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Vegetation pyramid for phytogeographic representation in the Três Irmãos municipal park, Terra Rica-PR

Pirámide de vegetación para la representación fitogeográfica en el parque municipal de Três Irmãos, Terra Rica-PR

Pirâmide de vegetação para representação fitogeográfica no parque municipal Três Irmãos, Terra Rica-PR

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Abstract

Morro Três Irmãos, in Terra Rica-PR, is located in the northwest of Paraná, under the Atlantic Forest in the interior, with the main physiognomy being the Semideciduous Seasonal Forest, with the presence of floristic elements typical of a vegetation enclave. The application of the phytosociological study in this area aims to analyze the most relevant characteristics of the area and its present conditions, using the technique of graphical representation of vegetation pyramids. The field survey was carried out according to the relevant methodology, generating a comparative analysis of the evolution of the vegetation in the area. The study resulted in qualitative and quantitative information located spatially and temporally, such as the abundance, frequency, dominance and diversity indices, in addition to the so-called species importance value, representing the vegetation of the vertically collected points.

Keywords: phytogeographic survey, socio-environmental dynamics, biogeography

Resumen

Morro Três Irmãos, en Terra Rica-PR, está ubicado en el noroeste de Paraná, bajo el dominio del Bosque Atlántico interior, siendo la principal fisonomía el Bosque Estacional Semideciduo, con presencia de elementos florísticos típicos de un enclave de vegetación. La aplicación del estudio fitosociológico en esta área tiene como objetivo analizar las características más relevantes de la zona y sus condiciones actuales, utilizando la técnica de representación gráfica de pirámides de vegetación. El relevamiento de campo se realizó de acuerdo con la metodología correspondiente, generando un análisis comparativo de la evolución de la vegetación en la zona. El estudio dio como resultado información cualitativa y cuantitativa ubicada espacial y temporalmente, como los índices de abundancia, frecuencia, dominancia y diversidad, además del llamado valor de importancia de las especies, que representa la vegetación de los puntos recolectados verticalmente.

Palabras clave: estudio fitogeográfico, dinámica socioambiental, biogeografía

Resumo

O Morro Três Irmãos, em Terra Rica-PR, localiza-se no noroeste do Paraná, sob domínio da Mata Atlântica do interior, sendo a principal fisionomia a Floresta Estacional Semidecidual, com a presença de elementos florísticos típicos de enclave vegetacional. A aplicação do estudo fitossociológico nessa área objetivo-se em analisar as características mais relevantes da área e suas condições presentes, utilizando a técnica de representação gráfica das pirâmides de vegetação. O levantamento de campo foi realizado conforme metodologia pertinente, gerando uma análise comparativa da evolução da vegetação da área. O estudo resultou em informações quali-quantitativas localizadas espacial e temporalmente, como os índices de abundância, frequência, dominância e diversidade, além do chamado valor de importância das espécies, representando a vegetação dos pontos coletados verticalmente.

Palavras-chave: levantamento fitogeográfico, dinâmica socioambiental, biogeografia

Introduction

The graphic pyramids compose the approaches of some studies of the Geography, especially those related to the structure and internal dynamics of the vegetal cover. It is understood that the vertical phytogeographic study allows for in-depth knowledge of the biogeographic conditions and the evolution of the vegetation of an implantation point. Through the evaluation of phytosociological parameters, it is possible to obtain information regarding the vegetation evolutionary process and the characteristics of the different floors, where data can be obtained regarding the composition, structure, functioning, dynamics, history, distribution and environmental relations of plant communities, supported by plant taxonomy, phytogeography and forest science.

This study aims to evaluate the degree of preservation of forest vegetation in the Morro Três Irmãos Natural Monument, popularly consolidated as Três morrinhos, through the construction of vegetation pyramids in the Permanent Preservation Area (PPA) known as Três morrinhos park. This forest remnant is located in the countryside, close to the urban perimeter of Terra Rica.

The region is inserted in the northwest quadrant of the state of Paraná, and presents phytogeographic coverage originally belonging to the domain of the

Atlantic Forest inland, with its main physiognomy being the Semideciduous Seasonal Forest, geologically characterized by varied lithologies, on lithological neosols and quartzrenic Neosols (RODERJAN, et al., 2002), presents a very uniform seasonal forest cover, dominated by macrophanerophytes emerging from *Aspidosperma polyneuron* Müll Arg. (pink peroba) (IBGE 2012).

Since this formation has been properly studied by Maack (1981), having its records of historical importance in the reconstruction of the original imaginary of the Paraná floristic composition, it currently suffers different anthropic impacts arising from activities carried out in its surroundings such as landowner pressure for sugarcane, fires and others.

In the winter months, there is a significant reduction in precipitation and relative humidity, intimidating broad forms of epiphytism, such as *Philodendron bipinnatifidum* Schott ex Endl. (Araceae) the most characteristic species. The presence of lianas is expressive, with Bignoniaceae, Sapindaceae, Cucurbitaceae and Asteraceae being the most common families (RODERJAN, et al., 2002).

An analysis of the vegetation of the Morro Três Irmãos Natural Monument was carried out, gathering data through *in loco* observation, considering the participation of man, in the past and present, in the aspects of conservation and/or destruction of the studied space. The landscape, in this case, is seen as an environment resulting from human activity, but the vegetation also has its own characteristics and, therefore, must be observed and identified based on the diagnosis of the problems of fragility, evaluation and capacity for regeneration and use in the same way, Paula and Ferreira (2005).

Within the scope of these studies, the construction of pyramids is a methodology important phytosociological assessment, as they graphically represent the vertical structuring of a plant formation and offer an expressive view of the vegetal mat, being possible to classify the formations according to the level of covering, making the number of strata intervene and the existing competition between the species (PASSOS, 1998).

The survey allowed the identification of the main elements of vegetation cover, through the linear transect method, and the use of vegetation analysis pyramids as a method of analysis also allows representing the competition existing in the different layer of vegetation, the effects of anthropic action on the environment and as well as the role of topography, relief, climate and related edaphic conditions, giving a better idea of the relationships between vegetation and biological erosion. This is a permanent ecological factor that, associated with other phenomena, becomes a fundamental element in the distribution and dynamics of the vegetal mat, being a mobility factor (PASSOS, 1998).

The choice to carry out this study in Morro Três Irmãos is due to the fact that the area represents that its environmental situation is similar to the vast majority of isolated forest fragments in the northwest region of the state of Paraná. From the survey of the floristic, phytosociological and biogeographic characteristics of its composition, it was intended to evaluate the evolution and dynamics of the vegetation at different points of the geomorphological formation, generating data that can support actions for the recovery and conservation of forests with similar characteristics for the region.

Methodology and objectives

The study of landscape is understood as a result between the combination and the unstable dynamic accumulation of physical, biological and anthropic elements, dialectically articulating one another, according to Bertrand (2009). The study of vegetation can bring to light significant changes that have occurred in the landscape, allowing for an unfolding about the process of evolution, considering the study of its physiognomy and through the floristic composition to know the chronologically spatial behavior as well as the biophysical characteristics, by Martins (1989).

To carry out the phytosociological survey, three collection points were demarcated in the naturally vegetated area that make up the PPA area of the Três Irmãos park, which has an extension of approximately 3 km². For each of the collections, circular plots with a radius of 10 m (314 m²) were delimited in sectors that

represent the essential characteristics of the plant formation, object of study, totaling 942 m² of sampled area. Once the areas were defined, the information regarding the biogeographic files was collected, according to the model proposed by Bertrand (1966), which consequently helped in the application of the phytosociological analysis proposed by Braun-Blanquet (1979). The sheets have two independent parts, where one presents the phytosociological relationship, with the most important plant species within the analyzed clipping according to the distribution within the strata; and a second, which presents geographic elements, where the biogeographic facts that interfere in the found plant formation are listed.

The geographical characteristics, in the second part of the sheet, it is important to stick to elements that may interfere with the ecological potential, which must be previously identified. General climatic conditions, essential pedology, the geological substrate, to later represent the physical elements with greater accuracy. Still within the adopted cut, measurements with adequate equipment should be taken of the slope of the slope, altitude and especially the exposure of the soil, which must be taken in loco.

The phytosociological analysis works from the parameters Abundance-Dominance and Sociability.

-Abundance-Dominance corresponds to the surface covered by plants.

-Sociability corresponds to the configuration characterized by the grouping of plants.

To assess the degree of ground cover, corresponding to the different vegetation strata or floors and their habits, expressed from the top to the bottom of the vegetated column: emerging, upper arboreal, lower arboreal, shrubby, herbaceous and epiphytic, the methodology is used. by Braun-Blanquet (1979) to elucidate, listing the parameters in the left column.

Regarding the sociability that expresses the way in which plant individuals are grouped, the methodological criteria of Braun-Blanquet (1979) were used in the same way, defined in the column on the right.

Table 1 – Soil covering classes.

Abundance/Dominance Percentage		Sociability Percentage	
5	Covering between 75% to 100%	5	Continuous population; dense spots
4	Covering between 50% to 75%	4	Growth in small colonies; sparse dense patches
3	Covering between 25% to 50%	3	growth in groups
2	Covering between 10% to 25%	2	Grouped in 2 or 3
1	Abundant plant but with low coverage value, not exceeding 10%	1	isolated individuals
+	some rare specimens	+	Rare or isolated plants

Source: Adapted from Braun-Blanquet, 1979.

All stages of the inventory process were photographed, from the area covered to the specimens. The collections of botanical material were carried out in the period of August/2019 and June/2021. The plant species collected were herborized according to the methodology of Mori et al. (2011). The identification of specimens was carried out in the Biogeography laboratory of the State University of Maringá with the help of taxonomic keys, pertinent bibliography (DETTKE et al., 2020), (RAMOS et. al., 2015), comparisons with exsiccates, database consultation from the Brazilian Flora Species List (ZAPPI et al., 2015). Once identified, the specimens were stored in the Herbarium of the State University of Maringá, Department of Biology, where they were cataloged and included in the HUEM collection.

From the sum of information regarding the arrangement of horizontally and vertically arranged plants, this analysis allowed the manual construction of 3 vegetation pyramids, one for each segment, according to the methodology found in Bertrand (1966), which consists of drawing on a graph paper a 10 cm long horizontal straight segment. On this alignment, symmetrically to the center, a straight line is raised perpendicular to the axis of the pyramid.

Over the horizontal axis, the different layers of vegetation are superimposed, considering their normal order of superposition, their coverage index (abundance-dominance 1 = 1 cm, 2 = 2 cm, 3 = 3 cm, 4 = 4 cm, 5 = 5 cm). The thickness of each stratum, represented in the pyramid, is arbitrarily determined in order to facilitate biogeographic interpretations: stratum 1 = 0.5 cm, stratum 2 and 3 = 1 cm, stratum 4 =

1.5 cm, stratum 5 = 2 cm. Its digitization, a graphic work was done in the CoredDRAW® software to facilitate the visualization of the information.

The construction of the pyramid is completed with the addition of other pertinent information, since the degree of sociability of most species is strongly influenced by habitat and competence conditions (BRAUN-BLANQUET, 1979), referring to the geological/pedological/biological stratum. At the base, information relating to litter (thickness, covered surface) is included, as the accumulated biomass provides subsidies for an essential role in the balance of formation. Subsequent to this, the type (classification) of soil (thickness, simplified profile) and the nature of the bedrock are indicated. In order to have a representative image of the seasonal conditions (slope, insolation, runoff...), the pyramid is oscillated at the angle representing the value of the slope on which the formation is located; as a finalization, the horizontal arrows indicate the dynamics of the different strata (progressive, regressive and equilibrium).

Among the materials used for this study, existing cartographic material and satellite images were used for localization, characterization of the area and preparation of maps. In loco stays to capture information were essential and compensating.

Phytosociological analysis

The vertical study of vegetation provides an integrated knowledge of biogeographic conditions and vegetation evolution. Satellite images, despite ensuring good spatialization, do not make it possible to clearly represent the different floors and their structure, nor to identify the phytogeographic components that make up these sections.

In order to know the vegetation structure of the savannah fragments inserted in Morro Três Irmãos, the species and general characteristics in their different floor were identified. Data were collected in sito regarding the healthiness and morphological characteristics of the specimens: plant height, crown size, stem circumference and also the plant health, classifying them as healthy, unhealthy or

dead, important information for making the biogeographic record. There is an addendum on the use and occupation of the area in the past, when it was deforested, later abandoned and open to the transit and grazing of cattle, affected by common fires in the past and then only in the 1990s did a practice with a conservationist bias occur from restricting use, to natural regeneration by the law of creation of the Park.

At point 1, 4 floors were identified in loco, arboreal, arborescent, shrubby and herbaceous. In the arboreal stratum there is the occurrence of four species, namely: Jerivá (*Syagrus romanzoffiana* (Cham.) Glassman), Angico (*Parapiptadenia rigida* (Benth.) Brenan.), horse whip (*Luehea candicans* Mart. & Zucc.), Brown laurel (*Cordia trichotoma* (Vell.) Arráb. ex Steud.). Individuals have different heights, being between 15 and 18 m., in stage 4 of abundance/dominance (BRAUN-BLANQUET, 1979) revealing vegetation cover between 50 and 75% (Table 2) and sociability 1; this indicates the growth of isolated individuals, although with great coverage and well-developed height. As for dynamics, this extract is in the equilibrium stage.

In the arborescent stratum, there is no predominant species, occurring 5 different species with individuals with an average height of 9 meters. The description of the individuals in the stratum follows: monkey brush (*Amphilophium crucigerum* (L.) LGLohmann), guambê (*Philodendron bipinnatifidum* Schott ex Endl.), catiguá (*Trichilia claussenii* C. DC.), large leaf capororoca (*Myrsine umbellata* Mart. .), *Casearia sylvestris* Sw. The floor is in stage 3 of abundance/dominance, that is, covering between 25 to 50% of the area, sociability 3, with growth of individuals in groups and stage of equilibrium.

With 8 different species in the shrub layer, with an average height of 4.5 m; abundance/dominance is rated 2, covering between 10 and 25%, sociability 1, with isolated individuals, and stratum dynamics in progression. The species found were: bromeliad (*Tillandsia didisticha* (E. Morren) Baker), wild coffee tree, *Psychotria carthagenensis* Jacq., red camboatá (*Cupania vernalis* Cambess.), bitch mammica (*Zanthoxylum fagara* (L.) Sarg.), White Camboat (*Matayba elaeagnoides* Radlk.), Stinging nettle (*Urera baccifera* (L.) Gaudich.), purple flowering vine (*Amphilophium*

dusenianum (Kraenzl.) LGLohmann), strong-arm (*Piptocarpha sellowii* (Sch. Bip.) Baker).

The herbaceous stratum showed greater diversity, with 9 species and 6 families, namely: wild coffee (*Psychotria carthagenensis* Jacq.), St. Lucia's wort (*Commelina erecta* L.), hairy vine (*Microgramma vacciniifolia* (Langsd. & Fisch.) Copel), Piperaceae (*Peperomia glabella* (Sw.) A .Dietr.), Polypodiaceae (*Pleopeltis minima* (Bory) J. Prado & RY Hirai), coerana (*Cestrum strigillatum* Ruiz & Pav.), capororoca (*Myrsine coriacea* (Sw.) R.Br.), pariparoba (*Piper amalago* L.). The average height of these species is 80 cm; the abundance/dominance is 3, covering between 25 and 50% of the area. Sociability is 4, indicating growth in small colonies or patches and the stratum dynamics is progressive (Table 2).

Table 2 – Phytosociological record of point 1 of Morro Três Irmãos.

Point n. 1. Formation: Semideciduous Seasonal Forest - Place on the south face of Morro Três Morrinhos, access to hill 3 - **Municipality:** Terra Rica-PR - **Geographical Region:** Northwest of Paraná State - **Morphostructural Unit:** Plateau of Paranavaí - Bioclimatic Domain Mata Atlântica - **Date :** 06.06.2021 **- Location:** 22'47'24" S and 52'38'40" W - **Orientation:** north-south.					
Species by Stratum	**No. of Ind.**	**Alt. (m) approx.**	**Species**		**Stratum**
			A/D	**S**	**S/Din**
Arboreal					
Syagrus romanzoffiana (Cham.) Glassman	2	15			
Parapiptadenia rigida (Benth.) Brenan.	1	18			
Luehea candicans Mart. & Zucc.	1	16	4	1	R
Cordia trichotoma (Vell.) Arráb. ex Steud.	1	14			
Arborescent					
Amphilophium crucigerum (L.) L.G.Lohmann	2	9			
Philodendron bipinnatifidum Schott ex Endl.	1	9			
Trichilia claussenii C. DC.	1	10			
Casearia sylvestris Sw.	1	8	3	1	E
Myrsine umbellata Mart.	1	9			

Shrubby					
Tillandsia didisticha (E. Morren) Baker	1	6			
Psychotria carthagenensis Jacq.	1	4			
Cupania vernalis Cambess.	2	5,2			
Zanthoxylum fagara (L.) Sarg	1	6,5			
Matayba elaeagnoides Radlk.	1	6	2	1	P
Urera baccifera (L.) Gaudich.	1	3			
Amphilophium dusenianum (Kraenzl.) L.G.Lohmann	2	4			
Piptocarpha sellowii (Sch. Bip.) Baker	1	4,5			
Herbaceous\Creeting					
Psychotria carthagenensis Jacq.	12	0,5			
Commelina erecta L.	26	0,3			
Microgramma vacciniifolia (Langsd. & Fisch.) Copel	16	0,8			
Peperomia glabella (Sw.) A.Dietr.	9	0,4			
Pleopeltis minima (Bory) J. Prado & R.Y. Hirai	7	0,8			
Cestrum strigillatum Ruiz & Pav.	2	1	3	4	P
Myrsine coriacea (Sw.) R.Br.	2	1,3			
Piper amalago L.	8	1,5			
Syagrus romanzoffiana (Cham.) Glassman	1	0,3			

HEIGHT: 560 m**. CLIMATE:** Aw–Tropical Climate (Subhot). **TEMPERATURE:** annual average between 22°C and 23°C and minimum average temperature in the coldest month equal to 18°C, hot summer and less frequent frosts. Spreading across the extreme northwest of the state, along the border with the state of São Paulo, with two defined periods: rainy (October to March) and little rainy (April to September); rainy and hot summer.

PRECIPITATION: 1200-1400 mm (annual evapotranspiration 1051-1100 mm and high water deficit in winter where the maximum rainfall in the dry season tends to be ≤ 60 mm). **MICROCLIMA:** High slope. **HUMIDITY:** 68% to 70%. **ROCHA-MÃE:** Cretaceous sandstones from the Caiuá formation.

SOIL: litholic neosols dystrophic a horizon moderate medium texture, relatively strong wavy + rock outcrops.

HUMUS: Thin layer of leaf litter with slowly decomposing leaves. 5cm subsurface layer of decomposed humus.

EROSION: does not show. **RELIEF:** witness hill**. SLOPE:** 16 degrees.

ANTHROPIC ACTION: soils unsuitable for any agricultural activity; indiscriminate removal of vegetation (salisaparilla); tourism with uncontrolled and protected trails.

DYNAMICS OF THE SET: Permanent protection area with the presence of exotic species; highly degraded; private homes in the surroundings; features trampling of cattle and horses.

Source: BEIER; FERREIRA (2021).

In point 2, the four main strata, arboreal, arborescent, shrubby and herbaceous were also quantified and analyzed. In the arboreal stratum one species was observed: Angico Vermelho (*Parapiptadenia rigida* Benth. Brenan). The Angico presents itself individually, with an average height of 12 m., with only one specimen having been

identified in a less rocky plot. The stratum presents abundance/dominance 2 (BRAUN-BLANQUET, 1979) revealing vegetation cover between 10 and 25% (Table 3) and sociability 1, indicating the growth of isolated individuals. As for the dynamics, this stratum is in the regressive stage.

The arborescent layer has 5 species: Jerivá (*Syagrus romanzoffiana* (Cham.) Glassman, Fig (*Ficus luschnathiana* (Miq.), Mandacaru (*Cereus hildmannianus* K.Schum.) and Perobinha (*Acosmium dasycarpum* (Vogel) Yakovlev) and xique- Xique (*Praecereus euchlorus* (F.A.C.Weber) N.P.Taylor). There are 2 individuals of jerivá here, with quite different sizes, respectively 9 and 5 meters tall. The Ficus also presents itself duplicated within the area, one at each end of the point, with similar heights. An adult Mandacaru specimen was identified, with an approximate height of 7 m. With only 2 individuals, the perobinhas are 8 m tall each. The stratum presents abundance/dominance 3 revealing vegetation cover between 25 to 50% and sociability 3, indicating growth in groups as well. Regarding the dynamics of the stratum, it is in the progressive stage (Table 3).

With 8 different species, there is in the shrub stratum the presence of Perobinha (*Acosmium dasycarpum*), Hora-pro-nobis (*Pereskia aculeata* Mill.), Xique-Xique (*Praecereus euchlorus* (F.A.C.Weber) N.P.Taylor, bell vine purple (*Mansoa difficilis*) (cham.) Bureau & K. Schum., gunpowder (*Trema micranta*) (L.) Blume, fine-leaved dairy (*Tabernaemontana catharinensis*) A.DC., vine (*Amphilophium dusenianum*) (Kraenzl.) L.G.Lohmann, succara (*Dasyphyllum tomentosum*) (Spreng.) Cabrera. The average height of this stratum is 4 m, with abundance/dominance 3 and sociability 2, with individuals grouped into 2 or 3. The dynamics of the stratum presents a situation of progression.

At the base of the strata there is the largest number of individuals, 87 and also the greatest diversity of strata with 8 different species. With an average height of 0.5m, with the exception of *Trigonia nivea* Cambess. (2 m tall), the species that occur are: Figueira tree (*Ficus luschnathiana*), cologne (*Panicum maximum* Jacq CV), hairy vine (*Mikania cordifolia* (LF) Willd.), (*Sinningia carangolensis* Chautems), penny weed

(*Boerhavia diffusa* L.), Trapoeraba (*Commelina erecta* L.), wild coffee (*Psychotria carthagenensis* Jacq.) and lichen on the rocks. The abundance/dominance of the extract is 3 and sociability 3, with growth in groups. The dynamics of the strata are in progress.

Table 3 – Phytosociological record of point 2 of Morro Três Irmãos.

Point n. 2. Formation: Semideciduous Seasonal Forest - Watershed at Morro Três Morrinhos, hill 2 - **Municipality:** Terra Rica-PR - **Geographical Region:** Northwest of Paraná State - **Morphostructural Unit:** Plateau of Paranavaí - Bioclimatic Domain Mata Atlântica - **Date:** 29.08.2019-**Location**: 22'47'13" S and 52'38'44" W - **Orientation:** north-south.					
Species by Stratum	**No. of Ind.**	**Alt. (m) approx.**	**Species**		**Stratum**
			A/D	**S**	**S/Din**
Arboreal					
Parapiptadenia rigida (Benth.) Brenan	1	12	2	1	R
Arborescent					
Syagrus romanzoffiana (Cham.) Glassman	1	9			
Syagrus romanzoffiana	1	6			
Ficus luschnathiana (Miq.)	1	8			
Ficus luschnathiana	1	7			
Cereus hildmannianus K.Schum.	1	7	3	3	E
Acosmium subelegans (Mohlenbr.) Yakovlev	2	8			
Praecereus euchlorus (F.A.C.Weber) N.P.Taylor.	4	6			
Shrubby					
Acosmium subelegans	1	4			
Pereskia aculeata Mill.	1	5			
Pereskia aculeata	1	4			
Praecereus euchlorus (F.A.C.Weber) N.P.Taylor.	4	3			
Mansoa difficilis) (cham.) Bureau & k. Schum	3	5			
Trema micrantha (L.) Blume	1	4	3	2	P
Tabernaemontana catharinensis A.DC.	5	2			
Amphilophium dusenianum (Kraenzl.) L.G.Lohmann	3	5			
Dasyphyllum tomentosum (Spreng.) Cabrera	1	5			
Herbaceous\Creeting					
Ficus luschnathiana	1	2			
Panicum maximum Jacq CV	18	1			
Panicum maximum	9	0,5			
Mikania cordifolia (LF) Willd.	5	1,5			
Sinningia carangolensis Chautems	3	0,3	3	3	p

Boerhavia diffusa L.	7	0,3			
Trigonia nivea Cambess.	13	2			
Commelina erecta L.	22	0,2			
Psychotria carthagenensis Jacq.	9	0,5			

HEIGHT: 560 m **CLIMATE:** Aw–Tropical Climate (Subhot).

TEMPERATURE: annual average between 22°C and 23°C and minimum average temperature in the coldest month equal to 18°C, hot summer and less frequent frosts. Spreading across the extreme northwest of the state, along the border with the state of São Paulo, with two defined periods: rainy and hot-summer (October to March) and little rainy –winter- (April to September).

PRECIPITATION: 1200-1400 mm (annual evapotranspiration 1051-1100 mm and high water deficit in winter where the maximum rainfall in the dry season tends to be ≤ 60 mm). **MICROCLIMA:** High slope. **HUMIDITY:** 68% to 70%.

ROCHA-MÃE: Cretaceous sandstones from the Caiuá formation.

SOIL: litholic neosols dystrophic horizon a moderate medium texture, relatively strong wavy + rock outcrops.

HUMUS: Thin layer of leaf litter with slowly decomposing leaves. 5cm subsurface layer of decomposed humus**.**

EROSION: laminar and punctual. **RELIEF:** witness hill**. SLOPE:** 16 degrees.

ANTHROPIC ACTION: soils unsuitable for any agricultural activity; indiscriminate removal of vegetation (salisaparilla); tourism with uncontrolled and protected trails.

DYNAMICS OF THE SET: Permanent protection area with the presence of exotic species; highly degraded; private homes in the surroundings; features trampling of cattle and horses.

Source: BEIER; FERREIRA (2021).

Point 3 is located at coordinates 22°46'59" S and 52°39'00", having an average altitude of 609 m, being close to the top of the main hill, next to the free flight ramp. This area is heavily impacted, with little vegetation cover in some points. The arboreal layer is not observed in this plot, and the first elements are framed in the arborecent layer with elements such as: Murici (*Byrsonima intermedia* A.Juss.), pau de Tucano (*Vochysia tucanorum* Mart.), Embaúba-branca (*Cecropia pachystachya* Trécul. .), Terminalia (*Terminalia glabrescens* Mart.), cocão (*Erythroxylum pelleterianum* A.St.-Hil.), Cajueiro-do-cerrado (*Roupala montana* var. brasiliensis (Klotzsch)) KS Edwards, wild turkey (*Acosmium subelegans*) (Mohlenbr.) Yakovlev). The stratum is in the development stage, with species from the cerrado prevailing. With 6 individuals, *Terminalia* has the highest density, with *Byrsonima* and *Erythroxylum* still being abundant. With abundance/dominance 3 revealing vegetation cover between 25 to 50% and sociability 2, indicating growth in small clusters. Regarding the dynamics of the stratum, it is in the progressive stage (Table 4).

In the shrubby layer, 7 species are identified, including pau-terra (*Qualea dichotoma* (Mart.) Warm. var. dichotoma), Terminalia (*Terminalia glabrescens* Mart.), capororoca (*Myrsine umbellata* Mart.), canudo de pito (*Mabea fistulifera* Mart.) pixirica (*Miconia fallax* (DC.) Naud.), *Tillandsia streptocarpa* Baker, Monkey's Comb (*Amphilophium crucigerum* (L.) LGLohmann.). Regarding the abundance and dominance indexes 2 with coverage between 10 to 25%, and low sociability with isolated individuals. The stratum is in a regressive dynamics stage.

Table 4 – Phytosociological record of point 1 of Morro Três Irmãos.

Point n. 3. Formation: Semideciduous Seasonal Forest - South face of Morro Três Morrinhos, hill 1 - Vegetation Series - **Municipality:** Terra Rica-PR **- Geographical Region:** Northwest of Paraná State **- Morphostructural Unit:** Plateau of Paranavaí **-** Bioclimatic Domain Atlantic Forest **- Date: 06.06.2021 -** Location: 22'46'59" S and 52'39'00" W **- Orientation:** north-south.					
Species by Stratum	**No. of Ind.**	**Alt. (m) approx.**	**Species**		**Stratum**
			A/D	**S**	**S/Din**
Arboreal					
Byrsonima intermedia A.Juss.	5	9			
Vochysia tucanorum Mart.	3	8			
Cecropia pachystachya Trécul	1	8			
Terminalia glabrescens Mart.	6	6	3	2	P
Erythroxylum pelleterianum A.St.-Hil.	5	6			
Roupala montana var. brasiliensis (Klotzsch) K. S. Edwards	1	7			
Acosmium subelegans (Mohlenbr.) Yakovlev	2	7			
Arborescent					
Qualea dichotoma (Mart.) Warm. *var. dichotoma*	7	4			
Terminalia glabrescens Mart.	4	3			
Myrsine umbellata Mart.	2	2			
Mabea fistulifera Mart.	1	1,5			
Miconia fallax (DC.) Naud.	2	1	2	1	R
Tillandsia streptocarpa Baker	1	1,8			
Amphilophium crucigerum (L.) L.G.Lohmann	2	1,5			
Herbaceous\Creeting					

Pteridium aquilinum (L.) Kuhn	46	0,3			
Dicranopteris flexuosa (Schrad.) Underw.	15	0,3			
Trigonia nivea Cambess. var. pubescens (Cambess.) Lleras	5	0,3			
Coccocypselum lanceolatum (Ruiz & Pav.) Pers.	4	0,2	2	1	R
Austroeupatorium inulaefolium R.M. King & H. Rob.	3	0,4			
Dolichandra quadrivalvis (JACQ.) L.G. LOHMANN.	1	0,5			
Microgramma vacciniifolia. (Langsd. & Fisch.) Copel.	6	0,3			
Roupala montana var. brasiliensis (Klotzsch) K. S. Edwards	2	1			

ALTITUDE: 609 m **CLIMATE:** Aw– Tropical Climate (Subhot). **TEMPERATURE:** annual average between 22°C and 23°C and minimum average temperature in the coldest month equal to 18°C, hot summer and less frequent frosts. Spreading across the extreme northwest of the state, along the border with the state of São Paulo, with two defined periods: rainy and hot-summer (October to March) and little rainy –winter- (April to September).

PRECIPITATION: 1200-1400 mm (annual evapotranspiration 1051-1100 mm and high water deficit in winter where the maximum rainfall in the dry season tends to be ≤ 60 mm). **MICROCLIMA:** Media slope. **HUMIDITY:** 68% to 70%. **ROCHA-MÃE:** Cretaceous sandstones from the Caiuá formation. **SOIL:** litholic neosols dystrophic a horizon moderate medium texture, relatively strong wavy + rock outcrops.

HUMUS: Thin layer of leaf litter with slowly decomposing leaves. 5cm subsurface layer of decomposed humus**. EROSION:** laminar and punctual.

RELIEF: witness hill**. SLOPE:** 27 degrees**. ANTHROPIC ACTION:** soils unsuitable for any agricultural activity; indiscriminate removal of vegetation (salisaparilla); tourism with uncontrolled and protected trails.

DYNAMICS OF THE SET: Permanent protection area with the presence of exotic species; highly degraded; private homes in the surroundings; features trampling of cattle and horses.

Source: BEIER; FERREIRA (2021).

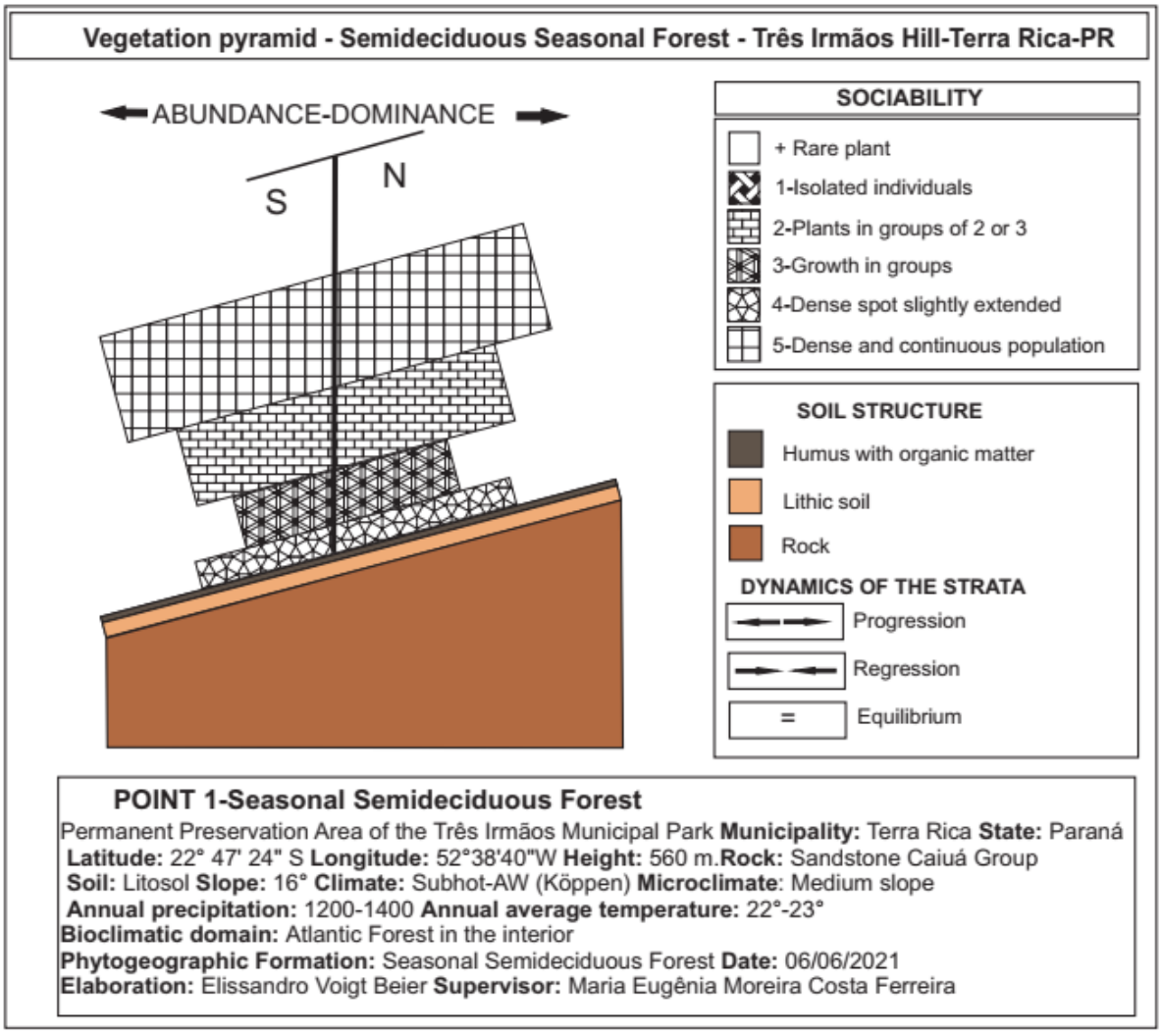
In the herbaceous stratum, the greatest floristic diversity occurs, with 8 distinct species, namely: Samambaia de tapera (*Pteridium aquilinum* (L.) Kuhn), samambaia de barranco (*Dicranopteris flexuosa* (Schrad.) Underw.), cipó-de-paina (*Trigonia nivea* Cambess. var. pubescens (Cambess.) Lleras), rubiaceae (*Coccocypselum lanceolatum* (Ruiz & Pav.) Pers.), Asteraceae (*Austroeupatorium inulaefolium* R.M. King & H. Rob.), Bignoniaceae (*Dolichandra quadrivalvis* (JACQ.) LOHMANN (JACQ.) .), Cipó-cabeludo (*Microgramma vacciniifolia*. (Langsd. & Fisch.) Copel.). Litter and humus cover between 25% and 50% of the soil. The herbaceous layer is at level 2, with a degree of coverage between 10% and 25%. The sociability of this stratum is identified by isolated individuals, without density and its dynamics presents itself in regression.

Phytosociological pyramids from three areas of the Três Irmãos hill

Based on the data collected in the field work carried out and on the forms presented above, the respective phytosociological pyramids of the points described above were elaborated through manual construction and subsequent representation in compatible software. In the vertical and horizontal analysis, it was decided to exclude the sub-shrubby layer from the arborescent layer, according to current models.

The pyramid at point 1 (Pyramid 1) represents the dominance of the arboreal, arborescent and herbaceous stratum in relation to the shrubby stratum. In the arboreal stratum, the process can be seen in equilibrium, with large, healthy adult individuals.

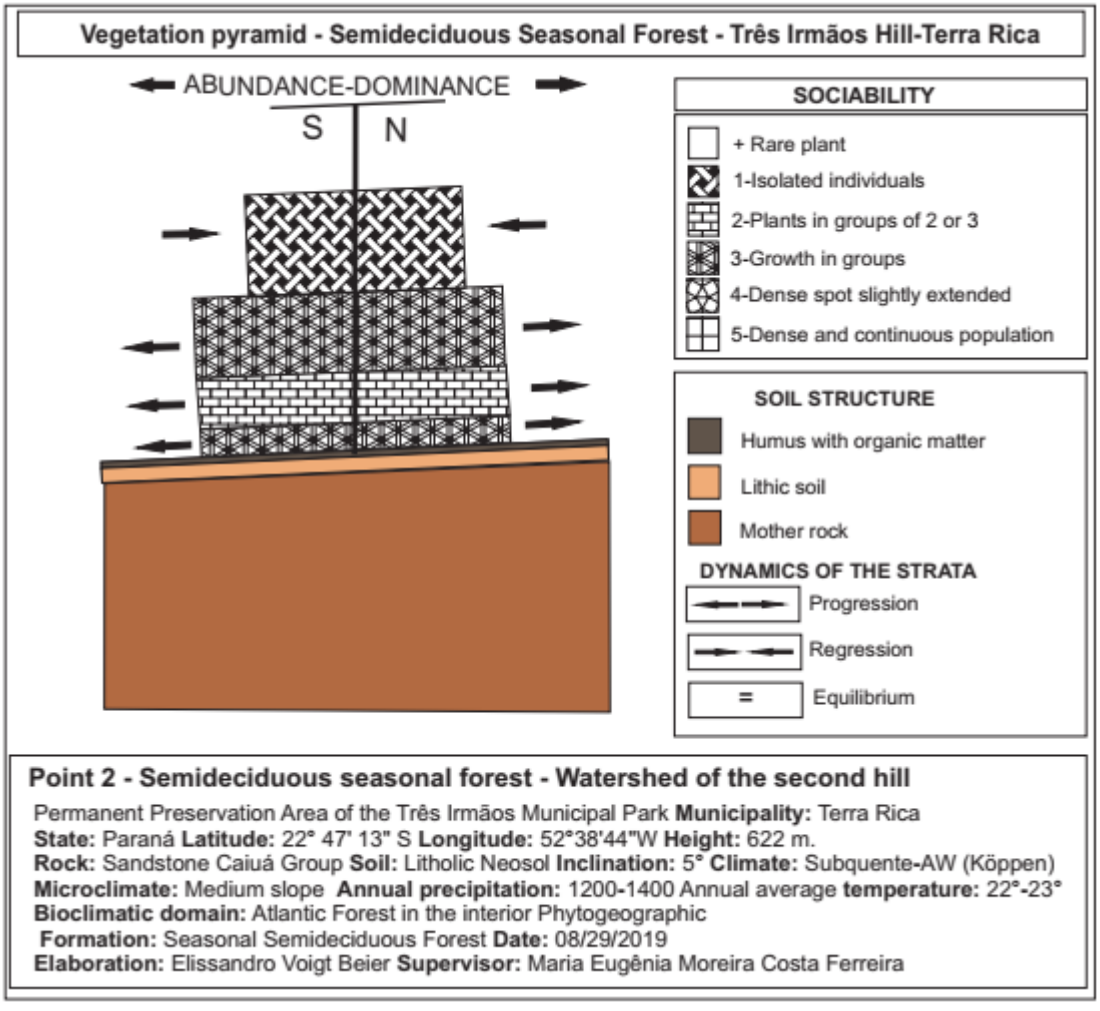
Pyramid 1 - Pyramid of Vegetation at point nº 01 in the municipality of Terra Rica – PR.



Source: BEIER; FERREIRA (2021).

The arborescent stratum, presents a higher number of individuals compared to the aforementioned, presents floristic diversification without dominance over the species; it is in equilibrium in the number of adults and in the crown's ascension stage. Without the predominance of one species, the shrub stratum has a greater number of species compared to the aforementioned, being in a progressive stage, the shrub stratum is due to expansion with isolated individuals within the plot, not negatively affecting the growth of the first.

Pyramid 2 - Pyramid of Vegetation at point nº 02 in the municipality of Terra Rica – PR.



Source: BEIER; FERREIRA (2021).

The herbaceous stratum presents the progression stage, with 9 distinct species and the predominance of low and creeping individuals as an exemplar of the Commelinaceae family, popularly known as erva-de-santa-Luzia, which presents the

highest density followed by *Psychotria carthagenensis* Jacq ., which in this portion of the forest presents a high density of young individuals.

The pyramid at point 2 (pyramid 2), presents the four stratum proposed in this analysis, with the arboreal stratum of this point having characteristics in regression, with only one species in the adult stage that has arboreal characteristics, one specimen of angico red and the dynamics of the stratum is in evident regression

The arborescent stratum is in a progressive stage, with 5 different species in this portion of the analysis, repeating the occurrence of specimens, but with different heights. In this parcel there is an exceptional landscape, with the area over the watershed on the north-south face, and it is approximately 2 meters wide and on its edges there is a sloping face for the respective slopes. In this portion of the landscape, there are rocky outcrops and the presence of xerophytic elements that are quite common in the hill landscape, such as cactuses of different species such as *Cereus* and *Praecereus euchlorus* (F.A.C.Weber) N.P.Taylor (image 1).

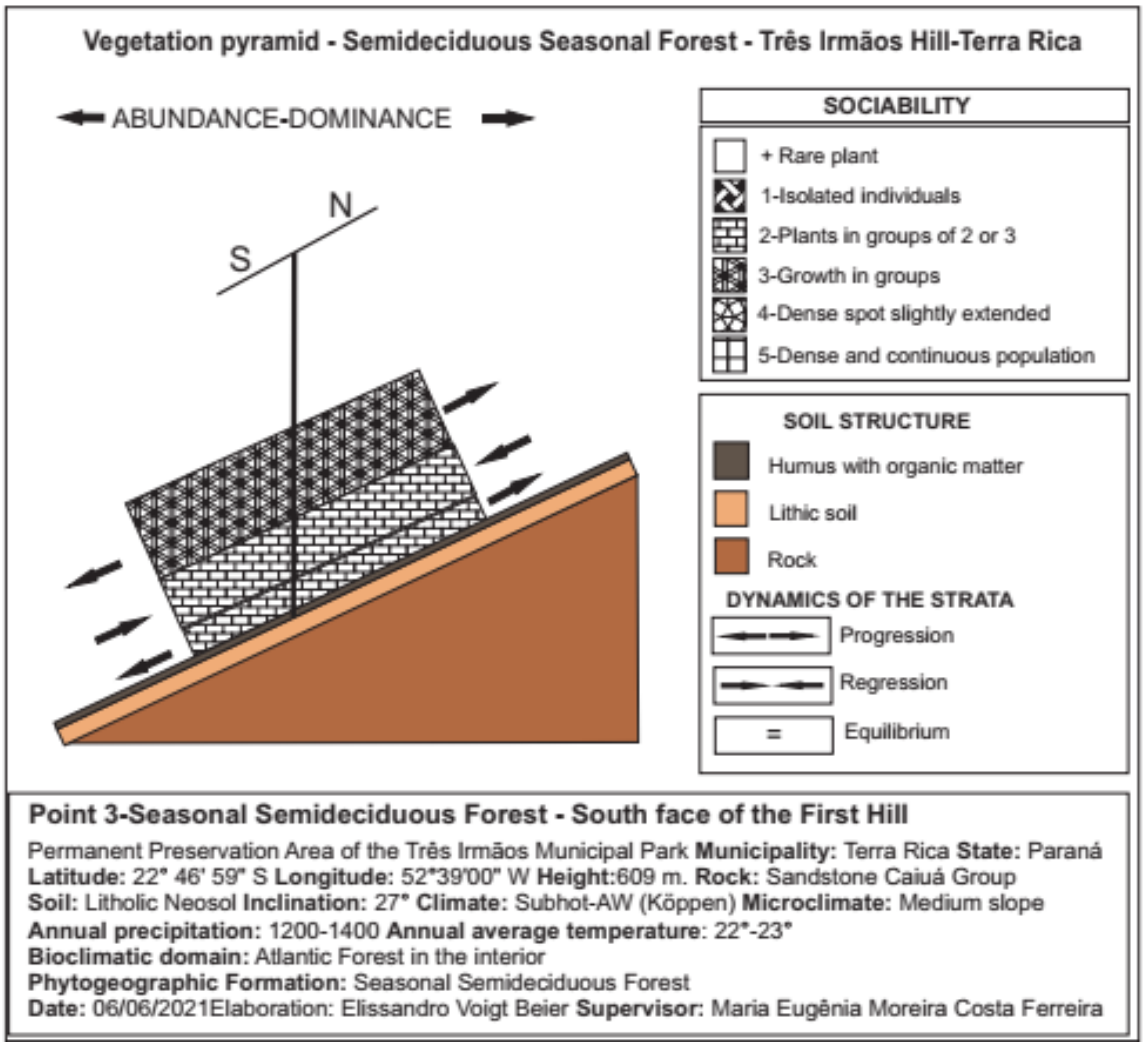
Image 1 - Vegetation at point 01.

Source: BEIER; FERREIRA (2021).

A collection of xerophytic floristic individuals such as *Pereskia aculeata* Mill occurs in the shrub stratum. and *Praecereus euchlorus* (F.A.C.Weber) N.P.Taylor. over lithosoil and rocky outcrop. In this portion, the sociability of individuals is presented in a grouping of individuals of 2 or 3 copies.

Herbaceous plants are distributed in larger groups, where cipó-de-paina, erva-de-Santa-Luzia e capim colonião have a large majority of the profile, with large concentrations. There are still fragments of exposed soil with clearings due to the discontinuity of the upper canopy, rocky outcrops with unidentified lichens are observed in small samples.

Pyramid 3 - Pyramid of Vegetation at point nº 03 in the municipality of Terra Rica – PR.



Source: BEIER; FERREIRA (2021).

Point 3 (pyramid 3) has only 3 strata, the arboreal stratum not being observed. Different species of individuals from the cerrado occur on this floor, such as

Byrsonima intermedia A.Juss., *Vochysia tucanorum* Mart., *Erythroxylum pelleterianum* A.St.-Hil., among other specimens of this phytogeographic formation.

The lower stratum, shrubby, presents little diversity, with a predominance of individuals from the upper stratum in the lower stage.

Finally, the herbaceous stratum has little species diversity and is in a regressive biodynamic stage, with a predominance of two species of pteridophytes with great dispersal and occupation power (*Pteridium aquilinum* (L.) Kuhn., *Dicranopteris flexuosa* (Schrad.) Underw.), that occupy a large portion of the soil, showing portions of this. The slope at this point is quite steep with limited accumulation of organic matter, forming a layer of approximately 5 cm at some accumulation points.

Final considerations

The 3 (three) points analyzed in this work have distinct phytosociological characteristics due to factors such as slope orientation, pedology and inadequate land use and occupation processes with intense anthropization arising mainly from previous processes of turning the area into a conservation space, and currently the impact of tourism is observed, uncontrolled cutting of plant specimens and trampling of trails produced by the movement of people.

With the obtainment of phytosociological data of the permanent preservation area of Morro Três Irmãos (Três Morrinhos), it was verified that the identification of the floristic composition, structure of the vegetation by floors, its dynamics, and the abundance/dominance and sociability indices are information relevant for the construction of a management plan, which even the area does not present so far, as these data show the most impacted areas.

The graphical representation of the phytosociological analysis (plant pyramids) indicates that the shrub and herbaceous strata are predominant in terms of biological diversity and abundance/dominance. Regarding the herbaceous stratum, the three lots are in progressive dynamics. This is due to the colonization of

the environment by species such as invasive ferns, *Commelina erecta* L. and colonião grass in rapid propagation and wide coverage. These species are typical of degraded environments where the soil surface receives greater solar radiation due to the absence or reduction of larger species. There are native species at an early stage and other herbaceous species in lower density of individuals.

The arborescent strata of the points in question are less representative in terms of biological diversity and good condition of dominance/abundance, as well as their low level of sociability, with balance in the dynamics of the floors. The environmental pressures that occur in environments 2 and 3 are reflected in the dynamics that, consequently, are related to the decrease in biodiversity causing imbalances in the energy and matter production cycles and considering the history of occupation of the area, these floors are in process of gradual recovery.

The arboreal stratum is observed only in lot 1 and 2, and in the latter it is quite altered and in regressive dynamics as a result of environmental pressures and the edge effect. Corroborating with Passos (2000), it is noteworthy that the pyramids show the vegetation dynamics and biogeographic conditions that are not possible to be observed by imaging processes by remote sensors, such as vertical steps and species, perfectly translating the competition between the species, as the upper floors cover the spaces of the lower strata, not allowing the visualization of open spaces, which can be occupied by herbaceous and shrub species that cover the ground, not allowing the emergence of erosive processes.

Finally, the phytosociological study allows us to visualize with greater clarity the dynamics of phytohorizons, which makes it possible to assess the dynamics of the strata and of the set in general. In this sense, the vegetation pyramid has a facilitating role, capable of creating a vertical cartographic representation of the plant structure, which together with the biogeographic sheets make up a final product, which exposes the composition of the strata in its dynamics with the pedo and geological variants, luminosity, slope and anthropic action.

Bibliographic references

BERTRAND, C.; BERTRAND, G. **A transversal and crossing geography:** the environment through territories and temporalities. Messias Modesto dos Passos (Org.) Maringá. Massoni, 2009.

BERTRAND, G. **Pour une étude géographique de la vegetation**. R.G.P.S-O, t. XXXVII, Toulouse, 1966.

BRAUN-BLANQUET, J. **Fitosociologia.** Bases para el estudio de las comunidades vegetales**.** ed. Blume, Madrid, 1979.

DETTKE, G. A., et al**. Pollen diversity of plants from the Paraná Semideciduous Seasonal Forest.** Presidente Prudente: Gráfica CS, 2020.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA – IBGE. **Technical Manual of**

Brazilian vegetation. Technical manuals in geosciences. Rio de Janeiro, 2012.

MAACK, R. 1981. **Physical Geography of the State of Paraná**. Rio de Janeiro: ED. José Olympio; Curitiba: Paraná State Department of Culture and Sport.

MARTINS, F. R. Forest Phytosociology in Brazil a Bibliographic History. Research – **Botanical Series 40**. São Paulo, 1989.

MARTINS, S. V. **Recovery of Riparian Forests**. In: Martins, S. V.; Vieira, E. A. (Eds.). Learn easy. Viçosa, 2001.

MORI, S. A.; BERKOV, A.; GRAC IE, C. A. & HECKLAU, E. F (eds). 2011. **Tropical plant collecting: from the field to the internet.** TECC Editora, Florianópolis. 332p.

PASSOS, M. M. 1998. B**iogeography and landscape**. Maringá, Paraná: UEM; Presidente Prudente, São Paulo: UNESP.

PASSOS, M. M. **For a study of the evolution of vegetation -** from the pyramid to the NDVI**.** Geosul. v.15, n.30, jul./dez. Florianópilis, 2000, p. 90-110.

PAULA, P. F. e FERREIRA, M. E. M. C. Preliminary phytogeographic survey in the park of the

50th anniversary in Maringá-PR. **Geography Magazine**. v.14, n.1, jan/jun, 2005. **Available in:** https://www.uel.br/revistas/uel/index.php/geografia/article/view/6749/6090. Access in: 10/09/2021.

RAMOS, V. S.; DURIGAN, G.; FRANCO, G. A. D. C.; SIQUEIRA, M. F. a de; RODRIGUES, R. R. **Seasonal semideciduous forest trees:** species identification guide. [S.l: s.n.], 2008.

RODERJAN, C. V.; F. GALVÃO; Y. S. KUNIYOSHI; & G. G. HATSCHBACH. 2002. The phytogeographic units of the State of Paraná. **Science and Environment Magazine**, 24: 75-92. **Available in: http://w3.ufsm.br/reciam/resenha.php?IDResenha=176.** Access in: 10/09/2021.

ZAPPI, D., TAYLOR, N., SANTOS, M.R., LAROCCA, J. 2015. **Cactaceae in Brazilian Flora Species List**. Rio de Janeiro Botanical Garden. Available in: http://floradobrasil.jbrj.gov.br/jabot/floradobrasil/FB70, (access in 10-10-2021).

Author contributions:

Author 1- text elaboration, data collection, elaboration of graphics, tables and pyramid

Author 2- Supervision of field work, production and proofreading,