

Social Wasps (Hymenoptera: Vespidae: Polistinae) of the Jaú National Park, Amazonas, Brazil

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Abstract. Social wasps are common elements in Neotropics, although even elementary data about this taxon in the Amazon region is partially unknown. Therefore the purpose of this work was to increase the knowledge of social wasp fauna at the Jaú National Park. A total of 494 specimens of Polistinae was collected with active search, malaise trap and light trap. Forty-nine species belonging to fourteen genera were recorded. The richest genera were *Polybia* (14 species), *Agelaia* (07), *Mischocyttarus* (05), *Apoica* (04), *Brachygastra* (04) and *Protopolybia* (04); the remaining genera were represented by less than two species. The Jaccard similarity coefficient showed a higher similarity of the Jaú National Park with Ducke Reserve (Manaus, Amazonas). Four species were collected for the first time in Amazonas state *Agelaia flavipennis* (Ducke), *Polybia affinis* Du Buysson, *Protopolybia nitida* (Ducke) and *Protopolybia sedula* (de Saussure), only in the Jaú National Park, showing the importance of this park for the social wasps preservation in the Amazon region.

Keywords: Amazon region; Inventory; Paper wasps; Upland forest.

Fauna de Vespas Sociais (Hymenoptera: Vespidae: Polistinae) do Parque Nacional do Jaú, Amazonas, Brasil

Resumo. Vespas sociais são elementos comuns na região Neotropical, embora até mesmo os dados elementares sobre este táxon na região amazônica ainda sejam parcialmente desconhecidos. Por isso objetivamos contribuir para o conhecimento sobre a fauna de vespas sociais que ocorrem no Parque Nacional do Jaú. Um total de 494 indivíduos de Polistinae foi coletado através de busca ativa, armadilha Malaise e armadilha luminosa. Quarenta e nove espécies de 14 gêneros foram registradas. *Polybia* (14 espécies), *Agelaia* (07), *Mischocyttarus* (05), *Apoica* (04), *Brachygastra* (04) e *Protopolybia* (04) são os gêneros com o maior número de espécies; os demais gêneros coletados foram representados por apenas uma ou duas espécies. De acordo com o coeficiente de similaridade de Jaccard, a composição de espécies de Parque Nacional do Jaú é semelhante a Reserva Ducke (Manaus, Amazonas). *Agelaia flavipennis* (Ducke), *Polybia affinis* Du Buysson, *Protopolybia nitida* (Ducke) e *Protopolybia sedula* (de Saussure) são considerados novos registros de ocorrência para o estado do Amazonas e foram coletados, até o momento, apenas no Parque Nacional do Jaú, demonstrando a importância deste parque para a preservação de vespas sociais na região amazônica.

Palavras-chave: Floresta de terra firme; Inventário; Região Amazônica; Vespas-papel.

The biodiversity of insects in Brazil is one of the highest of the world, representing around 20% of all known insects (MARINONI *et al.* 2006), distributed in six main Brazilian biomes (Amazon Rain Forest, Atlantic Forest, Caatinga, Cerrado, Pantanal and Pampas). The Amazon Forest is the biggest bioma within Brazilian territory, covering an area of 4,196.943 Km² (MINISTÉRIO DO MEIO AMBIENTE 2014).

The social wasps (Vespidae: Polistinae) comprise 26 genera and 958 species widely distributed in the Neotropical region (PICKETT & CARPENTER 2010). These wasps play an important role and are important components of complex interactions with other organisms in Neotropical ecosystems (SILVEIRA *et al.* 2012) as pollinators, predators or acting in biological control (HUNT 2007). The nests can be the size of a thimble or more than a meter long, as durable as hard felt or more fragile than egg shells, more regular and uniform than the much-celebrated honeybee comb or wildly chaotic with an intricate mazelike interior (WENZEL 1998).

The knowledge of social wasps remains from some few studies carried out in forest fragments. DUCKE (1904, 1907) conducted one of the first surveys of wasp fauna in the eastern region of the Brazilian Amazon, mainly in Pará State. Recently, similar works have been carried out in the Brazilian Amazon, as follow: Maracá River Island Ecological Satation, Roraima State (RAW 1998);

Caxiuana Reserve, Pará State (SILVEIRA 2002); Serra do Divisor National Park, Acre State (MORATO *et al.* 2008); Região dos Lagos, Amapá State and Mamirauá Reserve and Alvarães (SILVEIRA *et al.* 2008) and Ducke Reserve, Amazonas State (SOMAVILLA 2012).

Despite the contribution of these works, the richness of social wasps in Amazon Forest is still underestimated (SOMAVILLA 2012). SILVEIRA (2002) pointed out that 200 species were recorded in the Brazilian Amazon, which represents about two-thirds of all Brazilian Polistinae's fauna, although SOMAVILLA & OLIVEIRA (2013) highlighted the need of more studies focusing on distribution of wasps in the region.

In this work we present a list of species of social wasps (Polistinae) collected at the Jaú National Park comparing it with other areas sampled in Amazon Forest.

MATERIAL AND METHODS

The Jaú National Park (JNP) was established in 1980 and is considered the second largest Brazilian national park, occupying an area of 22,720 km². The park covers the Unini river and Jaú river hydrographic basins, right bank tributaries of the Negro

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river (BORGES *et al.* 2004) (Figure 1).

Water annual cycle variation ranges from 6 to 10 meters, between flood/low waters seasons. The precipitation reaches the peak from January to May, however the largest flood levels of the rivers occur during June and July. In opposite, the lowest rainfall season occurs between July and September and the lower river levels on October and November (Borges *et al.* 2004).

Seven different plant physiognomy cover the region: open upland forest (floresta de terra firme aberta), dense upland forest (floresta de terra firme densa), upland forest dense downland (floresta de terra firme submontana densa), open flooded forest (igapó aberto), closed flooded forest (igapó fechado), low white-sand forest (campina) and high white-sand forest (campinarana) (HENRIQUES & RAFAEL 1999; HENRIQUES 2004; PINHEIRO & BORGES 2004).

The specimens were collected in fast inventories (seven days each) - as by proposed SILVA *et al.* (2011). The inventories were performed in two different sampling points at JNP - Area 1 (02°00'03"S; 62°43'54"W) and Area 2 (01°53'04"S; 61°35'04"W) - during April and June 1993; April, June and August 2001; November 2003 and May 2004.

The wasps were actively collected with entomological net. Additionally, malaise traps (Townes model), installed during the seven days sampled, and light traps (a white sheet attached to one white and black light), between 6 p.m. to 5 a.m. from one night of sampling, were employed; these three methods were applied in all samples periods. Also, nests were actively collected along trails of the area, such as margins of creeks (igarapés) and surroundings of base, only in samples of 2003 and 2004.

Identification of the specimens followed the keys proposed by RICHARDS (1978), CARPENTER & MARQUES (2001) and CARPENTER

(2004). Voucher specimens were deposited at the Collection Zoological of Invertebrates at the Instituto Nacional de Pesquisas da Amazônia (INPA) in Manaus, Brazil.

The dominance of the taxa was calculated using the formula $D=(i/t) \times 100$, where D = Dominance (%), i = total number of individuals of a particular species and t = the total individuals collected, where $D > 10\%$ Eudominant, $D = 5 - 10\%$ Dominant, $D = 2 - 5\%$ Subdominant, $D = 1 - 2\%$ Recessive e $D < 1\%$ Rare (PALISSA *et al.* 1979).

The Jaccard similarity coefficient was undertaken in the R program (R Development Core Team 2011), version 2.13, Vegan (OKSANEN *et al.* 2008), comparing the species richness of JNP with others inventories carried out in the Brazilian Amazon. In this analysis, we excluded the specimens identified as "morphospecies" or "varieties".

RESULTS AND DISCUSSION

A total of 494 individuals, forty-nine species, belonging to fourteen genera of Polistinae, were collected in the Jaú National Park area. *Polybia* was the richest genera (14 species), followed by *Agelaia* (07), *Mischocyttarus* (05), *Apoica* (04), *Brachygastra* (04) and *Protopolybia* (04) (Table 1). The Eudominant or Dominant species were: *Agelaia fulvofasciata* (Ducke) (79 specimens), *Polybia bistriata* (Fabricius) (78), *Angiopolybia pallens* (Lepelletier) (32), *Apoica pallida* (Oliver) (27), *Polybia liliacea* (Fabricius) (25), *Polistes canadensis* (Linnaeus) (24). Rare species represented more than 50% of the total (27 species).

The Jaccard similarity coefficient (Figure 2) shows that the species composition and of JNP is more similar with Ducke Reserve (39%) situated 200 Km SE, followed by Caxiuanã (35%) in Pará State, followed by Alvarães (33%) and Mamirauá (32%) located also in Amazonas State. Maracá River Island in Roraima

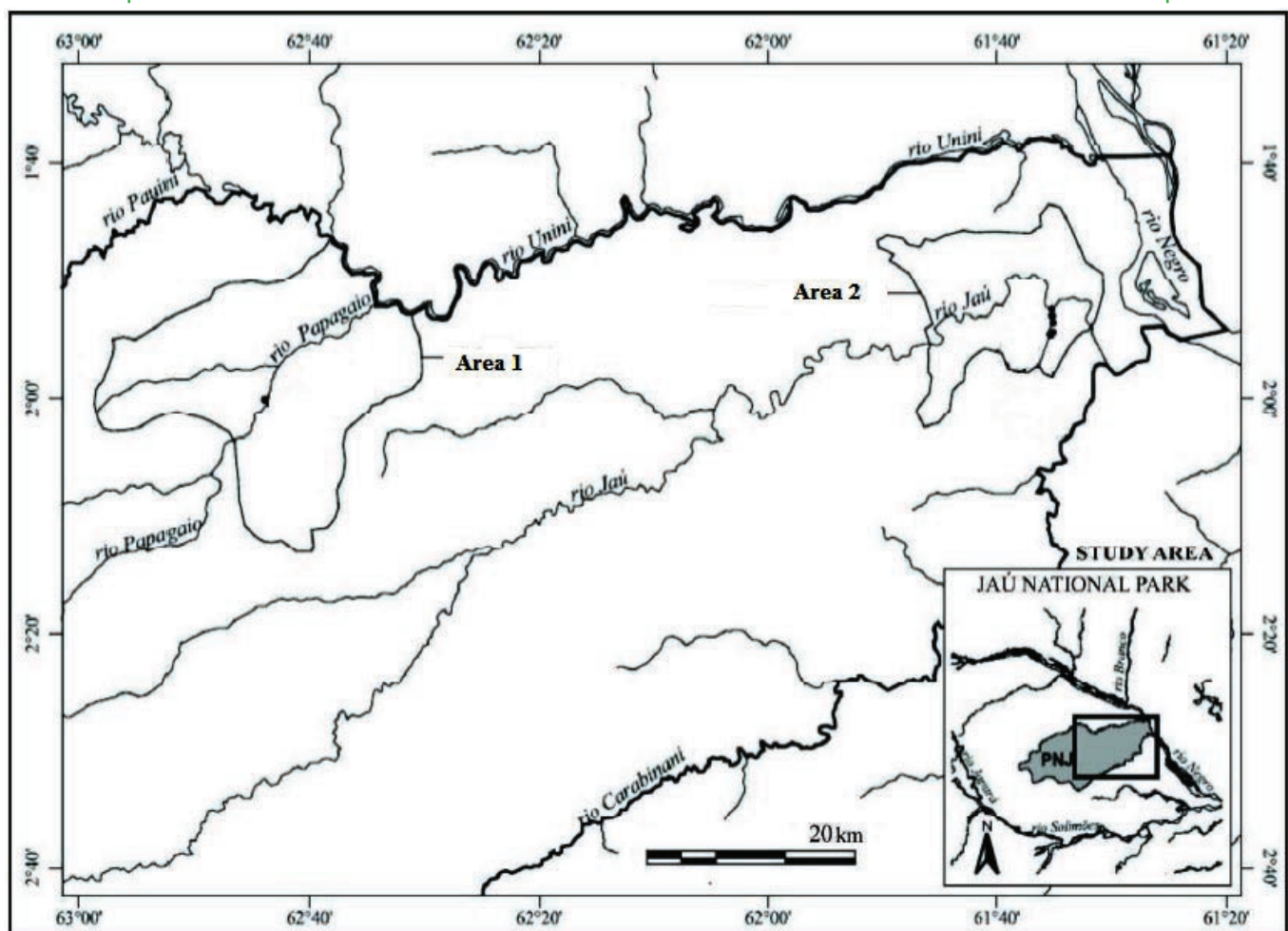


Figure 1. Map of Jaú National Park (PNJ) and the two places of samples: Area 1 and Area 2. Image adapted from HENRIQUES (2004).

Table 1. Species of social wasps collected at Jaú National Park, Amazonas, Brazil, as well as the method used to capture the species. Status: Eudominant (Ed) Dominant (D), Subdominant (Sd), Recessive (Rc) and Rare (Rr).

Species	Method	Number of specimens	Dominance Status
Epiponini			
<i>Agelaia angulata</i> (Fabricius)	Active search, Malaise trap	06	Rc
<i>Agelaia centralis</i> (Cameron)	Malaise trap	06	Rc
<i>Agelaia flavipennis</i> (Ducke)	Malaise trap	02	Rr
<i>Agelaia fulvofasciata</i> (DeGeer)	Active search, Malaise trap	79	Ed
<i>Agelaia pallipes</i> (Olivier)	Malaise trap	08	Rc
<i>Agelaia ornata</i> (Ducke)	Active search	01	Rr
<i>Agelaia testacea</i> (Fabricius)	Active search, Malaise trap	02	Rr
<i>Angiopolybia pallens</i> (Lepeletier)	Active search, Malaise trap	32	D
<i>Angiopolybia paraensis</i> (Spinola)	Active search, Malaise trap	11	Sd
<i>Apoica arborea</i> de Saussure	Light trap	22	Sd
<i>Apoica pallens</i> (Fabricius)	Light trap	15	Sd
<i>Apoica pallida</i> (Olivier)	Light trap	27	D
<i>Apoica thoracica</i> Du Buysson	Light trap	06	Rc
<i>Brachygastra augusti</i> (de Saussure)	Malaise trap	03	Rr
<i>Brachygastra bilineolata</i> Spinola	Malaise trap	14	Sd
<i>Brachygastra lecheguana</i> (Latreille)	Malaise trap	05	Rr
<i>Brachygastra scutellaris</i> (Fabricius)	Malaise trap	04	Rr
<i>Chartergus chartarius</i> (Olivier)	Malaise trap	02	Rr
<i>Clypearia sulcata</i> (de Saussure)	Malaise trap	01	Rr
<i>Leipomeles dorsata</i> (Fabricius)	Malaise trap	01	Rr
<i>Metapolybia nigra</i> Richards	Active search, Colony	22	Sd
<i>Parachartergus fraternus</i> (Gribodo)	Malaise trap	01	Rr
<i>Polybia affinis</i> Du Buysson	Malaise trap	01	Rr
<i>Polybia belemensis</i> Richards	Malaise trap	01	Rr
<i>Polybia bicyttarella</i> Richards	Malaise trap	01	Rr
<i>Polybia bistriata</i> (Fabricius)	Active search, Colony	78	Sd
<i>Polybia depressa</i> (Ducke)	Malaise trap	01	Rr
<i>Polybia dimorpha</i> Richards	Active search, Malaise trap	21	Sd
<i>Polybia jurinei</i> de Saussure	Active search, Malaise trap	13	Sd
<i>Polybia liliacea</i> (Fabricius)	Active search, Malaise trap	25	D
<i>Polybia occidentalis</i> (Olivier)	Active search, Malaise trap	09	Rc
<i>Polybia quadricincta</i> de Saussure	Malaise trap	01	Rr
<i>Polybia rejecta</i> (Fabricius)	Active search, Malaise trap	06	Rc
<i>Polybia scrobalis</i> Richards	Malaise trap	06	Rc
<i>Polybia singularis</i> Ducke	Malaise trap	01	Rr
<i>Polybia striata</i> (Fabricius)	Active search, Malaise trap	02	Rr
<i>Protopolybia bituberculata</i> Silveira & Carpenter	Malaise trap	02	Rr
<i>Protopolybia chartergoides</i> (Gribodo)	Malaise trap	07	Rc
<i>Protopolybia nitida</i> (Ducke)	Malaise trap	02	Rr
<i>Protopolybia sedula</i> (de Saussure)	Malaise trap	01	Rr
<i>Synoecca surinama</i> (Linnaeus)	Active search	01	Rr
<i>Synoecca virginea</i> (Fabricius)	Active search	02	Rr
Mischocyttarini			
<i>Mischocyttarus drewseni</i> de Saussure	Active search	04	Rr
<i>Mischocyttarus labiatus</i> (Fabricius)	Malaise trap	03	Rr
<i>Mischocyttarus metathoracicus</i> (de Saussure)	Active search, Colony	02	Rr
<i>Mischocyttarus socialis</i> (de Saussure)	Malaise trap	01	Rr
<i>Mischocyttarus surinamensis</i> (de Saussure)	Malaise trap	01	Rr
Polistini			
<i>Polistes canadensis</i> (Linnaeus)	Active search, Colony	24	Sd
<i>Polistes carnifex</i> (Fabricius)	Active search, Colony	08	Rc

State, Região dos Lagos in Amapá and Serra do Divisor in Acre were those areas with the lowest similarity between the species composition (values near to or below 20%). The similarity, grouped areas with coefficient of similarity plant physiognomy.

Even in relation of richness, JNP (49 species) was grouped with Mamirauá Reserve (46 species) and the outskirts of Alvarães (42 species), both in Amazonas (SILVEIRA *et al.* 2008). However, the highest richness in Amazon basin was registered in Caxiuana reserve (97), followed by Ducke Reserve (87). In contrast, the lowest richness was found in the Amazon forest, were found in Maracá River Island, Roraima, with 36 species (RAW 1998), Região dos Lagos, Amapá, with 31 species (SILVEIRA *et al.* 2008) and Serra do Divisor, Acre, with 20 species (MORATO *et al.* 2008).

In your research, SILVEIRA *et al.* (2012) showed that fast inventories are efficient to sample more abundant species, mainly three genera (*Agelaia*, *Polybia* and *Mischocyttarus*). However, in this work only the genera *Agelaia*, *Polybia* and *Angiopolybia* were considered abundant. In both works, *Agelaia* was the most abundant genera probably because the species of this genera usually form big colonies with millions of individuals (ZUCCHI *et al.* 1995), and consequently have a higher probability of being captured (SILVEIRA *et al.* 2012). However some species are rarely collected in the Amazon region, as *A. flavipennis* (SILVEIRA 2002), and also, as recorded in this work *Polybia affinis*, *Polybia nitida* and *Polybia sedula*. These four species are new records for Amazonas State.

Methods for collecting wasps are something troublesome. Unfortunately different methods (malaise traps, active search, attractive solution, etc.) have been employed in different ecosystems and with also a different collecting efforts.

Comparisons of local faunas using of information in collections always confront obstacles arising from non-standardized collecting methods (SILVEIRA 2002). In general, appropriate information about the efforts spent in finding a certain number of species is not available, and data about the relative abundance of the species are hardly recoverable (SILVEIRA 2002).

Despite such problems, we suggest that different methods must be employed for maximize the effectiveness of the survey (SILVEIRA 2002). In this work the majority of the species of Epiponini collected, belonging to *Brachygastra*, *Clypearia*, *Leipomeles*, *Protopolybia* and some species of *Polybia* were captured only in Malaise trap. In contrast, collected species of Mischocyttarini and Polistini were less efficient using this method, a pattern that has also been reported by SILVEIRA (2002), and SILVA & SILVEIRA (2009). Therefore, the employment of Malaise traps as the only way for collecting social wasps may underestimate the richness of the Polistini and Mischocyttarini as well as species of *Apoica*, that forage at night (HUNT *et al.* 1995), which reduces the possibility of capturing these wasps during the day. In the present study *Apoica arborea*, *Apoica pallens* (Fabricius), *Apoica pallida* and *Apoica thoracica* Du Buysson were collected only with light traps.

The species number of Maracá River Island and Serra do Divisor is similar to other Brazilian biomes such as cerrado (Brazilian Savanna), campos rupestres (rock outcrop formations), Atlantic forest or crops areas and anthropogenic environments (HERMES & KÖHLER 2006; SILVA *et al.* 2011; TANAKA-JR. & NOLL 2011;), since these are modified Amazon areas, but the species composition changes. However, in areas of Amazonian upland forests, like Caxiuana Reserve, Ducke Reserve and JNP the species richness is greater than these biomes, therefore the Amazon is the biome with the highest species richness of social wasps in Brazil. We

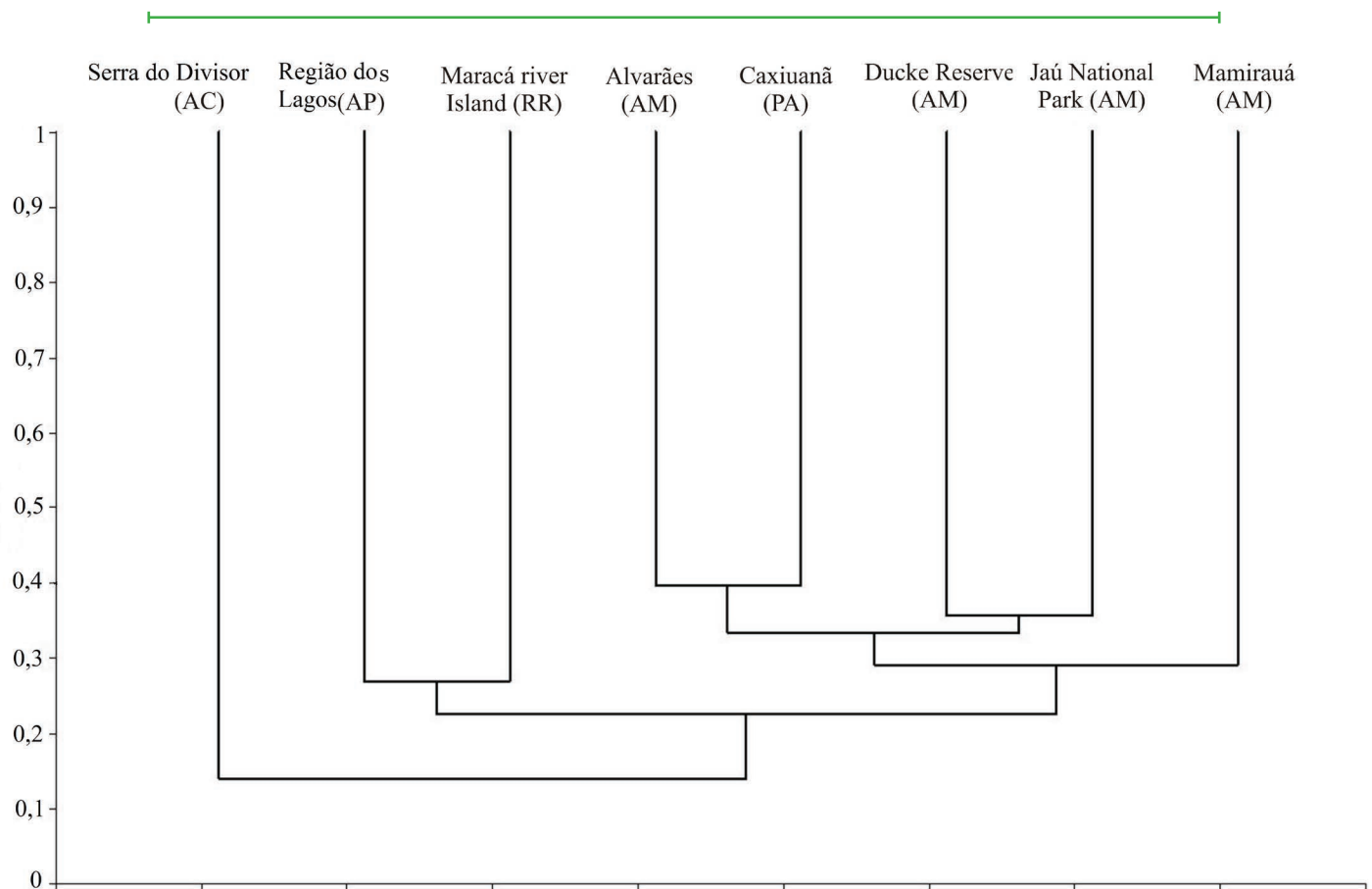


Figure 2. Dendrogram generated by Jaccard similarity coefficient for the species composition of Jaú National Park (AM) with other inventories in the Amazon Region: Ducke Reserve (AM), Alvarães (AM), Mamirauá Reserve (AM), Caxiuana Reserve (PA), Região dos Lagos (AP), Maracá River Island Ecological Station (RR) and Serra do Divisor National Park (AC).

hope that this work stimulate other surveys in Amazon Region.

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