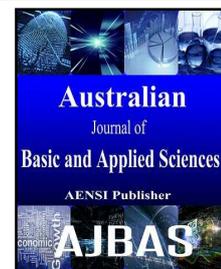




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Monospecific Dominance In An Alluvial Mixed Ombrophyllous Forest In Southern Brazil

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ABSTRACT

The study site is located in the areas of Mixed Ombrophyllous Forest associated with the Iguaçú River basin, south-central portion of the First Paraná Plateau, at an average height of 920 m asl. It is located in the metropolitan region of Curitiba, in Araucaria city of Paraná. The aim of this research was to obtain qualitative and quantitative characteristics of this forest. We used 18 fixed plots of 10 x 10 m where the following information was collected: breast height diameter (bhd), total height and botanical identification of all trees ≥ 5 cm bhd. We considered three ecological groups regarding the light requirement, the species were classified as pioneers, light demanding climax and shade tolerant climax. Regarding tolerance to water saturation, common to these environments, species were grouped in generalist and preferred. Chi-square test to detect relations between these two species groups was used. The forest showed 13 families, 21 genera and 27 tree species. *Sebastiania commersoniana*, *Schinusterebinthifolius* and *Hoveniadelphica* were the species that highlighted the ecological group of pioneer species. *Allophylus edulis*, *Myrrhinius atropurpureum* and *Eugenia uniflora* were the main species in the group of shade tolerant climax and *Blepharocalyx salicifolius*, *Myrcogeniaglaucescens* and *Guettarda uruguensis* belong to the group of light demanding climax. Considering the community, most of the species are generalists and the others are preferred. The opposite occurs individuals is most preferred, followed by general. It was observed that all species light demanding climax are general. Regarding pioneer species, the most is general followed by the preferred. The reverse was found in the shade tolerant climax species, the most is preferred, followed by generalist. Exclusive species were not observed in the community. According to the chi-square test, the data showed that there is a significant relationship ($p < 0.05$) between the ecological groups related to water tolerance associated with the light (Fig. 2). When the sociological position is related to the two types of ecological groups was detected a strong association for light-related groups ($p < 0.05$). The pioneer and preferred species *Sebastiania commersoniana* stands out as monodominant to present more than 60% of the relative density. The monodominance, in this environment, possibly, is subject to the soil water saturation.

INTRODUCTION

The Alluvial Mixed Ombrophyllous Forest occurs on the banks of rivers, running into a plan or wavy geomorphology of land (Roderjan *et al.*, 2002). Occurs in the southern highlands of Brazil in areas subject to periodic flooding pulse. *Sebastiania commersonia*, *Allophylus edulis*, *Lithraea brasiliensis*, *Schinus terebinthifolius*, *Podocarpus lambertii*, *Drimys brasiliensis*, *Capsicodendron dinisii*, *Blepharocalyx salicifolius*, *Luehea divaricata* and *Vitex megapotamica* are the mainly species of this community (Carvalho *et al.* 2009; Curcio *et al.*, 2006; Klein and Hatschbach, 1962). These forests have own structure and functionality and it is depending on geological variations, geomorphological and pedological processes (Curcio, 2006) and

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fluctuations of the water table (Durigan *et al.*, 2001). The distribution of species is related to microtopography due to variation of the requirements for tolerance to water saturation (Joly, 1991).

The adaptations of the species allows their classification according to the requirements of specific conditions and resources. There is still no consensus in academic regarding the most appropriate classification and the framework of some species. The most important factors that act in river environments are the light and the water regime. Therefore, Swaine and Whitmore (1988) suggested group the species in pioneer and climax. Considering the water regime, Walter and Ribeiro (1997) distinguish the tree species into three groups: general, preferred and exclusive.

The alluvial forests are characterized by having lower plant diversity than the slope (Lobo and Joly, 2000), presenting monodominance by a species in various situations. Connell and Lowman (1989), define this characteristic as one where a single species is more than 60% of the number of canopy individuals or basal area and that persists in the environment when recruits and regenerates below his own shadow. Hart (1990) describes the factors that control the diversity of species in tropical forests and analyzes the causes of monodominance in forests subject to flooding in Central America. In Brazil numerous studies report that analysis (Nascimento and Proctor, 1997; Marimon and Felfilli, 2000; Nascimento and Nunes da Cunha, 1989; Arieira and Cunha, 2012; Amador *et al.*, 2012).

In this study we evaluated the qualitative and quantitative characteristics of a Alluvial Mixed Ombrophyllous Forest in Araucaria municipality in Paraná state, Brazil.

In this forest, possibly monodominance it appears a pioneer and preferred species to flooding environments, being the main factor soil waterlogging.

MATERIALS AND METHODS

Study area:

The study site is located in the areas of Mixed Ombrophyllous Forest associated with the Iguaçu River basin, south-central portion of the First Paraná Plateau, at an average height of 920 m asl. It is located in the metropolitan region of Curitiba, in Araucaria city of Paraná, near the Presidente Getúlio Vargas Refinery - REPAR, next to the coordinates 25°34'02.5"S and 49°20'53.5"W (Fig. 1).

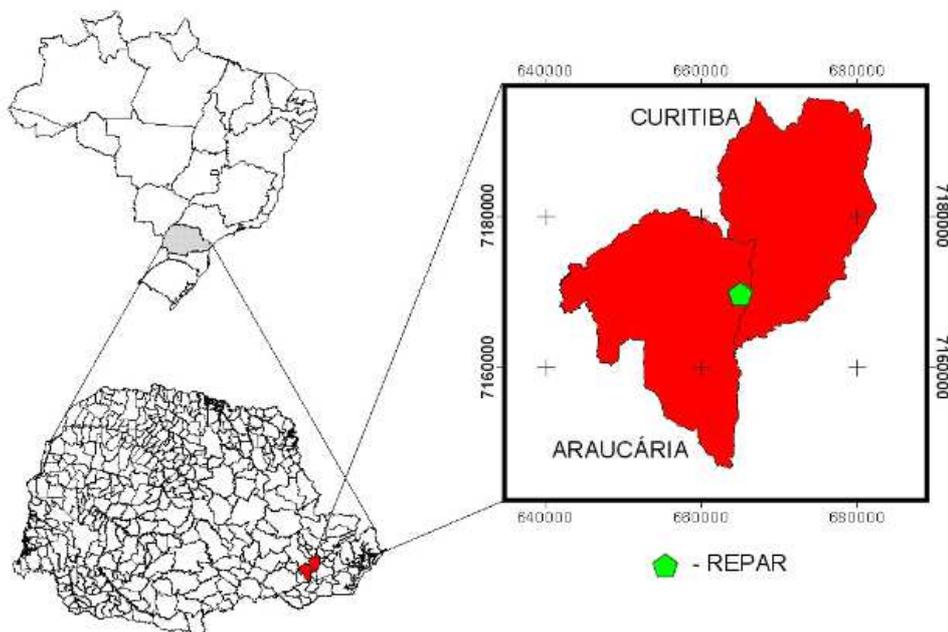


Fig. 1: Study site localization

The climate in the region is mesothermalsubtropical humid, with the occurrence of severe and frequent frosts without a dry season. The annual rainfall is between 1,400-1,600 mm, the average annual temperature between 16-18 °C and the relative humidity ranges 80-85% (IAPAR, 2014). The average annual precipitation over the basin of the Iguaçu River is 1500 mm year, and the rain distribution is quite irregular in time and space, therefore there is no well-defined wet season. Annual changes alter the distribution its pattern, as the presence of El Niño. The cold front entry can quickly change the height of the water table (Mine and Tucci, 2002).

The alluvial plains of the Metropolitan Region of Curitiba, in general, have clay-silty-sandy sediments, occupy about 490 km², or 20% of the basin area of the Curitiba city, mainly covering the Iguaçu River floodplain and its major tributaries. Soils are characterized as mineral hydromorphic the order of

Gleysols (Barbado et al., 2002; FAO, 2006).

The drainage system of the study area is represented by the feeder rivers of the Paraná River basin, and the Iguaçú River as collector master and its tributaries, among them and as a highlight, the river Barigui, present in the study area. The last one is located along the right or northern Iguaçú and runs for a length of 64.9 km through several municipalities in the region and had an drainage area of 272,5 km² [25].

Data survey and analysis:

The phytosociological survey was assessed of 18 permanent plots of 10 x 10 m. All individual trees with perimeter at breast height less than 15 cm were sampled. The number of individuals per species and sociological position (canopy, middle strata and understory) was observed.

We considered three ecological groups regarding the light requirement, the species were classified as pioneers, light demanding climax and shade tolerant climax (Swaine and Whitmore, 1988). Regarding tolerance to water saturation, common to these environments, species were grouped in generalist, preferred and exclusive (Walter and Ribeiro, 1997).

Chi-square test was used in contingency tables of two factors to determine possible associations between these groups of variables. The botanical material was collected and is available in the Herbarium of Forestry Course (EFC) of the Federal University of Paraná. The verification of scientific names, and abbreviations authors were performed according Missouri Botanical Garden (2002).

Results:

The 436 individuals sampled are distributed in 13 families, 21 genera and 27 species. It was found that most individuals belong to pioneer, followed by of shade tolerant climax and light demanding climax. Considering the total number of species, the most is light demanding climax, followed by shade tolerant climax and pioneer (Table 1).

Sebastianiacomersoniana, *Schinusterebinthifolius* and *Hoveniadulcis* were the species that highlighted the ecological group of pioneer species. *Allophylusedulis*, *Myrrhiniumatropurpureum* and *Eugeniauniflora* were the main species in the group of shade tolerant climax and *Blepharocalyxsalicifolius*, *Myrceugeniaglaucescens* and *Guettarda uruguensis* belong the group of light demanding climax.

According to the sociological position, the largest number of individuals lies middle strata, followed by the canopy and understory.

Considering the community, most of the species are generalists and the others are preferred. The opposite occurs individuals is most preferred, followed by general. It was observed that all species light demanding climax are general. Regarding pioneer species, the most is general followed by the preferred. The reverse was found in the shade tolerant climax species, the most is preferred, followed by generalist. Exclusive species were not observed in the community.

According to the chi-square test, the data showed that there is a significant relationship ($p < 0.05$) between the ecological groups related to water tolerance associated with the light (Fig. 2). When the sociological position is related to the two types of ecological groups was detected a strong association for light-related groups ($p < 0.05$). In this community, most preferred pioneer behaves as a hydromorphic environment, however, the light demanding climax is the most general comprises (Fig. 2). Individuals characterized as pioneers and light demanding climax are well represented in middle strata and the shade tolerant climax in the just below the canopy strata and the understory. It can be considered that there is no significant association between the variables of sociological position and groups regarding tolerance to water, since the p-value was very close to 0.05 (Fig. 3).

Table 1: Species, numbers of individuals (NI), sociological position (PS), relative density (RD) and importance value (IV) for ecological groups in an Alluvial Mixed Ombrophylous Forest in southern Brazil

| EG | Species | Families | NI | SP | | | RD | IP | |
|--|--|--------------------------|----|----|---|---|-----|-----|-----|
| | | | | 1 | 2 | 3 | | | |
| Light demanding climax and generalist | <i>Blepharocalyxsalicifolius</i> (Kunth) O. Berg | Myrtaceae | 13 | 10 | 3 | | 3,2 | 5,2 | |
| | <i>Myrceugeniaglaucescens</i> (Cambess.) D. Legrand & Kausel | Myrtaceae | 9 | 5 | 3 | 1 | 2,1 | 1,5 | |
| | <i>Guettarda uruguensis</i> Cham. & Schtdl. | Rubiaceae | 6 | 1 | 5 | | 1,2 | 0,7 | |
| | <i>Lithraeabrasiliensis</i> Marchand | Anacardiaceae | 5 | 3 | 2 | | 1,2 | 1,1 | |
| | <i>Campomanesia xanthocarpa</i> Mart. ex O. Berg | Myrtaceae | 4 | 3 | 1 | | 0,9 | 1,1 | |
| | <i>Machaerium paraguariense</i> Hassl. | Leguminosae Faboideae | - | 4 | 3 | 1 | | 0,9 | 0,8 |
| | <i>Machaerium brasiliense</i> Vogel | Leguminosae Faboideae | - | 1 | | 1 | | 0,2 | 0,1 |
| | <i>Dalbergia frutescens</i> (Vell.) Britton | Leguminosae Faboideae | - | 2 | | 2 | | 0,5 | 0,3 |
| <i>Machaerium stipitatum</i> (DC.) Vogel | Leguminosae | - | 1 | | | 1 | 0,5 | 0,3 | |

| | | | | | | | |
|--------------------------------------|--|----------------|-----|-----|-----|----|------|
| | | Faboideae | | | | | |
| | <i>Inga marginata</i> Willd. | Leguminosae | 1 | 1 | | | 0,2 |
| | | Mimosoideae | | | | | 0,2 |
| | <i>Calyptanthus concinna</i> DC. | Myrtaceae | 1 | | 1 | | 0,1 |
| | <i>Myrcianthes gigantea</i> (D. Legrand) D. Legrand | Myrtaceae | 1 | | 1 | | 0,2 |
| Total | | | 48 | 26 | 20 | 2 | |
| Shade tolerant climax and preferred | <i>Allophylusedulis</i> (A. St.-Hil., A. Juss. & Cambess.) Hieron. ex Niederl. | Sapindaceae | 43 | 1 | 19 | 23 | 9,5 |
| | <i>Myrrhinium atropurpureum</i> Schott | Myrtaceae | 22 | 2 | 12 | 8 | 5,1 |
| | <i>Sebastiania brasiliensis</i> Spreng. | Euphorbiaceae | 3 | | 2 | 1 | 0,7 |
| | <i>Scutiabuxifolia</i> Reissek | Rhamnaceae | 2 | | | 2 | 0,3 |
| | <i>Myrciariatenella</i> (DC.) O. Berg | Myrtaceae | 2 | | 1 | 1 | 0,5 |
| Shade tolerant climax and generalist | <i>Eugenia uniflora</i> L. | Myrtaceae | 6 | | 2 | 4 | 1,4 |
| | <i>Caseariadecandra</i> Jacq. | Flacourtiaceae | 3 | | 1 | 2 | 0,5 |
| | <i>Eugenia uruguayensis</i> Cambess. | Myrtaceae | 1 | | | 1 | 0,2 |
| Total | | | 82 | 3 | 37 | 42 | |
| Pioneers and preferred | <i>Sebastiania commersoniana</i> (Baill.) L.B. Sm. & Downs | Euphorbiaceae | 285 | 120 | 134 | 31 | 66,3 |
| | <i>Syagrus romanzoffiana</i> (Cham.) Glassman | Arecaceae | 2 | 1 | | 1 | 0,2 |
| | <i>Vitex megapotamica</i> (Spreng.) Moldenke | Verbenaceae | 2 | | 2 | | 0,5 |
| Pioneer and generalist | <i>Schinusterebinthifolius</i> Raddi | Anacardiaceae | 11 | 8 | 1 | 2 | 2,3 |
| | <i>Hovenia dulcis</i> Thunb. | Rhamnaceae | 3 | 1 | 1 | 1 | 0,7 |
| | <i>Luehdivaricata</i> Mart. | Malvaceae | 2 | 2 | | | 0,5 |
| | <i>Ligustrum lucidum</i> W.T. Aiton | Oleraceae | 1 | | | | 0,2 |
| Total | | | 306 | 132 | 138 | 35 | 100 |

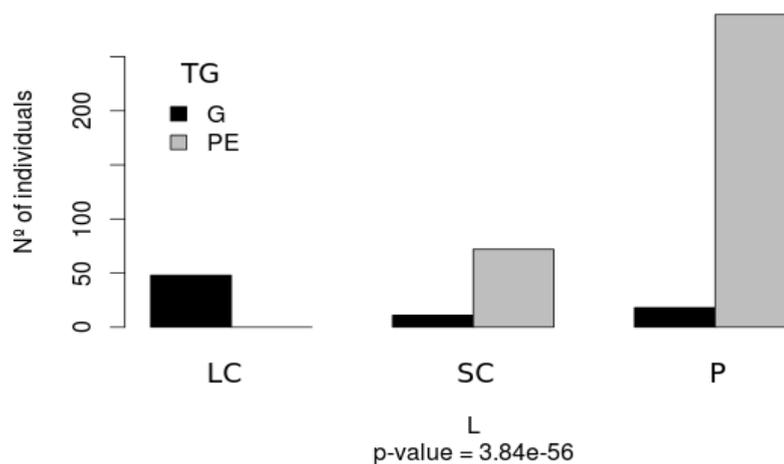


Fig. 2: Relationship between environmental group about the tolerance to water and in relation to light. TW: ecological group for tolerance to water (G - general, PE - preferred). L: ecological groups in relation to light (LC – light demanding climax, SC – shade tolerant climax, P - pioneer)

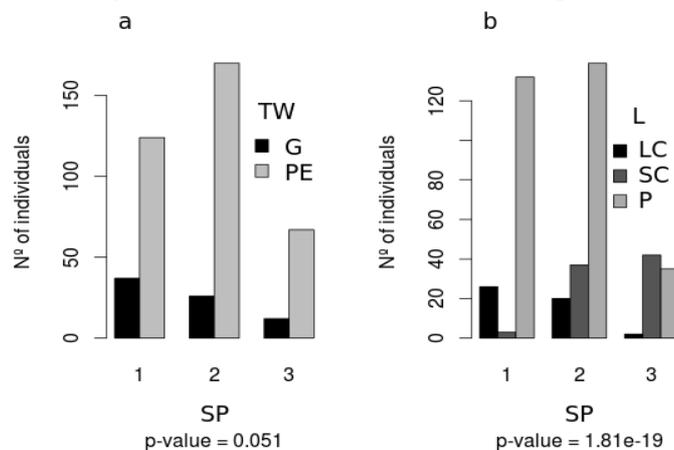


Fig. 3: Relationship between the different ecological groups (a) and the sociological position (b). SP: sociological position. TW: ecological group for tolerance to water (G - general, PE - preferred). L: ecological groups in relation to light (LC – light demanding climax, SC – shade tolerant climax, P - pioneer)

Discussion:

Most individuals surveyed are pioneers and preferred, however, the smallest of the species belong to these two ecological groups. Thus, few species dominate the community, featuring a homogeneous environment. It is therefore a remnant of Alluvial Mixed Ombrophylous Forest (IBGE, 2012), defined as climax edaphic (Richards, 1979), constituting a hydrosere (Kuniyoshi, 1994), characterized by a natural disturbance processes, which is the main factor that works in the natural selection of species (Ivanauskas *et al.*, 1997). After a peak flood, when the water table is near the soil surface, it is restrictive to the development of tree species (Kozłowski, 1984; Brinson, 1990; Casanova and Brock, 2000; Curcio, 2006). The Gleysol which is typical of where this situation is verified, is the predominant in of the study site, mostly suitable for hydrophilic species (Curcio *et al.*, 2007).

Considering the number of individuals in the community, *Sebastianiacommersonia* has 65% of the total and 50.8% of the importance of percentage. This is a pioneer specie, selective swamp, very frequent and abundant, almost exclusively of floodplains, where usually becomes dominant, constituting 60-80% of continuous canopy strata (Carvalho *et al.*, 2009; Barddalet *et al.*, 2004; Smith *et al.*, 1988; Reitz *et al.* 1983). In poorly drained tropical forests there is a tendency to dominance by a few species or a single species (Richards, 1979). The expansion of forests in temperate areas during the Lower Holocene, caused by increased heat, has created unfavorable conditions, highly shaded for many of the plants that had previously been dispersed near the glacial stage. Climate change after this stage, were harmful to these species and many of them have become restricted high altitudes, especially at low latitudes. Certain species are more tolerant of higher temperatures, but are unable to survive under dark shadows. For these species there were other opportunities, as is the case of environments that for some reason do not harbor forests and provided safe havens, such as habitats disturbed by periodic flooding (Cox, 2010).

The largest number of individuals present in the middle strata and canopy was also *Sebastianiacommersoniana*. Because of its requirement in light and dominates the canopy, this can be considered that their presence in middle strata is stock of individuals that future will be recruited for the canopy before a disturbance, determining opening clearing. Thus, the species which occur together with recruiting are species that are already established and are typical of this strata (Carvalho *et al.*, 2009).

The structural importance of this specie makes the environment to be monodominant because a single specie has number of individuals to 60% of the total (Connel and Lowman, 1984). Thus, the monodominance is common in alluvial forests of the Brazilian southern plateau.

In a study conducted in a floodplain in cities from Paraná state, was found in one of the situations with higher water saturation, the predominance of *Sebastianiacommersoniana*. The species showed 59.7% compared to the number of individuals and occupied the dominant strata (Nogueira *et al.*, 2010). In two compartments of the Iguaçú River, the density of this species ranged from 45% to 63.5% (Pasdiora, 2003). Similar relationship in the floodplain of the Iguaçú River, where 60-80% of the canopy was composed of this species (Silva *et al.*, 1997). In a remnant of alluvial forest in São José dos Pinhais was observed that *Sebastianiacommersoniana* was the most abundant species occupying the canopy and the middle strata (Bufrem, 1997). In the same forest in Paraná Stat, the canopy was between 10 and 14 m, where stood out *Sebastianiacommersoniana*, with six times more individuals than the other species (Ziller, 1993).

In alluvial forests of the Iguaçú River in a fragment of Paraná state, the relative density of *Sebastianiacommersoniana* ranged from 96% to 64.6% and the other fragment in Santa Catarina ranged from 79.6% to 44%. Possibly this parameter is correlated with the evolutionary stage of the forest. Gradually, the pioneers are replaced by climax species. Therefore, the low relative density of the species show the evolution of successional stage (Curcio *et al.*, 2007). As these authors, this species is closely tied to the luminous intensity zones, identified bad and regular states for bands below the canopy (below 6 m high), featuring suppression process in succession dynamics. They consider that the patterns of soil drainage is essential importance in the dynamics of occupation of the tree.

This species gives the vegetation a very typical face, the green-white color, high on the physiognomy and structural characterization of alluvial forests of southern Brazil, mainly in the region of occurrence of Mixed Ombrophylous Forest in unstructured soils (Dias *et al.*, 2002).

The importance of other species is much less than *Sebastianiacommersoniana*. The following species is *Schinusterebinthifolius*. It is a pioneer and abundant on the edge of the alluvial forest fragments (Barddalet *et al.*, 2004; Reitz *et al.* 1983). *Hoveniadulcis*, native to Japan and China also pioneer, therefore intolerant to shade (Carvalho, 1994), considered as invasive specie in Brazil (World Resources Institute *et al.*, 1992). *Allophylusedulis*, *Myrrhiniumatropurpureum* and *Eugenia uniflora* were the main species in the group of shade tolerant climax and *Blepharocalyxsalicifolius*, *Myrceugeniaglaucescens* and *Guettarda uruguensis* the group of light demanding climax species, are selective hygrophilous and that develop in floodplains (Reitz *et al.*, 1983; Reitz *et al.*, 1979) where the environment is semi-hydromorphic or hydromorphic (Curcio *et al.*, 2007).

Conclusion:

The site has monodominance of *Sebastiani commersoniana*, the most remarkable species in the two upper strata. Belongs to the group of the pioneers and the preferred and may be concluded that these are environmental groups that determine the physiognomy of the forest in question. The dominance of a single species maybe is a consequence of soil waterlogging.

Studies in other alluvial areas are needed give the continuing strongly changed that are suffering and its importance in relation to quality of water resources. Long-term follow-up will give the possibility to understand the dynamics of these environments, which is a subsidy for the management and the management of these ecosystems.

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