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Original Paper

Distribution of *Pleroma asperius* (Melastomataceae) in Rio Grande do Sul, Brazil: spatial analysis for conservation strategies

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Abstract

Pleroma asperius is a shrubby Melastomataceae endemic to southern Brazil and threatened with extinction in the Rio Grande do Sul (RS) state. Aiming to better understand the distribution of the species in different environments in RS and contribute to its conservation, a literature review, searches on online platforms and field expeditions were carried out. From 270 records obtained, ninety-one presented location data and were treated as distinct occurrence points, six of them located in Conservation Units (CUs). Maps for *P. asperius* occurrence (82 non-overlapping points) were constructed, with layers referring to relief, biomes with phytogeographic regions, and hydrographic basins. Most points are below 50 m.a.s.l. in altitude (86.8%). The Pampa biome and Pioneer Formations have the highest percentages of occurrence points (74.4 and 71.9%, respectively). The interpolation of the occurrence points with environmental data characterized the preferential distribution of *P. asperius* in low-altitude areas, especially in wetlands and in the Pioneer Formations. These environments undergo intense changes by anthropic interventions. We draw attention to the low number of occurrence points in UCs. We still recommend to review the conservation status of *P. asperius*, include it for recomposing vegetation in degraded areas and create more CUs in the Pampa biome.

Key words: ecological niche, endemic species, pioneer vegetation, *Tibouchina asperior*.

Resumo

Pleroma asperius é uma Melastomataceae arbustiva, endêmica do Sul do Brasil e ameaçada de extinção no estado do Rio Grande do Sul (RS). Com objetivo de melhor compreender a distribuição da espécie nos diferentes ambientes do RS, contribuindo para a sua conservação, foram realizadas revisão bibliográfica, buscas em plataformas digitais e expedições ao campo. De 270 registros obtidos, noventa e um apresentaram dados de localização e puderam ser tratados como pontos de ocorrência distintos, dos quais seis localizados em Unidades de Conservação (UCs). Foram construídos mapas de ocorrência de *P. asperius* (82 pontos não-sobrepostos), com camadas referentes a relevo, biomas com regiões fitogeográficas, e bacias hidrográficas. A maioria dos pontos está abaixo de 50 m de altitude (86,8%). O bioma Pampa e as Formações Pioneiras tiveram as maiores porcentagens de pontos de ocorrência (74,4 e 71,9%, respectivamente). A interpolação dos pontos de ocorrência com dados ambientais caracterizou a distribuição preferencial de *P. asperius* em áreas de baixa altitude, especialmente em áreas úmidas e nas Formações Pioneiras no RS. Esses ambientes sofrem intensas mudanças por intervenções antrópicas. Nós chamamos atenção para o baixo número de pontos de ocorrência em UCs. Ainda recomendamos revisar o estado de conservação de *P. asperius*, incluí-la para recomposição da vegetação em áreas degradadas e criar mais UCs no Bioma Pampa.

Palavras-chave: nicho ecológico, espécie endêmica, vegetação pioneira, *Tibouchina asperior*.

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Introduction

Melastomataceae is the seventh largest family of angiosperms, with around 4,500 species worldwide (Santos *et al*. 2012), of which two-thirds are Neotropical (Clausing & Renner 2001; Goldenberg *et al*. 2012). The family has a high level of endemism in Brazil (Goldenberg *et al*. 2021) and plays an important ecological role as it serves as a source of pollen for many bees (Harter *et al*. 2002). Many species of Melastomataceae are suitable for restoration efforts due to the ecophysiological attributes of their seeds and seedlings (Silveira *et al*. 2013).

Pleroma asperius (Cham.) Triana, formerly considered a member of the genus *Tibouchina*, is a shrub species with very striking characteristics, such as showy flowers and hard and leathery leaves covered by very hard hairs (Fig. 1) (Souza 1986). Being endemic to Brazil, the species occurs in the states of Rio Grande do Sul and Santa Catarina (Guimarães 2021), restricted to the Atlantic Forest and Pampa biomes, mainly in humid locations (Souza 1986; Guimarães *et al*. 2019). These environments are characterized by flat areas with a period of flooding and a community of macrophytes that do not tolerate periods of soil drying (COMITESINOS 2022; Schulz *et al*. 2021). The Atlantic Forest and Pampa are highly impacted by human activities, such as land occupation for housing, agricultural production and industries (Steinke & Saito 2008; Burgueño *et al*. 2013; Cunha *et al*. 2015), which threatens natural populations of *P. asperius*. *Pleroma asperius* is

Figure 1 – a-e. *Pleroma asperius* in a natural environment – a. detail of flower; b. individuals at the edge of a water body; c. individuals forming clumps in an open, sunny field; d-e. individuals with stolons.

classified in the *Endangered* (EN) category on the Lista de Espécies Ameaçadas do Rio Grande do Sul (Rio Grande do Sul 2014).

The Atlantic Forest biome originally occupied about 40% of the state of Rio Grande do Sul (RS) but has been reduced to the present 2.69% (FEPAM 2022a). Furthermore, protected areas and remnants of this biome are highly fragmented by agricultural fields, roads and other human pressures, resulting in the isolation of native populations in forest fragments (Tabarelli *et al*. 2012). In Brazil, the Pampa biome is restricted to RS, occupying about 193,000 km^2, which corresponds to about 60% of the state's territory (IBGE 2019a; IBF 2022). According to the Ministério do Meio Ambiente (MMA 2021a), about 46% of its original area remains, which has been decreasing sharply in recent years, converted mainly into areas of agricultural cultivation. In addition, there is little representation of protected areas (PAs), which cover only 2.5% of the native fields of the Atlantic Forest and Pampa biomes (Brandão *et al*. 2007).

One of the priorities of researchers and organizations responsible for biodiversity conservation is to obtain and make available concrete and updated data on the geographic distribution of species (Marchioretto *et al*. 2004; Martins *et al*. 2020). For conservation to be effective, it is necessary to designate areas where plants species can be maintained and managed *in situ*. Among these are Conservation Units (CUs), areas that are legally established by the government in its three spheres (municipal, state and federal) (WWF 2022). According to Law No. 9,985, of July 18, 2000, which established the Sistema Nacional de Unidades de Conservação da Natureza (SNUC), CUs are defined as terrestrial and aquatic territorial spaces that have relevant natural characteristics, being determined with a view to conservation and the protection of their species and environmental resources (Brasil 2000).

In addition to designating the best locations for the implementation of CUs, studies on patterns of geographic distribution of populations are extremely important for a better spatial and ecological understanding of the biological diversity of plants (Marchioretto 2016). This, in turn, generates a greater understanding of floristic links between ecosystems, continental and intercontinental floristic relationships, the range of species distributions, the physical and ecological restriction of groups and endemism at restricted or large scales. Environmental characteristics can also be used in the study and management of biodiversity. Altitude, for example, comprises vertical distance measurements that show differences in relief (Tuler 2014), which have a direct influence on various abiotic factors and plant communities (Fritzsons *et al*. 2008; Dullius *et al*. 2018). The characteristics of phytoecological regions and biomes allow them to be used as units for the management and conservation of biodiversity, since they make up the landscape and are determined by geology, climate and species distribution (Coutinho 2006; IBGE 2019b; IBGE 2022a). Yet another example is hydrographic basins, which form territorial units directly related to the distribution of water in habitats and within which conservationist practices can be implemented through the integrated management of natural resources in relation to human activities (Santana 2003; Verdum *et al*. 2012).

Current knowledge of the occurrence of *P. asperius* is limited and little is known about its distribution in relation to habitat characteristics, making it difficult to define *in situ* conservation strategies. In this context, this study aimed to determine areas of occurrence of *P. asperius* in Rio Grande do Sul and construct maps to better understand the distribution of the species in the different environments of this state, and contribute to its conservation.

Material and Methods

A scientific literature review was carried out, from February 2020 to November 2021, searching for floristic surveys with records of the occurrence of *P. asperius* in RS. Searches were performed for articles available at Portal de Periódicos CAPES, Scielo, Scopus and Google Scholar, using for the keywords "*Lasiandra asperior*", "*Pleroma asperius*" and "*Tibouchina asperior*". Concomitantly, the online platforms of the Global Biodiversity Information Facility (GBIF 2022), the Virtual Herbarium REFLORA (2022) and the information system SpeciesLink (2022) were searched for records of *P. asperius* and its synonyms in the state.

Through the analysis of satellite images, obtained from Google Earth Pro (Google 2022), locations presenting vegetation with characteristics compatible with the possible presence of *P. asperius* were selected for field expeditions to the Coastal Hydrographic Unit and the Guaíba Hydrographic Unit (ANA 2017). Expeditions took place in February, March, April and May of

2020 and February, March, April, May, September, October and November of 2021, encompassing the reproductive period of the species.

Authorizations for the collection and transport of biological material were requested through a project submitted to the Instituto Chico Mendes de Biodiversidade - ICMBio via the electronic service system Sisbio, authorization nº 76834/1. Occurrence records for found populations of *P. asperius* were made through photographs, georeferencing of points and manual collection of branches (stem, leaves and, when present, fruits and flowers). Collected biological material was used for the preparation of exsiccates that were deposited at the Herbarium Anchieta - PACA, of the Instituto Anchietano de Pesquisas, of the Universidade do Vale do Rio dos Sinos, São Leopoldo (RS).

Records were classified into three groups: Group 1 - those acquired from scientific literature (books and research articles); Group 2 - those acquired from online platforms GBIF, REFLORA, SpeciesLink; and Group 3 - those acquired by field expeditions.

The descriptions available in the records (including the collections carried out in field expeditions in the present study) were used to classify each record according to: (1) subcategories of environment: (1a) open field (1b) forest edge; (1c) mosaic vegetation; (2) subcategories of habit: (2a) shrub; (2b) herb; (3) citation of the species as threatened (yes/no); (4) citation of road and highway proximity (yes/no); (5) citation of habitat as wetland (yes/no).

The percentage of records in each subcategory (P1) of the categories ambient and habit was calculated by the formula: $P1 = (NSC \times 100)/NC$, where NSC is the number of records in the respective subcategory and NC is the total number of records in the corresponding category. To calculate the percentages of records mentioning extinction risk, road proximity and/or the occurrence in wetland, was applied the formula: $P2 = (NP \times 100)/NC$, where NP is the number of positive records for a given mention (extinction risk, road proximity, occurrence in wetland) and NRC is the total number of records with mention to at least one of these characteristics.

To obtain occurrence points of the species in RS, duplicates of the same point/collection/collector that were in two herbaria or those records to which we were unable to assign a geographic coordinate were invalidated. For records without geographic coordinates, coordinate pairs were assigned whenever possible based on the information of the municipality (central coordinate) or locality informed in the record. The assignment of coordinate pairs was performed by verifying the information from the herbarium records and scientific publications, searching for locations on the Google Earth platform (Google 2022). This method follows the assumptions of Martinelli *et al*. (2018).

The occurrence points were plotted on a map of RS, using the ArcGIS 10.3 software, together with layers referring to relief (Weber *et al*. 2004), biomes (with phytogeographic regions) (MMA 2021a) and hydrographic basins (FEPAM 2022b). The resulting figures were analyzed to understand the occurrence of *P. asperius* in RS in relation to the environmental characterization obtained by the secondary data for the state. During this step, a new selection of occurrence points was performed, so that overlapping points that did not allow observation in the maps created were not considered for the calculations of the distribution of *P. asperius* in relation to environmental variables. Altitude data and spatial analysis of the occurrence points were obtained using Google Earth Pro (Google 2022). Occurrence percentages for *P. asperius* were calculated from the number of occurrence points in relation to a given environmental variable (altitude range, vegetation unit, hydrographic basin) divided by the total number of occurrence points recorded and maintained in this step according to the criteria described above.

Results

We obtained 232 occurrence records of *P. asperius* from online platforms. Data collected by scientific literature review identified eight occurrence records of the species in the municipalities of Osório (Boldrini *et al.* 2008), Pelotas (Venzke *et al.* 2018), Porto Alegre (Brack *et al.* 1998) Rio Grande (Costa *et al.* 2003; Kafer *et al.* 2011), Tapes, Palmares do Sul (Becker *et al.* 2007) and Torres (Dewes *et al.* 2021). Thirty occurrences of *P. asperius* were record by our field expeditions, from which samples were collected and taken to the herbarium for future studies (Tab. 1). Thus, a total of 270 records were obtained in our searches.

Of the total records of *P. asperius*, 120 (44.4%) mentioned extinction risk, road proximity and/or the occurrence in wetland (Tab. 2). The most common citation was the classification of the species as threatened with extinction, according to the state decree. The second most frequent mention

Table 1 – Municipalities, coordinates and voucher number of *Pleroma asperius* samples collected during field expeditions. The order of the data refers to the voucher number, which was determined by the temporal order in which the samples were collected.

Municipality	Latitude	Longitude	Voucher number
Sapiranga	51°1’43.43”O	29°37’54.31”S	119270
Sapiranga	51°2’8.41”O	29°38’26.29”S	119271
Sapiranga	51°2’6.78”O	29°38’42.28”S	119272
Sapiranga	50°58’34.79”O	29°39’19.61”S	119273
Sapiranga	50°58’30.13”O	29°39’48.30”S	119274
Campo Bom	51°1’49.81”O	29°40’32.42”S	119275
Nova Hartz	50°53’53.74”O	29°36’38.83”S	119276
Araricá	50°57’12.25”O	29°40’33.38”S	119277
Araricá	50°56’27.69”O	29°38’58.65”S	119278
Osório	50°13’48.63”O	29°58’4.18”S	119279
Osório	50°13’52.09”O	29°58’18.87”S	119280
Torres	49°43’3.82”O	29°19’51.98”S	119281
Camaquã	51°43’9.01”O	30°49’36.01”S	119282
Rio Grande	52°16’10.33”O	31°53’44.92”S	119283
Tapes	51°24’4.11”O	30°29’55.92”S	119284
Barra do Ribeiro	51°20’22.17”O	30°23’31.93”S	119285
Araricá	50°55’36.99”O	29°39’4.95”S	119286
Imbé	50°6’50.17”O	29°57’15.71”S	119287
Torres	49°46’24.95”O	29°22’18.03”S	119288
Arroio do Sal	49°48’23.98”O	29°26’33.35”S	119289
Osório	50°16’55.41”O	29°54’43.89”S	119290
Santo Antônio da Patrulha	50°30’15.70”O	29°52’47.68”S	119291
Viamão	50°39’55.19”O	30° 6’40.22”S	119292
Tavares	51° 2’49.88”O	31°16’6.14”S	119293
Capivari do Sul	50°27’26.55”O	30° 7’0.20”S	119294
Mostardas	50°50’48.53”O	31° 0’54.82”S	119295
Mostardas	50°27’23.85”O	30°30’50.09”S	119296
Palmares do Sul	50°28’47.65”O	30°17’51.39”S	119297
Osório	50°21’7.00”O	29°59’21.00”S	119298
Novo Hamburgo	51° 6’34.50”O	29°41’15.33”S	119299

Table 2 – Categories of environmental characteristics and habit of *Pleroma asperius* in Rio Grande do Sul, Brazil.

Category		Number of records [1]	% [2]	Total number of records [3]
Threat of extintion		71	59.2	120
Roadside		22	18.3	120
Wetland		43	35.8	120
Ambient	Forest edge	17	23.6	72
	Open field	43	59.7	72
	Mosaic	12	16.7	72
Habit	Shrub	62	86.1	72
	Herb	10	13.9	72

Number of records [1] = absolute number of records with the respective mention; % [2] = percentage of records with the respective mention in the correspondent category; Total number of records [3] = sum of records in the category.

was that the plants collected occurred in humid areas, followed by the mention of plant occurrence near to roads and highways (Tab. 2). Fields were the most cited environment, followed by forest edges and mosaic areas. As for habit, most plants were classified as shrubs or subshrubs, although some records classified the plants as herbs (Tab. 2).

The plants observed during the field expeditions could be easily identified by the shape of the clumps, were usually observed with a bushy habit, have purple flowers and prominent yellow stamens (Fig. 1b-c). We recorded for the first time that many individuals were propagating vegetatively, with the presence of stolons and clump formation (Fig. 1d-e).

Ninety-one records of the 270 had location data and could be treated as distinct points of occurrence (33.7% of total records). The analysis revealed that six occurrence points (6.6%) are located in CUs, which are the Área de Proteção Ambiental do Banhado Grande (state CU, Viamão), the Área de Relevante Interesse Ecológico Henrique Luís Roessler (municipal CU, Novo Hamburgo), the Estação Ecológica do Taim (federal UC, Santa Vitória do Palmar), the Parque Estadual de Itapeva (state CU, Torres), the Parque Estadual de Itapuã (state CU, Viamão) and the Refúgio de Vida Silvestre Banhado dos Pachecos (state CU, Viamão). The Área de Proteção Ambiental do Banhado Grande is a new record, obtained during the field expeditions. A record found in the literature (Venzke *et al.* 2018) describes that one of the occurrence points is in planning for the implementation of a new CU, which should complete seven CUs in RS with the occurrence of *P. asperius*.

Pleroma asperius occurs in the region of RS with the lowest relief. The average altitude of the occurrence points was 28.4 m and data reveal that of all 91 occurrence points of the species, 79 (86.8%) are located in areas at altitudes below 50 m.a.s.l. and only 12 (13.2%) in areas above. Of these 12, five points (5.5% of the total) are located in areas with altitudes above 100 m.a.s.l., in the municipalities of Canguçu (30°59’59”S, 52°25’40”W), Viamão (30°04’51.96”S, 51°01’23.16”W), Santo Antônio da Patrulha (29°49’03”S, 50°31’10.92”W), Herval (32°01’24.97”S, 53°23’44.16”W) and Encruzilhada do Sul (30°32’38.04”S, 52°31’18.84”W), the last being the highest point of occurrence (426 m.a.s.l.). Of the 91 occurrence points, 82 did not present overlaps in the generated maps and were maintained for the environmental calculations. These points can be seen in Fig. 2, where they were interpolated on the RS altitude map. It is observed that most of the occurrence points of *P. asperius* are in areas of low altitude as confirmed by our calculations (Fig. 2).

The Pampa is the biome with the greatest number of occurrence points of *P. asperius* with 61 (74.4% of the total). The phytogeographic region with the greatest representation of the species are Pioneer Formations, with 59 occurrences (71.9% of the total records). In second place, only 16 occurrences (19.5% of the total records) are

located in Seasonal Semideciduous Forest (Fig. 3). The species also occurs in Steppe and Seasonal Deciduous Forest (4.9 and 3.7%, respectively), while there are no records for Mixed Ombrophilous Forest and Dense Ombrophilous Forest.

Occurrence of *P. asperius* was recorded in 11 hydrographic basins of the RS. The Rio Tramandaí Basin presented the highest number of occurrence points (Fig. 4), followed by the Litoral Médio basin, respectively with 18 and 16 points and representing 22.0 and 19.5 % of the total. The Rio dos Sinos and Lagoa Mirim-São Gonçalo basins had 11 points each, representing 13.4% of the total points, respectively (Fig. 4). The basins with the lowest number of points of occurrence of *P. asperius* were the Rio Mampituba and the Rio Caí, with one point each and representing 1.2% of the total, respectively.

Discussion

The data obtained by the present study increase the scientific understanding of the occurrence of *P. asperius*, as well as the amount of material available in biological collections, thus contributing to future studies. Although 91 occurrence points were found here for *P. asperius* in RS, only six are within CUs, all in the Pampa biome. The "Priority Areas for Conservation, Sustainable Use and Benefit Sharing of Brazilian Biodiversity", revised in 2018 (MMA 2022a), include 105 areas of the Pampa biome, of which 39% are considered to be of extremely high biological importance. However, the Pampa represents only 0.4% of Brazil's continental area protected by the National System of Conservation Units (MMA 2022b). Nevertheless, this biome covers 63% of the territory of RS and has already lost 49% of its native vegetation cover, especially due to agribusiness, impacting the originally rich biological diversity (Brentano *et al*. 2015). The UCs are relevant protection elements as they limit the expansive landscape de-characterization.

The limited amount of biological material of *P. asperius* represented in CUs may be related to ineffective control and management of the protected areas in the study areas. Rocha & Rocha (2019) argue that the vast majority of state CUs do not have a management plan, due to the lack of qualified professionals and scarcity of public financial incentives, requiring the creation of actions and management strategies in these areas. According to data from the Secretaria do Meio Ambiente e Infraestrutura of Rio Grande do Sul

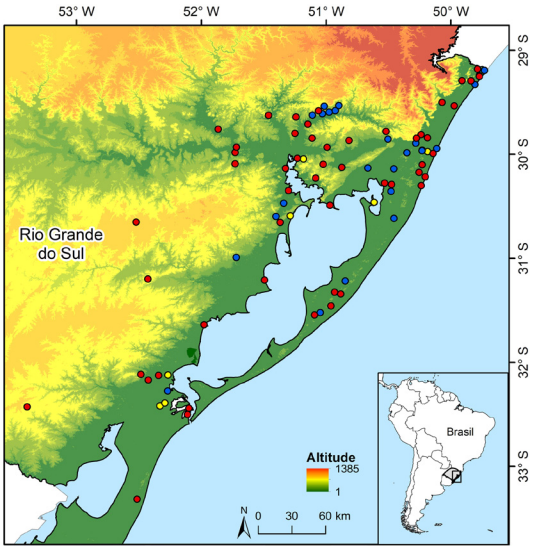

Figure 2 – Relief of the state of Rio Grande do Sul with occurrence points of *Pleroma asperius*. Red dots are occurrence records from biological collections; blue dots are occurrence records made during field expeditions; yellow dots are occurrence records from scientific literature.

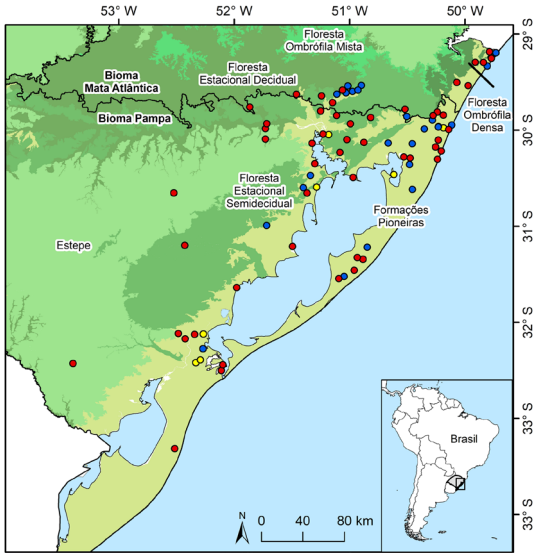

Figure 3 – Atlantic Forest and Pampa biomes and phytogeographic regions in the state of Rio Grande do Sul with occurrence points of *Pleroma asperius*. Red dots are occurrence records from biological collections; blue dots are occurrence records made during field expeditions; yellow dots are occurrence records from scientific literature.

(SEMA), only 12 state CUs have a management plan, which represents 50% of the State CUs under public administration (SEMA 2022b). Along with this is a tendency to neglect herbaceous and shrub species in vegetation surveys, as they are not legally required to be considered for forest compensation calculations (Rio Grande do Sul 2018), which may also be responsible for the low number of occurrence points of *P. asperius* in CUs. Recently the list of endangered native species in Brazil was instituted, as an incentive to use these species in programs of vegetation restoration in degraded or altered areas (MMA 2021b). However, because *P. asperius* is classified as *Least concern* (LC) at the national level (CNCFlora 2012a), it does not fit the requirements to compose this list. There is no equivalent legislation in RS, a state in which *P. asperius* is considered *Endangered* (Rio Grande do Sul 2014).

The justification for the *Least Concern* status of *P. asperius* at the national level is its wide geographic distribution and its protection in CUs (CNCFlora 2012a). However, the species has its occurrence concentrated mainly in Rio Grande do Sul besides a few localities in the states of Santa Catarina and São Paulo (CNCFlora 2012a). Furthermore, the occurrence of *P. asperius* in CUs

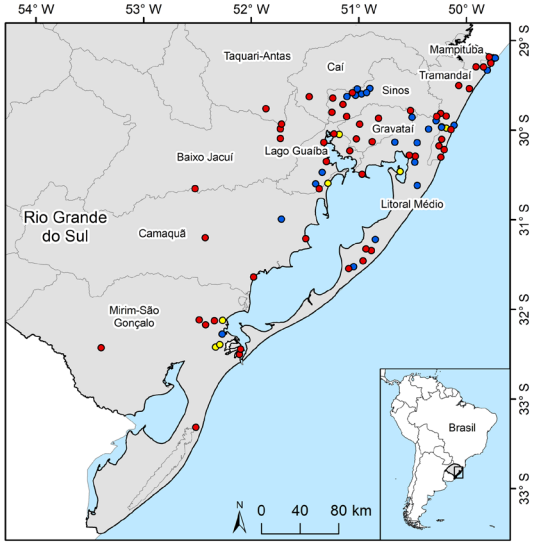

Figure 4 – Hydrographic basins in the state of Rio Grande do Sul with occurrence points of *Pleroma asperius*. Red dots are occurrence records from biological collections; blue dots are occurrence records made during field expeditions; yellow dots are occurrence records from scientific literature.

in RS is not representative enough, which is in agreement with its categorization as *Endangered* by the Lista de Espécies Ameaçadas do Rio Grande do Sul (Rio Grande do Sul 2014). According to the criteria of the International Union for Conservation of Nature (IUCN 2022), which are adopted for the lists of threatened species in Brazil, a taxon has the status of *Least Concern* when it does not fit into the categories of threat, is abundant and widely distributed. No records in the literature indicate that *P. asperius* was evaluated based on the five criteria adopted by the IUCN (2022). Due to the limited data on the species, we consider categorizing it as *Data Deficient* (DD) according to IUCN (2022). *P. asperius* is still not sufficiently known regarding its biology (vegetative and reproductive) and its population attributes. The inclusion of *P. asperius* in DD would point to the need for studies that make it possible to conclude on its proper classification.

The present study revealed that the distribution of *P. asperius* is strongly related to landscape relief. Most records of the species are associated with zones at altitudes of up to 50 m.a.s.l., and only five points of occurrence were at altitudes above 100 m.a.s.l. Thus, even with the relatively low average altitude (177 m.a.s.l.) of the relief of RS, with the exception of the Planalto Norte Rio-Grandense, which ranges from 700 to 1,300 m.a.s.l. (Becker & Nunes 2012; Yamazaki *et al*. 2017), the species has its widest distribution in areas lower than the state average.

The occurrence points of *P. asperius* are predominantly in lowlands and most of those obtained during field expeditions were located in wetland areas or on the edge of water bodies, corroborating with information available in the literature on the species (Souza 1986; Guimarães *et al*. 2019; Guimarães 2021). This same pattern was observed for *Clidemia urceolata* DC. (Miranda *et al*. 2011) and *Pterolepis perpusilla* (Naudin) Cogn. (Renner 1994; CNCFlora 2021b), two Melastomataceae which occur preferentially in sites of water runoff such as wet lake shores and seasonal flooded or swampy areas. Wetlands form in flat regions produced by sedimentation from nearby water bodies, such as lakes, lagoons, rivers, outcrops of the water table and rainfall (Carvalho & Ozorio 2007). Soil slope acts on environmental conditions, such as humidity and nutrient deposition, and lower places tend to have greater water availability and higher concentrations of organic matter, which directly influence the plant community (Cardoso & Schiavini 2002). Thirty-

six percent of the 120 occurrence points obtained from the survey of the herbarium collections that mentioned extinction risk and/or environmental characteristics cited presence of *P. asperius* in wetland, reinforcing the observations in field expedition.

Due to being classified in the *Least Concern* category, *P. asperius* is also not included in the National Action Plan for the Conservation of Lake and Lagoon Systems in Southern Brazil (MMA 2018), whose objective is to improve the conservation status of threatened species and environments in the coastal estuarine-lagoon complex of RS and Santa Catarina. However, the species may be indirectly benefiting from the conservation and environmental education actions promoted by researchers and citizens of the involved locations, since more than 75% of the occurrence points recorded in the present study are within the geographic limits contemplated by this plan.

The greater number of *P. asperius* records for the Pampa biome, when compared to the Atlantic Forest biome, reinforces a preference by the species for areas of restinga forest and clean and humid grasslands, as already reported in the literature (Guimarães *et al*. 2019). The Pampa biome is characterized by a predominance of native grasslands and extensive representation of wetlands (MMA 2022c), in addition to occupying the largest proportion of RS at about 63% of the territory (IBGE 2019b; IBF 2022). The Atlantic Forest, in turn, occupies a smaller area in RS (FEPAM 2022a) and has a higher incidence of arboreal vegetation, high relief and greater water flow dynamics (IESB 2007), ecological characteristics that may hinder the establishment of *P. asperius*.

Some of the records of *P. asperius* are located in, or close to, the political zone that surrounds the Atlantic Forest biome in RS (IBGE 2019a) and in the area of Pioneer Formations. This zone is characterized by open fields with floodable areas and restinga vegetation (Cordeiro & Hasenack 2009). Therefore, even though located within the Atlantic Forest, the characteristics of these environments can still be considered favorable for the development of *P. asperius*. Along with this, the Atlantic Forest biome is considered a biodiversity hotspot and is even included in the Brazilian constitution as national heritage such that its use must ensure environmental preservation (Brasil 1988). For this reason, data on the occurrence of *P. asperius* within this biome are important for decision making for environmental preservation projects.

The phytogeographic region with the second highest *P. asperius* occurrence is Semideciduous Seasonal Forest. Unlike Pioneer Formations, the climate of this region favors the growth of deciduous tree species, which form canopy forests (IBGE 2012; Jurinitz & Jarenkow 2003). However, the landscape of this region has been significantly transformed into a rural anthropic landscape, with 80% of its total area being covered by agricultural physiognomies (Cordeiro & Hasenack 2009). *P. asperius* occurs at the edges of forest fragments, in swampy and poorly drained areas (Luz *et al*. 2014). For this reason, the suppression of tree species for agriculture and livestock, and the proximity of records to the area of Pioneer Formations, may have contributed to the establishment of the species in the area.

Another important dataset comprises occurrence points of *P. asperius* in storm drains along roadsides and rural roads. Factors such as land cover change for livestock farming and road construction can interfere with the natural processes of local water runoff and put pressure on biological communities to establish themselves in small ecological niches (Tucci & Clarke 1997; Foley *et al*. 2005; Roveder *et al*. 2009), in addition to contributing to reduced plant diversity when compared to preserved areas (Rocha & Vale 2017). Such plants may have adapted to the sunny conditions that these environments close to roads provide, since populations of the genus can be found in environments with high exposure to sunlight (Justino *et al*. 2021). The records of *P. asperius* in these altered locations may reflect a pressure experienced by the species to establish itself in modified areas of the natural environment where it originally occurred. There have been no studies assessing the health of the remaining populations of *P. asperius*, or even the reproductive capacity of these plants. This situation, in which populations live under altered conditions, may place the species at an even greater risk of vulnerability.

The record of asexual reproduction by stolons is unprecedented for the species. These structures are lateral stem axes that grow parallel to the soil surface and are capable of forming a new plant (Gonçalves & Lorenzi 2011) or even acting as protective organs. A previous record of stolons for Melastomataceae was provided by Ferreira & Conceição (2012) when they showed that vegetative

growth by stolons aids the regrowth of *Marcetia taxifolia* (A.St.-Hil.) DC. after fire events. Although sexual reproduction is essential in assuring adaptive potential in the face of environmental adversities due to the genetic diversity of individuals in a population (Ribeiro & Rodrigues 2006), vegetative propagation in *P. asperius* can be an important alternative for the survival of these plants. Stolon formation may indicate a strategy for coping with the environmental stress to which individuals may be exposed.

The hydrographic basins that have the greatest representation of occurrence points of *P. asperius* are located in the north of the Coastal Plain and east of the Central Depression of RS. However, the vegetation of Pioneer Formations, which seems to constitute more favorable environmental conditions for the establishment of the species, extends to the extreme south of RS (Cordeiro & Hasenack 2009). This greater occurrence in the north of the Coastal Plain and east of the Central Depression may reflect larger sampling due to greater human proximity. With intense human occupation comes the establishment of residential subdivisions and the designation of sites for the construction of buildings for industry, commerce and agricultural production. Such development requires environmental studies for the correct installation of projects (Rio Grande do Sul 2018). The Rio Tramandaí Hydrographic Basin has high concentration of people and is heavily urbanized, when compared to other coastal hydrographic basins in RS (SEMA 2022a). In addition, many municipalities belonging to this watershed are part of the North Coast region of RS and are intensively used for seasonal tourism (Strohaecker *et al*. 2006). The Litoral Médio Hydrographic Basin is also highly populated and some of its coastal municipalities are also heavily used for ecotourism, mainly due to the presence of the Parque Nacional da Lagoa do Peixe (Pinheiro & Silva 2018; SEMA 2022b). The Rio dos Sinos Hydrographic Basin has the highest human occupation in the state and great industrial concentration (IBGE 2022b; SEMA 2022a).

The Coastal Hydrographic Unit and the Guaíba Hydrographic Unit, which make up the RS portion of the South Atlantic Hydrographic Region (ANA 2017), cover all occurrence points of *P. asperius*. Although the South Atlantic Hydrographic Region still integrates the coastal region of the state of Santa Catarina, its predominant area is in RS. This hydrographic region is characterized by high urbanization (88% of the total area). Its population density (70 inhabitants km^{-2}) is about three times higher than the Brazilian national average (ANA 2017). The high number of inhabitants and land use may be some of the factors responsible for reducing the occurrence of *P. asperius* populations in RS, which are strongly related to water. The main uses of water in the South Atlantic Hydrographic Region are irrigation (66%) and industrial activities (19%) (ANA 2017). Moreover, the occurrence points in the Guaíba Hydrographic Unit are positioned very close to some of the main cities in the state, further aggravating the conservation status of *P. asperius*. Several points of occurrence were recorded in the middle and lower stretches of the Rio dos Sinos Hydrographic Basin, both with several wetlands (COMITESINOS 2022; SEMA 2022a). Due to the presence of *P. asperius*, there are several areas, including urbanized and metropolitan matrices, that are priorities for conservation of the species in RS.

The present study provides an overview of the distribution of *P. asperius* in RS based on data available in scientific literature, herbarium collections and field expeditions. The use of geographic information tools allowed the interpolation of environmental data with plant occurrence records, showing the environmental preferences of the species and contributing not only to its *in situ* conservation, but also to the design of *ex situ* conservation strategies.

The distribution of *P. asperius* in low-altitude areas and in Pioneer Formations demonstrates the importance of wetlands for the establishment of populations. The more records in hydrographic basins in the north of the Coastal Plain and east of the Central Depression may be related to the significant representation of wetlands and the high supply of water in these regions. However, these areas are the most anthropized and altered of the RS, which can worsen the conservation status of the species.

We alert to: (i) the evidence of the restricted distribution of *P. asperius* in Brazil; (ii) the occurrence of the species in highly anthropized and degraded natural environments that may lead to the disappearance of populations in short term; (iii) the low record in protected areas, which deserves attention and requires the creation of new sites for environmental preservation, as pointed for one record described in our study. We propose including *P. asperius* in species lists for recomposing native

vegetation in degraded or altered areas and reviewing its conservation status at the state and national level, considering that the current lists of threatened species were published about ten years ago. Detailed population studies should support the categorization of the species based on the criteria adopted in the red lists.

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