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Opiliones (Arachnida) in a mixed forest in southern Minas Gerais state, Brazil

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Abstract

The Opiliones are an order that provides relevant environmental services to different ecosystems, but there is little information on these arachnids for many Brazilian environments. In the Minas Gerais state, Southeastern Brazil, there is no data for Mixed Forests, the dominant phytophysognomy of the Atlantic Forest domain. To address this issue, we aimed to assess the opilionid fauna in Mixed Forest environments. This study took place at the Parque Estadual Serra do Papagaio state park between November 2017 and April 2018, with a total 57 hours of sampling effort. We recorded 17 species, including a *Spinopilar* species unknown to Science. Despite the low species richness when compared to other assessments, we found the Opiliones fauna of the Mixed Forest to be noteworthy due to their endemic status.

Keywords: Gonyleptidae; laniatores; *Gonyleptes*; atlantic forest

1. Introduction

The Opiliones are an order in Class Arachnida, popularly known as harvestmen. They make up about 6,000 species, of which 1,000 can be found in Brazilian ecosystems^[1, 2]. Harvestmen live in the soil, on cliffs, under forest litter, in moss patches, under tree barks, and even inside caves^[3]. They are harmless to humans and generally unknown to the general public due to their nocturnality^[4]. Opilionids are commonly mistaken for spiders, although both groups have distinct morphologies: a spider's body is divided into cephalothorax and abdomen, while in a harvestman cephalothorax and abdomen are fused together.

Harvestmen are directly influenced by microclimate conditions. They are adapted to narrow temperature and humidity bands and are highly susceptible to dehydration^[5]. This possibly explains their nocturnality and higher diversity in rainforests^[6]. Furthermore, many species of harvestmen are negatively impacted by human action such as forest fragmentation, forest fires and the rearing of livestock. Opiliones communities under such stresses show altered species composition and decreased species richness^[3, 7, 8].

Populations of harvestmen contribute to the decomposition of organic matter and to nutrient cycling^[9, 10]. They are important bioindicators of an environment's conservation, given that higher diversity occurs in ecosystems under lower anthropic influence^[11].

The Atlantic Forest is the Brazilian biome with the higher number of harvestmen species by study site (12-64)^[12] and also the most sampled one for Opiliones, followed by the Amazon Rainforest (21-28 species per site)^[13]. The Caatinga and Cerrado biomes show a lower diversity of opilionids, with less than 10 species per site^[14, 12]. These low numbers may, however, be reflect of sub-sampling^[15, 13].

Despite the ecological relevance of harvestmen, the group's diversity still is underestimated or even ignored in many ecosystems and Brazilian states. As an example, there are forests in the Minas Gerais state, Southeastern Brazil, for which data on Opiliones diversity is completely absent from literature. In that state, harvestmen studies are restricted to: (1) ecology and behavior of a few species in Cerrado areas^[16-18]; (2) reviews for Atlantic Forest areas^[19]; (3) descriptions of new species^[2, 20]; and data on cave-dwelling species^[21].

Aiming to contribute to filling this gap in literature, in this study, we aimed to sample and identify opilionid species in the Parque Estadual da Serra do Papagaio state park, Southeastern Brazil.

2. Methodology

2.1 Study area and period

The study was carried out at the Parque Estadual da Serra do Papagaio state park (22°12'18.22"S, 44°47'11.30"W), South of Minas Gerais state. This Unit of Conservation is spread between the municipalities of Aiuruoca, Alagoa, Baependi, Itamonte and Pouso Alto (Figure 01). Located on the Serra da Mantiqueira mountain range complex in Southeastern Brazil, the park has one of the few remaining patches of Atlantic Forest in the state. It includes ecoregions of Mixed Ombrophilous Forest and Altitude Fields.

Sampling was carried out between November 2017 and April 2018. There were 6 sessions of data collection of 4 consecutive days each, totaling 19 days and 57 hours of sampling in 12 points above 1,600 m of altitude.

2.2 Sampling and storing methods

The method used to collect species was active search during the night. It consisted in scanning the soil, litter, spaces under trunks and rocks and tree trunk surfaces and hollows for arachnids with the aid of flashlights. Sampling was carried out between 6 and 9 pm, when harvestmen activity reaches its peak^[4]. Collected specimens were stored in 70% ethanol and sent to the Museu Nacional da Universidade Federal do Rio de Janeiro national museum, where they were species-identified and photographed by specialist Ludson Neves de Ázara.

This study was authorized by SISBIO under permit 60120-1 and by IEF-MG under permit 065/2017.

2.3 Statistical analysis

In order to assess the similarities of the opilionid fauna sampled in this study with other works published in literature for Atlantic Rainforest influence areas Soares 1970^[22], Bragagnolo 2003^[4], Bragagnolo 2007^[10], Resende 2012^[23], we used Jaccard's community coefficient (SJ) processed in the PAST 2.1 software^[24].

To assess sampling efficiency, we used the Jackknife 1 species richness estimator in the R software^[25].

3. Results

We collected 182 specimens from 17 species of Opiliones in the suborders Laniatores and Eupnoi. They belonged to the families Gonyleptidae, Cryptogeobiidae and Cosmetidae (Table 01). Sampling efficiency was around 85%. The most frequent species was *Gonyleptes atrus* Mello-Leitão, 1923 (Figure 02a, b) with 40 specimens collected. We recorded a species unknown to Science in the *Spinopilar* genus (Figure 03), currently undergoing description by taxonomist Dr. Adriano Brilhante Kury at the invertebrate laboratory in the Museu Nacional do Rio de Janeiro museum.

The fauna showed in our study was most similar to the one reported by Resende^[23] (Figure 04), which was studied in the Parque Estadual Carlos Botelho state park and in the Floresta Nacional (FLONA) forest in Ipanema, São Paulo state, Southeastern Brazil.

4. Discussion

Despite the small sampled area, our study had high sampling efficiency, as shown by the species richness estimator (Figure 05). This is due to the homogeneity of the sampling area, since all samples were taken from above 1,600 meters of

altitude and in similar phytophysiognomies. Similar efficiency was also calculated for the assessment of social wasp diversity in the same area^[26, 27].

The low number of species found may be a reflex of the area's altitude. It has been previously reported that harvestmen fauna decreases drastically in high altitudes due to the lower temperature and humidity^[28].

The species *Gonyleptes atrus* Mello-Leitão, 1923 also occurs in areas in other municipalities (Campos do Jordão, Delfim Moreira, Itamonte, Itatiaia, Lambari and Poços de Caldas)^[29]. Every record was made above 900 meters of altitude, which may indicate a trend for the species' spatial distribution.

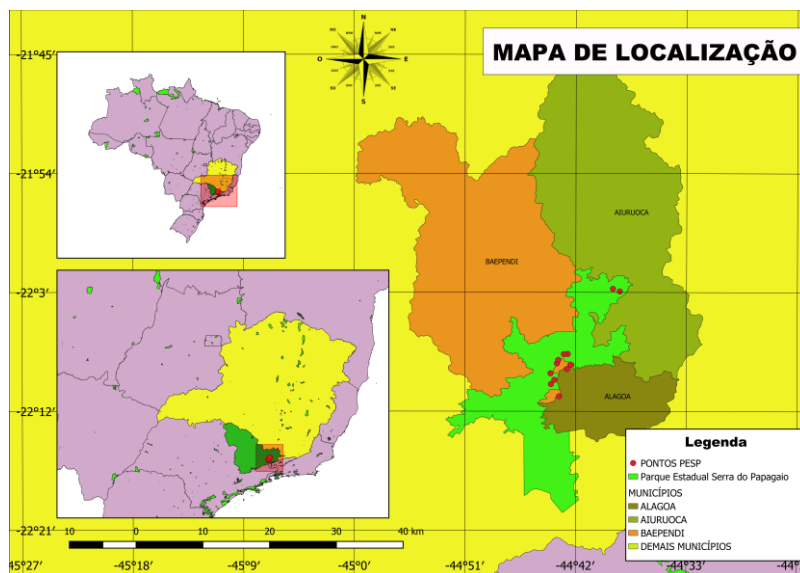
The new species recorded belongs to the family Cryptogeobiidae. Until then, this family had 6 species known to the Atlantic Forest in the Rio de Janeiro state, Southeastern Brazil (*Spinopilar anomalis* Sørensen, 1932, *Spinopilar armatus* Mello-Leitão 1940, *Spinopilar friburguensis* H. Soares, 1946)^[15], and other three species undergoing description by the specialist Dr. Adriano Brilhante Kury: one for the Espírito Santo state (*Spinopilar apiacaensis* Kury, 92)^[15] and two others in the Minas Gerais state (*Spinopilar moria*)^[30], both in Southeastern Brazil.

When compared to other studies, the opilionid fauna in our study is most similar to the one found in the in the Parque Estadual Carlos Botelho state park and in the Floresta Nacional (FLONA) forest in Ipanema, São Paulo state, Southeastern Brazil^[23]; and yet, there are only two species common to both studies. This might be a reflex of our study area's phytophysiognomy, Mixed Forest and Altitude Fields, which is distinct from other assessments. Such unique species composition evidences that the harvestmen fauna in Parque Estadual da Serra do Papagaio behaves endemically. Endemism in the area may be due to heterogeneous flora, geological composition and ecosystem conservation, which affect some insect taxa^[31].

By assessing similarities between the opilionids of Parque Estadual da Serra do Papagaio and the Parque Nacional do Itatiaia national park^[22] we find a single species in common to both areas (*Gonyleptes atrus* Mello-Leitão, 1923), despite both being part of the same group of conservation reserves in the Serra da Mantiqueira mountain range complex (Unidades de Conservação do Complexo da Mantiqueira) (Figure 06). Those differences may be due to the higher altitude in Parque do Itatiaia (2,300 m on average), which creates a natural barrier and isolates harvestmen communities. A similar effect is observed in some insect taxa across both areas^[26, 32].

The unique composition of the Opiliones community in conservation reserves within the Atlantic Forest such as the Parque Estadual Serra do Papagaio state park further adds to the importance of studying the group in these areas. The endemic status of harvestmen communities means they are even more susceptible to being impacted by human action and puts them under high threat of extinction. It is thus extremely important to maintain and conserve the environments these species are associated to.

Our study shows the importance of Parque Estadual da Serra do Papagaio for the maintenance of the opilionid fauna in Minas Gerais. This is reflected both in the endemism and in the new species found. Despite the relatively small sampling effort, the number of species sampled indicates the presence of high diversity of harvestmen in the area.



Source: Dr. Paulo Augusto Ferreira Borges.

Fig 1: Sampling points for sampling of opiliones (Arachnida) in the State Park of Serra do Papagaio, state of Minas Gerais.



Source: Ludson Neves de Ázara

Fig 2a. Male of *Gonyleptes atrus*, Mello-Leitão, 1923 collected at Serra do Papagaio State Park, state of Minas Gerais, Brazil.



Source: Ludson Neves de Ázara

Fig 3: Male of *Spinopilar* sp. 01 collected at the Serra do Papagaio State Park, state of Minas Gerais, Brazil



Source: Ludson Neves de Ázara

Fig 2b: Female of *Gonyleptes atrus*, Mello-Leitão, 1923 collected at Serra do Papagaio State Park, state of Minas Gerais, Brazil.

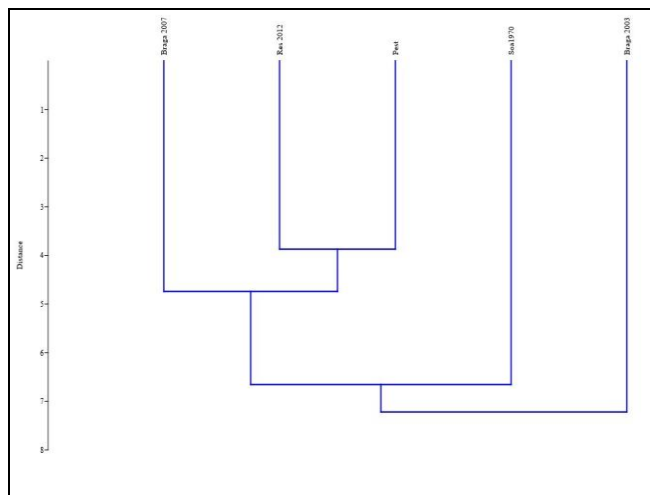


Fig 4: Opiliofauna similarity test of Serra do Papagaio State Park, state of Minas Gerais, Brazil

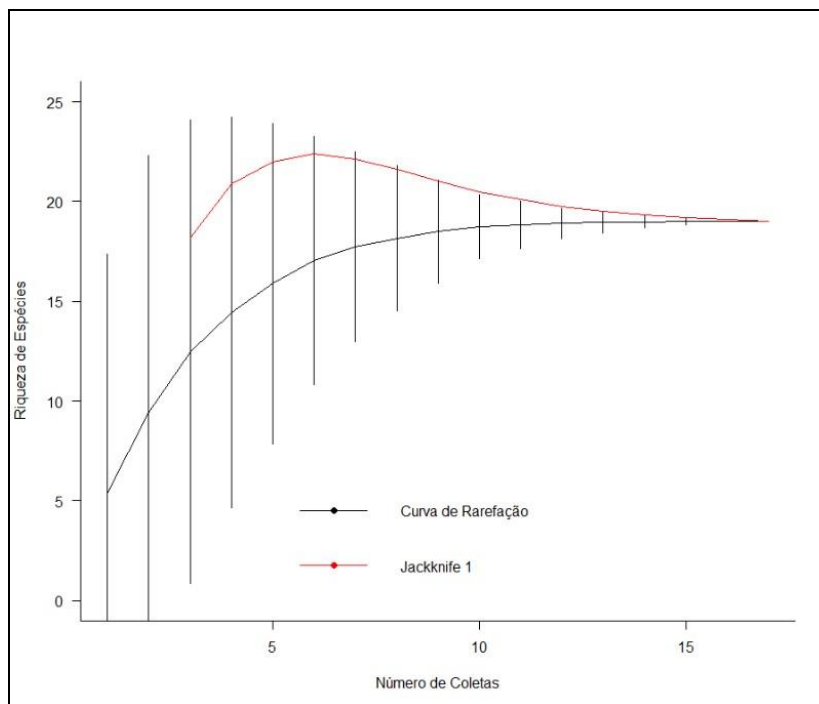


Fig 5: Number of species of opilions collected (rarefaction curve) and estimated by the Jackknife 1 species estimator from Serra do Papagaio State Park, state of Minas Gerais, Brazil

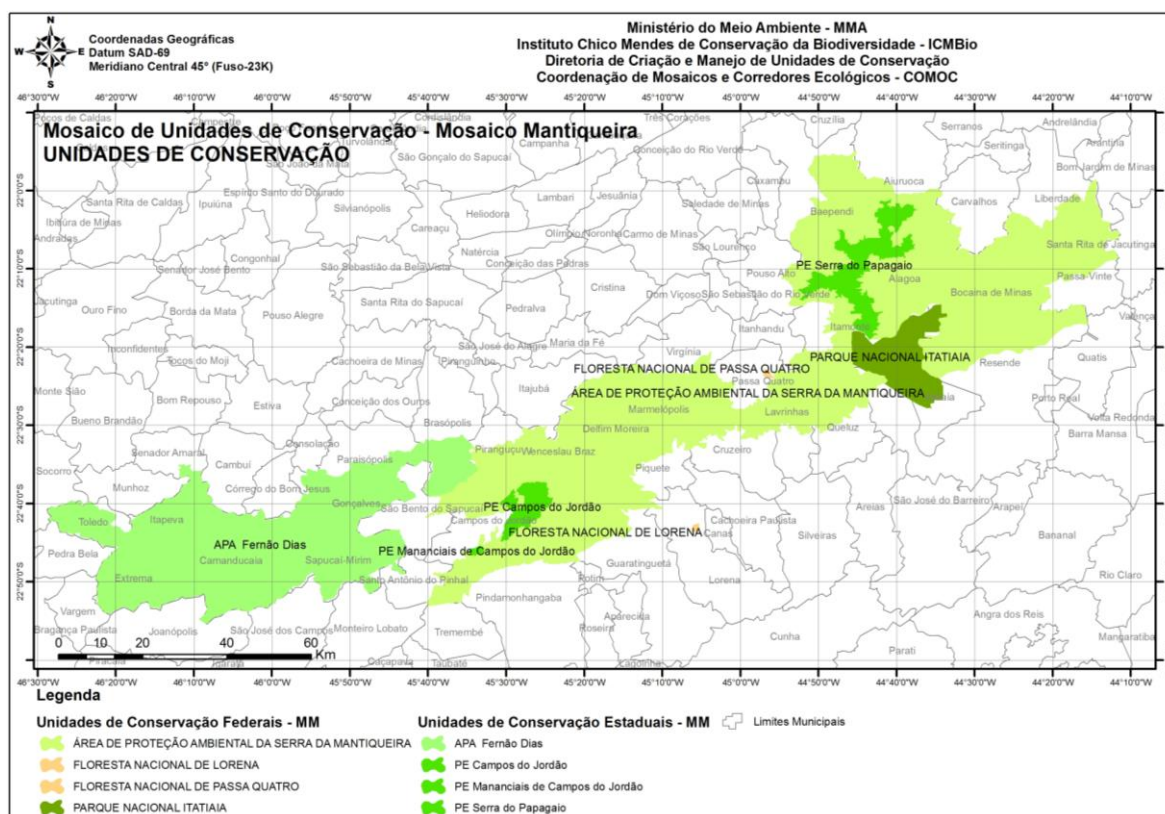


Fig 6: Group of Conservation Units of the Serra Mantiqueira complex, southeastern Brazil

Table 1: Suborder, family, subfamily, genus and number of specimens per species of harvestmen collected in the Parque Estadual da Serra do Papagaio state park, Minas Gerais state, Southeastern Brazil.

Suborder	Family	Subfamily	Genus	Specie	N. of individuals
Laniatores	Gonyleptidae	Caelyopyginae	<i>Pristocnemus</i>	<i>Pristocnemus albimaculatus</i> (Roewer, 1913)	3
Laniatores	Gonyleptidae	Goniosomatinae	<i>Acutisoma</i>	<i>Acutisoma longipes</i> Roewer, 1913	4
Laniatores	Gonyleptidae	Gonyleptinae	<i>Acanthogonyleptes</i>	<i>Acanthogonyleptes fulvigranulatus</i> (Mello-Leitão, 1922)	2
Laniatores	Gonyleptidae	Gonyleptinae	<i>Acanthogonyleptes</i>	<i>Acanthogonyleptes</i> sp.1	10
Laniatores	Gonyleptidae	Gonyleptinae	<i>Currala</i>	<i>Currala</i> sp.1	3

Laniatores	Gonyleptidae	Gonyleptinae	<i>Gonyleptes</i>	<i>Gonyleptes atrus</i> Mello-Leitão, 1923	40
Laniatores	Gonyleptidae	Gonyleptinae	<i>Longiperna</i>	<i>Longiperna trembão</i> Pinto-da-Rocha & Bragagnolo, 2010	8
Laniatores	Gonyleptidae	Goniosomatinae	<i>Mitogoniella</i>	<i>Mitogoniella indistincta</i> Mello-Leitão, 1936	11
Laniatores	Gonyleptidae	Goniosomatinae	?	sp.1	2
Laniatores	Gonyleptidae	Pachylinae	<i>Discocyrtus</i>	<i>Discocyrtus granulatus</i> Soares & Soares, 1970	10
Laniatores	Gonyleptidae	Pachylinae	<i>Eusarcus</i>	<i>Eusarcus hastatus</i> Soerensen, 1884	1
Laniatores	Gonyleptidae	Pachylinae	?	sp.1	39
Laniatores	Cryptogeobiidae		<i>Camarana</i>	<i>Camarana</i> sp.1	2
Laniatores	Cryptogeobiidae		<i>Spinopilar</i>	<i>Spinopilar</i> sp.1	1
Eupnoi	Sclerosomatidae	Gangrellinae	?	sp.1	9
Eupnoi	Sclerosomatidae	Gangrellinae	?	sp.2	17
Eupnoi	Sclerosomatidae	Gangrellinae	?	sp.3	20

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