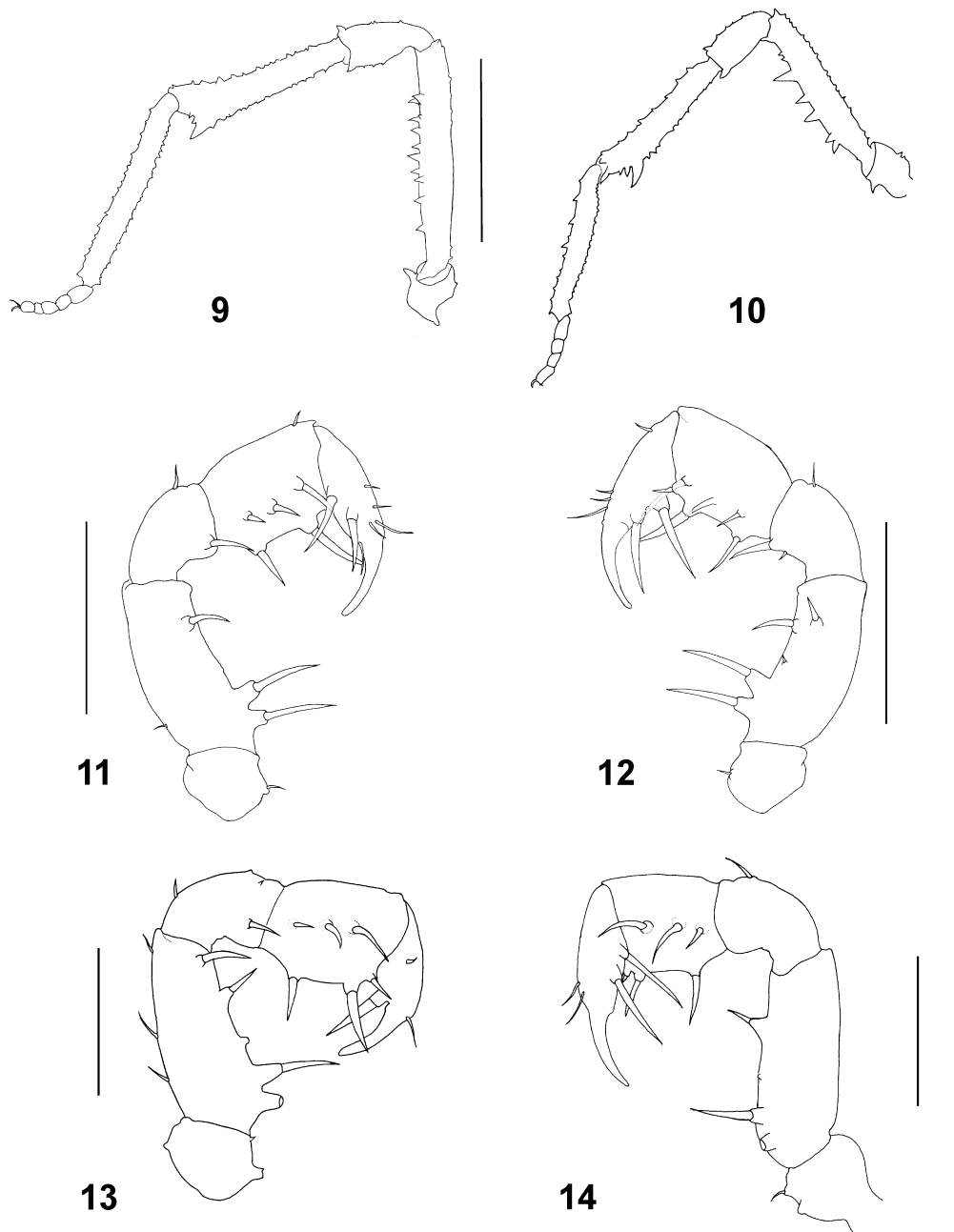
strong (Figs 11–12).

Legs. I–IV tuberculate. Coxae IV with sharp-pointed dorsal tubercles, posterior margin of coxae II–III armed with larger tubercles (Figs 1, 5). Trochanters I–IV with one sharp-pointed retrolateral tubercle (Fig. 5). Femur IV with two rows of 10–11 large and thin tubercles. Patella IV with sharp-pointed distal tubercles larger than others. Tibiae with one ventroapical tubercle larger than others. Tarsi tuberculate (Fig. 9). Tarsal formula: 3(2), 5(3), 5, 5.



FIGURES 1–8. *Fissiphallius chicoi* n. sp., male holotype (1, 3, 5, 7); *Fissiphallius tucupi* n. sp., male holotype (2, 4, 6, 8). Body (1–2 dorsal view, 3–4 lateral view, 5–6 ventral view, 7–8 posterior view). Scale bars = 0.1 mm (1, 3, 5, 7), 0.5 mm (2, 4, 6, 8).

Penis. Stragulum entire, with a long central furrow only visible distally. Apical portion of stragulum in the shape of a “parrot bill” (Fig. 17). Stragulum as long as in *F. sturmi* but with shorter rutrum (Figs 17–18). Rutrum medially with large number of irregularly arranged setae (paired in other species) (Figs 17–18), pergula narrow, without setae. Rutrum with truncus portion of pergula very thin and narrower than stragulum (Figs 16–18). Ventral side of truncus near level of stragulum basis with sclerotised structure in shape of a balcony, armed with three sharp-pointed setae and with two ventral rows of conical protuberances (similar laterodorsal rows of protuberances present in *F. spinulatus*) (see Martens 1988: figs 17–18). Truncus basis ventrally with another balcony-shaped structure and dorsally with a folded area (Figs 16–18).



FIGURES 9–14. *Fissiphallius chicoi* n. sp., male holotype (9, 11–12); *F. tucupi* n. sp., male holotype (10, 13–14). 9–10 right leg IV, lateral view; 11–12 right pedipalp (11 ectal view, 12 mesal view); 13–14 right pedipalp (13 ectal view, 14 mesal view). Scale bars = 1.0 mm (9, 11–12), 0.5 mm (10, 13–14).

Color (in 75% ethanol). Body yellowish, prosoma with reticulated brown stains (Fig. 1). Lateral borders and median region of scutal areas I–IV with brown stains, reticulated

brown stains in between them. Posterior margin of dorsal scutum and free tergites and sternites with brown lateral stains. Anal operculum brown, with yellow stain in the middle. Pedipalps, coxae and throchanters pale yellow, all other leg segments brown. Free sternites brown. Coxae I–IV yellow, coxae IV with brown dorsal stain.

Description of the female paratype. Very similar to the male, different in the following: legs considerably shorter, tubercles of leg IV shorter.

Measurements. Total length: 3.0. Carapace region of scutum: 1.0 long, 1.2 wide. Scutum: 2.0 long, 2.0 maximum width. Pedipalp: 2.7. Legs: 5.9/4.1/5.2/3.1. Tarsal formula: 3(3), 5(3), 5, 5.

Distribution. Known only from the type locality (Fig. 22).

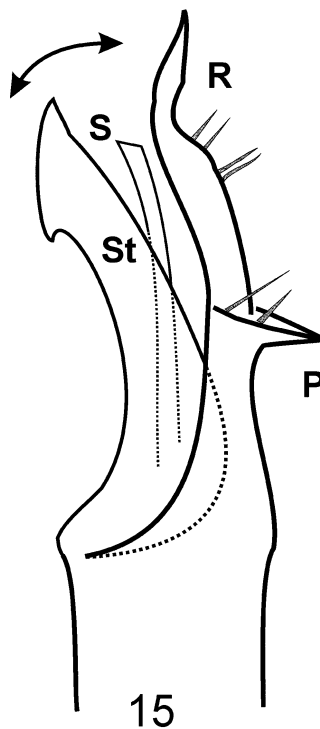


FIGURE 15. Schematic penis of Fissiphalliidae showing the principal diagnostic structures, lateral view. Abbreviations: P = pergula, R = rutrum, S = stylus, St = stragulum.

***Fissiphallius tucupi* n. sp.**

Figs 2, 4, 6, 8, 10, 13–14, 19–22

Type material. Male holotype (INPA 907), Brazil, Amazonas State, Castanho municipality, between km 81 and 83 of the BR-319 highway, 3.60665°S, 06.19784°W, 10–16.X.2005, Ana Tourinho, Rodrigo Dias & Sergio Marques de Souza leg. Paratypes: 7 males, 5 females (INPA 908), 5 males, 4 females, 2 juveniles (INPA 909), 8 males, 6 females (INPA 910), 1 male, 11 females (INPA 911), 1 male (INPA 912), Ana Tourinho

leg., 11 females (INPA 913), 3 males, 2 females (MNRJ 17815), with the same data as the holotype.

Etymology. Noun in apposition. Tucupi is a Tupi word, used for a regional manioc soup, which is prepared with duck or fish and which is widely consumed in the Amazon region.

Diagnosis. Eye mound armed with a pair of long and sharp spiniform median apophyses very close to each other (Figs 2, 4). Clearly distinguished from congeneric species by its male genitalia: rutrum with slightly bifid apex, truncus ventrally with a rounded protuberance proximally of pergula (Figs 19–21).

Description of male holotype. Measurements. Total length: 2.8. Carapace region of scutum: 1.3 long, 1.1 wide. Scutum: 1.5 long, 2.0 maximum width. Pedipalp: 2.4 long. Legs: 7.1/4.9/6.3/4.0 long.

Dorsal view. Anterior border of prosoma with a pair of very small tubercles on each side (Fig. 2). Scutal areas I–IV each with a row of very small tubercles (almost indiscernible). Lateral margin of dorsal scutum armed with 16 sharp-pointed tubercles on each side, these increasing in length posteriorly (variation: 12–17/13–17), posterior margin armed with 15 small tubercles, the median one largest (Figs 2, 4, 8). Free tergites I–III armed with sharp-pointed tubercles: free tergite I with 15, II with 13 and III with 11, the median one always larger than others (variation: 11–15/11–13/7–11).

Ventral view. Posterior margin and sternites armed with tubercles increasing in length laterally. Sternites IV and V with two pairs of larger median tubercles (Fig. 6). Anal operculum with two rows of tubercles, anterior row with four sharp-pointed tubercles, posterior row with five tubercles, the median one largest (Figs 6, 8).

Chelicerae. Without remarkable armature. Bulla short and well marked. Fingers without teeth.

Pedipalps. Coxa with one ventral tubercle and two small dorsal protuberances. Femur ventrally with ventral tubercles, two basal and one distal setiferous tubercle, one distal setiferous tubercle in mesal region. Patella mesally with one setiferous tubercle. Tibia mesally and ectally with one row of three setiferous tubercles. Tarsus with two setiferous tubercles on each side; small setae scattered. Tarsal claw long and strong (Figs 13–14).

Legs. I–IV tuberculate. Posterior margin of coxae II–III armed with ventral tubercles (Fig. 6). Coxa IV with sharp-pointed dorsal tubercles (Fig. 2). Trochanters I–IV with one retrolateral sharp-pointed tubercle (Figs 6, 10). Femur IV with two rows of seven sharp-pointed ventral tubercles larger than others. Patellae with sharp-pointed distal tubercle. Tibia with one larger tubercle (Fig. 10). Tarsi tuberculate, anterior and posterior margins with a row of tubercles. Tarsal formula: 4(2), 5(3), 6, 5.

Penis. Stragulum with only short distal cleft. Apical portion of stragulum in the shape of a “parrot bill” (Figs 19–20). Rutrum medially with slightly bifid apex and three pairs of setae (Figs 19, 21). Pergula laterally with two pairs of setae (Figs 19, 21). A pair of setae present proximally of pergula and a rounded protuberance at same level as stragulum basis

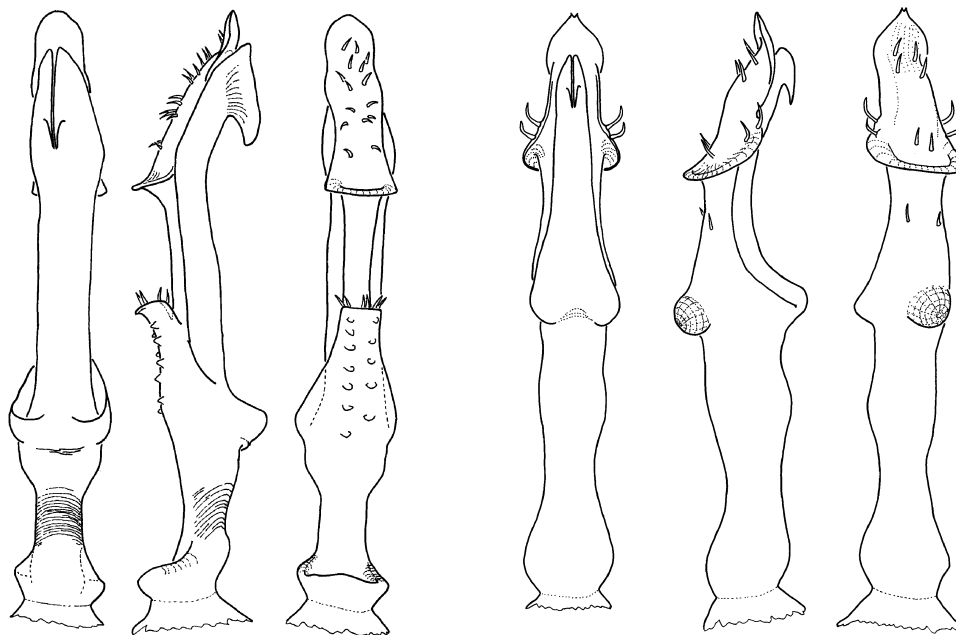
(Figs 20–21).

Color (in 75% ethanol). Body yellowish, carapace region of scutum with reticulated brown stains and with yellow stripes behind eye mound (Fig. 2). Lateral borders and median region of scutal areas I–IV with brown stains. Posterior margin of dorsal scutum and free tergites and sternites with brown lateral stains. Anal operculum brown, with yellow stain in the middle. Pedipalps and chelicerae pale yellow. Trochanters of legs yellow, femora and tibiae brown. Coxae I–IV yellow, coxa IV with brown dorsal stains.

Description of the female paratype. Very similar to the male, different in the following features: legs considerably shorter, armature of free tergites and sternites shorter, tubercles on free sternites all of the same length.

Measurements. Total length: 2.1 Carapace region of scutum: 0.9 long, 0.8 wide. Scutum: 1.5 long, 2.1 maximum width. Pedipalp: 2.3 long. Legs: 5.1/3.9/5.2/3.0 long. Tarsal formula: 4(2), 5(3), 6, 5.

Distribution. Known only from the type locality (Fig. 22).



16 **17** **18** **19** **20** **21**
FIGURES 16–21. *Fissiphallius chicoi* n. sp., male holotype (16–18); *F. tucupi* n. sp., male holotype (19–21). Penis (16, 19 dorsal view, 17, 20 lateral view, 18, 21 ventral view).

Biotope and natural history

F. chicoi n. sp. was collected in the flooded forests of Gurupá, community of São José. The landscape of this region is dominated by low terraces and flooded forests, called “várzea”. Throughout the year the Amazon region receives plenty of rain. Only two

seasons are distinguished: the flooded season, when the volume of water drastically increases, and the low water season, when the water drains off. The Amazon floodplains are classified as “várzea” (white water areas) and “igapó” (black water areas). The várzea water has high concentrations of sediments and nutrients, mainly carried from the Andes, and the igapó have poorer water, carried from the Guianas (Furch & Junk 1997; Irion 1997; Junk 1996). The differences in nutrient contents of the water affect directly and indirectly the organisms, influencing the occurrence and frequency of species in the Amazon (Junk & Furch 1985).

Large areas of forest between Manaus and the Atlantic Ocean remain flooded during the whole year. The tides from the Atlantic Ocean allow the water to freely run in and out of the swamps. This gives the impression that the whole estuary of the Amazonas River is submerged in the ocean. Collecting was carried out during the low water season, although then, due to the influence of sea tides in Gurupá, some dry areas were flooded in less than four hours and part of the low vegetation were already under the water.

F. tucupi **n. sp.** was collected in the forests of Castanho municipality between km 81 and 83 of the BR-319 highway, which was planned to connect the city of Manaus (Amazonas State) with Porto Velho (Roraima State). The region is located in the Solimões formation (Rosseti *et al.* 2005; Araujo *et al.* 1978). Its topography is predominantly flat, with tabular interfluves and hills with sedimentary deposits from the Tertiary, known as “paleo-várzea” (Mauro *et al.* 1978). The soil is reddish yellow (podzolic) and the vegetation is characterized as Dense Tropical Forest (Araujo *et al.* 1978; Doi 1978).

The vegetation of the forest in Gurupá and Castanho was extremely humid during collecting. In Gurupá a rainstorm started a few hours before sampling. In Castanho there was a light rain during most of the collecting period, a factor that may have influenced the high activities and significant abundances of the species in this site (43 individuals sampled in two sites, ten plots, in seven hours). Most Opiliones are extremely vulnerable to dehydration and their need for moist habitats is probably a significant ecological factor that limits their occurrence in xeric environments (Curtis & Machado *in press*). This suggests that there may exist a gradient of harvestmen abundance related to the distance from rivers.

The specimens of *F. chicoi* **n. sp.** and *F. tucupi* **n. sp.** were mostly collected from the vegetation by beating. The only exception was one specimen of *F. tucupi* **n. sp.**, it was walking on the surface of a palm leaf and was caught at night by visual search. Palms are very abundant in the Amazon forests, and especially in the forests of Castanho. No fissiphalliids were caught in the soil or in the leaf litter. *F. tucupi* **n. sp.** was usually caught by beating branches of palms. According to Adis (1997) and Adis & Junk (2002), terrestrial invertebrates living on the floodplains are influenced by the frequency, amplitude and the source of flooding. These factors have favored the development of flood-adapted survival strategies. The vegetation is an important refuge for invertebrate species living in inundated areas such as the várzeas in Gurupá. When the volume of water

increases, small invertebrates can migrate vertically and take shelter in the leaves of shrubs and trees. Vertical migration of terrestrial invertebrates on tree trunks in Central Amazonian inundation forests in response to the flood pulses has been interpreted as a behavioral adaptation, because it is not observed in upland forests (Adis & Junk 2002; Adis & Schubart 1984).

Nevertheless, it seems that the use of a higher vertical stratum by fissiphalliids is not only a consequence of inundation, but the preferred habitat of these species. *F. chicoi* **n. sp.** (várzea species) and *F. tucupi* **n. sp.** (paleo-várzea species) were found exclusively on palms and shrubs. Also only one specimen of *F. martensi* (upland species) was collected in an arboreal termite nest, and none in soil or leaf litter (Pinto-da-Rocha 2004). Additional species collected in Juruti, Pará State (upland species) followed the same pattern. Just 12 specimens were collected by manual leaf litter sorting, soil extraction through Winkler apparatus and pitfall traps, versus more than 190 collected by beating the vegetation (Pinto-da-Rocha & Bonaldo, pers. comm.).

Field observations by A. Tourinho suggest a close association between *F. tucupi* **n. sp.** and palms. The same result was obtained in recent inventories carried out in upland sites of Manaus and Rio Preto-da-Eva, both in Amazonas State, where all the minute Opiliones related to zalmoxoids were caught exclusively on the palm *Attalea* sp. One of the collectors of *F. chicoi* **n. sp.** gave detailed information on the site and collecting conditions in Gurupá. He described the type locality of this species as “a sea of palms” (Felipe Rego, in litt.). The high abundance of palms was seen in pictures of the sites sent by the collectors, but unfortunately they did not observe if the specimens were caught exclusively in association with palms. Recently, Opiliones have been collected at other várzea site, the Piranha Reserve, Manacapuru municipality, Amazonas State, by using the same protocol and sampling methods, but no fissiphalliids were among them. Coincidentally palms were not found at this site (Tourinho, unpubl. data). The apparent relation of *F. tucupi* **n. sp.** and the opilionids from Manaus and Rio Preto-da-Eva with palms is currently being more thoroughly investigated at all three sites. The final results of that study shall be published elsewhere.

Other Opiliones collected in the same area where *F. tucupi* **n. sp.** was caught are: *Paecilaema manifestum* Roewer, 1927 (Cosmetidae), *Protimesius longipalpis* (Roewer, 1943) and *Stygnus* sp. (both Stygnidae), *Trinella* sp. (Agoristenidae), two undescribed *Geaya* and one *Prionostemma* (both Sclerosomatidae), and an undescribed Minuidae species. Other Opiliones collected together with *F. chicoi* **n. sp.** are: *Hutamaia caramaschii* Soares & Soares, 1977 (Gonyleptidae), two undescribed *Geaya* and one *Prionostemma* (both Sclerosomatidae), *Eucynortula pentapunctata* Roewer, 1947, *Gryne amazonica* Roewer, 1947, an undescribed *Flirtea* and three unidentified *Cynorta* (all Cosmetidae).

Some recent studies in the Brazilian Atlantic Forest showed that Opiliones species are very susceptible to environmental changes and habitat fragmentation (Bragagnolo 2005).

The reconstruction of the BR-319 highway presents a risk for harvestmen communities by increasing deforestation in this region (Fearnside 2005, Fearnside & Graça, in press). The forest of Castanho, particularly in this region along km 81 and 83 of the BR-319, have undergone significant changes, deforestation of this area has began ten months after our expedition to that area. We know very little about Opiliones in Amazonia, and absolutely nothing about them in the paleovárzea. Several new species probably exist in sites never sampled along this highway; most of them will probably disappear before we get to know them.

Discussion

Some studies suggest that most of the forests in Amazonia are less diverse than the Atlantic forest (Morellato & Haddad 2000, Pinto-da-Rocha *et al.* 2005). Other recent studies state that Amazonia is the largest and most diverse of the tropical forest wilderness areas (Bobrowiec in press; Haffer 1997; Hayes & Sewlal 2004; Lima *et al.* 2006; Nores 2000; Ribeiro *et al.* 1999; Röhe in press; Silva *et al.* 2005). The Atlantic forest has a higher diversity for some groups extensively studied in both regions. Most of the Atlantic forest have been intensively sampled and studied in the last decades. On the other hand, many groups, especially invertebrates, remain poorly investigated in Amazonia (Adis 2000; Kury 2003; Kury & Pinto-da-Rocha 2002). About 2% of the world's described species of Arachnida live in this region (Adis 2000); Ricinulei represents 28% and Schizomida 9% of them. The surprisingly low known diversity of Opiliones in Amazonia is certainly due to undersampling (Kury 2003). The material collected by specialists in the last years contains a great number of undescribed species (Kury & Pinto-da-Rocha 2002; Tourinho, unpubl. data). Therefore comparisons with other areas are considered by us as premature.

The description of two new Fissiphalliidae is the first stage of our ongoing project. We decided to treat the tiny Opiliones first, mainly because of their phylogenetic importance. These groups currently represent the hardest challenges to opilionologists, as they contain a multitude of obscure undescribed species still awaiting study and bearing complex and hard-to-interpret male genitalia (Kury & Pérez, in press). The following stages of this project will treat the other poorly investigated families (e.g., Cosmetidae, Escadabiidae, Icaleptidae, Manosbiidae, Minuidae, and Sclerosomatidae), which are nevertheless astoundingly diverse and abundant in this region.

The description of two new Fissiphalliidae increases the species diversity by one third and also indicates that the distributional range of this family is much larger than previously known. Besides the poor current knowledge of Fissiphalliidae, the latest data on their morphological diversity points to two alternative hypotheses for their relationship with Zalmoxidae: the Fissiphalliidae may be either the sister group of the Zalmoxidae or needs to be merged into the Zalmoxidae. The comparative study of the two new species, several

unpublished zalmoxids from South America, and the species known from the literature show that somatic and genital morphology are very similar among species of Fissiphalliidae and Zalmoxidae. The similar somatic morphology plus the shared presence of pergula and rutrum in the male genitalia are reasons why Fissiphalliidae is presently considered as the sister group of Zalmoxidae (Kury & Pérez 2002). Due to these remarkable similarities, family and specific diagnoses are fundamentally based on the male genital characters.

The family Fissiphalliidae is distinguished by the presence of an entire, long stragulum and by the distal portion of truncus bearing a pergula and a rutrum. Those characteristics, however, are also the main synapomorphies for Zalmoxidae. The familial rank ascribed to Fissiphalliidae is currently based on the peculiar shape of the stragulum, although the usefulness of this character to define monophyletic groups has to be tested in a cladistic analysis. Future cladistic studies of this group of Grassatores should determine if the Fissiphalliidae is in fact the sister group of Zalmoxidae or just a synonym of it. All known fissiphalliids have a remarkable morphological resemblance. The three Amazonian species seem to be more closely related with each other than to the Colombian ones. These three species have a similar shape of the stragulum, with the apical region looking like a “parrot bill”. Despite the higher number of morphological autapomorphies present in *F. martensi*, it has a penis more similar to that of *F. tucupi* **n. sp.** than *F. chicoi* **n. sp.**

The distributional range of Fissiphalliidae is considerably enlarged to the eastern part of Amazonia by the presence of *F. chicoi* **n. sp.** in Gurupá (Fig. 22). *F. chicoi* **n. sp.** and the three species described by Martens probably represent only the current extreme points of a cline in this family. We predict that several new Fissiphalliidae may exist in the unsampled Amazonian (between those localities) and Andean areas. The finding of *F. tucupi* **n. sp.** shows that the distribution of this family also includes other localities south of the Amazonas River. The Amazonian rivers represent the largest river system in the world and are important barriers influencing species endemism by delimiting species distributions and restricting gene flow among populations (Ayres & Clutton-Brock 1992; Gascon *et al.* 2000; Hayes & Sewlal 2004; Wallace 1852; Van Roosmalen *et al.* 2002; Voss & Silva 2001).

The “river hypothesis” or “riverine barrier hypothesis” is not recent. It was first published by Wallace (1852), who distinguished four areas of endemism in Amazonia, delimited by the rivers Amazonas-Solimões, Negro and Madeira. The eight areas of endemism proposed after Wallace’s publication usually accord with or are nested within his “districts” (Cracraft 1985; Haffer 1978, 1985, 1987; Haffer & Prance 2001; Silva *et al.* 2005). They have also been supported by studies on different groups of vertebrates (Ávila-Pires 1995; Caprella 1988, 1991; Haffer 1969, 1992; Ron 2000; Silva & Oren 1996), invertebrates (Hall & Harvey 2002; Tyler *et al.* 1994) and plants (Prance 1982).

Presently little can be said about fissiphalliid endemism, although two Amazonian species fit in two of the eight areas of endemism known in the Amazon region. *F. martensi*

is found in the Guiana area, limited by both the large Amazonas and Negro rivers. On the other hand *F. tucupi n. sp.* was caught in the Inambari area, bordered by the Solimões and Madeira rivers. Moreover these two species are separated by the lower, wider section of the Amazonas River, which is a greater barrier to dispersal of organisms than its upper, narrower section (Ayres & Clutton-Brock 1992; Haffer 1974; Hayes & Sewlal 2004). *F. chicoi n. sp.* was recorded from the Island of Gurupá. Apparently the fauna of that region is similar to the southern Tapajós and Xingu areas of endemism. Based on this information and the generally high degree of endemism in New World Opiliones (Kury 2003; Kury & Pinto-da-Rocha 2002; Pinto-da-Rocha 1999; Tourinho 2004; Tourinho & Kury 2003), the taxonomic composition of Fissiphalliidae in the two areas is expected to be different. Furthermore, species of this family are very small, live in a highly stratified habitat and probably have very limited dispersal capabilities, as is the case of several other Amazonian species of Opiliones (Pinto-da-Rocha 1999). Therefore we also expect a high degree of endemism for Amazonian Fissiphalliidae. The three Colombian species were collected in an area of less than 80 km². In addition, two of them, *F. sturmi* and *F. sympatricus*, occur syntopically. This gives further support to our hypothesis.

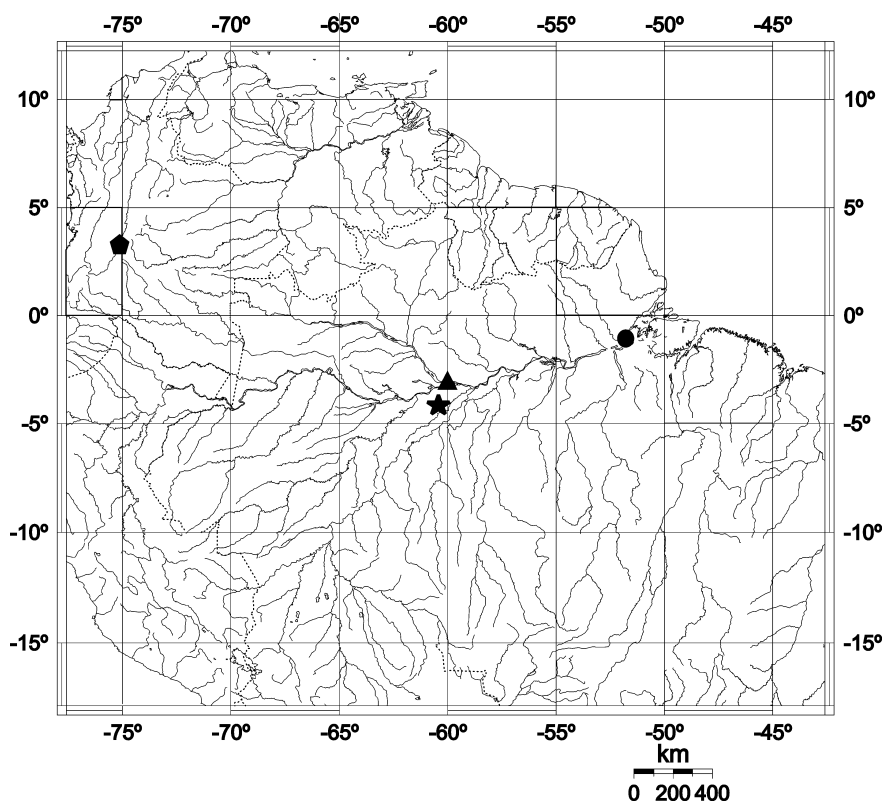


FIGURE 22. Northern South America showing the localities of the six nominal species of *Fissiphallius*. *F. sturmi* Martens, *F. spinulatus* Martens, *F. sympatricus* Martens (pentagon), *F. martensi* Pinto-da-Rocha (triangle), *F. tucupi n. sp.* (star), *F. chicoi n. sp.* (circle). Dotted lines = country boundaries, thin lines = rivers.

Some Amazonian species of Cosmetidae, Gagrellinae, and the Ampycinae *Hutamaia caramaschii* seem to exhibit wider distributional ranges. However, this fact is due to the river dynamics in this region, and to the use of different types of habitats and of flotsam dispersal by those species. Small floating islands, especially those composed of macrophytes, are carried away by the river currents and are responsible for the colonization of other regions by some species. Flotsam is also used for transport by spiders (Raizer & Amaral 2001) and is probably an important refuge for some species of spiders and opiliones living in the floodplains. Cosmetidae is so far the most abundant family of Opiliones found in association with macrophytes at the sampled várzea localities. Several species of this family have been sampled from floating and fixed banks of macrophytes in the várzea in both seasons (Tourinho unpublished data). Some cosmetid and gagrelline species seem to exploit most available habitats in a similar way. They were observed and collected in very different habitats, as soil, litter layer, trunks and the arboreal stratum, and are found throughout upland, paleovarzea and floodplains sites. This widespread occurrence through different habitats and geographical areas was not observed for Amazonian fissiphalliids. None of them was collected on water macrophytes. Their preference for the higher strata of the vegetation may also reduce their success in dispersal by flotsam, which typically does not contain palms and trees.

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