

## Biology-Botany

# Phenotypic plasticity of *Miconia chamissois* Naudin (Melastomataceae) in a gallery forest and humid grassland of Central Brazil

Plasticidade fenotípica de *Miconia chamissois* Naudin (Melastomataceae) em floresta de galeria e campo sujo úmido do Brasil Central

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## ABSTRACT

We investigated the influence of soil physicochemical parameters on variations in shrub architecture and foliar characteristics of *Miconia chamissois* Naudin in both a gallery forest and humid grassland in the southern region of the state of Goiás, central Brazil. Our study aimed to address the following questions: 1) Is there a difference in the shrub architecture and leaf characteristics of *M. chamissois* between gallery forests and humid fields? 2) What is the relative importance of soil physicochemical parameters in determining phenotypic patterns? We selected 30 individuals from each phytophysiognomy and analyzed their shoot system architecture and leaf characteristics. Soil samples were additionally collected to analyze physical-chemical parameters such as soil humidity, temperature, and slope of the land near each sampled specimen. Individuals from the gallery forest exhibited more significant variation in shrub architecture and leaf characteristics than those from the humid grassland. Specimens of *M. chamissois* in the gallery forest displayed higher leaf area, total height, canopy length, canopy width, and canopy area values, whereas those in the humid grassland exhibited longer leaves. However, variations between individuals were more pronounced between phytophysiognomies than within them, indicating an environmental effect on shrub architecture, particularly leaf characteristics. Soil physicochemical parameters were found to be primarily responsible for the observed variation in leaf traits. Our results reveal that specimens of *M. chamissois* from the gallery forest have different shrub architecture and leaf characteristics than those from the humid grassland, such as leaf area, crown length, and total height, among others. These results are associated with soil physicochemical parameters (moisture, slope, sand and silt) and corroborate the existence of phenotypic plasticity in *M. chamissois* populations in anthropic landscapes in Central Brazil.

**Keywords:** Functional traits; Riparian vegetation of Cerrado; Wetlands

## RESUMO

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Nós investigamos a influência de parâmetros físico-químicos do solo nas variações na arquitetura arbustiva e nas características foliares de *Miconia chamissois* Naudin em uma floresta de galeria e campo sujo úmido no sul do estado de Goiás, Brasil Central. Nosso objetivo foi responder às seguintes questões: 1) Existe diferença na arquitetura arbustiva e nas características foliares de *M. chamissois* entre florestas de galeria e campos úmidos? 2) Qual a importância relativa dos parâmetros físico-químicos do solo na determinação de padrões fenotípicos? Seleccionamos 30 indivíduos em cada fitofisionomia e analisamos a arquitetura do sistema caulinar e as características foliares. Também coletamos amostras de solo para analisar parâmetros físico-químicos, como umidade e temperatura do solo, e declividade do terreno próximo a cada espécime amostrado. Os indivíduos de floresta de galeria variaram mais do que os do campo sujo úmido em relação à arquitetura arbustiva e características foliares. Espécimes de *M. chamissois* encontrados na floresta de galeria apresentaram maiores valores de área foliar, altura total, comprimento de copa, largura de copa e área de copa, enquanto aqueles encontrados no campo sujo úmido apresentaram folhas mais longas. No entanto, as variações entre os indivíduos foram maiores entre as fitofisionomias do que dentro delas, mostrando um efeito do tipo de ambiente na arquitetura arbustiva e, principalmente, nas características foliares. Os parâmetros físico-químicos do solo foram responsáveis pela maior variação associada aos caracteres foliares. Nossos resultados revelam que espécimes de *M. chamissois* da floresta de galeria possuem arquitetura arbustiva e características foliares diferentes daqueles do campo sujo úmido, como por exemplo a área foliar, o comprimento da copa, a altura total entre outros. Esses resultados estão associados a parâmetros físico-químicos do solo (umidade, declividade, areia e silte) e corrobora a existência de plasticidade fenotípica em populações de *M. chamissois* em paisagens antrópicas do Brasil Central.

**Palavras-chave:** Traços funcionais; Vegetação ripária do Cerrado; Áreas úmidas

## 1 INTRODUCTION

Phenotypic plasticity is the ability of a single genotype to express two or more phenotypes in response to environmental changes, which may be an important mechanism for responding to climate change (Nicotra et al., 2010; Franks et al., 2014). Plasticity can be significant for plants to respond to changing environmental conditions (Pigliucci & Preston, 2004), as climate instability intensifies agricultural and ecological challenges to plant performance. Increasing attention is being directed towards understanding the natural mechanisms of plant resilience (Mackenzie & Kundariya, 2019).

Plasticity is better understood as a multivariate process since it involves correlated alterations in multiple traits (Murren et al., 2015). It can influence natural selection patterns and facilitate adaptation to new environments (Moczek et al., 2011; Wund,

2012; Lind et al., 2015). The variety in foliar features is crucial for developing species in diverse habitats, as it enables plants to adapt to different environmental stressors (Valladares et al., 2006; 2007). The capacity of plants to occupy different environments is possible due to phenotypic plasticity, which is fundamental for species survival in heterogeneous environments, as found in the vegetational mosaic that consists of the Cerrado biome (Pearcy et al., 2004; Valladares et al., 2007).

The Cerrado biome vegetation is determined by several environmental factors, mainly edaphic, radiative, variations in the rainfall regime, and soil depth (Rossatto et al., 2012). Gallery forests and humid grasslands occur within the Cerrado's wetlands (Ribeiro & Walter, 2008), with *Miconia* Ruiz & Pav. (Melastomataceae) being one of the most representative genera in these environments (Goldenberg et al., 2024), and subjected to different environmental processes and stresses as a function of the heterogeneity degree of vegetation fragments where it occurs (Marques, 2015). About 20 % of Brazil's territory consists of wetlands, which vary in size and shape and are distributed across the country (Cunha et al., 2015). These wetlands serve as habitats for specific plant and animal species that have adapted to their unique hydrological conditions (Junk et al., 2014).

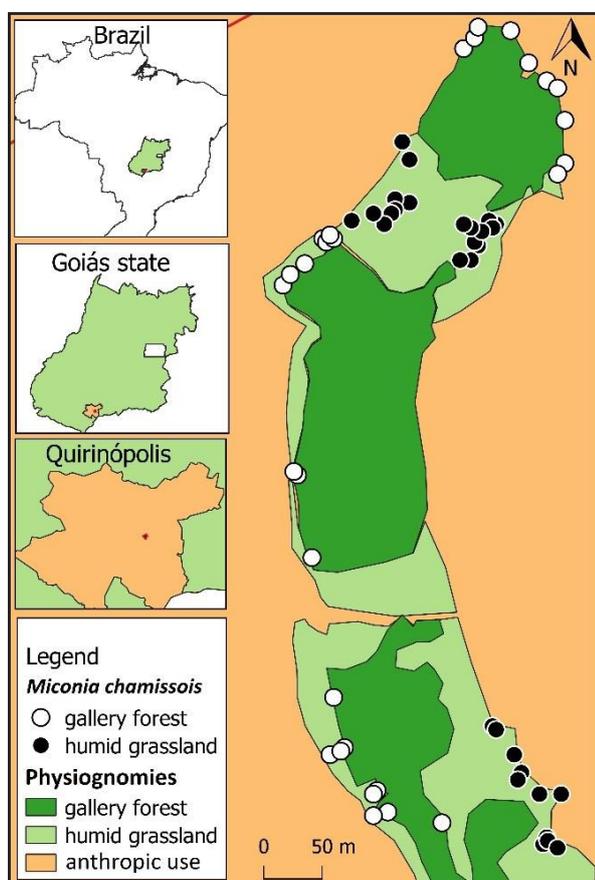
In this study, we investigated the phenotypic plasticity of *M. chamissois* Naudin in an anthropized landscape formed by gallery forests and humid grasslands in central Brazil. *Miconia chamissois* occurs with high abundance and coverage in secondary vegetation of riparian zones. It also presents high potential for restoration since it functions as a nucleating species, providing resources to pollinators and seed dispersers from nearby fragments (Albuquerque et al., 2013). We evaluated shoot architecture and foliar traits of individuals present in both environments and evaluated the influence of soil physicochemical parameters on phenotypic patterns. We aimed to answer the following questions: 1) Is there a difference in the shrub architecture and foliar traits of *M. chamissois* between gallery forests and humid grasslands? Our hypothesis is that *M. chamissois* individuals in gallery forests will have higher

values of shoot architecture and foliar characteristics compared to individuals in wet grasslands; 2) What is the relative importance of soil physicochemical parameters in determining phenotypic patterns? Our hypothesis is that individuals of *M. chamissois* will exhibit adaptive responses to different soil conditions, resulting in changes to the shoot architecture and foliar structure.

## 2 MATERIAL AND METHODS

### 2.1 Study site

Figure 1 – Location of the study area in the municipality of Quirinópolis, State of Goiás, central Brazil, highlighting *Miconia chamissois* individuals in the humid grassland and at the edge of the gallery forest



Source: The authors (2023)

The study was conducted in an anthropogenic landscape (~39.7 ha) covered by gallery forest and humid grassland phytophysionomies located at the headwater of the Formiga stream (18°26'41.40" S and 50°25'16.24" W) in the urban area of the municipality of Quirinópolis, southern State of Goiás, central Brazil (Figure 1). The soil on the left bank of the stream is primarily used for pasture areas, while on the right bank it is used for a combination of pastures, residences, and mostly for a plot of land that is currently being marketed. The altitude at the site ranges from 553 to 567 m. The average annual temperature is 21°C, and the monthly averages vary little during the year. The average rainfall is 1,400 mm/year and irregularly distributed throughout the year, with the highest incidence from November to April (Galinkin, 2003).

## **2.2 *Miconia chamissois*: shoot architecture and leaf traits**

*Miconia chamissois* is a shoot or tree occurring from Mexico to Argentina in the Neotropics, including in most Brazilian geographic regions (North, Northeast, Central-West, South, and Southeast Brazil) (Goldenberg et al., 2013, 2024). It is abundant in both gallery forests and humid grasslands in the shoot form. We measured 60 *M. chamissois* individuals (height in meters: minimum = 0.6, maximum = 3.3, mean =  $1.89 \pm 0.55$  SD) from November 2018 to January 2019, with 30 individuals from a gallery forest and another 30 from a humid grassland (Figure 1). Measurements were taken with the use of a measuring tape for shrub architecture [total height (TH), crown length (CL), crown width (CW), and crown area (CA =  $CW \times CL \times \pi/4$ )], according to Poorter and Bongers (2006). Ten leaves were randomly collected from each individual, spanning from the stem to assess leaf characteristics, amounting to 300 leaves for the gallery forest and an additional 300 for the humid field. Fully expanded leaves were collected with no signs of herbivory or damage caused by pathogens to minimize interference of the leaf development stage on its dimensions. The collected leaves were packaged in

closed plastic bags until the functional traits of lamina length (LL) and width (LW), as well as the petiole length (PL) were measured.

All measurements were taken with the use of a digital caliper. We considered length as the distance between the petiole insertion point in the leaf blade and the leaf apex, and width as the largest dimension perpendicular to the leaf length axis. We used the mean values based on the ten leaves to represent the leaf traits. We adapted the methodology by Barros et al. (1973) to estimate the leaf area, which used the gravimetric method described by Kemp (1960) and Huerta and Alvim (1962) as standard, then correlating the values found to those obtained with the dimensions of the rectangles circumscribed to the leaf blades by linear regression. Thus, we multiplied the length by the width and decreased 30% of the obtained area to calculate the leaf area.

### **2.3 Environmental heterogeneity**

The environmental heterogeneity in the gallery forest and the humid grassland was evaluated using temperature, humidity and slope data, which are the explanatory variables in the present study. Soil humidity and temperature were measured using the TDR probe, which was placed at a depth of 5 cm in the soil at the base of each shrub individual. The slope was measured using a Haglof digital clinometer. The soil for the physical and chemical analyses was collected at a depth of 10 cm, totaling 60 samples, with 30 in the gallery forest and 30 in the humid grassland. The soil samples were analyzed at the Soil Analysis and Foliar Laboratory of the School of Agronomy and Food Engineering of the Universidade Federal de Goiás according to the methodological procedures recommended by Teixeira et al. (2017). We analyzed the particle size of the soil (sand, silt, and clay) and the following macronutrients: Copper (Cu), Iron (Fe), Manganese (Mn), Zinc (Zn), Organic Matter (OM), Hydrogen Potential (pH), Phosphorus (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Exchangeable Acidity (H+Al), Aluminum (Al),

Cation Exchange Capacity (CEC), Aluminum Saturation Percentage (M%), Base Saturation Percentage (V%), Calcium Magnesium Ratio (Ca/Mg), Magnesium Potassium Ratio (Mg/K), Calcium Potassium Ratio (Ca/K), Calcium cation exchange capacity (Ca/CEC), Magnesium cation exchange capacity (Mg/CEC), and Potassium cation exchange capacity (K/CEC).

## 2.4 Statistical analyses

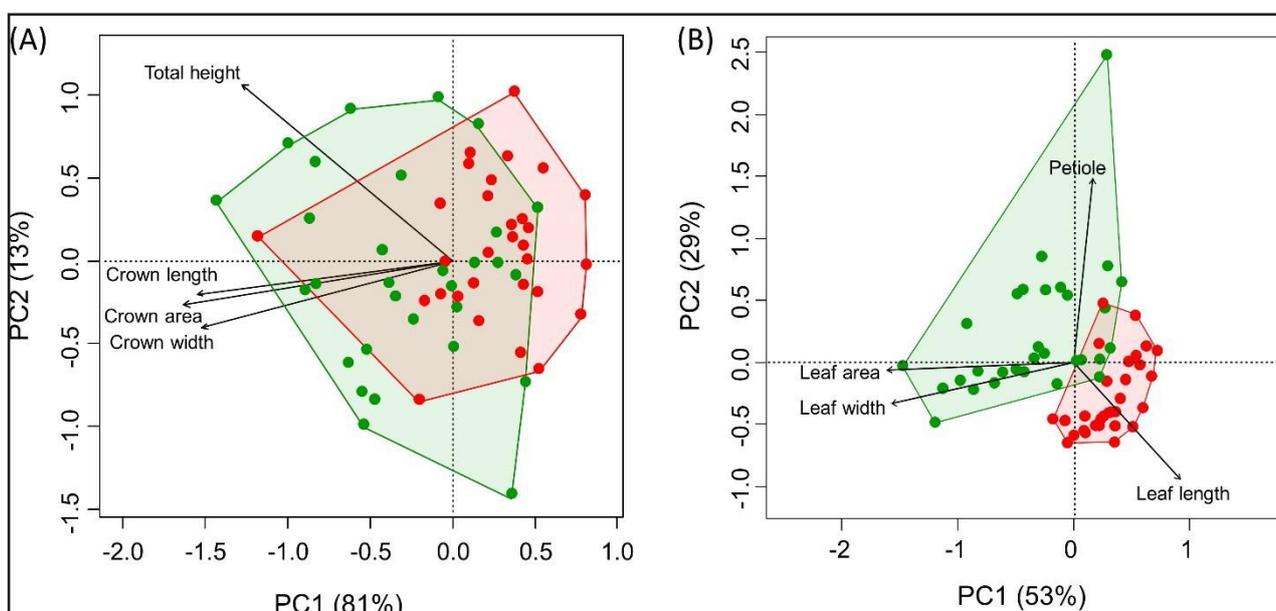
We initially ordered the phenotypic parameters obtained for the two groups (shoot architecture and foliar traits) using the Principal Component Analysis (PCA) to investigate the differences in the shoot architecture and foliar traits of the *M. chamissois* individuals in the gallery forest and humid grassland, and then tested the effect of the environment on the distance matrix using the Permanova analysis. Next, we standardized the magnitude of all investigated variables (shoot architecture, leaf traits, physical and chemical soil parameters) using the decostand function (standardize criterion) to investigate the influences of the physical and chemical soil variables on shoot architecture and foliar traits of *M. chamissois*. We used the Nonmetric Multidimensional Scaling (NMDS) to sort the phenotypic attributes of *M. chamissois*, considering maximum stress of 0.2. Then, we used the envfit function to test the linear relationships of the soil physicochemical variables (predictor variables) with the NMDS axes (response variables: phenotypic attributes). All multivariate analyses were performed using the vegan package (Oksanen et al., 2019) in the R environment (R Development Core Team R, 2021).

## 3 RESULTS

The first two PCA axes for shoot architecture and foliar traits extracted 94% and 82% of phenotypic variation, respectively (Figure 2A and B). The *M. chamissois* individuals from the gallery forest exhibited greater variation in shrub architecture and foliar characteristics than those from the humid grassland. Those in the gallery

forest exhibited greater leaf area, total height, crown length, crown breadth, and crown area measurements (Figure 2A). In contrast, the ones in the humid grassland exhibited longer leaves (Figure 2B). However, the variations of the individuals were greater among the phytophysiognomies than within them, showing that there is an effect of the type of environment on the shoot architectural traits ( $R^2 = 0.25$ ,  $p = 0.001$ ), and mainly on the foliar traits ( $R^2 = 0.28$ ,  $p = 0.001$ ).

Figure 2 – Principal Component Analysis (PCA) ordering individuals of *Miconia chamissois* in the gallery forest (green dots) and humid grassland (red dots) according to shoot (A) and foliar (B) traits in an anthropized landscape in the southern State of Goiás, central Brazil



Source: The authors (2023)

Physical soil parameters accounted for 34% of the ordering (two NMDS axes) of the shoot architectural traits of *M. chamissois*. Still, only slope showed a significant association ( $R^2 = 0.10$ ,  $p = 0.047$ ) with the components (Table 1, Figure 3A). On the other hand, physical soil parameters accounted for 83% of the variation associated with the two NMDS axes referring to foliar traits (Table 1, Figure 3B). Specifically, humidity ( $R^2 = 0.12$ ;  $p = 0.016$ ), slope ( $R^2 = 0.12$ ;  $p = 0.023$ ), and silt ( $R^2 = 0.16$ ;  $p = 0.011$ ) were positively associated with leaf traits of the humid grassland individuals, while the sand in the soil

percentage was significantly ( $R^2 = 0.28$ ;  $p = 0.0031$ ) associated with leaf traits of the plants from the gallery forest (Figure 3B).

Table 1 – Results of linear relations between physical-chemical variables of the soils and components 1 and 2 of NMDS of the shoot architecture and leaf traits of *Miconia chamissois* in gallery forest and humid grassland in a fragmented landscape of central Brazil

(Continue)

<b>Physical of the soil on shrub architecture</b>				
<b>Predictor variables</b>	<b>NMDS1</b>	<b>NMDS2</b>	<b>R<sup>2</sup></b>	<b>P</b>
Humidity	-0.29857	-0.95439	0.0241	0.480
Temperature °C	0.42117	0.90698	0.0939	0.073
Slope	-0.87631	-0.48174	0.1023	0.047
Clay%	-0.97418	-0.22578	0.0254	0.491
Silte%	-0.97741	0.21136	0.0379	0.340
Sand%	0.99988	0.01577	0.0659	0.152
<b>Physical of the soil on leaf traits</b>				
<b>Predictor variables</b>	<b>NMDS1</b>	<b>NMDS2</b>	<b>R<sup>2</sup></b>	<b>P</b>
Humidity	-0.14649	0.98921	0.1208	0.016
Temperature °C	0.92556	0.37860	0.0019	0.944
Slope	0.18792	0.98219	0.1198	0.023
Clay%	-0.64671	0.76273	0.1440	0.018
Silte%	-0.69337	0.72058	0.1625	0.011
Sand%	0.70063	-0.71353	0.2790	0.001
<b>Chemical of the soil on shrub architecture</b>				
<b>Predictor variables</b>	<b>NMDS1</b>	<b>NMDS2</b>	<b>R<sup>2</sup></b>	<b>P</b>
Organic matter	0.11825	0.99298	0.0180	0.606
ph(CaCl <sub>2</sub> )	-0.81799	0.57523	0.0061	0.854
P(mg/dm <sup>3</sup> )	0.33473	-0.94231	0.1346	0.016
K(mg/dm <sup>3</sup> )	-0.89661	-0.44282	0.0043	0.876
Ca(cmolc/dm <sup>3</sup> )	0.09996	-0.99499	0.0058	0.862
Mg(cmolc/dm <sup>3</sup> )	0.31868	-0.94786	0.0080	0.810
H+Al(cmolc/dm <sup>3</sup> )	0.34197	0.93971	0.0030	0.924
Al(cmolc/dm <sup>3</sup> )	0.95375	0.30060	0.0280	0.453
CTC(cmolc/dm <sup>3</sup> )	0.44944	-0.89331	0.0047	0.862
M%	0.70262	0.71156	0.0010	0.970
V%	0.40004	-0.91650	0.0033	0.917
Ca/Mg	-0.44848	-0.89379	0.0122	0.694
Mg/K	0.79259	0.60976	0.0912	0.067
Ca/K	0.73734	0.67553	0.0361	0.366

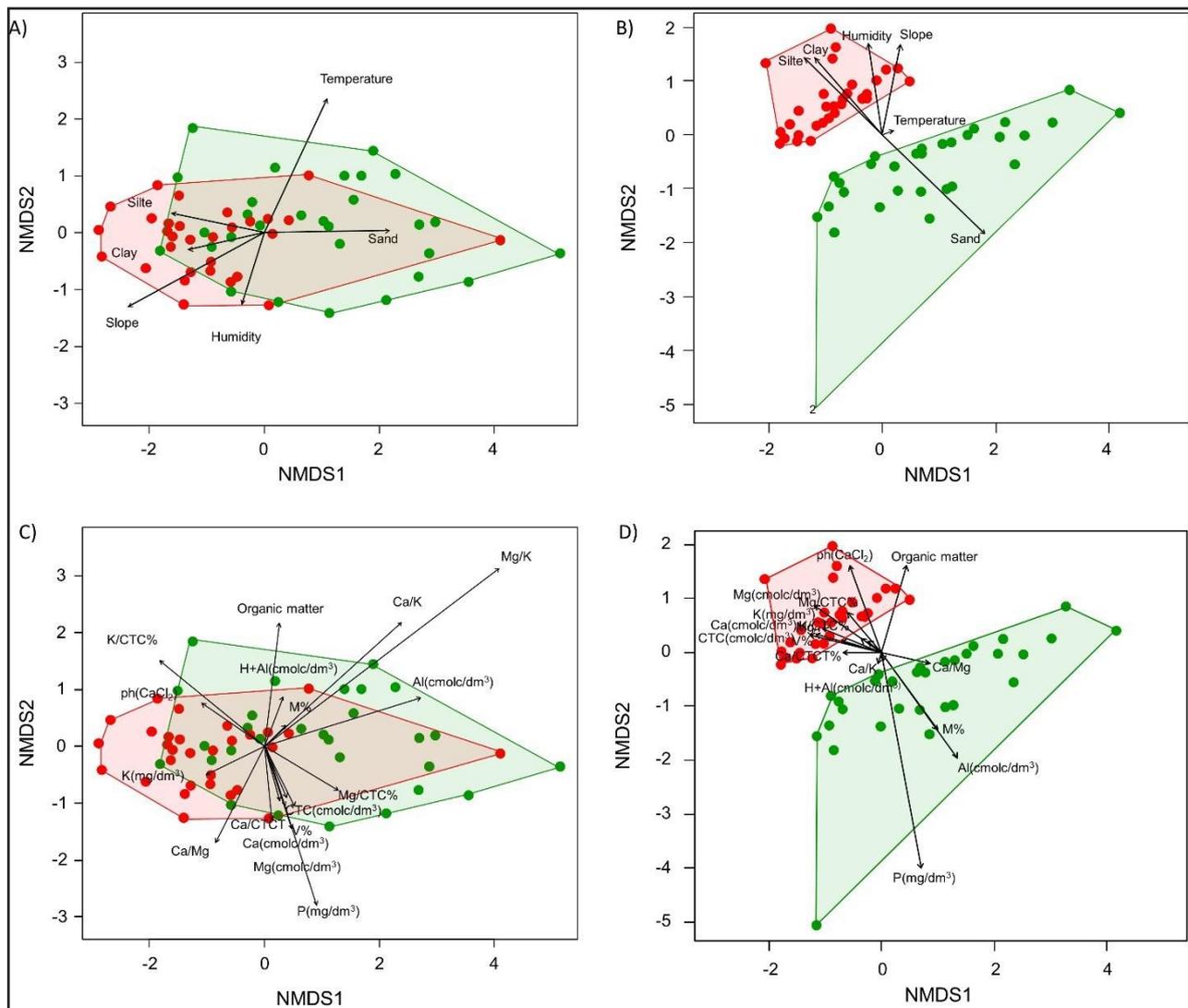
Table 1 – Results of linear relations between physical-chemical variables of the soils and components 1 and 2 of NMDS of the shoot architecture and leaf traits of *Miconia chamissois* in gallery forest and humid grassland in a fragmented landscape of central Brazil  
(Conclusion)

<b>Chemical of the soil on shrub architecture</b>				
<b>Predictor variables</b>	<b>NMDS1</b>	<b>NMDS2</b>	<b>R<sup>2</sup></b>	<b>P</b>
Mg/CTC%	0.85850	-0.51282	0.0077	0.833
K/CTC%	-0.76923	0.63897	0.0192	0.590
<b>Chemical of the soil on leaf traits</b>				
<b>Predictor variables</b>	<b>NMDS1</b>	<b>NMDS2</b>	<b>R<sup>2</sup></b>	<b>P</b>
Organic matter	0.26439	0.96441	0.0708	0.111
ph(CaCl <sub>2</sub> )	-0.34127	0.93996	0.0744	0.094
P(mg/dm <sup>3</sup> )	0.17090	-0.98529	0.4204	0.001
K(mg/dm <sup>3</sup> )	-0.92086	0.38990	0.0333	0.375
Ca(cmolc/dm <sup>3</sup> )	-0.96374	0.26684	0.0383	0.326
Mg(cmolc/dm <sup>3</sup> )	-0.81110	0.58491	0.0559	0.181
H+Al(cmolc/dm <sup>3</sup> )	-0.33721	-0.94143	0.0013	0.963
Al(cmolc/dm <sup>3</sup> )	0.56570	-0.82461	0.1426	0.019
CTC (cmolc/dm <sup>3</sup> )	-0.96953	0.24498	0.0448	0.273
M%	0.56559	-0.82469	0.0781	0.083
V%	-0.95468	0.29764	0.0144	0.653
Ca/Mg	0.97228	-0.23384	0.0194	0.566
Mg/K	-0.82637	0.56312	0.0051	0.849
Ca/K	0.23041	-0.97309	0.0006	0.976
Ca/CTCT%	-0.99996	-0.00855	0.0126	0.704
Mg/CTC%	-0.64235	0.76641	0.0232	0.500
K/CTC%	-0.78118	0.62431	0.0027	0.934

Source: The authors (2023)

Soil chemical parameters accounted for 41% and 85% of the variation in the two NMDS axes referring to the shoot architecture and foliar traits, respectively (Table 1, Figure 3C and D). However, P (Mg/dm<sup>3</sup>) was the unique chemical variable associated with the shrub architecture ( $R^2 = 0.13$ ;  $p = 0.016$ ) and foliar traits ( $R^2 = 0.42$ ;  $p = 0.001$ ) of *M. chamissois*, while Al (cmolc/dm<sup>3</sup>) was also associated with foliar traits in the anthropized landscape of central Brazil (Table 1).

Figure 3 – Nonmetric multidimensional scaling (NMDS) ordering individuals of *Miconia chamissois* in the gallery forest (green dots) and humid grassland (red dots) according to shoot and foliar traits and their linear relationships with physical and chemical soil parameters. (A) sh and (B) foliar traits related to soil physical parameters; (C) shoot and (D) foliar traits related to soil chemical parameters



Source: The authors (2023)

## 4 DISCUSSION

*M. chamissois* individuals in the gallery forest had a higher leaf area, suggesting an adaptive strategy to limiting conditions regarding the amount of light available compared

to the humid grassland. Shade leaves present a high specific leaf area combined with high chlorophyll content to maximize light absorption compared to sun leaves through lower investment in leaf area (Evans & Poorter, 2001). The gallery forest plants exhibit a greater degree of investment in their leaf area, resulting in increased exposure of leaves to light and maximizing their ability to absorb and utilize resources (Lambers, Chapin III & Pons, 2008). Increases in the leaf area and other functional traits, such as height and length of internodes due to shading, compensate for the low availability of light due to the greater vegetation density and enhance growth and reproduction (Pearcy, 2007).

As the requirements for optimal leaf functioning differ for high and low irradiance, the plant continuously adjusts to changes in the luminous environment, implying increased adaptability (Bradshaw, 1965; Rozendaal et al., 2006). Müller et al. (2020) found that sun leaves showed a greater leaf and petiole length than those present inside the forest when evaluating possible strategies of morphoanatomical acclimatization to luminosity of *Miconia nervosa* (Sm.) Triana in a forest fragment in the southern Amazon rainforest.

Regarding leaf architecture, the plastic responses of *Miconia sellowiana* Naudin in a mesomorphic-xeromorphic gradient suggested that leaf morphological traits are affected by differentiated environmental conditions (Boeger et al., 2009). *Miconia chamissois* is distributed in the Caatinga, Atlantic Forest, and Cerrado within Brazil (Goldenberg et al., 2024). The specimens at the location of the present study are widely dispersed in both the humid field and along the edge of the gallery forest, which appears to be related to the species' potential for plasticity, as expressed in the studied shrub architecture and leaf characteristics. In addition to light availability, other factors such as soil nutrient and water availability should be considered. Our results indicated that soil parameters were significantly associated with the components of leaf characteristics and shrub architecture studied.

In this context, the humidity, slope, and silt percentage among the physical soil parameters were positively associated with the foliar traits of the individuals

of the humid grassland, which could have contributed to the greater investment in the lamina length measurements in this environment. The arboreal cover is less than 5% in the humid grassland, resulting in high luminosity. On the other hand, the groundwater is superficial (Ribeiro & Walter, 2008), providing plants with water throughout the year. Therefore, the greater leaf blade length observed in individuals from the humid grassland may be due to greater water availability, since the reduced leaf size is an adaptation to modify the conductance of the leaves and thus adapt to the higher evaporative demand conditions (Yates et al., 2010). In addition, the lowest values observed for the crown architecture of plants in humid grassland would be understood as an architectural response of *M. chamissois* to lower ground depth and higher wind incidence.

For soil chemical parameters, phosphorus and aluminum presented a significant relationship with the functional traits evaluated, with higher concentration in the gallery forest, and above all to foliar traits. Amorim and Melo (2017) observed a greater reduction in specific leaf area (SLA) for the population of *Pleroma clavatum* (Pers.) P.J.F. Guim. & Michelang. (Melastomataceae) occurring in herbaceous vegetation compared to forest vegetation in restinga located in the southern region of Brazil, possibly as a water conservation strategy in growing plants in soils with less capacity to retain water and low fertility, in addition to which mineral nutrition is essential for leaf structure production. These plants showed favorable conditions given by the greater supply of nutrients in the forest environment with greater investment of growing individuals. Plants in nutrient-poor soils invest in higher foliar attributes to maximize nutrient use efficiency (Groom; Lamont, 1999). This explains the higher values in leaf blade length of individuals in the humid grassland of the present study. Studies with other Melastomataceae species have shown that *Marcetia taxifolia* (A.St.-Hil.) DC. individuals had greater height development in soil with a higher aluminum saturation index (Gardoni et al., 2007), in addition to the positive effect of aluminum in increasing the content of chlorophyll a, b, total and carotenoids, suggesting adaptation of *Pleroma granulosum* (Desr.) D. Don to aluminum application (Freitas et al., 2017). Thus, these results

suggest environmental factors, such as soil fertility, especially phosphorus and aluminum concentrations, may be the important factors that influence the foliar traits.

Still regarding leaf characteristics, there are two types of strategies related to resource acquisition and use: acquisitive and conservative, which are at the extremes of the global leaf economic spectrum (WLES), representing a pattern of correlations between the leaf functional characteristics that plants can present (Donovan et al., 2011). At one end are individuals which employ an acquisitive strategy, characterized by rapid growth, with short-term leaves and low dry mass investment per area. Therefore, these individuals have structurally low-cost leaves, high nitrogen content, and photosynthetic and breathing rates. On the other hand, individuals with a more conservative strategy usually have slow growth, long-term leaves, high dry mass investment, tissue protection, high-cost structural and reserve structures, low nitrogen content, and low photosynthetic and breathing rate (Donovan et al., 2011). Therefore, we can infer that *M. chamissois* individuals in the humid grassland adopted the most conservative strategy, while in the gallery forest they adopted a more acquisitive strategy considering the functional traits evaluated in the present study.

Plasticity in anthropogenic environments (such as the study area) can lead to phenotypes becoming partially adapted to shape the adaptive and evolutionary processes of plant species (Valladares et al., 2014) to new environmental conditions. Furthermore, the foliar traits respond in a more plastic way to environmental changes (Monteiro et al., 2005). Thus, it is noted that *M. chamissois* modifies the expression of foliar traits to fit locally and use the nutrients available in the environment more efficiently.

## 5 CONCLUSIONS

Our findings reveal that: i) *Miconia chamissois* specimens originating from the gallery forest have distinct shoot architectural and leaf characteristics compared to those found in the humid grassland; ii) shoot architecture patterns and leaf traits of *M. chamissois* are associated with soil physicochemical parameters. These findings corroborated our initial hypotheses and highlighted that *M. chamissois* in an

anthropogenic landscape of central Brazil display phenotypic plasticity. The shoot architecture and leaf traits (except leaf length) were larger in *M. chamissois* individuals from the gallery forest than those from the humid grassland.

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