



Diversity, distribution and conservation of tribe Bignonieae (Bignoniaceae) in Northern and Northwestern Paraná, Southern Brazil

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ABSTRACT. Climbing Bignoniaceae are an important group in tropical forests, with high species diversity in Brazil. Regional floristic studies, which involve reviewing regional herbaria, are fundamental to understanding diversity. This study reviews the species of the tribe Bignonieae in the Northwestern, Northern Central, and Northern Pioneer mesoregions of Paraná. A total of thirty-five species were identified and are distributed among the following genera: *Adenocalymma*, *Amphilophium*, and *Dolichandra* (five species each), *Anemopaegma*, *Bignonia*, *Tanaecium*, and *Tynanthus* (two species each), and *Cuspidaria*, *Mansoa*, *Pyrostegia*, *Stizophyllum*, and *Xylophragma* (one species each). The Seasonal Semideciduous Forest predominates in the region and contains 32 species. Areas of greatest diversity generally coincide with the most sampled areas, and most species were collected within Conservation Units. We provide photographs of most species, as well as maps showing the richness and occurrence of each species in the studied area. Collection gaps in the region are still significant, covering nearly half of the territory. Furthermore, three rare species are probably extinct in the region: *Adenocalymma peregrinum*, *Bignonia decora*, and *Fridericia platyphylla*.

Keywords: Seasonal Semideciduous Forest; vines; threatened species; floristics; liana.

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Introduction

Climbing plants are an important component of tropical forest diversity, and family Bignoniaceae is the most diverse in nearly all rainforests and dry neotropical sites (Gentry, 1991). Similarly, floristic surveys of various Brazilian ecosystems have shown that Bignoniaceae has greater species richness than other families, such as Sapindaceae, Malpighiaceae, Apocynaceae, Fabaceae, and Asteraceae (Rezende & Weiser, 2014).

The climbing Bignoniaceae are grouped into one of the eight recognized tribes in the family (Olmstead et al., 2009): the tribe Bignonieae. This tribe contains approximately 21 genera and 393 species, and is strongly supported as monophyletic (Lohmann, 2006; Lohmann & Taylor, 2014). The Bignonieae include woody vines and, more rarely, shrubs. They are characterized by anomalous secondary growth, in which segments of the cambium fail to produce secondary xylem, typically forming four or multiples of four phloem wedges (Pace et al., 2009; Pace et al., 2011). These plants have opposite, compound leaves, with one leaflet modified into a tendril; pentamerous, zygomorphic flowers; a showy, gamopetalous corolla in various colors; an androecium with four didynamous stamens; a gynoecium with a bilocular ovary and axial placentation; and fruits with dehiscence parallel to the septum. Bignonieae is found exclusively in the Americas, with its center of diversity in Brazil (Gentry, 1980), where 20 genera and approximately 320 species are present (Flora e Funga do Brasil, 2024).

The diversity of the tribe in the state of Paraná remains uncertain. Kaehler et al. (2014) identified 14 genera and 55 species, Durigon et al. (2014) identified 14 genera and 51 species, and Flora e Funga do Brasil (2024) reported the occurrence of 13 genera and 47 species. Studies in the North and Northwest of the state, where the Seasonal Semideciduous Forest predominates, show that this group is significant in terms of floristic composition and is among the most diverse families (e.g., Costa et al., 2011; Dettke et al., 2018; Garcia et al., 2017; Rossetto & Vieira, 2013). In the Seasonal Semideciduous Forest of Paraná, the Bignoniaceae family is the richest among climbing plants, comprising 11 genera and 25 species (Santos et al., 2014).

However, we noticed that many plants in regional collections are either unidentified or identified with names not indicated as occurring in Paraná. This makes it difficult to assess regional diversity. Thus, this study aimed to review the species of Bignoniaceae occurring in the mesoregions of Northwest, North Central, and North Pioneer of Paraná, to answer the following questions: I) What is the diversity of genera and species? II) Are there species endemic to Paraná or Brazil? III) What are the most common and rarest species? IV) What is the distribution of species across the different phytogeographical units of the study area? V) What are the collection gaps in the region? VI) How many species are protected within conservation units in the region, and which species are they?

Materials and methods

Study area

The study area (Figure 1) included the mesoregions Northwest (61 municipalities), North Central (79 municipalities), and North Pioneer (46 municipalities) in the state of Paraná (Instituto Brasileiro de Geografia e Estatística [IBGE], 1990). These mesoregions encompassed 61,771.049 km² (31% of Paraná's territory).

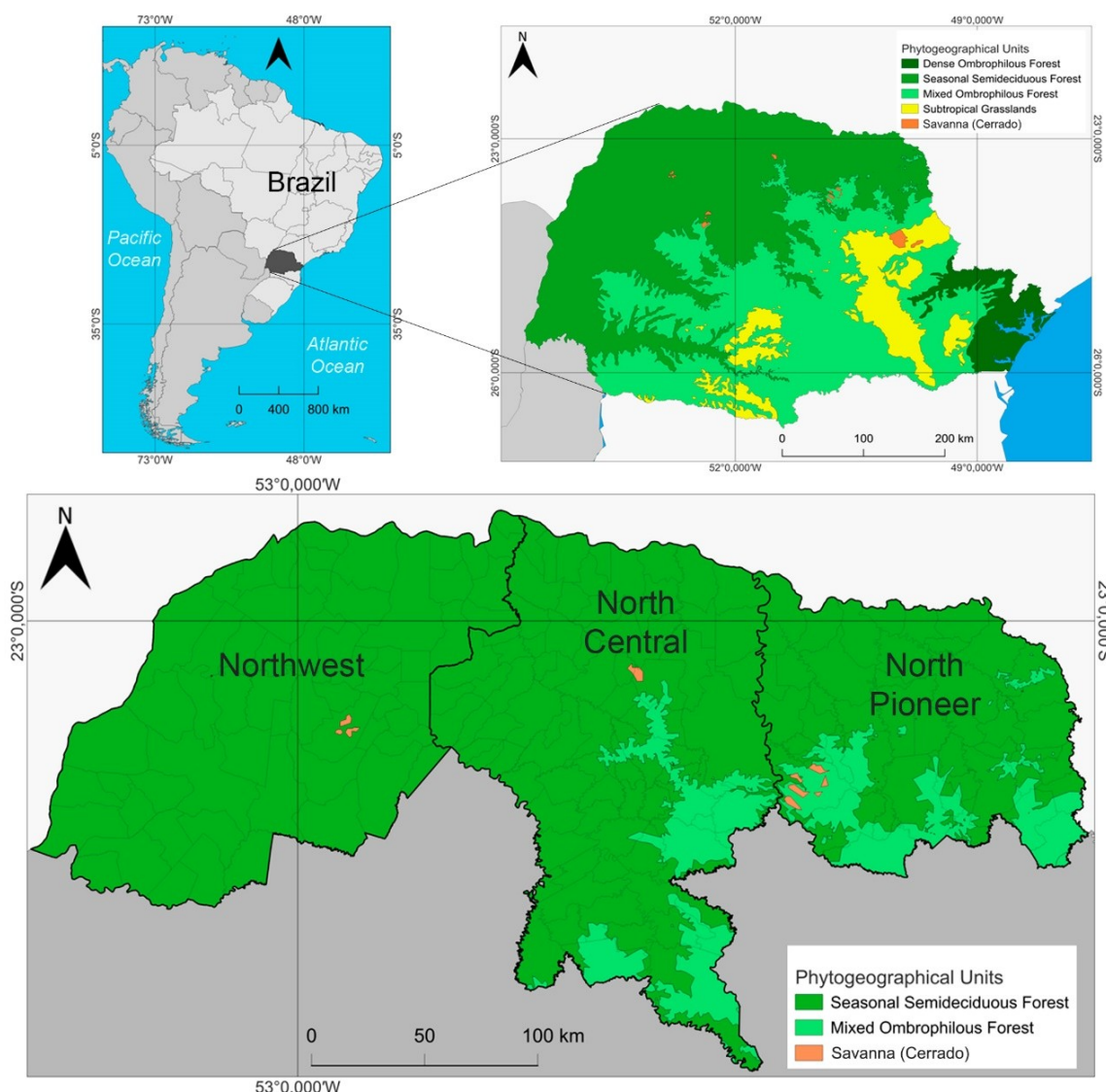


Figure 1. Location of the state of Paraná with the phytogeographical units (modified from Maack, 1950) and the study area.

The climate in the study area is predominantly Cfa, which is classified as mesothermal humid subtropical in the Köppen-Geiger climate classification system (Beck et al., 2023). This climate is characterized by hot summers and a low frequency of severe frosts, with rainfall concentrated in the summer. Dry periods occur more frequently in the North of the state, especially during the colder months (May to August) (Salton et al., 2021).

The soils in the study area are predominantly Latosols. Notably, Argisols are present in the Northwestern region (Arenito Caiuá). In the North Central and North Pioneer, Nitisols, Neosols, and Argisols are frequently found (Instituto de Terras, Cartografia e Geociências [ITCG], 2008).

The vegetation in Northern and Northwestern Paraná is part of the Atlantic Forest Domain, which is one of the world's biodiversity hotspots (Mittermeier et al., 2004). This area has high levels of richness and endemism. The study area is predominantly characterized by the phytogeographical unit of the Seasonal Semideciduous Forest. This type of forest is characterized by dual climatic seasonality and partial deciduousness of 20–50% of its trees annually during periods of drought in tropical regions or intense cold in subtropical regions (Instituto Brasileiro de Geografia e Estatística [IBGE], 2012; Veloso et al., 1991). In the study area, this forest has a canopy that is 15 to 20 m high with emerging trees that are around 30 m high (Roderjan et al., 2002). The region is highly fragmented (Campos, 2005) and is the most deforested area in Paraná due to the establishment of monocultures.

To the South of the study area is the Mixed Ombrophilous Forest, which is typical of southern Brazilian plateaus. This forest has milder temperatures, well-distributed rainfall, and a regular occurrence of frost in the winter (Roderjan et al., 2002). This forest is characterized by temperate elements, especially the presence of *Araucaria angustifolia* (Bertol.) Kuntze (Araucariaceae), a species that forms a continuous and dominant stratum above 30 m in height, with emergent individuals reaching over 40 m (Roderjan et al., 2002). Today, less than 1% of this original forest formation remains (Castella & Britez, 2004), in which large forest areas have been replaced by commercial plantations of non-native species, primarily *Pinus* species, and, more recently, monocrops of wheat, oats, and soybeans.

Vegetation of the Brazilian savanna (Cerrado) is also found in the form of small enclaves disjunct from the Cerrado Domain. These enclaves represent relics of semi-arid Pleistocene vegetation (Maack, 1948; 2017). Only a few remaining fragments are located in the municipalities of Cianorte and Tuneiras do Oeste (small areas not visible on the map in Figure 1), as well as in Rondon in the Northwest, in Sabáudia in the North Central, and São Jerônimo da Serra in the North Pioneer.

Data collection

This study was based on an analysis of exsiccates from three herbaria present in the North and Northwest regions of Paraná: The Herbarium of the *Universidade Estadual de Maringá* (HUEM), the Herbarium of the Nupélia Research Group in Limnology, Ichthyology, and Aquaculture (HNUP), and the Herbarium of the *Universidade Estadual de Londrina* (FUEL). Additionally, databases from other herbaria (national and international) were retrieved using the SpeciesLink network database (Centro de Referência em Informação Ambiental [CRIA], 2024), Jabot (Jardim Botânico do Rio de Janeiro, 2024), and the Reflora Virtual Herbarium (Reflora, 2024). Thus, the collections of 76 herbaria with specimens collected in the study area were verified: ALCB, ASU-PLANTS, BOTU, CEN, CESJ, CGMS, CNMT, CSTR, DVPR, EAFM, EFC, ESA, ESAL, FLOR, FURB, HAS, HB, HBR, HCF, HDELTA, HEPH, HFC, HPAN, HRB, HRCB, HST, HTSA, HUCO, HUCP, HUCS, HUEFS, HUESB, HUFJS, HUFU, HUTO, IAC, IBGE, ICN, INPA, IPA, IRAI, JOI, K, LUSC, MAC, MACK, MBM, MBML, MFS, MICH, MO, NY, P, PACA, PEL, PEUFR, RB, RBR, RFA, RON, SHPR, SLUI, SMDB, SP, SPF, SPFR, SPSF, UB, UEC, UFACPZ, UFMT, UFP, UNOP, UPGB, US and VIC (Thiers, available in <https://sweetgum.nybg.org/science/ih/>). The botanical family (Bignoniaceae) and all municipalities present in the study area were used as data filters. For Jan Christiaan Lindeman's historical collections, in which the municipalities are not marked or have changed over time, all collections in Paraná were searched and checked individually regarding the collection locations. Those belonging to the North and Northwest of Paraná were selected. Most of these collections are in MBM, MO, NY, P, and US.

All herbarium specimens were checked for species identification by consulting the physical material or high-definition images, and corrections or determinations were made using taxonomic studies, consultation with specialists, or comparison with material stored in reference herbaria. For quantification purposes, records with name changes were classified as follows: new identification when no binomial was previously assigned, corrected identification when an erroneous binomial was previously assigned and corrected, and corrected synonym when the previously assigned binomial was changed to a currently accepted name.

All collections were georeferenced using the original coordinates, if present on the labels, or by manually searching for locations using Google Earth Pro® (Google, 2024). We constructed the species occurrence maps and the richness map using the QGIS software, version 3.34.7 (QGIS Development Team, 2024). For the richness map, we counted the points within the polygon (municipality) and specified the scientific name in

the class field (that is, if there are several points with the same scientific name within the polygon, it will only be counted once).

Results

We analyzed 2,372 records (number including duplicates) corresponding to 1,405 collections and 35 species of tribe Bignonieae from the North and Northwest regions of Paraná (Table 1; Table S1, available on supplementary material). Most of the records came from the herbaria FUEL, HUEM, MBM, HNUP, HCF, MO, and SPF (Figure 2A). We could not validate the identification of 75 records due to missing material (59 in FUEL, 6 in HUEM, 6 in HNUP, 2 in HRCB, 1 in ICN, and 1 in VIC), so these records were excluded from the study.

Table 1. Bignonieae species from the North and Northwest of Paraná, Brazil. N: number of collections; MR: mesoregions (NC: North Central, NW: Northwest, NP: North Pioneer); PU: Phytogeographical Units (MOF: Mixed Ombrophilous Forest, SAV: Savanna (Cerrado), SSF: Seasonal Semideciduous Forest); CC: Collected in Conservation Units. *Endemic to Brazil.

	Species	Vouchers	Figs.	N	MR	PU	CC
1	<i>Adenocalymma bracteatum</i> (Cham.) DC.	HUEM 35959	3A1-3, 9A	57	NW, NC, NP	SSF, MOF, SAV	yes
2	<i>Adenocalymma dusenii</i> Kraenzl. *	MBM 216206	9A	1	NP	SSF	no
3	<i>Adenocalymma marginatum</i> (Cham.) DC.	HUEM 36260	3B1-6, 9B	127	NW, NC, NP	SSF, MOF, SAV	yes
4	<i>Adenocalymma paulistarium</i> Bureau & K.Schum.	MBM 173620	3C1-2, 9A	19	NW, NC, NP	SSF, MOF	yes
5	<i>Adenocalymma peregrinum</i> (Miers) L.G.Lohmann	MBM 11655	9B	1	NW	SAV	no
6	<i>Amphilophium crucigerum</i> (L.) L.G.Lohmann	HUEM 35799	3D1-6, 9C	35	NW, NC, NP	SSF, MOF	yes
7	<i>Amphilophium dolichoides</i> (Cham.) L.G.Lohmann *	FUEL 24303	3E1-3, 9C	1	NP	MOF	no
8	<i>Amphilophium dusenianum</i> (Kraenzl.) L.G.Lohmann *	HUEM 35577	3F1-6, 9D	32	NW, NC, NP	SSF, MOF	yes
9	<i>Amphilophium elongatum</i> (Vahl) L.G.Lohmann	HCF 10416	9C	6	NW, NC, NP	SSF, SAV	yes
10	<i>Amphilophium paniculatum</i> (L.) Kunth	HUEM 26987	3G1-4, 9D	33	NW, NC, NP	SSF	yes
11	<i>Anemopaegma chamberlaynii</i> (Sims) Bureau & K.Schum.	HUEM 34573	4A1-8, 9E	71	NW, NC, NP	SSF, MOF, SAV	yes
12	<i>Anemopaegma prostratum</i> DC.	MBM 17237	4B1, 9E	3	NC	SSF	no
13	<i>Bignonia decora</i> (S.Moore) L.G.Lohmann	MBM 35282	9F	1	NW	SSF	no
14	<i>Bignonia sciuripabulum</i> (K.Schum.) L.G.Lohmann	HUEM 36204	4C1-4, 9F	46	NW, NC, NP	SSF, MOF	yes
15	<i>Cuspidaria convoluta</i> (Vell.) A.H.Gentry	MBM 129637	4D1-2, 9F	10	NW, NC, NP	SSF, MOF, SAV	yes
16	<i>Dolichandra chodatii</i> (Hassl.) L.G.Lohmann	HUEM 35533	4E1-5, 9G	48	NW, NC, NP	SSF, MOF	yes
17	<i>Dolichandra cynanchoides</i> Cham.	HUEM 604	4F1, 9G	3	NW, NC, NP	SSF	no
18	<i>Dolichandra hispida</i> (DC.) L.H.Fonseca & L.G.Lohmann	HUEM 13902	4G1-2, 9H	13	NC	SSF, MOF	yes
19	<i>Dolichandra quadrivalvis</i> (Jacq.) L.G.Lohmann	HUEM 21401	9G	8	NW, NC, NP	SSF	yes
20	<i>Dolichandra unguis-cati</i> (L.) L.G.Lohmann	HUEM 36355	4H1-4, 9H	127	NW, NC, NP	SSF, MOF, SAV	yes
21	<i>Fridericia caudigera</i> (S.Moore) L.G.Lohmann	HUEM 21459	5A1-2, 10A	25	NW	SSF	yes
22	<i>Fridericia chica</i> (Bonpl.) L.G.Lohmann	HCF 22168	5B1-2, 10A	25	NW, NC, NP	SSF, MOF	yes
23	<i>Fridericia florida</i> (DC.) L.G.Lohmann	HUEM 22166	5C1-2, 10B	72	NW, NC, NP	SSF, MOF	yes
24	<i>Fridericia mutabilis</i> (Bureau & K.Schum.) Frazão & L.G.Lohmann	MBM 237103	5D1-4, 10B	69	NW, NC, NP	SSF	yes
25	<i>Fridericia platyphylla</i> (Cham.) L.G.Lohmann	MBM 35297	5E1-2, 10A	1	NW	SAV	no
26	<i>Fridericia samydoides</i> (Cham.) L.G.Lohmann	HCF 22170	5F1-3, 10B	25	NW, NC, NP	SSF, MOF, SAV	yes
27	<i>Fridericia triplinervia</i> (Mart. ex DC.) L.G.Lohmann	HUEM 36297	5G1-5, 10A	24	NW, NC, NP	SSF	yes
28	<i>Mansoa difficilis</i> (Cham.) Bureau & K.Schum.	HUEM 33588	6A1-7, 10C	189	NW, NC, NP	SSF, MOF, SAV	yes
29	<i>Pyrostegia venusta</i> (Ker Gawl.) Miers	HUEM 34262	6B1-8, 10C	100	NW, NC, NP	SSF, MOF, SAV	yes
30	<i>Stizophyllum perforatum</i> (Cham.) Miers	HUEM 34272	7A1-5, 10D	56	NC, NP	SSF, MOF	yes
31	<i>Tanaecium pyramidatum</i> (Rich.) L.G.Lohmann	HUEM 36211	7B1-2, 10E	13	NW	SSF	yes
32	<i>Tanaecium selloi</i> (Spreng.) L.G.Lohmann	HCF 19178	7C1-2, 10E	46	NW, NC, NP	SSF, MOF, SAV	yes
33	<i>Tynanthus cognatus</i> (Cham.) Miers *	MBM 433406	7D1, 10F	47	NW, NC, NP	SSF, MOF	yes
34	<i>Tynanthus micranthus</i> Corr.Mello ex K.Schum.	HUEM 34363	7E1-3, 10F	54	NW, NC, NP	SSF, MOF	Yes
35	<i>Xylophragma myrianthum</i> (Cham.) Sprague	HUEM 16345	7F1-3, 10D	18	NW	SSF	Yes

Of the 2,372 herbarium records, 826 (35%) had a change in their scientific names, including: 467 new identifications, 206 corrected identifications, and 153 corrected synonyms.

The collections of Bignonieae began in 1936 (Figure 2B) with German botanist Günter T. Tessmann (1884–1969) at the *Museu Paranaense* in the municipality of Rolândia of the North Central region of Paraná. In 1966 and 1967, Dutch botanist Jan C. Lindeman (1921–2007) and Gerdt G. Hatschbach (1923–2013) from the *Museu Botânico Municipal de Curitiba* collected several species in the Northwest of Paraná. However, the group's collections only intensified from 1984 onward with the establishment of the FUEL and HUEM herbaria. Since then, some collection peaks have been observed in the years 1999, 2004–2006, 2012, and 2018 (Figure 2B). Half of the collections made during the peak between 2004 and 2006 correspond to those of Juliana S. Carneiro, a student at the *Universidade Estadual de Londrina*.

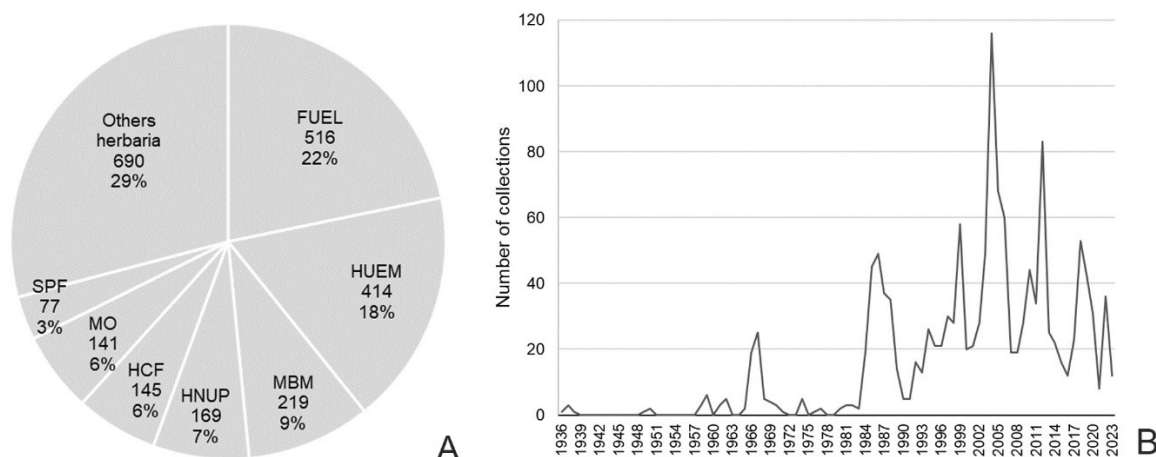


Figure 2. A. Contribution of herbaria to the records of Bignoniaceae in the North and Northwest of Paraná, Brazil. B. Distribution of Bignoniaceae collections from the North and Northwest of Paraná over the years.

Of the 1,405 collections (excluding duplicates), over half originate from the North Central (739 collections, or 53%), followed by the Northwest (492 collections, or 35%), and the North Pioneer (174 collections, or 12%). In the North Central, collections are concentrated in the municipalities of Londrina (267), Maringá (196), Lupionópolis (58), Nova Tebas (27), and Ibiporã (24); and 27 municipalities (44%) have no collections in their territory. In the Northwest, collections are concentrated in Diamante do Norte (129), Porto Rico (92), São Pedro do Paraná (44), Tuneiras do Oeste (41), and Cianorte (30), while 42 municipalities (53%) have no collections. In the North Pioneer, collections are concentrated in the municipalities of Mariana (31), Tomazina (18), Jundiá do Sul (16), and Sapopema (14). Twelve municipalities (27%) in the region have no collections.

The 35 species confirmed in this study are listed in Table 1. Field photographs of 30 of these species are shown in Figures 3, 4, 5, 6 and 7, and richness and occurrence maps are illustrated in Figures 8, 9 and 10. The genera with the greatest species richness were *Fridericia* (seven species), followed by *Adenocalymma*, *Amphilophium*, and *Dolichandra* (five species each). *Anemopaegma*, *Bignonia*, *Tanaecium*, and *Tynanthus* had only two species each, while *Cuspidaria*, *Mansoa*, *Pyrostegia*, *Stizophyllum*, and *Xylophragma* were monospecific. All species are native to Brazil, and most are widely distributed throughout South America. Only four species are endemic to Brazil: *Adenocalymma dusenii*, *Amphilophium dolichoides*, *Amphilophium dusenianum*, and *Tynanthus cognatus*.

The most common species, with the highest number of collections, were *Adenocalymma marginatum*, *Dolichandra unguis-cati*, *Mansoa difficilis*, and *Pyrostegia venusta*, all with more than 100 collections in the study area. On the other hand, the rarest species, with only one collection each, were *Adenocalymma dusenii*, *Adenocalymma peregrinum*, *Amphilophium dolichoides*, *Bignonia decora*, and *Fridericia platyphylla*.

The Northwest mesoregion showed the greatest species richness, with 30 species (Table 1), followed by the North Central and North Pioneer mesoregions with 27 species each. Most species (24) occur in the three mesoregions. However, *Adenocalymma peregrinum*, *Bignonia decora*, *Fridericia caudigera*, *Fridericia platyphylla*, *Tanaecium pyramidatum*, and *Xylophragma myrianthum* are exclusive to the Northwest. *Anemopaegma prostratum* and *Dolichandra hispida* are exclusive to the North Central, while *Adenocalymma dusenii* and *Amphilophium dolichoides* were only recorded in the North Pioneer.

The species richness map (Figure 8) illustrates a range from municipalities with no recorded species to those with up to 23 species. The areas of greatest richness coincide with the highest concentration of collections. Notably, 81 municipalities, representing 44% of the total in study area, lack any records of Bignoniaceae.

Regarding the vegetation type, most species (32) occur in the Seasonal Semideciduous Forest (SSF). Twenty-one species are recorded in the Mixed Ombrophilous Forest (MOF), and 12 species are recorded in the Savanna (Cerrado). The eleven species exclusive to the SSF are *Adenocalymma dusenii*, *Amphilophium paniculatum*, *Anemopaegma prostratum*, *Bignonia decora*, *Dolichandra cynanchoides*, *Dolichandra quadrivalvis*, *Fridericia caudigera*, *Fridericia mutabilis*, *Fridericia triplinervia*, *Tanaecium pyramidatum*, and *Xylophragma myrianthum*. Only *Amphilophium dolichoides* is exclusive to the MOF, while *Adenocalymma peregrinum* and *Fridericia platyphylla* are exclusive to the Savanna (Cerrado).

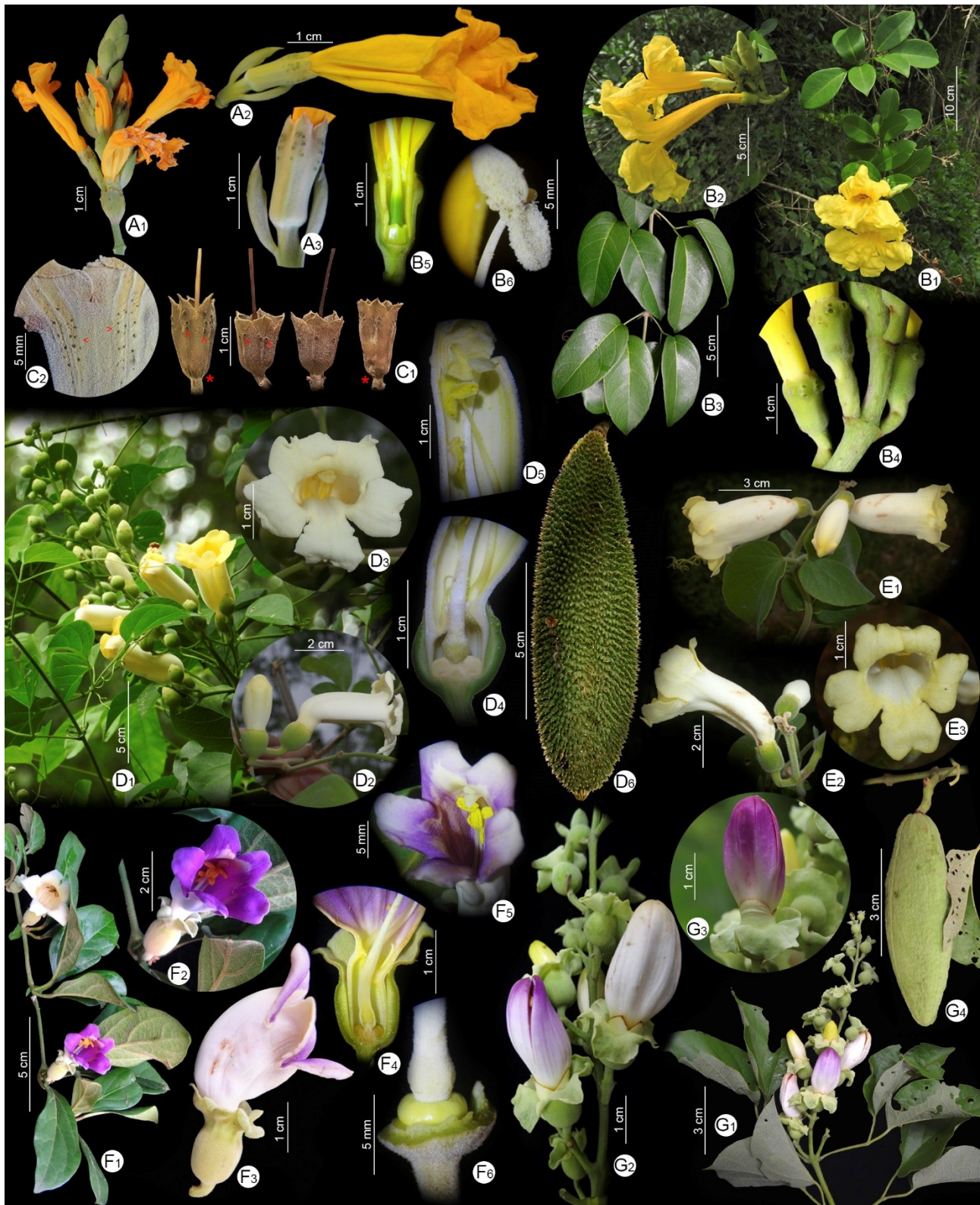


Figure 3. Bignoniaceae species from North and Northwest of Paraná, Brazil. A1–A3. *Adenocalyma bracteatum*. B1–B6. *Adenocalymma marginatum*. C1–C2. *Adenocalymma paulistarum* (asterisk marks the calyx of *Adenocalyma bracteatum* and arrows indicate cupular trichomes of *A. paulistarum*). D1–D6. *Amphilophium crucigerum*. E1–E3. *Amphilophium dolichoides*. F1–F6. *Amphilophium dusenianum*. G1–G4. *Amphilophium paniculatum*. Photos: A1–A3, B3–B6, D4–D5, F1–F6, G1–G2, G4: M.A. Milaneze; B1–B2, D1: P.P.A. Ferreira; C1–C2, D2–D3, E1–E3: G.A. Dettke; D6: J.M. Garcia; G3: A. Rosado.

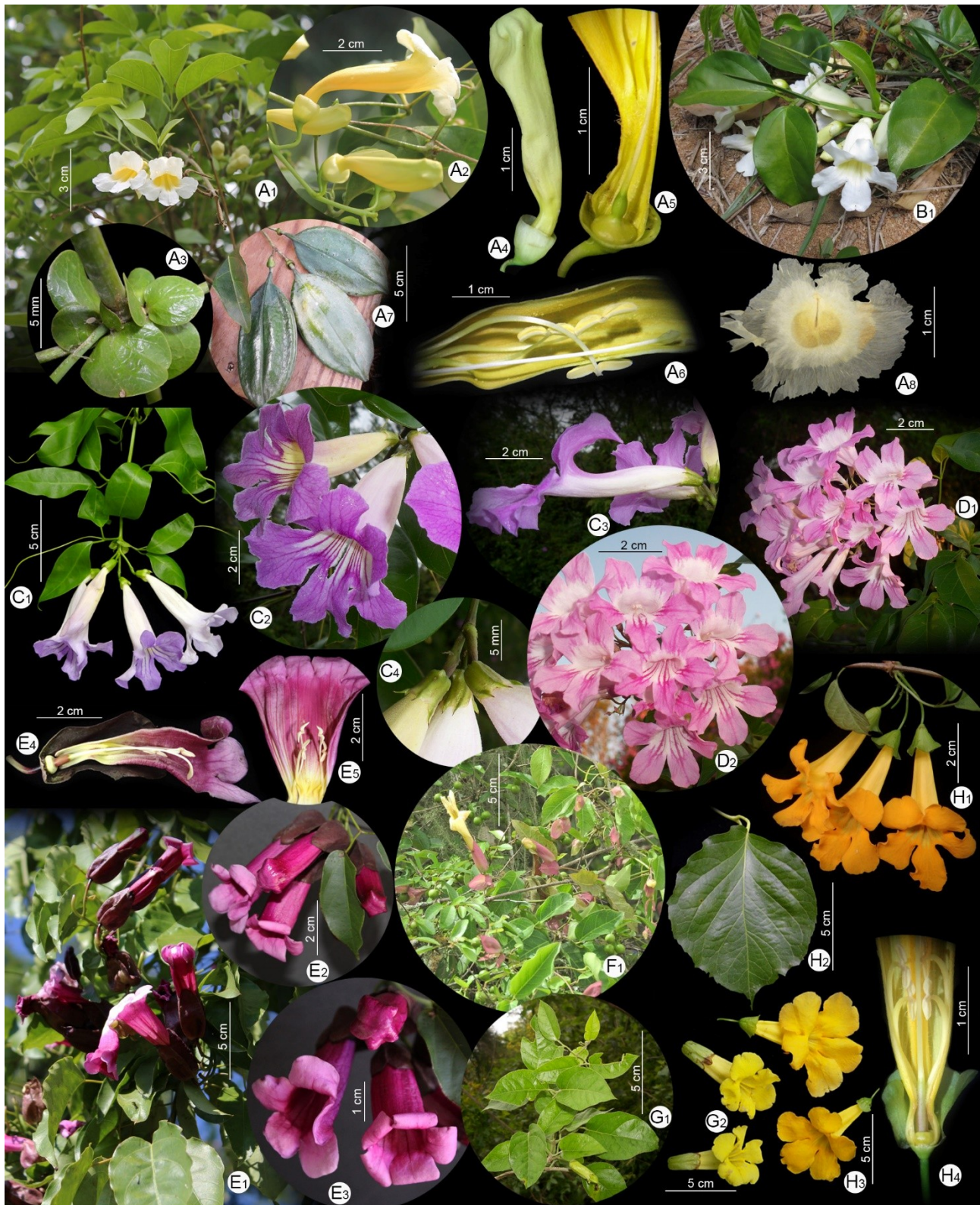


Figure 4. Bignoniaceae species from North and Northwest of Paraná, Brazil. A1-A8. *Anemopaegma chamberlaynii*. B1. *Anemopaegma prostratum*. C1-C4. *Bignonia sciuripabulum*. D1-D2. *Cuspidaria convoluta*. E1-E5. *Dolichandra chodatti*. F1. *Dolichandra cynanchoides*. G1-G2. *Dolichandra hispida*. H1-H4. *Dolichandra unguis-cati*. Photos: A1-A2, E1-E3, E5: A. Rosado; A3-A6, A8, C1, E4, H1-H2, H4: M.A. Milaneze; A7: J.M. Garcia; B1: L. von Linsingen; C2-C4, D1-D2, G1-G2, H3: G.A. Dettke; F1: P.P.A. Ferreira.



Figure 5. Bignoniaceae species from North and Northwest of Paraná, Brazil. A1-A2. *Fridericia caudigera*. B1-B2. *Fridericia chica*. C1-C2. *Fridericia florida*. D1-D4. *Fridericia mutabilis*. E1-E2. *Fridericia platyphylla*. F1-F3. *Fridericia samydoides*. G1-G5. *Fridericia triplinervia*. Photos: A1-A2, C2, D1-D3, G3: A. Rosado; B1-B2, F1-F3: G.A. Dettke; C1, D4, G1-G2, G5: M.A. Milaneze, E1-E2: T. Monteiro-Ré; G4: P.P.A. Ferreira.

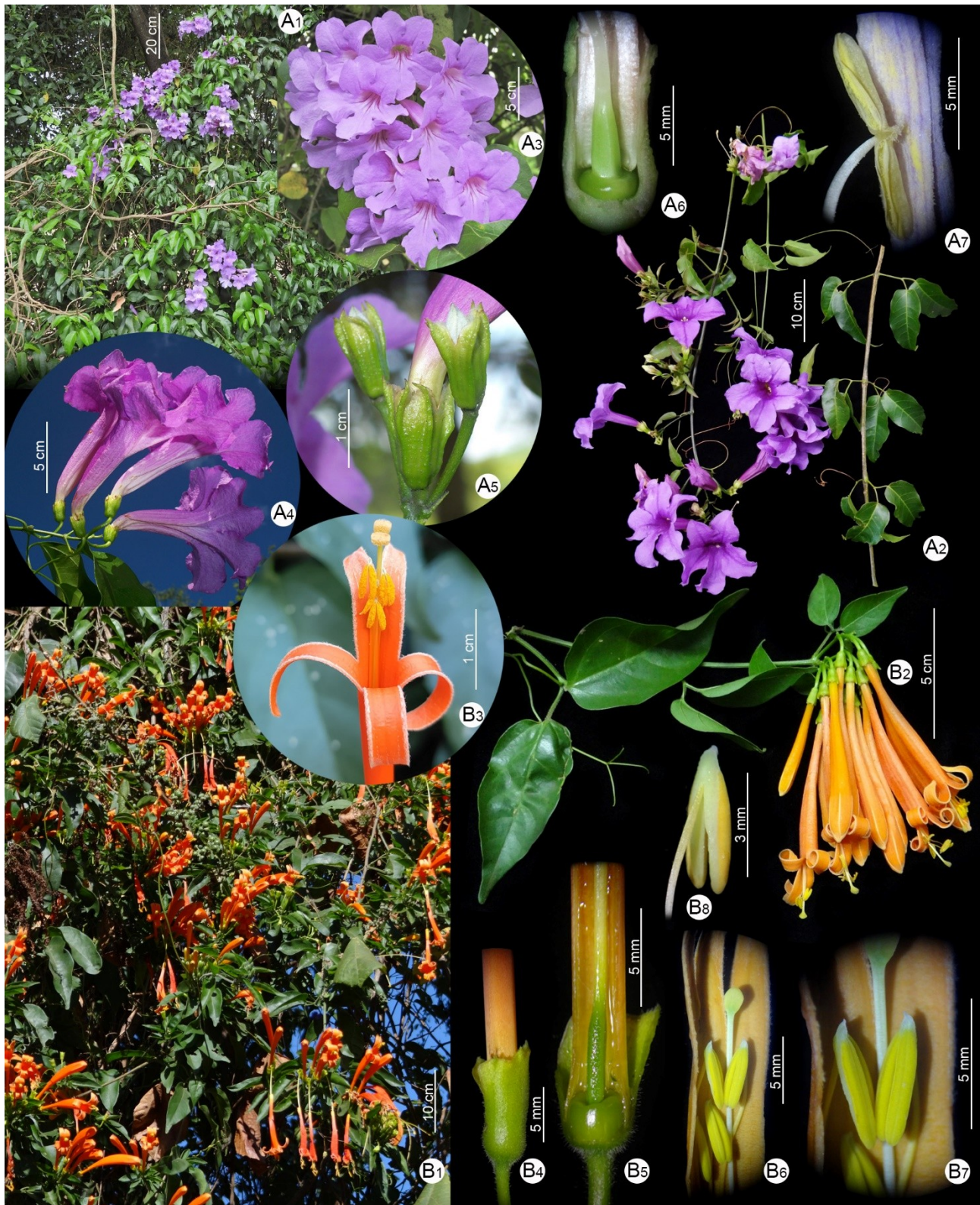


Figure 6. Bignoniaceae species from North and Northwest of Paraná, Brazil. A1-A7. *Mansoa difficilis*. B1-B8. *Pyrostegia venusta*. Photos: A1, A3: P.P.A. Ferreira; A2, B1, B4-B5: A. Rosado; A4-A5: G.A. Dettke; A6-A7, B2, B6-B8: M.A. Milaneze; B3: M.W.A. Silva.



Figure 7. Bignoniaceae species from North and Northwest of Paraná, Brazil. A1-A5. *Stizophyllum perforatum*. B1-B2. *Tanaecium pyramdatum*. C1-C3. *Tanaecium selloi*. D1. *Tynanthus cognatus*. E1-E3. *Tynanthus micranthus*. F1-F3: *Xylophragma myrianthum*. Photos: A1-A4, E1-E2, F1-F3: A. Rosado; A5, B1-B2, E3: M.A. Milaneze; C1: J.M. Garcia; C2-C3, D1: G.A. Dettke.

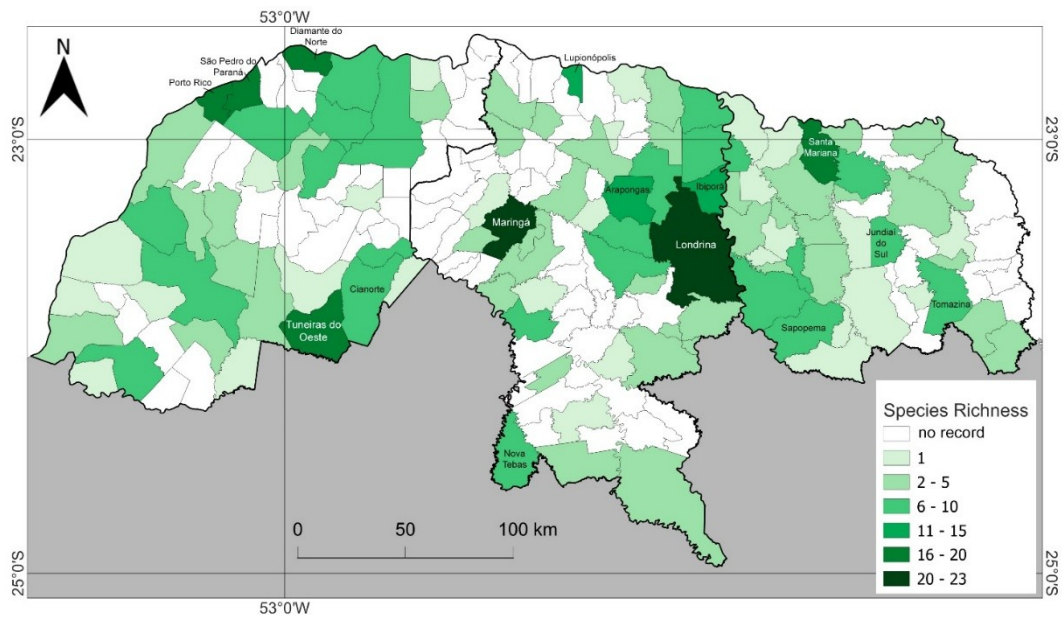


Figure 8. Species richness map of Bignoniaceae from the North and Northwest of Paraná, Brazil.

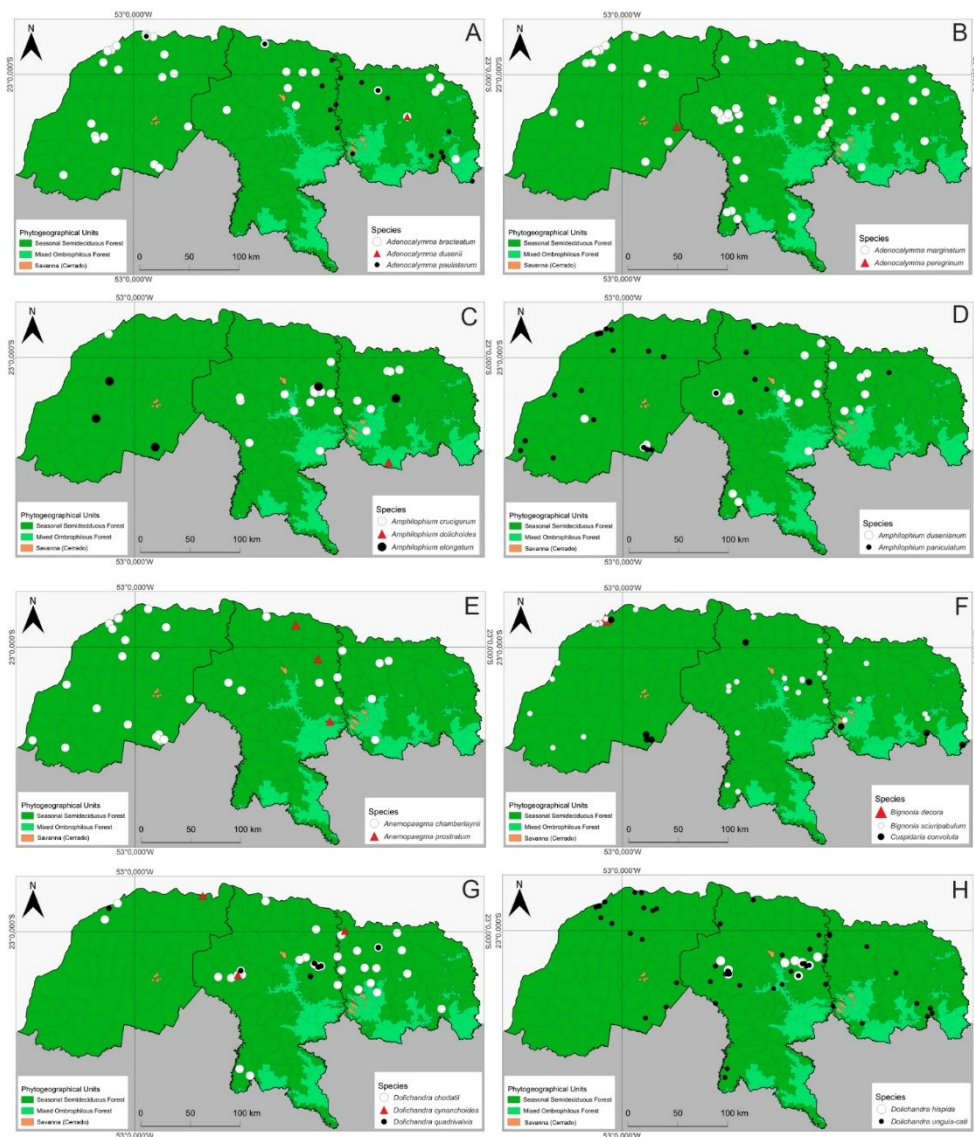


Figure 9. Occurrence map of Bignoniaceae species from the North and Northwest of Paraná, Brazil: *Adenocalymma* to *Dolichandra* species.

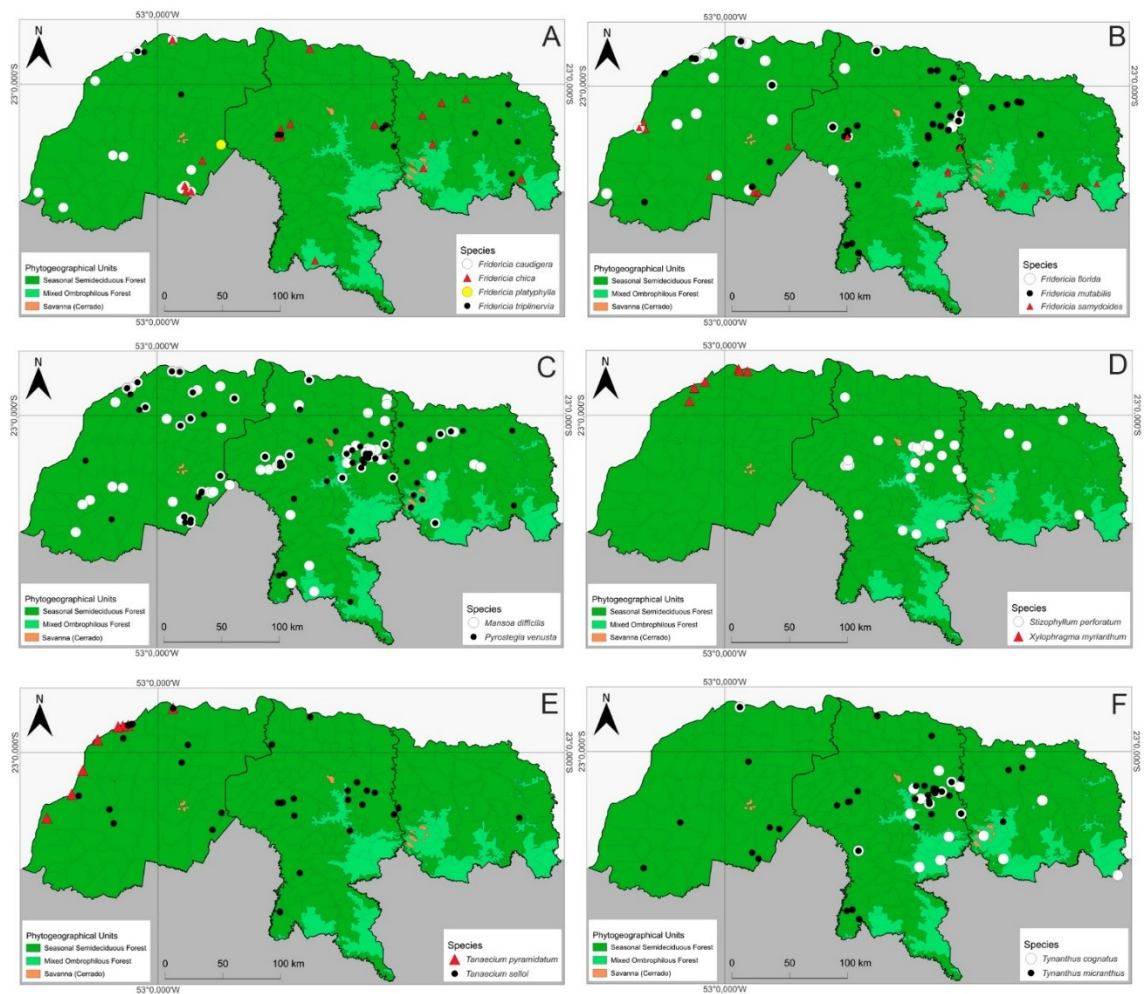


Figure 10. Occurrence map of Bignoniaceae species from the North and Northwest of Paraná, Brazil: *Fridericia* to *Xylophragma* species.

Seven species were not collected within Conservation Units in the study area: *Adenocalymma dusenii*, *Adenocalymma peregrinum*, *Amphilophium dolichoides*, *Anemopaegma prostratum*, *Bignonia decora*, *Dolichandra cynanchoides*, and *Fridericia platyphylla*. These species have few or unique collections. *Adenocalymma peregrinum*, *Bignonia decora*, and *Fridericia platyphylla* have not been collected in the last 60 years.

Table 2 shows the 36 Conservation Units with Bignoniaceae species recorded in Northern and Northwestern Paraná. The number of recorded species varies from one to 17. The places with the greatest diversity were the following: *Área de Proteção Ambiental das Ilhas e Várzeas do Rio Paraná*, *Reserva Biológica das Perobas*, *Estação Ecológica de Caiuá*, *RPPN Mata do Barão (Fazenda Figueira)*, *Parque Estadual Mata São Francisco*, *Parque Estadual Mata dos Godoy*, *RPPN Mata São Pedro*, *Parque Municipal Arthur Thomas*, and *Parque Florestal dos Pioneiros*.

Table 2. Conservation Units with recorded Bignoniaceae species in the North and Northwest of Paraná, Brazil.

Conservation Units	Sites	Area (hectares)	Species number	Species in Table 1
Área de Proteção Ambiental das Ilhas e Várzeas do Rio Paraná	Northwest PR, MS, and SP	279,259.26 (in PR)	17	1, 3, 6, 10, 11, 14, 19, 20, 21, 23, 24, 26, 28, 29, 31, 32, 35
Parque Nacional de Ilha Grande	Alto Paraíso, Altônia, Guaíra, Icaraíma, São Jorge do Patrocínio (PR), and MS	65,092.38 (in PR)	8	3, 10, 11, 14, 23, 26, 31, 32
Reserva Biológica das Perobas	Cianorte and Tuneiras do Oeste	8,716.00	16	1, 3, 8, 9, 10, 11, 15, 20, 21, 22, 23, 24, 26, 28, 29, 34
Parque Municipal dos Três Morrinhos	Terra Rica	2,500.00	3	20, 23, 28
Estação Ecológica de Caiuá	Diamante do Norte	1,449.48	17	1, 3, 4, 11, 14, 20, 21, 22, 23, 24, 28, 29, 31, 32, 33, 34, 35
RPPN Mata do Barão – Fazenda Figueira	Londrina	1,126.10	16	3, 4, 6, 11, 14, 16, 20, 24, 26, 27, 28, 29, 30, 32, 33, 34
Parque Estadual Mata São Francisco	Cornélio Procópio and Santa Mariana	832.58	15	1, 3, 4, 8, 11, 14, 16, 19, 20,

				22, 24, 28, 29, 30, 34
Parque Estadual Mata dos Godoy	Londrina	690.18	14	3, 6, 8, 14, 18, 19, 20, 24, 28, 29, 30, 32, 33, 34
RPPN Mata Suíça II – Fazenda Urutagua	Lunardelli	645.00	2	3, 32
Parque Municipal Cinturão Verde	Cianorte	623.00	5	22, 24, 28, 29, 34
RPPN Fazenda Barbacena	São Pedro do Ivaí	554.80	8	3, 6, 14, 24, 28, 30, 33, 34
RPPN Mata São Pedro	Lupionópolis	429.22	15	1, 3, 4, 10, 11, 14, 16, 20, 22, 23, 24, 28, 29, 32, 34
Estação Ecológica Municipal Reinaldo Petrechen	Nova Tebas	260.34	8	3, 14, 16, 20, 24, 29, 32, 34
Parque Ecológico da Raposa	Apucarana	244.42	6	6, 20, 28, 29, 30, 33
Parque Estadual de Amaporã	Amaporã	204.56	8	3, 11, 20, 27, 28, 29, 32, 34
RPPN Fazenda da Mata	Querência do Norte	137.05	1	21
RPPN Bordignon	Tomazina	133.22	2	3, 14
Estação Ecológica Municipal Dr. Orlando Sanchez	Nova Tebas	123.53	5	3, 8, 24, 29, 34
Parque Municipal Arthur Thomas	Londrina	85.47	14	6, 14, 15, 16, 18, 19, 20, 22, 24, 28, 30, 32, 33, 34
Estação Ecológica Municipal João Dasko	Nova Tebas	76.96	7	3, 8, 14, 16, 24, 28, 34
Estação Ecológica Municipal Faian	Ivaiporã	73.50	1	28
Parque Estadual de Ibiporã	Ibiporã	72.16	6	3, 14, 23, 28, 29, 30
Parque Ecológico Dr. Marciano de Barros	Jacarezinho	65.34	2	1, 29
RPPN João Batista do Nascimento	Tomazina	53.13	4	4, 16, 20, 29
Parque Florestal dos Pioneiros	Maringá	47.60	15	3, 6, 11, 14, 18, 20, 22, 23, 24, 27, 28, 29, 30, 32, 34
Parque do Ingá	Maringá	47.30	9	3, 8, 16, 20, 28, 29, 30, 32, 34
RPPN Salto das Orquídeas I	Sapopema	41.81	7	3, 11, 20, 26, 28, 29, 33
Parque Ecológico Primavera	Iporã	24.00	7	1, 10, 11, 14, 24, 28, 34
Bosque Municipal de Paranaíba	Paranaíba	20.20	1	28
Parque do Cinquentenário	Maringá	11.80	7	3, 8, 16, 18, 19, 24, 28
Parque Municipal Peroba Rosa	Cambé	9.80	2	29, 30
Parque Natural Municipal Dazinger Hof	Cambé	9.00	2	18, 28
Parque Florestal Municipal Palmeiras	Maringá	6.11	6	3, 14, 22, 24, 28, 30
Parque Ecológico Syllas Peixoto	Jacarezinho	4.84	2	1, 27
RPPN Mata do Suíço	Rolândia	3.08	3	28, 29, 32
Parque Municipal de Paraíso do Norte	Paraíso do Norte	1.04	1	23

Discussion

Comparisons with the numbers presented in Flora e Funga do Brasil (2024) show that the North and Northwest regions of Paraná contain a high diversity of Bignoniaceae species. These species represent approximately 70% of the flora of Paraná and 11% of the Brazilian flora.

Our review revealed that Bignoniaceae diversity is often underestimated in regional floristic studies. After our review, all previously studied areas had an increase in the number of species.

In the Mata do Araldo area in Porto Rico Slusarski & Souza (2012) and Souza and Monteiro (2005) recorded a total of six species. From these records, we determined that *Lundia virginalis* DC. (*S.R. Slusarski 433*) is *Tanaecium selloi*, and that indeterminate Bignoniaceae 1 and 2 are *Xylophragma myrianthum*. Thus, the number of species in this remnant increases to seven: *Adenocalymma bracteatum*, *Adenocalymma marginatum*, *Bignonia sciuripabulum*, *Dolichandra unguis-cati*, *Mansoa difficilis*, *Tanaecium selloi*, and *Xylophragma myrianthum*.

Costa et al. (2011) recorded six species of Bignoniaceae for the *Parque Estadual de Ibiporã* (Ibiporã). However, *Amphilophium crucigerum* (G.M. Ferreira 100) corresponds to the already listed *Bignonia sciuripabulum*, and *Dolichandra unguis-cati* (D.A. Estevan 1284) corresponds to *Adenocalymma marginatum*. After this study, *Stizophyllum perforatum* was added to the area, bringing the total to six species (see Table 2).

Carneiro and Vieira (2012) evaluated the climbing species of the *Estação Ecológica de Caiuá* (Diamante do Norte) and recorded six species of Bignoniaceae. Of these, *Arrabidaea* sp. and *Bignonia platyphylla* Cham.

(C.I.L.F. Rosa 93 and 118) correspond to *Fridericia caudigera*. Up to 2011, collections show the occurrence of 13 species of Bignonieae in the area, making it one of the conservation units with the highest number of registered species (17, as listed in Table 2).

Rossetto and Vieira (2013) list 16 species of Bignonieae in *Parque Estadual Mata dos Godoy* (Londrina). However, it is important to note that, among the listed names, *Bignonia campanulata* Cham. (FUEL 8759) corresponds to *Bignonia sciuripabulum*, *Cuspidaria convoluta* (FUEL 2143) is *Tynanthus micranthus*, *Dolichandra unguis-cati* (FUEL 8763) is *Dolichandra hispida*, and *Fridericia dichotoma* (Jacq.) L.G.Lohmann (FUEL 2225) is *Fridericia mutabilis*. Since these names are already included, the total number of species in the list is reduced to 12. After this review, we identified 14 species in this conservation unit (Table 2).

In a remnant in the municipality of Maringá, Garcia et al. (2017) recorded four species of Bignonieae and three undetermined collections. This study identified these collections, adding *Bignonia sciuripabulum*, *Fridericia mutabilis*, and *Pyrostegia venusta* to the list of Garcia et al. (2017), totaling seven species for this remnant.

Dettke et al. (2018) listed 15 species for the *Reserva Biológica das Perobas* (Tuneiras do Oeste), of which *Amphilophium crucigerum* (HCF 712) was corrected to *Amphilophium elongatum* and *Cuspidaria pulchella* (Cham.) K.Schum. (HCF 1507) corresponded to *Cuspidaria convoluta*; neither species was listed. With the addition of *Fridericia florida*, the total number of species of Bignonieae in this remnant is now 16 (see Table 2).

These changes in previously listed names, together with the increase in the number of species, represent an improvement in the quality of these lists. They also reinforce the importance of regional flora review work and the use of materials already deposited in regional herbaria. Our name changes exceeded one-third of the records, with most (80%) being new or corrected identifications. These changes would not be resolved if the database were treated automatically, as synonymous names could be treated as such. A good example of a regional effort is the work of Ribeiro et al. (2024), who created a checklist of Bignoniaceae species in the state of Mato Grosso through field expeditions and herbaria reviews, indicating the first occurrence of a genus and 12 new species occurrences for the state.

Among the endemic species of Brazil, *Adenocalymma dusenii* is typical of the Dense Ombrophilous Forest, occurring from São Paulo to the extreme North of the state of Rio Grande do Sul (Durigon et al., 2019; Fonseca, 2024). It was recorded in the municipality of Jundiá do Sul in the North Pioneer region, being the most distant collection from the Brazilian Atlantic coast. Similarly, *Amphilophium dolichoides* is most frequently found in the Dense Ombrophilous Forest in the states of Rio de Janeiro to Rio Grande do Sul (Durigon et al., 2019; Pool, 2007). In the North Pioneer region of Paraná, this species was collected in an area of Mixed Ombrophilous Forest in the municipality of Curiúva, not far from Ortigueira (approximately 50 km), where the species has already been recorded (FUEL 26411). *Amphilophium dusenianum* and *Tynanthus cognatus* have a wider distribution in Brazil and occur in various types of vegetation, including SSF. *T. cognatus* occurs in moist broadleaf forests in Brazil, and *A. dusenianum* advances to the Central Brazilian Savanna (Medeiros, 2024; Medeiros & Lohmann, 2015; Thode, 2024). These two species were found in all three evaluated regions, with more collections in North Central in SSF and MOF.

Three species listed as endemic to Brazil in Flora e Funga do Brasil (2024) also occur in other countries. *Adenocalymma peregrinum* is found in Bolivia, Brazil, and Paraguay (Fonseca & Lohmann, 2019); *Fridericia mutabilis* is found in Argentina, Bolivia, Brazil, and Paraguay (Frazão & Lohmann, 2020); and *Xylophragma myrianthum* is found in Bolivia, Brazil, Paraguay, and Peru, associated with dry forests and savannas (Kaehler & Lohmann, 2020). *Adenocalymma peregrinum* and *Xylophragma myrianthum* were not cited for the state of Paraná by Flora e Funga do Brasil (2024), nevertheless, they have been documented in previous studies (Durigon et al., 2014; Kaehler et al., 2014; Kaehler & Lohmann, 2020).

Notably, species with wide distributions are present, and in the Northern and Northwestern regions of Paraná, they are collected quite frequently in the three phytogeographical units, such as *Adenocalymma marginatum*, *Dolichandra unguis-cati*, *Mansoa difficilis*, and *Pyrostegia venusta*. Predominantly heliophytes, these species can become overabundant in very small remnants and/or areas with recent disturbances, such as fire, fallen trees, and the dry season. With large populations and a competitive advantage over other species, these lianas can form “blankets” or “towers” over trees or in clearings, impacting the survival and regeneration of trees and shrubs (Arcanjo et al., 2020; Marshall et al., 2020; Paul & Yavitt, 2011; Schnitzer & Bongers, 2011; Schnitzer & Carson, 2010; Tobin et al., 2012). In highly fragmented regions such as the North and Northwest of Paraná, these disturbances and the formation of climbing towers are frequent. Thus, knowledge of these species and their behavior is necessary for making management decisions that would prevent the indiscriminate cutting (or elimination) of rare or uncommon species in liana communities.

Santos et al. (2014) indicates 25 species of Bignoniaceae for the Seasonal Semideciduous Forest of Paraná, but the presented list is problematic. After reviewing the mentioned names, we found that *Fridericia candicans* (Rich.) L.G.Lohmann (HCF 58) is *Mansoa difficilis*; *Fridericia dichotoma* (Jacq.) L.G.Lohmann (FUEL 2225) is *Fridericia mutabilis*; *Fridericia leucopogon* (Cham.) L.G.Lohmann (FUEL 4199) is *Amphilophium dusenianum*; *Fridericia platyphylla* (Cham.) L.G.Lohmann (FUEL 1355) is *Tanaecium selloi*, and *Fridericia pulchella* (Cham.) L.G.Lohmann (HCF 5902) is *Cuspidaria convoluta*. In the present study, we indicate the presence of 32 species in the SSF. However, this number is likely higher when considering the entire extent of this vegetation in Paraná, including the Central-West, West, and Southwest mesoregions.

Three species in the study area are considered rare. Given that their collections are very old, they are likely regionally extinct. This raises concerns about their conservation status and the overall biodiversity of the region. *Adenocalymma peregrinum* and *Fridericia platyphylla* were collected in 1966 by J.C. Lindeman and G.G. Hatschbach in the Cerrado relict of Fazenda Lagoa, located in the municipality of São Tomé, south of the Ivaí River. Access to Fazenda Lagoa, a sugarcane cultivation property owned by *Companhia Melhoramentos Norte do Paraná*, was not permitted to research teams (M.G. Caxambú, personal communication), so nothing is known about the permanence of this Cerrado vegetation. Both species are common in the Brazilian Cerrado; however, *Adenocalymma peregrinum* has only one recorded occurrence in Paraná, and *Fridericia platyphylla* is only recorded in Cerrado relicts in the municipality of Campo Mourão, approximately 50 km from São Tomé (Monteiro-Ré et al., 2023). Another rare species, with a single record in Paraná, is *Bignonia decora*, which was collected in Porto São José, on the banks of the Paraná River. This species is found in Bolivia, Brazil (the Central West and Southeast regions), Ecuador, and Peru (Zuntini, 2024; Zuntini, et al., 2015), and its occurrence in Paraná marks the southernmost extent of its range.

Considering all species in the study area, the greatest species richness is observed in the municipalities of Londrina and neighboring areas, and Maringá in the North Central region. Decentralized from these two locations, high species richness is found in Lupionópolis and Nova Tebas, as well as in Porto Rico, Diamante do Norte, and Tuneiras do Oeste in the Northwest and Mariana in the North Pioneer. The areas with the greatest species richness generally coincide with the most thoroughly sampled municipalities. This is highly related to the presence of important conservation units surveyed by researchers from the *Universidade Estadual de Londrina* (UEL), the *Universidade Estadual de Maringá* (UEM), and the *Universidade Federal Tecnológica do Paraná* (UTFPR). These universities have long-term ecological research projects (LTERs), which allow for data collection in conservation units and other locations over time, providing a greater volume of collections.

Conversely, extensive gaps exist in the study area, as evidenced by the lack of richness in Figure 8, and these areas are a priority for new floristic surveys. Of the 186 municipalities in the study area, 81 (44%) have no record of Bignoniaceae species. The largest gaps are in the North Central and Northwest despite these regions having the largest number of collections. This indicates a concentration of collections in a few municipalities.

Most species of Bignoniaceae were recorded within conservation units, which may reflect effective conservation efforts for this group in the region, despite the presence of rare unprotected species discussed earlier. The greatest species diversity (14 to 17 species) was recorded in conservation units larger than 400 hectares. However, some small conservation units also recorded high diversity (14 or 15 species), such as *Parque Florestal dos Pioneiros* and *Parque Municipal Arthur Thomas*. This suggests that sampling these areas is important for documenting new records. Even in units that have already been sampled, it is relevant to include this group of climbing plants in surveys.

Conclusion

The North and Northwest regions of Paraná are home to a wide variety of climbing Bignoniaceae species, representing approximately 70% total species in the state. The Seasonal Semideciduous Forest predominates in the region and contains the majority of species. The areas of greatest diversity generally coincide with the areas that have been most thoroughly sampled, and the majority of species were collected within conservation units. However, large collection gaps still cover almost half of the territory, and three rare species are probably already extinct in the region: *Adenocalymma peregrinum*, *Bignonia decora*, and *Fridericia platyphylla*.

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