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Artigo Original

Phytosociology of the arboreal component in an area of springs, Pernambuco

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Abstract

This study aimed to know the phytosociological composition of the arboreal component in an area of springs in Sirinhaém - PE. Ten plots (10 m x 25 m) were arranged in rays above the springs and distributed systematically in 5 lines, separated by a 45° angle, each. In each line, 2 plots were allocated, at an interdistance of 25 m. In each plot, all individuals with CAP ≥ 15 cm were sampled, which were measured and had the estimated height. The phytosociological parameters were analyzed and an admissible sampling error of 20% and probability level of 95% was adopted. The calculated sampling error was 18%, lower than that established. The springs had a density of 1,236 individuals ha-1, with an estimated basal area of 27,647 m^2 ha^{-1}. *Tapirira guianensis* was characterized by a combination of large numbers of individuals, high dominance and high frequency, demonstrating that it is a species with wide distribution in the area. Regarding the relative frequency, in addition to *T. guianensis*, *Eschweilera ovata* and *Inga flagelliformis* were distinguished. The highest values of absolute dominance were of the species *T. guianensis* and *Virola gardneri*. In terms of Importance Value, the highlight was on *T. guianensis* and *V. gardneri*.

Keywords: Floristics; Preservation; Atlantic forest

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1 Introduction

The term springs is defined by the Forestry Code, Law no 12.651, of May 25, 2012, as a natural outcrop of the water table that presents perenniality and starts a watercourse, forming part of the Permanent Preservation Area (PPA). A minimum radius of 50 meters wide must be preserved around the Springs, but if the area is considered consolidated, ie with anthropic occupation pre-existing before July 22, 2008, the minimum mandatory radius for preservation is only 15 meters, assuming the maintenance of agroforestry activities, ecotourism or rural tourism (BRASIL, 2012).

The characteristics of a springs can be influenced by several factors, such as climate, vegetation cover, topography, geology, as well as type, use and management of the soil of the area in which the source is located. They are characterized as the place where a water course begins (river, stream), independently of the dimensions (LOZINSKI *et al.*, 2010).

According to Oliveira *et al.* (2012), despite the environmental importance and legal protection, springs s continue to be degraded and the reduction of ciliary vegetation in these areas cause a significant increase in soil erosion processes, with losses of regional hydrology, reduction of biodiversity and degradation of large areas.

Preserving the forest cover in the surroundings of these environments, has become a necessity, therefore, according to Balbinot *et al.* (2008) the flow of water in areas with full forest cover is more stable and sustainable than in other cases. For Oliveira and Amaral (2004), floristic and phytosociological studies are essential for the conservation of diversity, since they provide the knowledge of the current state of the fragments and subsidies for their recovery plans.

In this sense, this work aimed to know the phytosociological composition of the arboreal component of the vegetation occurring in the Springs area, located in Córrego do Campo, which flows into the Sirinhaém River, in the municipality of Sirinhaém - PE, to promote restoration and preservation of these environments.

2 Materials and methods

Study area

The study was carried out in the springs of Córrego do Campo, which flows into the Sirinhaém River, located in the Engenho Buranhém, belonging to Usina Trapiche S / A, in the Municipality of Sirinhaém, Pernambuco, under coordinates 8° 34' 38'' S and 35° 10' 4.9' ' W. The area studied has an average altitude of 75 m and the forest is classified according to the IBGE (2012) as Lowland Rain Forest (Figure 1). According to Köppen's classification, the region presents an Am monsoon climate type (ALVARES *et al.*, 2013), with an annual average temperature of 25.6°C and precipitation around 1,800 mm. Soils found in the region are of the Yellow Latosol type; Yellow Argisol; Red-Yellow and Greyish; Gleissolo; Cambissolo and Neosolos Flúvios (SANTOS *et al.*, 2013).

2.2. Collection of data

For the data collection of the arboreal component, 10 plots measuring 10 m x 25 m were arranged in rays, above the springs and distributed systematically in 5 lines, separated by 45° angle, each. In each line, 2 plots were allocated, separated by a distance of 25 m.

The sample units were geo-referenced with the aid of a GPS (Global Positioning System) receiver, model Garmim - V. In each plot, all individuals with Chest Height Circumference (CAP) ≥ 15 cm were sampled, which were tagged and enumerated progressively with PVC plaques (5 cm x 5 cm). Each tree sampled had the CAP measured with tape, and the estimated height with modules (1.5 m each) of high pruning shears.

The individuals sampled had the botanical material collected, labeled and subjected to oven drying (65°C) for 48 hours. The identification was carried out by comparison with samples belonging to the Herbarium Dárdano de Andrade Lima of the Agronomic Institute of Pernambuco (IPA), where the fertile material was deposited, as well as by consulting specialists and specialized literature. The identification followed the classification system APG IV (Angiosperm Phylogeny Group) (APG IV, 2016) and the botanical nomenclature and their respective authors were obtained from the Flora of Brazil website (http://floradobrasil.jbrj.gov.br).

Data analysis

This study utilized phytosociological parameters such as Absolute Density (DA), Relative Density (DR), Absolute Frequency (FA), Relative Frequency (FR), Absolute Dominance (DoA), Relative Dominance (DoR), Coverage Value of Importance (VI), according to Mueller-Dombois and Ellenberg (1974).

In this work an acceptable sampling error (E%) of 20% and probability level of 95% were adopted. The sampling error was obtained by the following expression (SOARES; PAULA NETO; SOUZA, 2007):

$$E\% = \pm \frac{S_{\overline{Y}} . t}{\overline{Y}} . 100$$

Where: $S_{\overline{Y}}$ = standard error of the mean; t = tabulated value of Student's t distribution (α 5%, n-1 gl); and $\overline{Y}$ = mean number of trees per plot.

3 Results and discussion

For the conditions under which the work was performed, it was found that the number of sample units utilized was sufficient to meet the admissible sampling error of 20%, at 95% probability. The calculated sampling error, taking into account the number of individuals per plot was 18%, which is lower than the established value.

Figure 1 - Photograph of the Buranhém Plant, Trapiche S/A Plant, Sirinhaém / PE, with detail of the Lowland Rain Forest fragment and data collection point (Source: Usina Trapiche S/A)

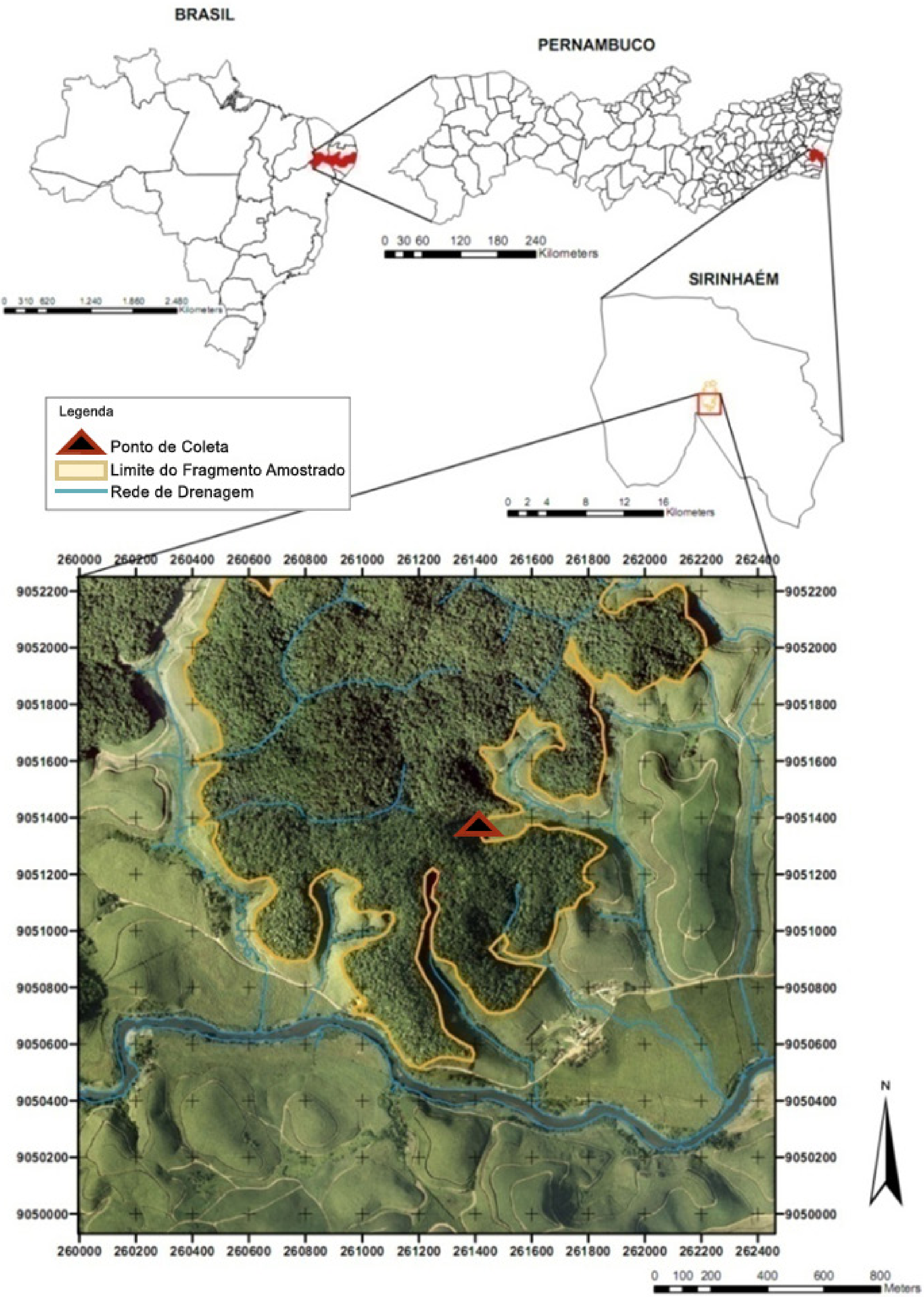


Table 1 - Phytosociological parameters of the species sampled at the springs of Córrego do Campo, Mata do Engenho Buranhém, in the municipality of Sirinhaém, Pernambuco, in descending order of importance (VI). In which: Ni - Number of individuals of species i; DA - Absolute density (ind. ha^{-1}); DR - Relative density (%); FA - Absolute frequency (%); FR - Relative frequency (%); DoA - Absolute dominance (m^2 ha^{-1}); DoR - Relative dominance; VC - Value of coverage and VI - Value of importance.

Species	Ni	DA	DR	FA	FR	DoA	DoR	VI	VC
Tapirira guianensis Aubl.	33	132	10.68	70	4.79	5.142	18.60	34.07	29.28
Virola gardneri (A. DC.) Warb.	7	28	2.27	50	3.42	3.135	11.34	17.03	13.61
Protium heptaphyllum (Aubl.) Marchand	20	80	6.47	60	4.11	1.568	5.67	16.25	12.14
Inga flagelliformis (Vell.) Mart.	21	84	6.80	70	4.79	0.970	3.51	15.10	10.30
Eschweilera ovata (Cambess.) Miers	16	64	5.18	80	5.48	0.905	3.27	13.93	8.45
Schefflera morototoni (Aubl.) Maguire, Steyerm. & Frodin	18	72	5.83	50	3.42	1.281	4.63	13.88	10.46
Eschweilera ovata (Cambess.) Miers	16	64	5.18	80	5.48	0.905	3.27	13.93	8.45
Schefflera morototoni (Aubl.) Maguire, Steyerm. & Frodin	18	72	5.83	50	3.42	1.281	4.63	13.88	10.46
Mabea occidentalis Benth.	20	80	6.47	50	3.42	0.966	3.49	13.39	9.97
Parkia pendula (Willd.) Benth. ex Walp.	4	16	1.29	30	2.05	2.735	9.89	13.24	11.19
Annona montana Macfad.	12	48	3.88	70	4.79	1.191	4.31	12.99	8.19
Miconia minutiflora (Bonpl.) DC.	11	44	3.56	60	4.11	0.460	1.67	9.33	5.23
Guatteria pogonopus Mart.	17	68	5.50	40	2.74	0.173	0.62	8.87	6.13
Dialium guianense (Aubl.) Sandwith	7	28	2.27	30	2.05	0.937	3.39	7.71	5.65
Simarouba amara Aubl.	3	12	0.97	30	2.05	1.281	4.63	7.66	5.60
Pouteria sp.	8	32	2.59	40	2.74	0.614	2.22	7.55	4.81
Thyrsodium spruceanum Benth.	8	32	2.59	50	3.42	0.208	0.75	6.77	3.34
Miconia prasina (Sw.) DC.	9	36	2.91	30	2.05	0.307	1.11	6.08	4.02
Nectandra cuspidata Nees & Mart.	3	12	0.97	20	1.37	0.999	3.61	5.96	4.59
Miconia holosericea (L.) DC.	7	28	2.27	40	2.74	0.157	0.57	5.57	2.84
Coussarea sp.	4	16	1.29	30	2.05	0.353	1.28	4.63	2.57
Myrcia fallax (Rich.) DC.	4	16	1.29	40	2.74	0.097	0.35	4.38	1.64
Rheedia brasiliensis (Mart.) Planch. & Triana	6	24	1.94	30	2.05	0.075	0.27	4.27	2.21
Cupania oblongifolia Mart.	1	4	0.32	10	0.68	0.765	2.77	3.77	3.09
Tovomita brevistaminea Engl.	5	20	1.62	20	1.37	0.193	0.70	3.69	2.32
Himatanthus phagedaenicus (Mart.) Woodson	3	12	0.97	30	2.05	0.169	0.61	3.64	1.58
Siparuna guianensis Aubl.	4	16	1.29	20	1.37	0.254	0.92	3.58	2.21
Miconia falconi Brade	5	20	1.62	20	1.37	0.089	0.32	3.31	1.94
Guazuma ulmifolia Lam.	5	20	1.62	10	0.68	0.185	0.67	2.97	2.29
Pera ferruginea Mull. Arg.	3	12	0.97	20	1.37	0.128	0.46	2.81	1.44
Protium giganteum Engl.	3	12	0.97	20	1.37	0.120	0.44	2.78	1.41
Henriettea succosa (Aubl.) DC.	2	8	0.65	20	1.37	0.166	0.60	2.62	1.25
Vismia guianensis (Aubl.) Choisy	3	12	0.97	20	1.37	0.067	0.24	2.58	1.21
Psychotria cf. platypoda DC.	5	20	1.62	10	0.68	0.058	0.21	2.51	1.83
Helicostylis tomentosa (Poepp. & Endl.) Rusby	3	12	0.97	20	1.37	0.031	0.11	2.45	1.08
Cupania racemosa (Vell.) Radlk.	2	8	0.65	20	1.37	0.111	0.40	2.42	1.05
Symphonia globulifera L. f.	1	4	0.32	10	0.68	0.331	1.20	2.21	1.52
Pogonophora schomburgkiana Miers ex Benth.	2	8	0.65	20	1.37	0.015	0.06	2.07	0.70
Bowdichia virgilioides Kunth	1	4	0.32	10	0.68	0.258	0.93	1.94	1.26
Byrsonima sp.	1	4	0.32	10	0.68	0.165	0.60	1.61	0.92
Macrosamanea pedicellaris (DC.) Kleinhoonte	2	8	0.65	10	0.68	0.047	0.17	1.50	0.82
Cecropia pachystachya Trécul	1	4	0.32	10	0.68	0.130	0.47	1.48	0.80
Indeterminada 1	1	4	0.32	10	0.68	0.126	0.46	1.47	0.78
Swartzia pickelii Killip ex Ducke	2	8	0.65	10	0.68	0.034	0.12	1.46	0.77
Inga sp.	1	4	0.32	10	0.68	0.118	0.43	1.44	0.75
Indeterminada 3	1	4	0.32	10	0.68	0.076	0.28	1.28	0.60
Rubiaceae 1	1	4	0.32	10	0.68	0.067	0.24	1.25	0.57
Plathymenia foliolosa Benth.	1	4	0.32	10	0.68	0.056	0.20	1.21	0.53

continuation...

continuation table 1...

Species	Ni	DA	DR	FA	FR	DoA	DoR	VI	VC
Guapira opposita (Vell.) Reitz	1	4	0.32	10	0.68	0.046	0.17	1.17	0.49
Andira nitida Mart. ex Benth.	1	4	0.32	10	0.68	0.044	0.16	1.17	0.48
Ocotea sp.	1	4	0.32	10	0.68	0.041	0.15	1.16	0.47
Anaxagorea dolichocarpa Sprague & Sandwith	1	4	0.32	10	0.68	0.126	0.46	1.47	0.78
Inga sp.	1	4	0.32	10	0.68	0.118	0.43	1.44	0.75
Indeterminada 4	2	8	0.65	10	0.68	0.034	0.12	1.46	0.77
Indeterminada 2	1	4	0.32	10	0.68	0.076	0.28	1.28	0.60
Rubiaceae 1	1	4	0.32	10	0.68	0.067	0.24	1.25	0.57
Plathymenia foliolosa Benth.	1	4	0.32	10	0.68	0.056	0.20	1.21	0.53
Guapira opposita (Vell.) Reitz	1	4	0.32	10	0.68	0.046	0.17	1.17	0.49
Andira nitida Mart. ex Benth.	1	4	0.32	10	0.68	0.044	0.16	1.17	0.48
Ocotea sp.	1	4	0.32	10	0.68	0.041	0.15	1.16	0.47
Ocotea cf. gardneri (Meisn.) Mez	1	4	0.32	10	0.68	0.037	0.13	1.14	0.46
Inga thibaudiana DC.	1	4	0.32	10	0.68	0.031	0.11	1.12	0.43
Myrtaceae 1	1	4	0.32	10	0.68	0.031	0.11	1.12	0.43
Sloanea sp.	1	4	0.32	10	0.68	0.029	0.10	1.11	0.43
Brosimum guianense (Aubl.) Huber	1	4	0.32	10	0.68	0.027	0.10	1.11	0.42
Dipteryx odorata (Aubl.) Willd.	1	4	0.32	10	0.68	0.017	0.06	1.07	0.38
Lauraceae 1	1	4	0.32	10	0.68	0.014	0.05	1.06	0.37
Gustavia augusta L.	1	4	0.32	10	0.68	0.008	0.03	1.04	0.35
Syzygium malaccense (L.) Merr. & L.M. Perry	1	4	0.32	10	0.68	0.008	0.03	1.04	0.35

The studied springs had a density of 1.236 individuals ha^{-1}, with an estimated basal area of 27.647 m^2 ha^{-1}. Table 1 presents the analysis of the phytosociological parameters of the springs.

The species that presented the highest values of density were: *Tapirira guianensis*, *Inga flagelliformis*, *Protium heptaphyllum*, *Mabea occidentalis* and *Schefflera morototoni* (Table 1). It was verified that 38% of the species found in the springs of Córrego do Campo presented only one individual, being considered by Oliveira et al. (2008) as "locally rare". These species, according to Scariot et al. (2003), are likely to experience a rapid decline in population terms, tending to local extinction. However, this consideration should be made only for the study area, without generalizations, because, the question of the rarity of a species may be associated with the sampling procedure or variations in the geographical distribution (SILVA; PRATA; MELLO, 2016).

The pioneer species *T. guianensis* was characterized by the combination of a large number of individuals (33), high dominance (5.142 m^2 ha^{-1}), and high frequency, present in 70% of the plots, showing a species with a wide distribution in the area. In Mata de Caldeiras, in Catende, Mata Sul of Pernambuco, *T. guianensis* recorded the highest values of density, frequency and dominance (COSTA JÚNIOR et al., 2008). According to Lopes et al. (2016), the species present a high percentage of natural regeneration.

In the study by Pinto et al. (2005) on the distribution of arboreal-shrub species along the soil moisture gradients from the basins of the Santa Cruz river basin in Lavras, Minas Gerais, *T. guianensis* and *P. heptaphyllum* were the most abundant, both in environments with well-drained soils. With this, it can be inferred that these species are well adapted to local conditions.

Regarding the relative frequency, in addition to *T. guianensis* (4.79%), the most outstanding species, in descending order of values were: *Eschweilera ovata* (5.48%); *Inga flagelliformis* (4.79), *Annona montana* (4.79); *Protium heptaphyllum* (4.11%) and *Miconia minutiflora* (4.11%); *Mabea occidentalis* (3.42%), *Schefflera morototoni* (3.42%), *Thyrsodium spruceanum* (3.42%) and *Virola gardneri* (3.42%) (Table 1). These species are well distributed in the sampled area, with absolute frequency greater than or equal to 50%.

The highest values of absolute dominance (DoA) in the analyzed area were of the species *T. guianensis* (5.142 m^2 ha^{-1}), *Virola gardneri* (3.135 m^2 ha^{-1}), *Parkia pendula* (2.735 m^2 ha^{-1}), *Protium heptaphyllum* (1.568 m^2 ha^{-1}), *Simarouba amara* (1.281 m^2 ha^{-1}), *Schefflera morototoni* (1.281 m^2 ha^{-1}), *Annona montana* (1.191 m^2 ha^{-1}), *Nectandra cuspidata* (0.999 m^2 ha^{-1}), *Inga flagelliformis* (0.970 m^2 ha^{-1}) and *Mabea occidentalis* (0.966 m^2 ha^{-1}). Relative dominance values are shown in Figure 2.

These results are similar to those found by Costa Júnior et al. (2008) and Teixeira et al. (2010), in floristic studies carried out in the southern Brazilian forest of Pernambuco, which highlighted among the dominant species: *Tapirira guianensis, Parkia pendula, Schefflera morototoni* and *Simarouba amara*.

The 10 most important species in the community in terms of Importance Value (VI), ordered in descending order, were: *Tapirira guianensis*, *Virola gardneri*, *Protium heptaphyllum*, *Inga flagelliformis*, *Eschweilera ovata*, *Schefflera morototoni*, *Mabea occidentalis*, *Parkia pendula*, *Annona montana* and *Miconia minutiflora*. These species represented about 53.07% of the VI of the species sampled (Figure 3). It is worth mentioning that 70% of these species are from the beginning of succession (pioneers

Figure 2 - Species with higher relative dominance (DoR), sampled at the springs s of the Córrego do Campo, Mata do Engenho Buranhém, in the municipality of Sirinhaém, Pernambuco

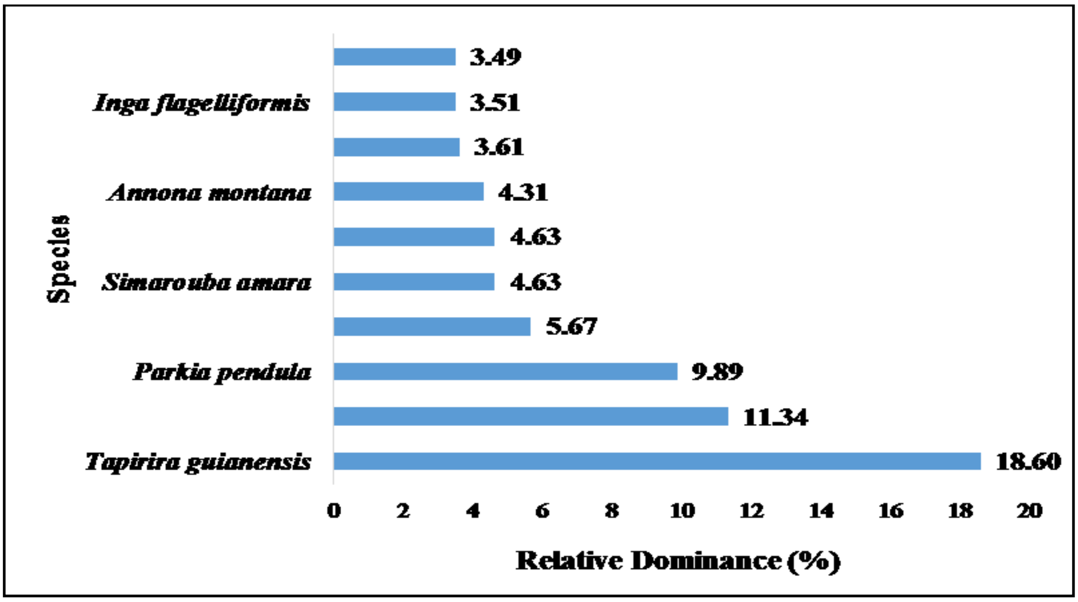
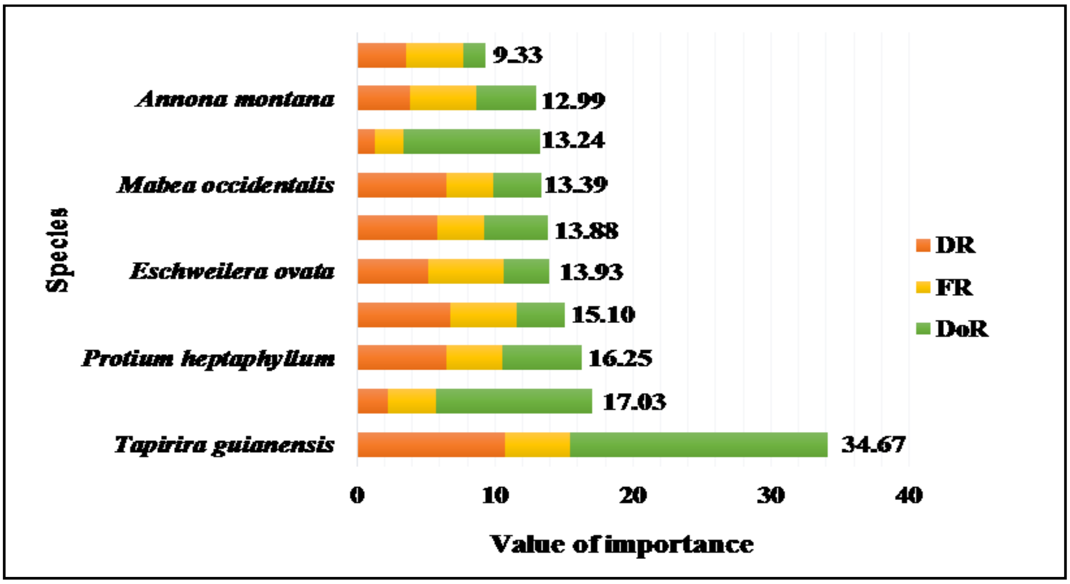


Figure 3 - Species with the ten largest values of Importance (VI), sampled at the springs of Córrego do Campo, Mata do Engenho Buranhém, in the municipality of Sirinhaém, Pernambuco



+ initial secondary), typical of secondary formations.

Among the species with high values of importance, *Tapirira guianensis, Eschweilera ovata* and *Schefflera morototoni* were sampled by Teixeira et al. (2010) in a floristic survey carried out in the Biological Reserve of Saltinho, Southern Coast of Pernambuco, demonstrating that they are common species for the region.

The highest coverage values (VC) were also obtained by *Tapirira guianensis* (29.28), *Virola gardneri* (13.61) and *Protium heptaphyllum* (12.14). The species *Tapirira guianensis* and *Protium heptaphyllum* were highlighted by the high values of relative density and relative dominance. The *Virola gardneri* species had low relative density, but it occupied the third position in the VC, due to the high diameter of its individuals, which influenced the relative dominance (DoR).

Regarding the state of conservation of the springs studied, taking into account the classification of Pinto et al. (2005), which classifies springs as conserved (presence of at least 50 m of natural vegetation in its surroundings, from the eye of water), disturbed (when it does not present 50 m of natural vegetation in its surroundings, but presents good state (high degree of disturbance, very little vegetation, compacted soil, presence of livestock, erosions and gullies), it is possible to infer that the Campo springs is classified as disturbed.

4 Final considerations

The characteristics of the environment may be interfering with the predominance and distribution of the species observed. The studied springs can be characterized as disturbed, which may explain the low dominance of the individuals in the sampled area, since only 20% of the species that are among the ten most important ones occupy this position due to the high relative dominance value.

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