

UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL
INSTITUTO DE BIOCÊNCIAS
PROGRAMA DE PÓS-GRADUAÇÃO EM ECOLOGIA

Dissertação de Mestrado

Padrões funcionais de comunidades de plantas lenhosas em
transições floresta-campo em resposta a gradientes ambientais no
sul do Brasil

MARIANA GLIESCH SILVA

Porto Alegre, abril de 2015.

Padrões funcionais de comunidades de plantas lenhosas em transições floresta-campo
em resposta a gradientes ambientais no sul do Brasil

Mariana Gliesch Silva

Dissertação de Mestrado apresentada ao
Programa de Pós-Graduação em Ecologia, do
Instituto de Biociências da Universidade Federal
do Rio Grande do Sul, como parte dos requisitos
para obtenção do título de Mestre em Ecologia.

Orientador: Profa. Dra. Sandra Cristina Müller

Comissão Examinadora

Prof. Dr. Marcus Vinicius Cianciaruso (UFG)

Prof. Dr. Juliano Morales De Oliveira (UNISINOS)

Prof. Dr. Valério De Patta Pillar (UFRGS)

Porto Alegre, abril de 2015

Dedico esta dissertação à minha família.

Agradecimentos

Gostaria de iniciar agradecendo a minha família que me deu todo apoio necessário a ir em busca do sonho deste mestrado em ecologia. Em especial agradeço meus pais, Ursula e Paulo por todo carinho, pelo amor, pela inspiração e pelo apoio dentro e fora de casa, muito obrigada! Aos meus irmãos queridos, Lais e Artur, que aguentaram todas as minhas fases de crise do mestrado com muito bom humor, mesmo quando estavam longe, e que sempre me deram aquele abraço apertado quando necessário. Agradeço também à minha querida avó, Ruth Gliesch, um exemplo de perseverança, que a cada dia me ensina uma nova forma de valorizar a vida. Ao meu namorado, Mateus, agradeço por teres estado ao meu lado me apoiando diariamente, pela tua paciência, por me dares forças para seguir buscando meus objetivos e por seres o meu porto seguro, te amo! Também agradeço a família Negreiros, que me deu muito carinho e apoio nos momentos que precisei.

Agradeço a minha orientadora Sandra Müller pelo carinho e pelos ensinamentos, pela paciência e pela dedicação a esse projeto e obrigada por teres me dado essa oportunidade de fazer parte do LEVEG! Agradeço, muito, ao Rodrigo Bergamin, colaborador deste artigo, companheiro das saídas de campo, de discussões sobre o trabalho, sobre o colorado e meu fiel fornecedor de chimarrão, obrigada por tudo! Aos meus colegas de laboratório: Kátia, Lidi, Milena, Sandra Contreras, Marcelo, Felipe, Joice e Rene obrigada pela companhia no dia-a-dia do LEVEG que resultou em lindas amizades construídas nesses últimos anos.

Agradeço também ao professor Valério Pillar pela oportunidade de trabalhar neste projeto maravilhoso que foi o SISBIOTA e também pelas aprendizagens nestes anos e pela especial atenção e disponibilidade para discutir assuntos relacionados à esse trabalho. Assim como agradeço aos meus amigos e colegas participantes deste projeto:

Eduardo Vélez, Grasi Casas, Marcos Carlucci e Helena Streit. Não poderia deixar de fazer um agradecimento especialíssimo aos super ajudantes e colaboradores queridos André Luza e Martin Molz, que me deram grande apoio, muito obrigada guris! Aos colegas do EcoQua, em especial a Anaclara, Rafael Machado, Omara e Vinícius por todo auxílio, discussões e também pela amizade. Também ao querido Vanderlei que sempre se mostrou disposto a discussões e auxílios com códigos do R. Aos meus dois colegas queridos de mestrado, que tornaram as aulas mais agradáveis: Alexandre e Monica obrigada pela convivência divertidíssima nesses anos!

Agradeço aos ilustres proprietários das terras em que pude realizar a coleta de dados, especialmente ao Sr. Afonso e a Sra. Mirna de Encruzilhada do Sul, que sempre nos receberam de braços abertos. Também agradeço ao ICMBio, à SEMA e a PUCRS por viabilizarem a entrada e o trabalho da nossa equipe nas unidades de conservação do PARNA Aparados da Serra, do PE Tainhas e do CPCN Pró-Mata.

Por fim, agradeço ao PPG Ecologia por toda estrutura e condições para a realização deste mestrado, em especial à Silvana por todo apoio durante o curso e também ao Manoel e ao Marcelo pelos auxílios em campo. Agradeço também ao CNPq pela bolsa concedida para o mestrado e pelo financiamento do projeto SISBIOTA, juntamente com a FAPERGS, a quem também agradeço, pois viabilizou as nossas saídas de campo e coleta de dados necessárias.

Resumo

Transições de floresta-campo são encontradas em diversas regiões do mundo. Sob condições climáticas favoráveis, tem-se observado um padrão de aumento na densidade de lenhosas e expansão florestal sobre áreas de vegetação campestre. Este trabalho tem como objetivo identificar diferenças de composição de espécies lenhosas e composição funcional entre comunidades florestais e de transição, bem como identificar padrões funcionais destas comunidades em resposta a gradientes de clima e solo. Para tanto, foram coletados dados em 18 áreas de transição floresta-campo no sul do Brasil, considerando a densidade de espécies lenhosas e atributos foliares mensurados em cada habitat (floresta e transição). Os sítios de amostragem foram descritos por variáveis de clima e solo, gerando assim três matrizes ambientais (**E**): tipo de habitat, climática e edáfica. A análise dos dados envolveu ajustes de *Procrustes* entre matriz **T** (atributos médios da comunidade ponderados pela abundância das espécies) e matriz **E** (r (**TE**)) para detectar padrões de convergência de atributos, e entre diversidade funcional (**R**) e matriz **E** (r (**RE**)) para detectar padrões de divergência, relacionando estes padrões a cada matriz **E**. Os resultados indicaram padrões de convergência e divergência em relação à matriz de habitat. Comunidades florestais e de transição diferiram em termos de média de SLA e área foliar, e também quanto à diversidade funcional (ambos com valores maiores na floresta). Considerando os gradientes ambientais, as comunidades de ambos os habitats apresentaram padrões de convergência com o clima e o solo. Em matéria de clima, o principal resultado foi em relação ao SLA, com valores mais altos em áreas de florestas estacionais. Quanto ao solo, as comunidades florestais demonstraram uma associação de SLA e espessura da folha com o gradiente de matéria orgânica / fertilidade, porém as comunidades de transição não apresentaram padrões claros. Padrões de divergência em relação ao solo foram observados para ambos os habitats, mas só a floresta apresentou divergência em relação ao gradiente climático. Concluímos que, apesar das diferenças locais entre habitats em termos de composição de espécies lenhosas e estratégias funcionais, as comunidades de transição e de floresta estão respondendo de forma semelhante aos gradientes climáticos regionais. No geral, as espécies lenhosas demonstram ter estratégias funcionais relacionadas a atributos foliares que tem possibilitado o processo de adensamento de lenhosas em ecossistemas campestres em áreas de transição de floresta-campo.

Palavras-chave: convergência, alfa-divergência, atributos foliares, ecótonos, sul do Brasil.

Abstract

Forest-grassland transitions are found in many different regions of the world. Through favorable climatic conditions, a pattern of woody encroachment and forest expansion over open grassy areas is observed. This work aims at identifying species composition and functional differences between forest and transition communities concerning woody plants, as well as functional patterns of communities in response to climate and soil gradients. We collected data in 18 forest-grassland transition areas in southern Brazil, considering woody plant species density and leaf traits that were measured for each habitat (forest and transition). Sites were described by climate and soil variables, leading to three different environmental matrices (**E**): habitat-type, climatic, and soil gradient. Data analysis involved *Procrustes* adjustment between matrix **T** (community-weighted mean traits) and matrix **E** ($r(\mathbf{TE})$) to detect trait-convergence, and between functional diversity (**R**) and matrix **E** ($r(\mathbf{RE})$) to detect patterns of divergence related to each matrix **E**. Results showed convergence and also divergence concerning the habitat-type matrix. Forest and transitional communities differed in terms of SLA and leaf area community-weighted means, and also in functional diversity. Concerning the environmental gradients, either forest or transition habitats presented convergence patterns with climate and soil gradients. Main results concerning climate were related to higher SLA at seasonal forest sites. As for soil, forest communities have demonstrated an association of SLA and leaf thickness with the organic matter/fertility gradient, but transition didn't present clear patterns. Concerning alpha-divergence both habitats responded to soil gradients, but only forest presented divergence concerning climate. We conclude that although woody species of both habitats locally differed in species composition and their functional strategies, communities of forest and grassland transitions are responding similarly to broader climate gradients. Overall woody species seem to have leaf traits strategies that enabled the encroachment process of grassy ecosystems in forest-grassland transitions.

Key-words: convergence, alpha-divergence, leaf traits, ecotones, southern Brazil.

Sumário

Agradecimentos	IV
Resumo	VI
Abstract	VII
Sumário	8
Lista de Figuras	9
Lista de Tabelas	10
Introdução geral	11
Referências Bibliográficas	14
Capítulo 1¹	16
Introduction	17
Material and Methods.....	22
Results	27
<i>Responses to habitat</i>	27
<i>Ordination analysis</i>	30
<i>Responses to soil and climate gradients</i>	31
Discussion	36
<i>Responses to habitat</i>	36
<i>Responses to soil and climate gradients</i>	39
References	43
Appendices	50
Considerações Finais	52
Referências Bibliográficas	53
Apêndices.....	54

Lista de Figuras

Figure 1 – Map of the study sites location at Rio Grande do Sul state, Brazil.....	23
Figure 2 – Ordination diagram of the PCoA of species density per plot, highlighting the compositional differences between forest and transition habitats across all study sites.	28
Figure 3 – Boxplot of functional diversity values (Rao’s quadratic entropy) obtained through the set of traits that maximized alpha divergence (SLA, LA, LT), i.e. the correlation congruence between Rao and the environmental variable (habitat type)....	29
Figure 4 – Relations of community-weighted mean of traits (log-transformed) and functional diversity (FD) against environmental gradients for the forest communities, considering the traits of assembly patterns shown in Table 3.	33
Figure 5 – Relations of community-weighted mean of traits (log-transformed) and functional diversity (FD) against environmental gradients for the transition communities, considering the traits of assembly patterns shown in Table 3.	35
Appendix 1 – Ordination diagram of the PCA of the climatic variables using correlation as resemblance measure.....	50

Lista de Tabelas

Capítulo 1

Table 1 – Mean values and standard deviations for community-weighted leaf traits according to each habitat type (forest, transition), and the respective p value extracted from the analysis of variance..... 29

Table 2 – Principal Component Analysis for 15 soil variables for forest and transition plots, and the percentage of explanation of each axis analyzed 31

Table 3 - Results of trait-convergence assembly pattern TCAP and alpha divergence analysis concerning the two environmental gradients: climatic and edaphic..... 32

Apêndices

Apêndice 1. Dados de atributos foliares por espécie por habitat. 54

Apêndice 2. Abundância de espécies por UAL (1 e 2) por sítio amostral de transição.. 63

Apêndice 3. Abundância de espécies por UAL (1 e 2) por sítio amostral de floresta.... 67

Apêndice 4. Abundância relativa de espécies (%) em unidades de floresta e transição. 73

Introdução geral

As grandes extensões de vegetação campestre entremeadas por manchas florestais formam uma paisagem exuberante no sul do Brasil. A presença de ecótonos floresta-campo em fitofisionomias distintas tem sido observada por naturalistas desde o início do século XX (Rambo 1954). Estas primeiras observações levaram a questionamentos acerca da vegetação natural da região: seria campo ou floresta?

Os campos sulinos (Overbeck et al. 2007) são remanescentes de um clima mais frio e seco que predominou na região até meados do Holoceno, quando a elevação da temperatura e da umidade favoreceu a expansão das florestas, formando assim as atuais áreas de mosaico campo-floresta (Behling et al. 2004; Behling et al. 2005; Behling et al. 2007). O clima atual, no entanto, segue favorecendo a expansão das florestas, mas a presença de distúrbios associados ao uso das áreas de campos sulinos parece atuar como fator limitante desta expansão (Müller, 2012).

O processo de expansão florestal no sul do Brasil está relacionado a dois mecanismos principais: nucleação e expansão a partir da borda. O primeiro ocorre com a colonização da matriz campestre por espécies lenhosas que facilitam a subsequente formação de pequenas manchas de floresta que algum tempo depois poderão se conectar à floresta principal, expandindo-a. A espécie arbórea *Araucaria angustifolia*, um pinheiro comum em florestas do sul do Brasil, tem sido reconhecida como uma planta nucleadora, ou seja, ela possui um maior recrutamento de mudas de outras espécies sob sua copa em comparação com áreas abertas ou outras espécies lenhosas (Duarte et al. 2006). Isto atribui-se a sua capacidade de melhorar as condições microclimáticas e químicas do solo sob a sua copa (Korndörfer et al. 2014), agindo, portanto, como um importante elemento condutor da expansão florestal. Além da *A. angustifolia*, afloramentos rochosos também funcionam como núcleos de formação de manchas

florestais (Carlucci, Duarte, et al. 2011). O segundo mecanismo, no entanto, é resultado de um lento processo de expansão da borda da floresta, que aos poucos insere novas espécies na matriz campestre adjacente (da Silva 2009), que geralmente representa um ambiente mais adequado para o desenvolvimento de espécies lenhosas. Este segundo mecanismo é responsável por criar zonas de transição entre a floresta e os campos abertos (com baixa presença de lenhosas), onde se observa um estrato herbáceo dominado por gramíneas características destes campos com a presença de lenhosas no estrato acima, seja de espécies oriundas da floresta, seja de espécies arbustivas altas do campo. Estas zonas de transição são objeto deste estudo.

Diferentes autores têm estudado o processo de expansão florestal no sul do Brasil (Pillar & Quadros 1997; Oliveira & Pillar 2004; Duarte et al. 2006; Carlucci, Duarte, et al. 2011; Korndorfer et al. 2014), no entanto, a maior parte dos trabalhos está restrita às áreas do planalto com ocorrência de florestas com Araucária, mas com destaque para os trabalhos de Müller et al. (2007 e 2012) e Blanco et al. (2014), realizados em mosaico de floresta-campo no Morro Santana, em Porto Alegre, com espécies típicas de floresta estacional decidual e floresta ombrófila densa. Contudo, a literatura ainda carece de informações acerca dos fatores associados ao processo de expansão florestal em diferentes regiões do sul do Brasil, como por exemplo, nas áreas de floresta-campo da região centro-oeste do estado do Rio Grande do Sul. Sendo assim, este trabalho se propõe a analisar comunidades de espécies lenhosas em ecótonos de floresta-campo considerando um gradiente regional climático e edáfico, a partir de uma perspectiva que abrange também as características funcionais das espécies.

Ao longo dos últimos anos, tem havido uma crescente tendência no meio científico em utilizar abordagens funcionais na análise de comunidades vegetais (Grime 2006; Pillar et al. 2009; Gotzenberger et al. 2011). Em uma definição dada por Violle et

al. (2007), atributos funcionais são as características morfo-fisio-fenológicas que impactam o *fitness* de forma indireta, pelos seus efeitos no crescimento, reprodução e sobrevivência das espécies. Os atributos funcionais também podem ser classificados em atributos de efeito ou de resposta, de acordo com a sua ligação com os processos ecossistêmicos ou a variação nas condições do ambiente (Blanco et al. 2007) e, por terem medidas padronizadas, possibilitam a comparação entre diferentes ambientes, permitindo assim a determinação de padrões funcionais regionais ou globais para ecossistemas distintos.

Neste sentido, este trabalho teve como objetivo determinar os padrões funcionais de resposta de comunidades de plantas lenhosas a gradientes climáticos e edáficos, bem como em relação ao habitat de ocorrência, floresta ou transição campestre, em áreas de ecótonos de floresta-campo. Para isto, foi utilizada a abordagem metodológica de Pillar et al. (2009) que permite avaliar padrões de convergência e divergência de atributos na organização de comunidades em relação a gradientes ambientais através da maximização da congruência entre matrizes, medida pelo ajuste de *Procrustes*.

Referências Bibliográficas

- Behling, H., Pillar, V.D., & Bauermann, S.G. 2004. Late Quaternary Araucaria forest , grassland (Campos), fire and climate dynamics , studied by high-resolution pollen , charcoal and multivariate analysis of the Cambará do Sul core in southern Brazil. *Palaeogeography, Paleoclimatology, Palaeoecology* 203: 277–297.
- Behling, H., Pillar, V.D., & Bauermann, S.G. 2005. Late Quaternary grassland (Campos), gallery forest, fire and climate dynamics, studied by pollen, charcoal and multivariate analysis of the São Francisco de Assis core in western Rio Grande do Sul (southern Brazil). *Review of Palaeobotany and Palynology* 133: 235–248.
- Behling, H., Pillar, V.D., Muller, S.C., & Overbeck, G.E. 2007. Late-Holocene fire history in a forest-grassland mosaic in southern Brasil : Implications for conservation. *Applied Vegetation Science* 10: 81–90.
- Blanco, C.C., Jr, E.E.S., Santos, B.R.C., Silva, M.A., & Pillar, V.D. 2007. On the overlap between effect and response plant functional types linked to grazing. *Community Ecology* 8: 57–65.
- Blanco, C.C., Scheiter, S., Sosinski, E., Fidelis, A., Anand, M., & Pillar, V.D. 2014. Feedbacks between vegetation and disturbance processes promote long-term persistence of forest – grassland mosaics in south Brazil. *Ecological Modelling* 291: 224–232.
- Carlucci, M.B., Duarte, L.D.S., & Pillar, V.D. 2011. Nurse rocks influence forest expansion over native grassland in southern Brazil. *Journal of Vegetation Science* 22: 111–119.
- Debastiani, V.J., Muller, S.C., Oliveira, J.M., Rocha, F.S., Sestren-Bastos, M.C., & Duarte, L.D.S. 2015. Recurrent patterns of phylogenetic habitat filtering in woody plant communities across phytogeographically distinct grassland-forest ecotones. *Community Ecology* 16: 1–9.
- Duarte, L.D.A.S., Dos-santos, M.M.G., Hartz, S.M., Ecologia, D. De, Federal, U., & Cp, A.B.G. 2006. Role of nurse plants in Araucaria Forest expansion over grassland in south Brazil. . doi: 10.1111/j.1442-9993.2006.01602.x
- Garnier, E., Cortez, J., Billés, G., Navas, M., Roumet, C., Debussche, M., Laurent, G., Blanchard, A., Aubry, D., Bellmann, A., Neill, C., & Toussaint, J. 2004. Plant functional markers capture ecosystem properties during secondary succession. *Ecology* 85: 2630–2637.
- Gotzenberger, L., Bello, F. de, Brathen, K.A., Davison, J., Dubuis, A., Guisan, A., Lepš, J., Lindborg, R., Moora, M., Pärtel, M., Pellissier, L., Pottier, J., Vittoz, P., Zobel, K., & Zobel, M. 2011. Ecological assembly rules in plant communities — approaches , patterns and prospects. *Biological Reviews*. doi: 10.1111/j.1469-185X.2011.00187.x

- Grime, J.P. 2006. Trait convergence and trait divergence in herbaceous plant communities : Mechanisms and consequences. *Journal of Vegetation Science* 17: 255–260.
- Korndorfer, C., Dillenburg, L., & Duarte, L. 2014. Assessing the potential of *Araucaria angustifolia* (Araucariaceae) as a nurse plant in highland grasslands of south. *New Zealand Journal of Botany* 37–41.
- Müller, S.C., Overbeck, G.E., Pfadenhauer, J., & Pillar, V.D. 2007. Plant Functional Types of Woody Species Related to Fire Disturbance in Forest–Grassland Ecotones. *Plant Ecology* 189: 1–14.
- Müller, S.C., Overbeck, G.E., Pfadenhauer, J., & Pillar, V.D. 2012. Woody species patterns at forest–grassland boundaries in southern Brazil. *Flora - Morphology, Distribution, Functional Ecology of Plants* 207: 586–598.
- Oliveira, J.M., & Pillar, V.D. 2004. Vegetation dynamics on mosaics of Campos and *Araucaria* forest between 1974 and 1999 in Southern Brazil. *Community Ecology* 5: 197–202.
- Overbeck, G., Muller, S., Fidelis, a, Pfadenhauer, J., Pillar, V., Blanco, C., Boldrini, I., Both, R., & Forneck, E. 2007. Brazil’s neglected biome: The South Brazilian Campos. *Perspectives in Plant Ecology, Evolution and Systematics* 9: 101–116.
- Pillar, V.D., Duarte, L.D.S., Sosinski, E.E., & Joner, F. 2009. Discriminating trait-convergence and trait-divergence assembly patterns in ecological community gradients. *Journal of Vegetation Science* 20: 334–348.
- Pillar, V.D., & Quadros, F.L.F. 1997. Grassland-forest boundaries in southern Brazil. *Coenoses* 12: 119–126.
- Rambo, P.B. 1954. *Fitofisionomia do Rio Grande do Sul*.
- Da Silva, A.S. 2009. Dinâmica de colonização de *Araucaria angustifolia* em campos e sua influência na expansão florestal no sul do Brasil.
- Violle, C., Navas, M.L., Vile, D., Kazakou, E., Fortunel, C., Hummel, I., & Garnier, E. 2007. Let the concept of trait be functional! *Oikos* 116: 882–892.

Capítulo 1¹

Functional patterns of woody plants in response to soil and climate gradients in forest-grassland transitions

¹Este capítulo apresenta a bibliografia e os itens formatados conforme requisitos para submissão ao periódico *Journal of Vegetation Science*. Este manuscrito ainda terá como co-autor Rodrigo S. Bergamin.

Introduction

Ecological communities are dynamic and respond to environmental changes and disturbances in different spatial and temporal scales. Contrasts in ecological conditions in many spatial scales might form transitional areas between adjacent types of vegetation, which are recognized as ecotones (Risser 1995). Ecotones are scale-dependent, usually defined for the purpose of the study, varying from larger scale definitions, for example contact zones between different biomes, to small scales such as local vegetation communities (Gosz 1993). Because ecotones join species from two different ecological systems, they are among the world's most diverse regions, they represent speciation-prone areas and are thus considered important hotspots for biological conservation (Schilthuizen 2000; Smith et al. 2001). The present work is dealing with forest-grassland ecotones, hereafter also referred to forest-grassland transitions.

Forest-grassland transition areas can be found in different regions of the world, where, in special for the last decades, the same pattern has been registered: woody cover is increasing over open grassy ecosystems (Archer 1995; Cabral et al. 2003; Müller et al. 2007; Bond 2008). One of the drivers of this woody encroachment process is the climate history, usually a conversion from a dry and cold to a warmer and wetter climate, as registered by paleoecological studies in the southern Brazil (Behling et al. 2004; Behling et al. 2005; Behling et al. 2007), but also for the north-American gallery forests (Briggs et al. 2005). Another driver of the worldwide woody encroachment process, and probably the most important one, is a combination of favorable climatic and edaphic conditions with the absence or low-frequency of disturbances on grassy areas (Bond 2008). This combination has proved to increase woody cover on African savanna, where it became significantly greater on areas with absence of fire (Gordijn et

al. 2012). Similarly, a study with aerial photographs for a south-American forest-grassland transition area (Oliveira & Pillar 2004) detected a significant increase in the percentage of shrubby grasslands converted into forest in an interval of 25 years, supporting a directional forest expansion. Also in South America, the combining of extreme rainfall events with the lack of disturbance might underpin the current forest expansion, due to the ability of trees in recruit fast and massively (Holmgren et al. 2013). In addition, Wigley et al. (2010) suggested that increasing atmospheric CO₂ and/or nitrogen deposition could have a positive effect in increased woody cover on South-African savanna, shading light into the possibility of having global drivers along with local drivers acting in this woodland expansion process.

Besides the abiotic and historical conditions, there are specific traits or strategies that enable woody species to establish on open areas. In South America, resprouting ability was identified as an important strategy to woody species' survival in grasslands with frequent fire events (Müller et al. 2007). Among forest and savanna trees from Brazilian *Cerrado*, two main strategies to overcome fire events and establish have been described: while the first invest in higher leaf area to quickly overtake the grass stratum (where fire is more intense), the latter has invested in higher bark thickness (Hoffmann et al. 2012). Dispersal also influences the spatial arrangement of woody plants, as in Argentinean grasslands, where ornithochorial seed dispersion are important for the formation of large patches and passive dispersal characterized the most abundant plants in small patches (Cabral et al. 2003). Moreover, the importance of within and between species trait variability for saplings communities was described in a canopy openness gradient in a forest-grassland mosaic, showing that responses of intraspecific variability for specific leaf area (SLA) mirrored the mean community responses (Carlucci et al. 2015). However, there are not many studies referring to functional traits related to the

dynamic of forest-grassland transitions, and the main focus is still being on determining whether woody cover is or is not expanding face to environmental changes (Anadón et al. 2014; Blanco et al. 2014).

Rainfall and temperature are two of the most common climate variables determining vegetation communities' functional composition, especially on a global scale (Moles et al. 2014). The authors found that leaf area and plant height were positively correlated with temperature, while SLA was negatively correlated, and only few traits were more correlated with precipitation than temperature, such as plant life span and leaf life span. Additionally, they discuss the possibility of a significant proportion of trait variation being explained by local factors, other than temperature and rainfall (Moles et al. 2014). So climate alone would not be responsible for all trait variation. The combined effects of climate and soil, for example, explained 50% of between sites SLA variation, including soil C:N ratio, mean annual precipitation, and their two-way interaction in another global-scale study (Ordoñez et al. 2009). Hence, there is a lack of regional scale studies exploring these theme.

Plant functional traits either vary or are similar among coexisting species, as commonly expressed by trait divergence or convergence patterns (Grime 2006). Trait convergence patterns may result from environmental filters selecting for specific strategies in a community, as seen when traits vary according to ecological variables (Joner et al. 2012), whereas trait divergence patterns may arise from processes of limiting similarity, which should lead to an overdispersion of traits in a given community (Weiher et al. 1998). Trait divergence patterns might account for the variability within-community (alpha) and among-communities (beta) (de Bello et al. 2009), regarding the scope of the study. Differencing trait-convergence and trait-divergence influences on the assembly patterns might help to understand processes and

mechanisms behind the coexistence of plants, which is a challenge. Pillar et al. (2009) proposed a methodology that discriminate trait-convergence and divergence considering ecological gradients, but this approach has been mostly applied to local gradients, as in the works with spiders assembly along a gradient of plant biomass and functional diversity (Podgaiski et al. 2013), herbaceous layer of a temperate forest along a gradient of canopy closure (Joner et al. 2012) and tree saplings along microhabitat gradients in forest patches (Carlucci et al. 2012). We propose here to analyze trait-convergence and alpha-divergence patterns of woody plant communities in regional climatic and edaphic gradients where the vegetation is characterized by forest-grassland transition, so that we can also evaluate functional patterns of forest expansion and woody encroachment under different climate and soil conditions.

The forest-grassland ecotones in southern Brazil have been maintained principally by climate history and disturbances of grazing and fire, which are associated with the traditional use of the southern Brazilian *campos* grassland (Behling et al. 2007; Overbeck et al. 2007; Müller et al. 2012). In absence of disturbances, the process of forest expansion should increase (Pillar & Quadros 1997, Oliveira & Pillar 2004), but even under disturbance there are some species typically from forests colonizing adjacent grassland areas (Müller et al. 2007; Debastiani et al. 2015). We intend to identify functional strategies related to leaf traits of woody species that successfully established themselves within grasslands across a regional gradient of climate and soil. Here we hypothesized that forest and transition zones (grasslands adjacent to the forest boundary) would differ in woody species composition and in functional strategies, resulting in distinct patterns of community-weighted means of traits for each habitat (significant trait-convergence concerning forest and grassland transition). In addition, we expect a pattern of trait-convergence for forest communities in relation to climate

variables, increasing leaf thickness (LT) and leaf dry matter content (LDMC), and decreasing SLA and leaf area (LA) toward areas of more stressful conditions, such as low rainfall and higher temperatures, whereas for grassland transition we do not expect any relation to climate, due to the strongest effect of the local habitat per se. In this sense, local differences in soil nutrients might ameliorate the establishment of varying species leading to trait-divergence patterns in transitions or yet distinct patterns of trait-convergence despite the major climate gradient.

Material and Methods

We selected nine areas (2 x 2 km – Landscape Unit) in southern Brazil, where forest ecosystem forms transition zones with the natural and predominant *campos* vegetation (Figure 1). Sites were chosen to reflect the diversity of vegetation types forming transition zones in the southernmost state of Brazil: Encruzilhada do Sul (EN), Santana da Boa Vista (SV) and Herval (HE) are sites located at mosaic zones of grasslands and seasonal Forest, while P.E.Tainhas (TA), CPCN Pró-Mata (PM) and PARNA Aparados da Serra (PA) are sites with highland grasslands (*Campos de Cima da Serra*) and Araucaria Forest, and Santana do Livramento (SL), São Francisco de Assis (SF) and Santo Antônio das Missões (ST) are located in the Pampa region, where grasslands dominate and some galleries and enclaves of forest occur with elements of the seasonal forest (Cordeiro & Hasenack 2009).

Seasonal forest of this region is then characterized by leaves lost of 30 to 60% (semi-deciduous forests) of the canopy trees in the dry and/or cold season (Oliveira-filho 2009) and has a predominance of species of *Parapiptadenia*, *Inga* and *Luehea* (IBGE 1982); Araucaria forest, also called Mixed forest, is a rain forest known by its outstanding element: *Araucaria angustifolia*, an important pine tree which dominates the canopy of the forest patches (Duarte et al. 2014). This forest formation has its distribution probably limited by increasing maximum temperature towards lower altitudes and latitudes, where it gets replaced by seasonal forest (Oliveira-filho et al. 2013). The western sites are located in the Pampa region, but their floristic composition has an important contribution of the *Chacoan* woody species, which are also present in local riparian forests, such as the genus *Schinus*, *Vachellia*, *Celtis*, *Lithraea* and *Astronium* (IBGE 1982). It is also possible to find forests with species from distinct forest formations, as already reported for Santana da Boa Vista's region, where seasonal

forest presents typical *Araucaria* forest elements such as *Podocarpus lambertii* and *Araucaria angustifolia* (Carlucci, Jarenkow, et al. 2011).

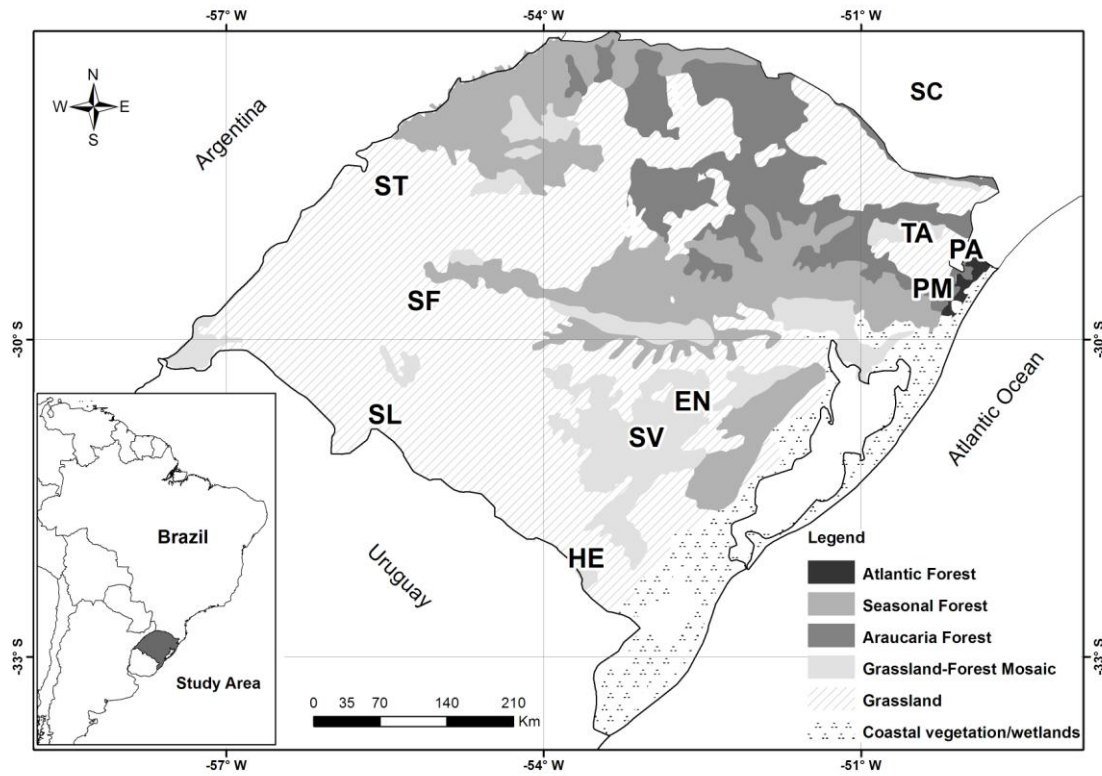


Figure 1 – Map of the study sites location at Rio Grande do Sul state, Brazil. Main vegetation types, in accordance to the limits of detailed vegetation formations defined by IBGE (2004). Sites are identified as EN – Encruzilhada do Sul; HE – Herval; PA – PARNA Aparados da Serra; PM – CPCN Pró-Mata; SF – São Francisco de Assis; SL – Santana do Livramento; ST – Santo Antonio das Missões; SV – Santana da Boavista and TA – PE Tainhas.

Climate on the study sites is classified by Köppen’s classification as Cfa in most of the regions and Cfb in the Araucaria Forest sites and also among HE and EN (Kuinchner & Buriol 2001; Alvares et al. 2013). The mean annual precipitation in the sites ranges from 1259 to 1959mm and mean annual temperature from 15 to 20°C, according to data extracted from the *Worldclim 1.4 Database* (Hijmans et al. 2005). SL, SF and ST are sites with a short dry season during summer, which is an important factor for vegetation at forest-grassland transitions (Oliveira-Filho et al. 2013). The soil has

different origins in the study sites: basaltic, granitic or both, differing greatly on the amounts of aluminum and organic matter (Streck et al. 2008).

In each of the nine sites we surveyed two areas of 140 x 70m each (local units). The local units were divided into two plots of 70 x 70m: one located within the forest and, adjacent to this, another plot at the forest-grassland transition. So we had two forest plots and two transition plots for each site, in a paired design, resulting in 18 forest plots and 18 transition plots. We determined that the grassland transition plot started when the continuous canopy from the forest ended and the grass layer could be identified as the predominant cover of the ground. In each plot, 15 subplots of 100m² were randomly distributed and sampled, where all woody plant individuals with a diameter greater than 5 cm (at breast height in the forest and at soil height in the transition) were measured. All species were identified and leaf samples were collected from 3 individuals for each species per plot per habitat for six of the nine sites (for logistic restrictions we collected data for all species only from EN, HE, PA, PM, ST and SF) to measure leaf traits: specific leaf area (SLA), leaf area (LA) and leaf dry matter content (LDMC). Leaf thickness (LT) was estimated by the equation proposed by Vile et al. (2005). So, for species that occurred in both habitats (forest and transition) we have specific measures for each one, which were considered in further functional analyses. Trait values for species exclusive of any of the other sites were either completed with own data or with data from sites from the same major vegetation type. Leaf traits measurement followed Pérez-Harguindeguy et al. (2013).

In order to evaluate differences in species composition between habitats we did permutational multivariate analyses of variance on a chord distance matrix, based on density of species per plot, and considering the landscape units as blocks, with significance level at 0.05. The result of this analysis was explored by an ordination

diagram of a principal coordinate analysis (PCoA) with Hellinger transformation and chord distance between the sampling units. These analyses were done with the software MULTIV (available at <http://ecoqua.ecologia.ufrgs.br/ecoqua/software.html>).

Considering the landscape unit, we extracted climatic variables with information of rainfall and temperature from the *Worldclim 1.4 Database* (Hijmans et al. 2005) to obtain environmental variables for each site. From a total of 19 variables, we performed a principal component analysis (PCA) to obtain the two main climate gradients of the studied region (Appendix 1), which were represented by the two axes with higher explanation percentage from the ordination analysis. We also collected soil samples per plot per habitat for each local unit: a sample was composed of three subsamples that were collected in order to represent the diversity of microhabitats of the plots. Leaf litter and other detritus were first removed from the soil surface, and samples consisted of 10 cm soil depth. They were sent to be analyzed in the *Laboratório de Análises de Solos* (UFRGS- RS/Brazil), which followed the methodology of Tedesco et al. (1995). The analysis resulted in 15 soil variables among nutrient contents (P and K (mg/dm^3), exchangeable Al, Ca and Mg ($\text{cmol}_c/\text{dm}^3$), potential acidity (Al+H), and Ca/Mg, Ca/K, Mg/K), physical (Organic Matter (%) and Clay (%)) and chemical variables (pH, cation-exchange capacity (CEC), % of Al and bases saturation of CEC). To identify the main soil gradient of local units in the studied region, but still considering the interaction of soil properties with current vegetation cover of the plots, we performed two separated PCA analyses, one for each type of habitat and selected the two axes with higher percentage of explanation from each PCA to proceed with the analysis.

The data were arranged in a matrix **W** of local species populations abundance (total number of individuals) by plots, standardized by marginal total; a matrix **B** of local species populations by traits, and three different matrices **E** containing

environmental information for each plot. To test our hypotheses, we organized the data of matrices **E** as follow: habitat type, climatic gradient and soil gradient. For the habitat type matrix, i.e. whether forest or grassland transition, we had a binary vector indicating in which type of habitat the plot was, with 0 for forest and 1 for transition areas. The climatic gradient matrix was built with the scores of the first two axis of its PCA analysis, but to use the information of plots as sampling units for species and traits, the landscape unit values were duplicated for each correspondent local unit. The soil gradient matrix was composed of the scores of the first two axis of the soil PCA, considering the respective PCA of forest or transition plots. Species present in both habitat types appeared twice in matrixes **W** and **B** in order to consider the local trait information for each species (local species populations), so that we had more accurate information on the functional strategies of each site.

With matrices **W** and **B** we computed CWM for each plot (community-weighted mean of traits *sensu* Garnier et al. (2004); $\mathbf{T}=\mathbf{B}'\mathbf{W}$), which allows scaling-up trait information from species to community level (Pillar et al. 2009). Congruence between matrices **T** and **E** ($r(\mathbf{TE})$) was calculated based on *Procrustes* adjustment (Pillar et al. 2013), which allowed identification of trait-convergence assembly patterns (TCAP) related to the environmental gradient analyzed. Trait-divergence was assessed by congruence of matrix **E** and the functional diversity (FD; Botta-Dukát 2005) estimated by Rao's Quadratic Entropy (**R**): ($r(\mathbf{RE})$) based on *Procrustes* adjustment), which should reveal the alpha divergence pattern. Alpha divergence is here considered as the congruence of within-communities' functional diversity and the environmental gradient. For each gradient analyzed, we performed a separate search for optimal trait subsets from **B** that could maximize TCAP or alpha divergence, so that we would end up with the set of traits that best represented the congruence with the environmental gradient of

interest (for more details of the methodology see Pillar et al. 2009 and Pillar et al. 2013). According to this, distinct set of traits might constitute the response variables (CWMs for convergence and FD for alpha divergence patterns). These analyses were performed with the software SYNCOSA (available at <http://ecoqua.ecologia.ufrgs.br/ecoqua/software.html>).

To express results concerning the convergence and divergence patterns found with the habitat type, we performed 2-way analysis of variance respectively with data from the CWMs and from FD, in order to compare habitats and using the landscape units as blocks. To represent results of TCAP and divergence concerning climatic and edaphic gradients (PCA' axes), we performed linear models with values of CWMs (log-transformed to meet normality) and of FD against the ordination axis (either climatic or soil gradients). These analyses were performed with the help of software R (R Core Team 2013).

Results

Responses to habitat

We found 175 species occurring on all nine sites of this study. A total of 83 species were exclusive from the forest habitat, while only 16 were exclusive from the transition and 76 species were recorded in both habitats. Most of the sampled units had higher species richness in the forest habitat; with only two sites (SL and HE) having higher number of shared species between both habitats than exclusive from one or another (Appendix 2). Despite this high number of shared species, we found a significant difference in species composition between forest and transition habitats across the studied regions, considering the abundance of species per plot ($p= 0.0001$). Most of the variation though, was found between sites, as highlighted by Figure 2.

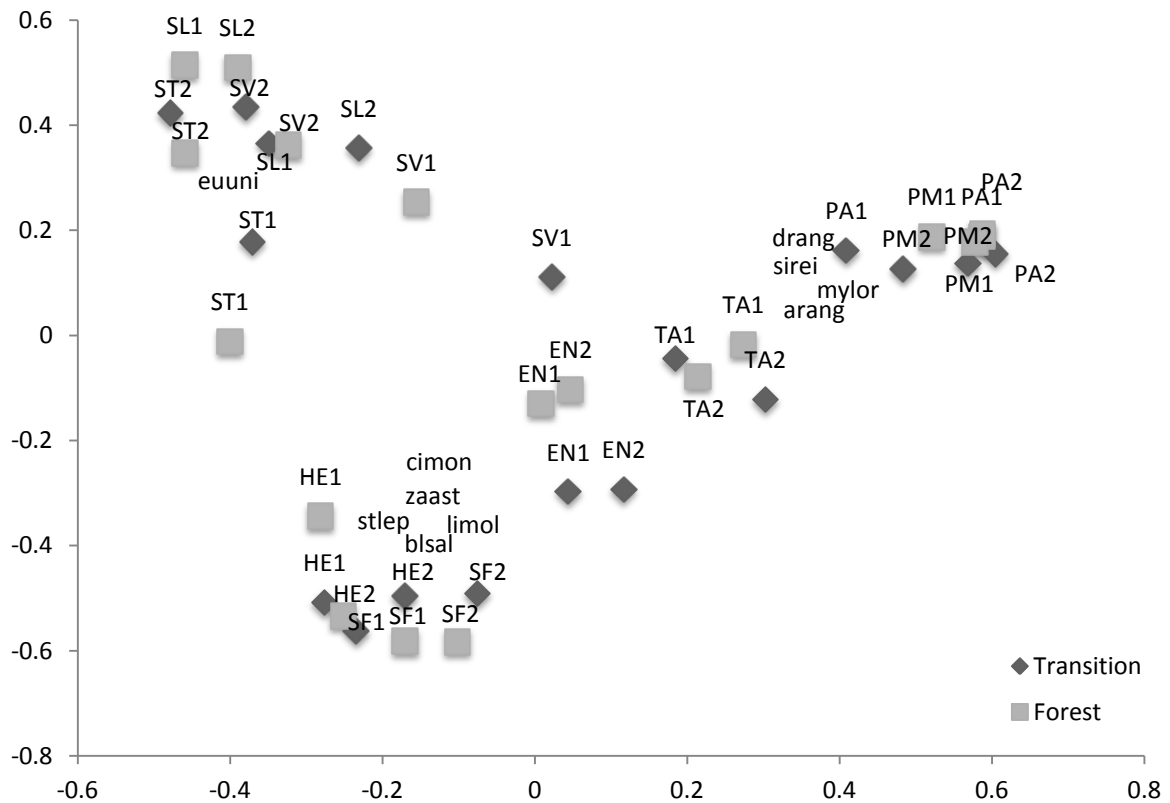


Figure 2 – Ordination diagram of the PCoA of species density per plot, highlighting the compositional differences between forest and transition habitats across all study sites (Percentage of explanation: Axis 1= 15.44 and Axis 2= 13.95). Site labels are: EN – Encruzilhada do Sul; HE – Herval; PA – PARNA Aparados da Serra; PM – CPCN Pró-Mata; SV – Santana da Boa Vista; SF – São Francisco de Assis; ST – Santo Antonio das Missões, and TA – PE Tainhas; numbers refer to the local units. Species labels on the diagram represent the five most correlated species with each axis. arang: *Araucaria angustifolia*; drang: *Drymis angustifolia*; euuni: *Eugenia uniflora*; mylor: *Myrsine lorentziana*; sirei: *Siphoneugena reitzii*; blsal: *Blepharocalyx salicifolius*; cimon: *Citharexylum monthevidensis*; limol: *Lithraea molleoides*; stlep: *Styrax leprosus*; zaast: *Zanthoxylum astrigerum*.

A significant congruence between the matrix **T** and the habitat type matrix **E** was found already using all traits in the analysis ($r(\mathbf{TE})=0.44$, $p=0.03$). With the selection of traits that maximized this congruence (LA and LDMC) we got a stronger *Procrustes* correlation ($r(\mathbf{TE})=0.50$, $p=0.03$). These results can also be viewed through the analysis of variance, where each community-weighted trait was analyzed separately (Table 1). ANOVA showed significantly lower values of LA and SLA for the transition

areas, but LT and LDMC did not differ between habitats (Table 1). We also found a significant correlation between Rao and the habitat-type vector ($r(\mathbf{RE})=0.63$, $p=0.04$) maximized by the set of SLA, LA and LT and which represents a pattern of alpha-divergence, shown by significantly higher FD values in the forest (Figure 3).

Table 1 – Mean values and standard deviations for community-weighted leaf traits according to each habitat type (forest, transition), and the respective p value extracted from the analysis of variance.

Leaf traits (CWM)	Forest		Transition		p value
	Mean	SD	Mean	SD	
LA (mm ²)	946.97	±448.56	517.08	±295.94	≤0.001
SLA (mm ² .mg ⁻¹)	10.86	±2.11	8.91	±2.47	≤0.001
LT (mm ²)	0.33	±0.10	0.35	±0.06	0.430
LDMC (mg.g ⁻¹)	416.10	±12.26	428.29	±34.03	0.130

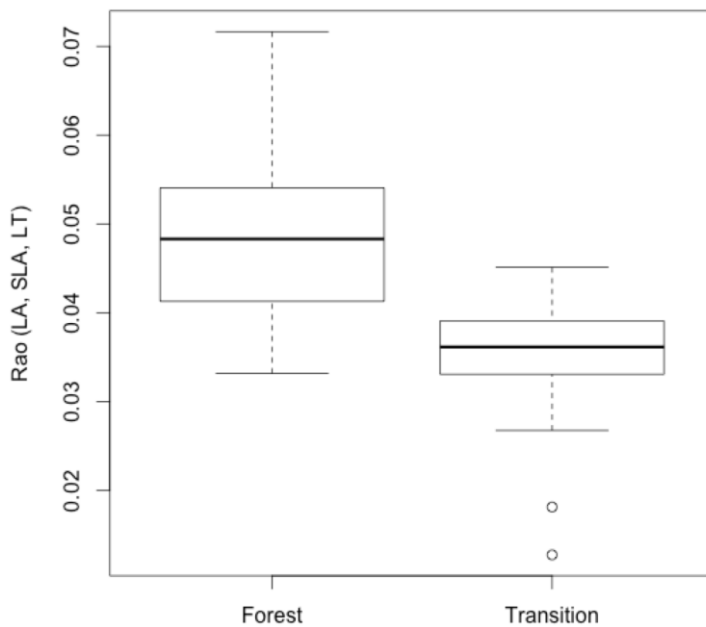


Figure 3 – Boxplot of functional diversity values (Rao's quadratic entropy) obtained through the set of traits that maximized alpha divergence (SLA, LA, LT), i.e. the correlation between Rao and the habitat type vector ($F_{2,33}=8.21$ $p=0.001$).

Ordination analysis

The PCA of the climatic variables extracted from the *WorldClim 1.4 Database* summarized 80% of the information on the first two axes (Appendix 1). The first axis represents a precipitation gradient (hereafter referred to rainfall gradient), where values on the left are related to higher rainfall areas. In the analysis, values from the first axis were multiplied by -1 to make interpretation more intuitive, so that lower values represent lower rainfall areas. The second axis represents a temperature gradient (hereafter referred to temperature); higher values are mainly representing sites with high mean annual temperature (Appendix 1).

The PCA of the soil variables from the forest plots had 72.85% of the information explained with the first two axes, while the PCA of the soil variables from the transition plots had 78.33% of the total information explained by the first two axes (Table 2). Both ordinations showed similar patterns concerning the two axes: the first axis represents an pH and aluminum gradient (hereafter called aluminum), with higher scores representing higher concentrations of this metal, while the second axis has lower scores relating to lower values of organic matter and CEC (hereafter called fertility and organic matter).

Table 2 – Principal Component Analysis for 15 soil variables for forest and transition plots, and the percentage of explanation of each axis analyzed. Values in boldface correspond to the five most-correlated variables with each axis.

Soil variables	Forest		Transition	
	PCA1	PCA2	PCA1	PCA2
P (mg/dm ³)	-0.007	0.200	0.248	0.673
K (mg/dm ³)	-0.555	-0.211	-0.396	0.490
Al (cmol _c /dm ³)	0.643	-0.331	0.753	0.341
Ca (cmol _c /dm ³)	-0.853	-0.347	-0.751	0.360
Mg (cmol _c /dm ³)	-0.765	-0.486	-0.698	0.387
Potential acidity (Al+H)	0.825	-0.416	0.605	0.552
Ca/Mg	-0.739	0.433	-0.437	-0.138
Ca/K	-0.783	-0.298	-0.696	0.066
Mg/K	-0.530	-0.576	-0.713	0.098
Organic matter (%)	0.140	-0.765	0.128	0.777
Clay (%)	-0.395	-0.439	-0.586	0.479
pH	-0.828	-0.060	-0.639	0.023
CEC (cmol _c /dm ³)	0.395	-0.816	0.070	0.819
% Al of CEC	0.904	-0.218	0.797	0.171
Base saturation of CEC	-0.913	0.047	-0.829	-0.041
% explained	51.5%	21.35%	50.85%	27.47%

Responses to soil and climate gradients

Considering only the forest communities, we found a significant TCAP with the climatic gradient, where the set of traits that maximized this congruence are SLA and LT (Table 3). Community-weighted mean of SLA had a polynomial relation with rainfall ($R^2_{adj}=0.22$), while with temperature it showed a linear relation ($R^2_{adj}=0.55$; Figure 4). Community-weighted mean of LT showed a linear and positive relation with temperature, increasing with higher temperatures ($R^2_{adj}=0.35$; Figure 4). A divergence pattern maximized by LDMC was also found with the climatic gradient ($r(\mathbf{RE})$),

although the relation of FD with the axes was weak and not clear (rainfall – $R^2_{adj} = 0.08$ and temperature – $R^2_{adj} = 0.11$).

Table 3 - Results of trait-convergence assembly pattern TCAP and alpha divergence analysis concerning the two environmental gradients: climatic and edaphic. Significant TCAP is given by the $r(\mathbf{TE})$, which is the congruence value between matrix **T** and **E** through Procrustes adjustment, and $r(\mathbf{RE})$ is the congruence between **R** and **E** revealing alpha-divergence patterns. Traits shown were the selected set that maximized the respective adjustments and their labels are: LA - leaf area; SLA - specific leaf area; LT - leaf thickness and LDMC - leaf dry matter content. ns: non-significant, *: $p < 0.05$, **: $p < 0.01$.

HABITAT	GRADIENT	TCAP	DIVERGENCE
FOREST	CLIMATIC	$r(\mathbf{TE}) = 0.48^{**}$	$r(\mathbf{RE}) = 0.36^*$
	<i>Traits</i>	SLA, LT	LDMC
	EDAPHIC	$r(\mathbf{TE}) = 0.50^{**}$	$r(\mathbf{RE}) = 0.50^{**}$
	<i>Traits</i>	SLA, LT	LDMC
TRANSITION	CLIMATIC	$r(\mathbf{TE}) = 0.47^{**}$	$r(\mathbf{RE}) = 0.14^{ns}$
	<i>Traits</i>	SLA, LDMC	SLA, LA, LDMC, LT
	EDAPHIC	$r(\mathbf{TE}) = 0.44^{**}$	$r(\mathbf{RE}) = 0.39^{**}$
	<i>Traits</i>	LA, LDMC	LT

The analysis of forest communities in relation to the soil gradient showed significant convergence and divergence patterns. TCAP was maximized by SLA and LT and these traits were correlated with the axis 2 related to fertility and organic matter content: SLA presented a positive linear relation with this axis ($R^2_{adj} = 0.17$), while LT exhibited a polynomial relation ($R^2_{adj} = 0.28$). SLA was higher at the poorer organic matter soils and LT was higher at more nutrient rich soils (Figure 4). Divergence was maximized by LDMC: higher values of FD estimated for the LDMC trait were found at the sites with higher aluminum proportion ($R^2_{adj} = 0.32$).

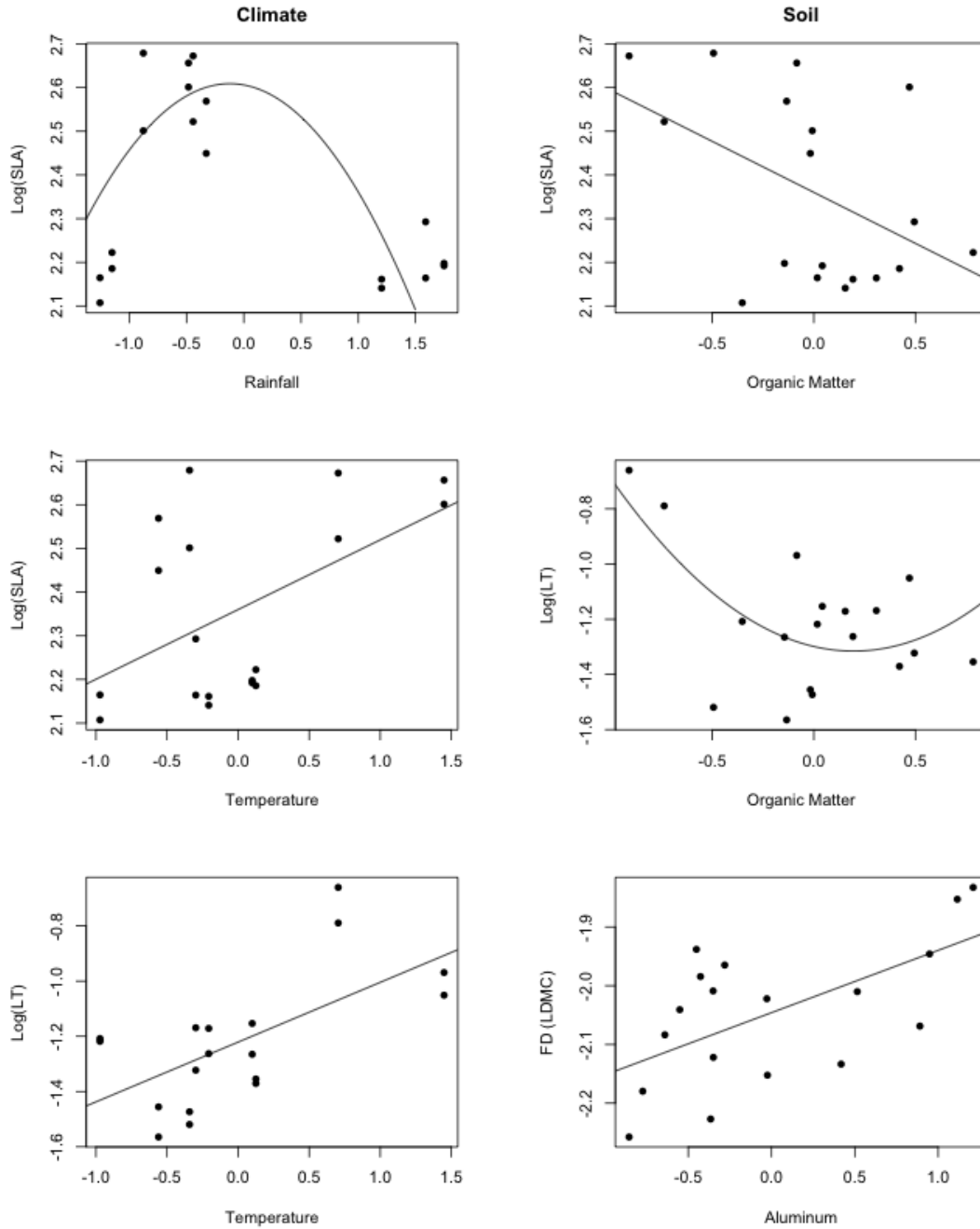


Figure 4 – Relations of community-weighted mean of traits (log-transformed) and functional diversity (FD) against environmental gradients for the forest communities, considering the traits of assembly patterns shown in Table 3. Climatic and edaphic gradients correspond to PCA axes (Appendix 1, Table 2) and are better explained in the text, but all the main variables named in the gradient (e.g. temperature) range from lower values in the left to higher in the right.

Considering the grassland transition areas, we found a trait-convergence assembly pattern with the climatic gradient maximized by SLA and LDMC (Table 3). In the regression analyses, SLA showed a linear and positive relation with temperature ($R^2_{\text{adj}}= 0.46$), increasing with higher temperatures (Figure 5). LDMC did not present a clear relation with neither of the PCA axes. We did not find significant alpha-divergence pattern for the transition communities considering the climatic gradient (Table 3). We also detected a significant TCAP for the communities of the transition considering soil gradients, which was maximized by LA and LDMC (Table 3), but individually we did not find any clear relation between these traits and the PCA axes (Figure 5). An alpha-divergence pattern with soil environmental conditions was maximized by LT, which when explored by a linear regression showed a negative trend ($R^2_{\text{adj}}= 0.17$), with lower FD at higher aluminum content sites.

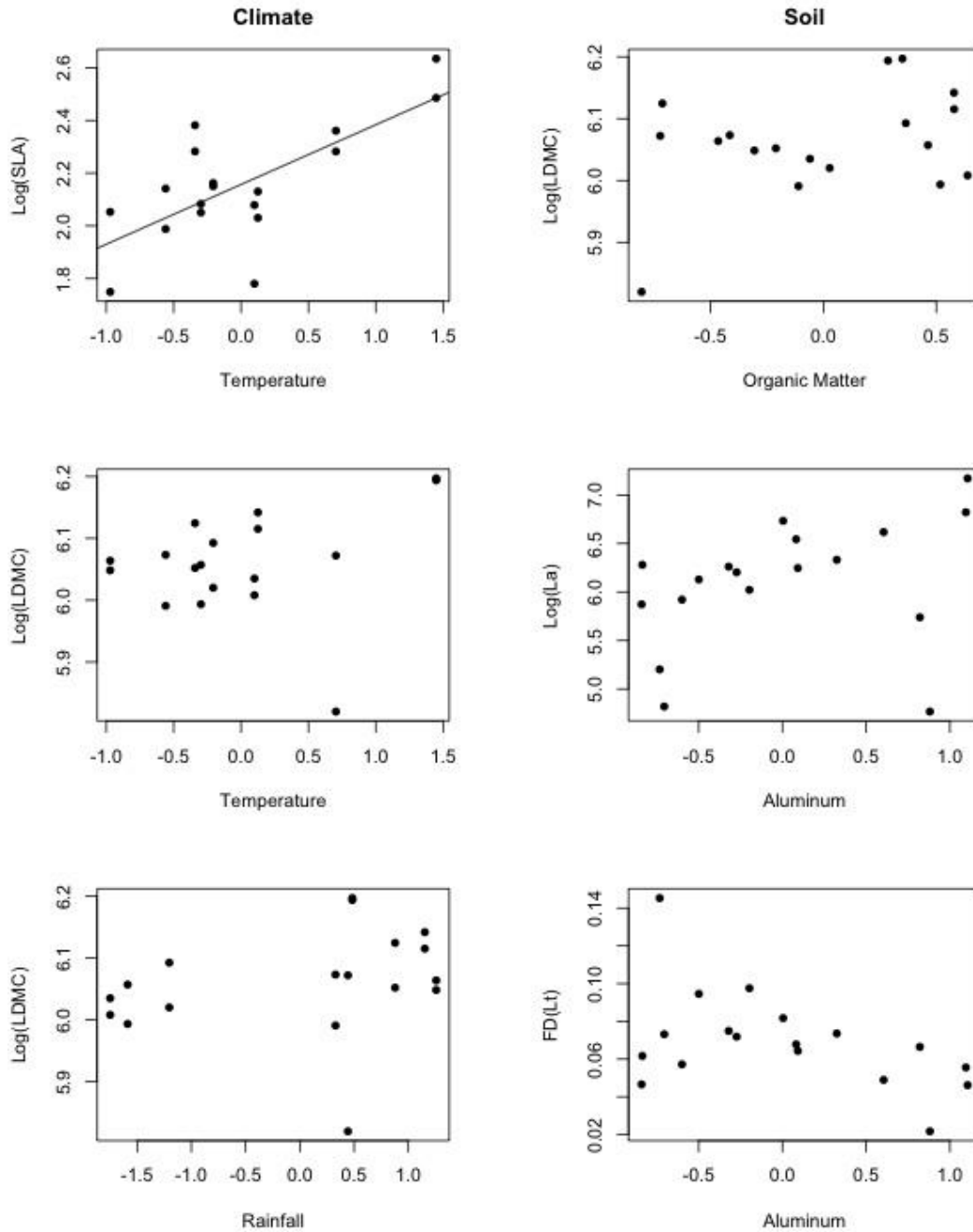


Figure 5 – Relations of community-weighted mean of traits (log-transformed) and functional diversity (FD) against environmental gradients for the transition communities, considering the traits of assembly patterns shown in Table 3. Climatic and edaphic gradients correspond to PCA axes (Appendix 1, Table 2) and are better explained in the text, but the main variables named in the gradient (e.g. temperature) range from lower values in the left to higher in the right. Graphics without lines means results of regression models were not significant.

Discussion

This paper aimed at identifying patterns of functional responses of forest and transition communities to climate and soil gradients as well as compositional and functional differences between these communities. Our results showed differences not only in woody species composition between forest and transition communities but also in their functional strategies. As hypothesized initially, community-weighted means of traits differed between habitats indicating a pattern of trait-convergence concerning the habitat-type (forest *versus* transition). Furthermore, forest and transition communities have shown significant functional patterns as a response of climatic and edaphic gradients. SLA was in the set of traits that maximized trait-convergence for both forest and transition communities regarding the climatic gradient, although each one had another trait in the set. Differences in soil conditions led to divergences in the communities of the two habitats and also to convergence patterns, but different traits were related to either forest or transition communities. The differences are discussed below.

Responses to habitat

Forest and transition communities differed in their species composition across all sites. The pattern expressed in **Figure 2** highlights mainly the differences in floristic composition between Araucaria and Seasonal forests that follow the differences in climate conditions across study sites, which is in accordance to what Oliveira-filho et al. (2013) have described for the southern region of Brazil. But, despite differences observed between forest types, we also found evidences for local differences in species composition between habitats at each site. There are species that seem to be unique to each habitat and thus reflect the differences found locally for each site in our analysis. That was the case of *Vachellia caven* in ST and *Baccharis uncinella* in the Araucaria

forest sites (TA, PA, PM), which were presented in high abundance and restricted to transition communities. Local differences in species composition between habitats were recurrent among sites, either for restricted occurrence in each habitat or differences in species density that might be due to constraints to the establishment of forest species in open areas. In a field experiment in Brazilian savanna (*cerrado*), Hoffmann et al. (2004) found that seedlings from forest species had a low establishment success at savanna sites, probably due to savanna's low water availability. This factor has also been related to differences in floristic composition between adjacent types of vegetation such as *cerrado* and *cerradão* (a tall woodland) (Cruz Ruggiero et al. 2002; de Assis et al. 2011).

Along with the differences in composition, both habitats also differed in their functional strategies. We found a convergence pattern in relation to the habitat type matrix, which indicates a functional distinction between both habitats, heading towards significant lower values of LA and SLA in the transition communities, whereas LDMC and LT values were higher. These findings are in accordance with a more conservative resource acquisition strategy by these plants, which tend to invest in a long-lasting leaf and probably a slow growth (Westoby et al. 2002). It is possible that the harsher environment found in open areas in comparison to nearby forests, such as higher light intensity and thermal shift along with wind exposure, creates hydric stress conditions (Scholes & Archer 1997; Sankey 2012). These abiotic conditions are predominantly driving the assembly of plants through these functional traits, as the lower value of leaf area found in transition communities is probably the result of higher light incidence on these plants, which in turn don't have the need to invest in light capture through larger leaf surface: a pattern recurrent of various studies with experiments of light incidence in leaf traits (Niinemets & Kull 1994; Poorter 1999). Higher LT and LDMC are related to

resource allocation to leaf resistance (Pérez-Harguindeguy et al. 2013), which may be necessary in face of the stressful conditions in the transition areas (Hoffmann et al. 2004) or yet the potential higher herbivore. The present found strategies might be an indicative that not only the woody species that are establishing at the *campos* vegetation are different from the ones in the forest, but also that they differ in their functional strategies. In addition, as we measured and analyzed the leaf traits at local population, maintaining the identity of each habitat, these functional patterns of community convergence are also considering intraspecific variation. That is, even if similar species have occurred in both habitats, they might be different in terms of the leaf trait state.

Differences in functional diversity between both habitats resulted in the alpha-divergence pattern found. In a recent work, Mouchet et al. (2010) showed that Rao's Quadratic Entropy embraces two components of functional diversity: functional richness and divergence; thus a higher FD at the forest sites represents communities with a broader range of values and also very different states of traits. FD is known to discriminate processes that rule community assembly related to biotic and environmental filters (Grime 2006; Cornwell & Ackerly 2009; de Bello et al. 2013). In face of our results, higher values of FD in forest communities indicate that the species present at this habitat are functionally more dissimilar than the ones at transition communities, which can be an indicative that biotic interactions or even microclimatic differences in forest interior are shaping these communities. In contrast, lower values of FD for the transition communities reinforce a pattern of filters acting in the assembly of these communities. Filters are generally associated with environmental conditions, which can be the case of our study, and has already been repeatedly reported in the literature (De Bello 2009; Cornwell & Ackerly 2009; Vandewalle et al. 2014). But the presence of biotic competition between woody species and grasses may also operate as

a filter and is reported to savanna ecosystems (Knoop & Walker 1985; Belsky & Joy 1994). This interaction can act as a restriction for the presence in transition habitat of woody species with more specific state of traits (*i.e.* lower LA, SLA and higher LT and LDMC) that would enable them to overcome the competition with the species present in the grass layer.

Responses to soil and climate gradients

Forest communities showed a TCAP in relation to both climatic and soil gradients. The same set of traits maximized the relation with both gradients: SLA and LT. Higher values of SLA were related to warmer and intermediate rainfall sites, as well as sites with higher organic matter content and fertility. Considering the leaf economic spectrum (Wright et al. 2004), higher SLA can be related to shorter leaf lifespan, which is a pattern commonly reported for deciduous trees (Reich et al. 1995; Reich et al. 1999; Prior et al. 2003; but see Cianciaruso et al. 2013). We found higher SLA values associated with sites of occurrence of Seasonal forest, where leaf deciduousness can get up to 60% of the trees of the community (Oliveira-filho 2009). This pattern was also found for the transition communities, reinforcing the effects of the climatic gradient on the functional strategies of communities of both habitats. SLA is also known to be positively correlated with soil fertility and phosphorus content (Ordoñez et al. 2009) and negatively correlated with soil pH (Orwin et al. 2010), but we did not find such relation considering the community-weighted means. In fact, we found the opposite pattern, with SLA increasing toward areas of lower fertility. Nevertheless, since SLA value is extremely affected by the deciduousness, we are confident that the results of higher SLA in soils with lower fertility and organic matter are been influenced by sites where deciduous species (*e.g.* *Parapiptadenia rigida* and *Annona neosalicifolia*) were dominant, as São Francisco de Assis (SF). Without this site there would be no

significant relation between soil gradient and community-weighted SLA value. The same pattern emerged with LT, increasing with lower organic matter content, which clearly is a response of the units of SF. We are very careful on discussing this result, because we strongly think they do not represent the general pattern, which would be to present lower values of LT associated to sites with lower fertility. On the other hand, LT's positive relation with temperature was expected, thus it reflects investment on the optimization of photosynthesis/respiration processes of the plant communities, because thicker leaves tend to lose less carbon during gas exchanges (Pérez-Harguindeguy et al. 2013), which can be very useful at warmer sites.

Concerning the climatic gradient represented by both PCA axes (rainfall and temperature), we found a divergence pattern related to the LDMC trait, which could not be expressed by simple regression models, probably due to the interaction of both axes influencing the functional diversity variation. Divergence pattern was also found with the soil gradient and it emerged through the FD (LDMC) relation with the aluminum/pH axis. A soil with high aluminum content does not necessarily mean is toxic, but in association with the soil acidity, aluminum becomes available (Poschenrieder et al. 2008) and thus toxic for some plants, which can be the case of our sites. To overcome this toxicity, plant species have evolved different strategies, most of them linked to root system and organic acids association (Ma et al. 2001), but the relation with leaf traits is yet not clear. Higher values of functional diversity regarding LDMC mean that the plants at these communities are more distinct from each other and this might influence the survival and competitive ability under such environment.

Concerning the transition communities, we refute our hypothesis, since we did find a TCAP maximized by SLA and LDMC with the climatic gradient. As well as in the forest communities, SLA presented a positive relation with the temperature axis.

Although we expected the habitat per se to be more important for the assembly of woody species in the transition communities, the regional gradient seems to affect both habitats in a similar way. Considering that the habitat also influenced community-weighted leaf traits through convergence, we can here discriminate the macro-influence of the climate gradients on these communities, even though locally the habitat seems to continue distinguish functional strategies for forest or transition communities.

There was no significant pattern concerning alpha-divergence and climatic gradients for the transition communities. But it was with the soil gradient, maximized by leaf thickness. FD (LT) declines towards sites with higher values of aluminum and lower pH. Aluminum content and acidity might be acting as an environmental filter for plants that are establishing in these transition communities, limiting the range of values of LT found at these sites. We found TCAP regarding the soil gradient for these communities as well, maximized by LA and LT, but any of the traits correlated to any of the soil gradient axes, which indicates a pattern related to both axes together. Liu et al. (2012) in a study in two forest plots, one in China and the other one in Panama, also tried to relate soil properties with functional traits: they found that LA was negatively correlated to soil acidity and positively correlated to soil nutrients, but only in the Chinese forests. The authors related the results to resource acquisition and growth strategies of the plant species, because higher LA (leading to higher SLA) means higher photosynthetic rates, which are expected in nutrient-rich environments. The opposite could be found in soils with nutritional constraints, leading to strategies of more investment in leaf structures, which we here refer to our LT results. The results found for the soil gradient indicate the importance of this component to the selection of functional strategies of plants in transition communities across the studied gradient. Plant communities in ecotones have long been related to soil properties, either altering

or being determined by them (Warman et al. 2013). Soil nutrient distribution, for example, has a strong association with species distribution in tropical forests (John et al. 2007) and in *cerrado* vegetation, where soil pH affects the species distribution, limiting the establishment of species from seasonal forest in areas of more acidic soils (Viani et al. 2014). In forest-grassland transitions, soil nutrient content in open areas is also known to vary with the increase of woody cover (Wigley et al. 2010).

In accordance with our initial hypothesis, forest-grassland transition communities differed in terms of species composition and leaf traits. Furthermore, despite their differences in functional strategies, both are affected by the regional climatic and edaphic gradient. Woody species have evolved different ways of facing environmental constraints on the process of forest expansion in forest-grassland transitions, so that singular strategies, even considering only leaf traits, have enabled the process of encroachment at adjacent open grassy ecosystems.

References

- Abades, R.S., Gaxiola, A., & Marquet, P.A. 2014. Fire , percolation thresholds and the savanna forest transition : a neutral model approach. *Journal of Ecology* 102: 1386–1393.
- Alvares, C.A., Stape, J.L., Sentelhas, P.C., De Moraes Gonçalves, J.L., & Sparovek, G. 2013. Köppen's climate classification map for Brazil. *Meteorologische Zeitschrift* 22: 711–728.
- Anadón, J.D., Sala, O.E., & Maestre, F.T. 2014. Climate change will increase savannas at the expense of forests and treeless vegetation in tropical and subtropical Americas. *Journal of Ecology* 102: 1363–1373.
- Archer, S. 1995. Mechanisms of shrubland expansion: land use, climate or co2? *Climatic Change* 29: 91–99.
- De Assis, A.C.C., Coelho, R.M., da Pinheiro, E.S., & Durigan, G. 2011. Water availability determines physiognomic gradient in an area of low-fertility soils under Cerrado vegetation. *Plant Ecology* 212: 1135–1147.
- Behling, H., Pillar, V.D., & Bauermann, S.G. 2004. Late Quaternary Araucaria forest , grassland (Campos), fire and climate dynamics , studied by high-resolution pollen , charcoal and multivariate analysis of the Cambará do Sul core in southern Brazil. *Palaeogeography, Paleoclimatology, Palaeoecology* 203: 277–297.
- Behling, H., Pillar, V.D., & Bauermann, S.G. 2005. Late Quaternary grassland (Campos), gallery forest, fire and climate dynamics, studied by pollen, charcoal and multivariate analysis of the São Francisco de Assis core in western Rio Grande do Sul (southern Brazil). *Review of Palaeobotany and Palynology* 133: 235–248.
- Behling, H., Pillar, V.D., Muller, S.C., & Overbeck, G.E. 2007. Late-Holocene fire history in a forest-grassland mosaic in southern Brasil : Implications for conservation. *Applied Vegetation Science* 10: 81–90.
- De Bello, F., Thuiller, W., Leps, J., Choler, P., Clément, J.-C., Macek, P., Sebastia, M., & Lavorel, S. 2009. Partitioning of functional diversity reveals the scale and extent of trait convergence and divergence. *Journal of Vegetation Science* 20: 475–486.
- De Bello, F., Vandewalle, M., Reitalu, T., Lepš, J., Prentice, H.C., Lavorel, S., & Sykes, M.T. 2013. Evidence for scale- and disturbance-dependent trait assembly patterns in dry semi-natural grasslands (P. Veski, Ed.). *Journal of Ecology* 101: 1237–1244.
- Belsky, A.J., & Joy, A. 1994. Influences of Trees on Savanna Productivity: Test of Shade, Nutrients, and Tree-Grass Competition. *Ecology* 75: 922–932.
- Blanco, C.C., Jr, E.E.S., Santos, B.R.C., Silva, M.A., & Pillar, V.D. 2007. On the overlap between effect and response plant functional types linked to grazing. *Community Ecology* 8: 57–65.

- Blanco, C.C., Scheiter, S., Sosinski, E., Fidelis, A., Anand, M., & Pillar, V.D. 2014. Feedbacks between vegetation and disturbance processes promote long-term persistence of forest – grassland mosaics in south Brazil. *Ecological Modelling* 291: 224–232.
- Bond, W.J. 2008. What Limits Trees in C 4 Grasslands and Savannas? *Annual Review of Ecology, Evolution, and Systematics* 39: 641–659.
- Botta-Dukát, Z. 2005. Rao ' s quadratic entropy as a measure of functional diversity based on multiple traits. *Journal of Vegetation Science* 16: 533–540.
- Briggs, J.M., Knapp, A.K., Blair, J.M., Heisler, J.L., Greg, A., Lett, M.S., & Mccarron, J.K. 2005. An Ecosystem in Transition : Causes and Consequences of the Conversion of Mesic Grassland to Shrubland. *BioScience* 55: 243–254.
- Cabral, A.A.C., Miguel, J.M. De, Rescia, A.J., Schmitz, M.F., & Pineda, F.D. 2003. Shrub encroachment in Argentinean savannas. *Journal of Vegetation Science* 14: 145–152.
- Carlucci, M.B., Debastiani, V.J., Pillar, V.D., & Duarte, L.D.S. 2015. Between- and within-species trait variability and the assembly of sapling communities in forest patches (F. de Bello, Ed.). *Journal of Vegetation Science* 26: 21–31.
- Carlucci, M.B., Duarte, L.D.S., & Pillar, V.D. 2011. Nurse rocks influence forest expansion over native grassland in southern Brazil. *Journal of Vegetation Science* 22: 111–119.
- Carlucci, M.B., Jarenkow, J.A., Duarte, L.D.S., & Pillar, V.D.P. 2011. Conservação da Floresta com Araucária no Extremo Sul do Brasil. *Natureza & Conservação* 9: 111–114.
- Carlucci, M.B., Streit, H., & Duarte, L.D.S. 2012. Individual-based trait analyses reveal assembly patterns in tree sapling communities. *Journal of Vegetation Science* 23: 176–186.
- Cianciaruso, M. V., Silva, I.A., Manica, L.T., & Souza, J.P. 2013. Leaf habit does not predict leaf functional traits in cerrado woody species. *Basic and Applied Ecology* 14: 404–412.
- Cordeiro, J.L.P., & Hasenack, H. 2009. Cobertura vegetal atual do Rio Grande do Sul. In *Campos Sulinos - conservação e uso sustentável da biodiversidade*, p. 403.
- Cornwell, W.K., & Ackerly, D.D. 2009. Community assembly and shifts in plant trait distributions across an environmental gradient in coastal California. *Ecological Monographs* 79: 109–126.
- Cruz Ruggiero, P.G., Batalha, M. a., Pivello, V.R., & Meirelles, S.T. 2002. Soil-vegetation relationships in cerrado (Brazilian savanna) and semideciduous forest, Southeastern Brazil. *Plant Ecology* 160: 1–16.

- Debastiani, V.J., Muller, S.C., Oliveira, J.M., Rocha, F.S., Sestren-Bastos, M.C., & Duarte, L.D.S. 2015. Recurrent patterns of phylogenetic habitat filtering in woody plant communities across phytogeographically distinct grassland-forest ecotones. *Community Ecology* 16: 1–9.
- Duarte, L.D.S., Bergamin, R.S., Marcilio-Silva, V., Seger, G.D. dos S., & Marques, M.C.M. 2014. Phylobetadiversity among Forest Types in the Brazilian Atlantic Forest Complex. *PloS one* 9: 1–10.
- Garnier, E., Cortez, J., Billés, G., Navas, M., Roumet, C., Debussche, M., Laurent, G., Blanchard, A., Aubry, D., Bellmann, A., Neill, C., & Toussaint, J. 2004. Plant functional markers capture ecosystem properties during secondary succession. *Ecology* 85: 2630–2637.
- Gordijn, P.J., Rice, E., & Ward, D. 2012. The effects of fire on woody plant encroachment are exacerbated by succession of trees of decreased palatability. *Perspectives in Plant Ecology, Evolution and Systematics* 14: 411–422.
- Gosz, J.R. 1993. Ecotone Hierarchies. *Ecological Applications* 3: 369–376.
- Gotzenberger, L., Bello, F. de, Brathen, K.A., Davison, J., Dubuis, A., Guisan, A., Lepš, J., Lindborg, R., Moora, M., Pärtel, M., Pellissier, L., Pottier, J., Vittoz, P., Zobel, K., & Zobel, M. 2011. Ecological assembly rules in plant communities — approaches, patterns and prospects. *Biological Reviews*. doi: 10.1111/j.1469-185X.2011.00187.x
- Grime, J.P. 2006. Trait convergence and trait divergence in herbaceous plant communities: Mechanisms and consequences. *Journal of Vegetation Science* 17: 255–260.
- Hijmans, R.J., Cameron, S.E., Parra, J.L., Jones, G., & Jarvis, A. 2005. Very High Resolution Interpolated Climate Surfaces For Global Land Areas. *International Journal of Climatology* 25: 1965–1978.
- Hoffmann, W.A., Geiger, E.L., Gotsch, S.G., Rossatto, D.R., Silva, L.C.R., Lau, O.L., Haridasan, M., & Franco, A.C. 2012. Ecological thresholds at the savanna-forest boundary: how plant traits, resources and fire govern the distribution of tropical biomes. *Ecology letters* 15: 759–68.
- Hoffmann, W.A., Orthen, B., & Franco, A.C. 2004. Constraints to seedling success of savanna and forest trees across the savanna-forest boundary. *Oecologia* 140: 252–260.
- Holmgren, M., Hirota, M., van Nes, E.H., & Scheffer, M. 2013. Effects of interannual climate variability on tropical tree cover. *Nature Climate Change* 3: 755–758.
- IBGE. 1982. *Projeto RADAM Brasil - Levantamento de Recursos Naturais, v.33 - Folha SH 22.*

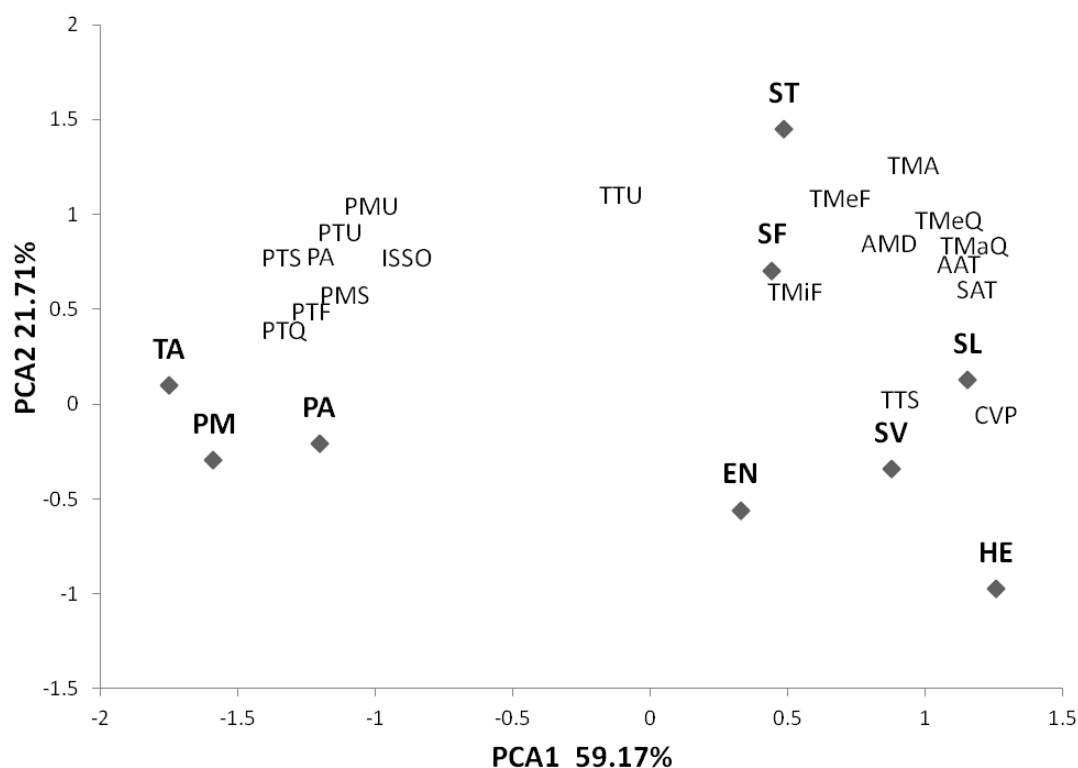
- John, R., Dalling, J.W., Harms, K.E., Yavitt, J.B., Stallard, R.F., Mirabello, M., Hubbell, S.P., Valencia, R., Navarrete, H., Vallejo, M., & Foster, R.B. 2007. Soil nutrients influence spatial distributions of tropical tree species. *Proceedings of the National Academy of Sciences* 104: 864–869.
- Joner, F., Anand, M., & Pillar, V.D. 2012. Trait-convergence and divergence assembly pattern in a temperate forest herbaceous layer along the gradient of canopy closure. *Community Ecology* 13: 178–184.
- Knoop, W.T., & Walker, B.H. 1985. Interactions of Woody and Herbaceous Vegetation in a Southern African Savanna. *Journal of Ecology* 73: 235–253.
- Kuinchtner, A., & Buriol, G.A. 2001. Clima do Estado do Rio Grande do Sul segundo a classificação climática de Köppen e Thornthwaite. *Disciplinarum Scientia* 2: 171–182.
- Liu, X., Swenson, N.G., Wright, S.J., Zhang, L., Song, K., Du, Y., Zhang, J., Mi, X., Ren, H., & Ma, K. 2012. Covariation in Plant Functional Traits and Soil Fertility within Two Species-Rich Forests. *PloS one* 7: e34767.
- Ma, J.F., Ryan, P.R., & Delhaize, E. 2001. Aluminium tolerance in plants and the complexing role of organic acids. *Trends in Plant Science* 6: 273–278.
- Moles, A.T., Perkins, S.E., Laffan, S.W., Flores-Moreno, H., Awasthy, M., Tindall, M.L., Sack, L., Pitman, A., Kattge, J., Aarssen, L.W., Anand, M., Bahn, M., Blonder, B., Cavender-Bares, J., Cornelissen, J.H.C., Cornwell, W.K., Díaz, S., Dickie, J.B., Freschet, G.T., Griffiths, J.G., Gutierrez, A.G., Hemmings, F. a., Hickler, T., Hitchcock, T.D., Keighery, M., Kleyer, M., Kurokawa, H., Leishman, M.R., Liu, K., Niinemets, Ü., Onipchenko, V., Onoda, Y., Penuelas, J., Pillar, V.D., Reich, P.B., Shiodera, S., Siefert, A., Sosinski, E.E., Soudzilovskaia, N. a., Swaine, E.K., Swenson, N.G., van Bodegom, P.M., Warman, L., Weiher, E., Wright, I.J., Zhang, H., Zobel, M., & Bonser, S.P. 2014. Which is a better predictor of plant traits: temperature or precipitation? (A. Helm, Ed.). *Journal of Vegetation Science* 25: 1167–1180.
- Mouchet, M. a., Villéger, S., Mason, N.W.H., & Mouillot, D. 2010. Functional diversity measures: An overview of their redundancy and their ability to discriminate community assembly rules. *Functional Ecology* 24: 867–876.
- Müller, S.C., Overbeck, G.E., Pfadenhauer, J., & Pillar, V.D. 2007. Plant Functional Types of Woody Species Related to Fire Disturbance in Forest–Grassland Ecotones. *Plant Ecology* 189: 1–14.
- Müller, S.C., Overbeck, G.E., Pfadenhauer, J., & Pillar, V.D. 2012. Woody species patterns at forest–grassland boundaries in southern Brazil. *Flora - Morphology, Distribution, Functional Ecology of Plants* 207: 586–598.
- Niinemets, Ü., & Kull, K. 1994. Leaf weight per area and leaf size of 85 Estonian woody species in relation to shade tolerance and light availability. *Forest Ecology and Management* 70: 1–10.

- Oliveira, J.M., & Pillar, V.D. 2004. Vegetation dynamics on mosaics of Campos and Araucaria forest between 1974 and 1999 in Southern Brazil. *Community Ecology* 5: 197–202.
- Oliveira-filho, A.T. 2009. Classificação das Fitofisionomias da América do Sul Cisandina Tropical e Subtropical: Proposta de um novo sistema - prático e flexível - ou uma injeção a mais de caos? *Rodriguésia* 60: 237–258.
- Oliveira-filho, A.T., Budke, J.C., Eisenlohr, P. V., & Neves, D.R.M. 2013. Delving into the variations in tree species composition and richness across South American subtropical Atlantic and Pampean forests. *Journal of Plant Ecology*. doi: 10.1093/jpe/rtt058
- Ordoñez, J.C., van Bodegom, P.M., Witte, J.-P.M., Wright, I.J., Reich, P.B., & Aerts, R. 2009. A global study of relationships between leaf traits, climate and soil measures of nutrient fertility. *Global Ecology and Biogeography* 18: 137–149.
- Orwin, K.H., Buckland, S.M., Johnson, D., Turner, B.L., Smart, S., Oakley, S., & Bardgett, R.D. 2010. Linkages of plant traits to soil properties and the functioning of temperate grassland. *Journal of Ecology* 98: 1074–1083.
- Overbeck, G., Muller, S., Fidelis, a, Pfadenhauer, J., Pillar, V., Blanco, C., Boldrini, I., Both, R., & Forneck, E. 2007. Brazil's neglected biome: The South Brazilian Campos. *Perspectives in Plant Ecology, Evolution and Systematics* 9: 101–116.
- Pérez-Harguindeguy, N., Díaz, S., Garnier, E., Lavorel, S., Poorter, H., Jaureguiberry, P., Bret-Harte, M.S., Cornwell, W.K., Craine, J.M., Gurvich, D.E., Urcelay, C., Veneklaas, E.J., Reich, P.B., Poorter, L., Wright, I.J., Ray, P., Enrico, L., Pausas, J.G., de Vos, a. C., Buchmann, N., Funes, G., Quétier, F., Hodgson, J.G., Thompson, K., Morgan, H.D., ter Steege, H., Sack, L., Blonder, B., Poschlod, P., Vaieretti, M. V., Conti, G., Staver, a. C., Aquino, S., & Cornelissen, J.H.C. 2013. New handbook for standardised measurement of plant functional traits worldwide. *Australian Journal of Botany* 61: 167–234.
- Pillar, V.D., Blanco, C.C., Muller, S.C., Sosinski, E.E., Joner, F., & Duarte, L.D.S. 2013. Functional redundancy and stability in plant communities. *Journal of Vegetation Science* 24: 963–974.
- Pillar, V.D., Duarte, L.D.S., Sosinski, E.E., & Joner, F. 2009. Discriminating trait-convergence and trait-divergence assembly patterns in ecological community gradients. *Journal of Vegetation Science* 20: 334–348.
- Pillar, V.D., & Quadros, F.L.F. 1997. Grassland-forest boundaries in southern Brazil. *Coenoses* 12: 119–126.
- Podgaiski, L.R., Joner, F., Lavorel, S., Moretti, M., Ibanez, S., & Mendonca, M.D.S. 2013. Spider trait assembly patterns and resilience under fire-induced vegetation change in South Brazilian grasslands. *PloS one* 8: e60207.

- Poorter, L. 1999. Growth responses of 15 rain forest tree species to a light gradient; the relative importance of morphological and physiological traits. *Functional Ecology* 13: 396–410.
- Poschenrieder, C., Gunsé, B., Corrales, I., & Barceló, J. 2008. A glance into aluminum toxicity and resistance in plants. *The Science of the total environment* 400: 356–68.
- Prior, L.D., Eamus, D., & Bowman, D.M.J.S. 2003. Leaf attributes in the seasonally dry tropics : a comparison of four habitats in northern Australia. *Functional Ecology* 17: 504–515.
- Reich, P.B., Ellsworth, D.S., Walters, M.B., Vose, J.M., Gresham, C., Volin, J.C., & Bowman, W.D. 1999. Generality of leaf trait relationships: a test across six biomes. *Ecology* 80: 1955–1969.
- Reich, P.B., Kloeppel, B.D., Ellsworth, D.S., & Walters, M.B. 1995. Different photosynthesis-nitrogen relations in deciduous hardwood and evergreen coniferous tree species. *Oecologia* 104: 24–30.
- Risser, P.G. 1995. The Status of the Science Examining Ecotones. *BioScience* 45: 318–325.
- Sankey, T.T. 2012. Woody-Herbaceous-Livestock Species Interactions. In Myster, R.W. (ed.), *Ecotones between forest and grassland*, p. 327. Springer New York.
- Schilthuizen, M. 2000. Ecotone: speciation-prone. *Trends in Ecology and Evolution* 15: 130–131.
- Scholes, R.J., & Archer, S.R. 1997. Tree-grass Interactions in Savannas. *Annual Review of Ecology and Systematics* 28: 517–544.
- Smith, T.B., Kark, S., Schneider, C.J., Wayne, R.K., & Moritz, C. 2001. Biodiversity hotspots and beyond: the need for preserving environmental transitions. *Trends in Ecology & Evolution* 16: 431.
- Streck, E.V., Kamp, N., & Dalmolin, R.S.D. 2008. *Solos do Rio Grande do Sul*. EMATER.
- Tedesco, M.J., Gianello, C., Bissani, C.A., Bohnen, H., & Volkweiss, S.J. 1995. *Análise de solo, plantas e outros materiais* (UFRGS, Ed.). UFRGS, Porto Alegre.
- Vandewalle, M., Purschke, O., de Bello, F., Reitalu, T., Prentice, H.C., Lavorel, S., Johansson, L.J., & Sykes, M.T. 2014. Functional responses of plant communities to management, landscape and historical factors in semi-natural grasslands (I. Kühn, Ed.). *Journal of Vegetation Science* 25: 750–759.
- Viani, R. a. G., Rodrigues, R.R., Dawson, T.E., Lambers, H., & Oliveira, R.S. 2014. Soil pH accounts for differences in species distribution and leaf nutrient concentrations of Brazilian woodland savannah and seasonally dry forest species. *Perspectives in Plant Ecology, Evolution and Systematics* 16: 64–74.

- Vile, D., Garnier, E., Shipley, B., Laurent, G., Navas, M.-L., Roumet, C., Lavorel, S., Díaz, S., Hodgson, J.G., Lloret, F., Midgley, G., Poorter, H., Rutherford, M.C., Wilson, P.J., & Wright, I.J. 2005. Specific Leaf Area and Dry Matter Content Estimate Thickness in Laminar Leaves. *Annals of Botany* 96: 1129–1136.
- Warman, L., Bradford, M.G., & Moles, A.T. 2013. A Broad Approach to Abrupt Boundaries: Looking Beyond the Boundary at Soil Attributes within and Across Tropical Vegetation Types. *PLoS ONE* 8: e60789.
- Weiher, E., Clarke, G.D.P., & Keddy, P.A. 1998. Community assembly rules, morphological dispersion, and the coexistence of plant species. *Oikos* 81: 309–322.
- Westoby, M., Falster, D.S., Moles, A.T., Vesk, P. a., & Wright, I.J. 2002. PLANT ECOLOGICAL STRATEGIES: Some Leading Dimensions of Variation Between Species. *Annual Review of Ecology and Systematics* 33: 125–159.
- Wigley, B.J., Bond, W.J., & Hoffman, M.T. 2010. Thicket expansion in a South African savanna under divergent land use: local vs. global drivers? *Global Change Biology* 16: 964–976.
- Wright, I.J., Reich, P.B., Westoby, M., Ackerly, D.D., Baruch, Z., Bongers, F., Cavender-bares, J., Chapin, T., Cornelissen, J.H.C., Diemer, M., Flexas, J., Garnier, E., Groom, P.K., & Gulias, J. 2004. The worldwide leaf economics spectrum. *Nature* 428: 821–827.

Appendices



Appendix 6 – Ordination diagram of the PCA of the climatic variables using correlation as resemblance measure. Variables labels are: TMA - Mean Annual Temperature (°C); AMD - Mean daily amplitude (°C); ISSO – Isothermality (%); SAT - Temperature Seasonality (°C); TMaQ - Maximum temperature of the warmest month (°C); TMiF - Min temperature of the coldest month (°C); AAT - Annual Temperature Range (°C); TTU - Average temperature of the wettest quarter (°C); TTS - Average temperature of the driest quarter (°C); TMeQ - Average temperature of the warmest month (°C); TMeF - Average temperature of the coldest quarter (°C); PA - Annual precipitation (mm); PMU - Precipitation of wettest month (Mm); PMS - Precipitation of the driest month (Mm); CVP -Coefficient of Precipitation variation (%); PTU - Precipitation of the wettest quarter (mm); PTS - Precipitation of the driest quarter (mm); PTQ - Precipitation of the warmest quarter (mm); PTF - Precipitation of the coldest quarter (mm). Sites are identified as EN – Encruzilhada do Sul; HE – Herval; PA – PARNA Aparados da Serra; PM – CPCN Pró-Mata; SF – São Francisco de Assis; SL – Santana do Livramento; ST – Santo Antonio das Missões; SV – Santana da Boavista and TA – PE Tainhas.

Appendix 2 - Species richness per site (total number of species) and species number that were exclusive from forest or from transition habitats and the number of species shared between them. Sites are identified as EN – Encruzilhada do Sul; HE – Herval; PA – PARNA Aparados da Serra; PM – CPCN Pró-Mata; SF – São Francisco de Assis; SL – Santana do Livramento; ST – Santo Antonio das Missões; SV – Santana da Boavista and TA – PE Tainhas.

	EN	HE	PA	PM	SB	SF	SL	ST	TA
Total richness	51	42	49	41	33	52	25	37	45
Forest exclusive	32	15	29	23	17	33	5	27	32
Transition exclusive	9	10	8	6	4	7	4	5	2
Shared species	10	17	12	12	12	12	16	5	11

Considerações Finais

A partir deste trabalho foi possível identificar os padrões funcionais de comunidades de plantas lenhosas em transições floresta-campo no sul do Brasil. Apesar das diferenças locais entre habitats de floresta e transição, foi possível identificar uma influência em maior escala dos gradientes climáticos e edáficos sobre estas comunidades.

Os principais resultados deste estudo mostraram que comunidades de plantas lenhosas de floresta e de transições diferiram quanto à sua composição de espécies. Os padrões encontrados foram resultantes de diferenças locais em cada sítio estudado, reforçando que a comunidade que está se expandindo, ou melhor, invadindo a matriz campestre não é a mesma que se encontra nas porções florestais, evidenciando um contingente próprio de espécies lenhosas de áreas de transição. As diferenças encontradas para a composição de espécies se repetem em termos de estratégias funcionais. Estes resultados possuem importantes aplicações em termos de conservação de ecossistemas, uma vez que demonstram que os habitats de transição são florística e funcionalmente distintos dos florestais. Nosso trabalho corrobora assim a importância da conservação das transições floresta-campo.

Os principais resultados encontrados, entretanto, dizem respeito à implementação da análise funcional dos gradientes ambientais. A partir da metodologia proposta por Pillar et al. (2009) foi possível identificar respostas funcionais das comunidades aos gradientes climáticos e edáficos onde elas ocorrem. Tanto comunidades florestais quanto de transição mostraram um padrão de convergência de atributos em relação aos gradientes estudados, reforçando as diferentes estratégias funcionais desenvolvidas por estas comunidades para seguir o processo de expansão florestal.

Mas será que podemos afirmar que a floresta está de fato se expandindo? Apesar de ter encontrado transições floresta-campo em diferentes regiões e em diferentes tipos florestais, não podemos, a partir deste trabalho responder a este questionamento, pois demandaria um monitoramento de longo prazo. Entretanto, o fato das comunidades de transição diferirem das florestais indica que há um contingente de plantas lenhosas em áreas abertas, o que não necessariamente expressa um processo de expansão da floresta. Naturalmente, as áreas escolhidas para este estudo são locais de maior adensamento de lenhosas, uma vez que isso é observado junto às bordas florestais. Estariam estas áreas tendo um aumento gradativo na densidade de lenhosas? O resultado encontrado indica que há várias espécies, com determinadas características foliares, que preferencialmente ou exclusivamente (como *Vachellia caven*) ocorrem na transição. Estariam elas agindo como plantas nucleadoras? Estudos mais específicos acerca do papel destas espécies no processo de expansão florestal e também análises temporais nestas áreas de transição poderiam auxiliar a responder tais questionamentos.

A maior parte dos trabalhos com ecótonos campo-floresta desenvolvidos até o momento ocorreu na região do planalto em florestas com Araucária, sendo assim, os resultados encontrados neste estudo vem a contribuir para uma visão mais ampla e regional das áreas de transição do sul do Brasil. Sobretudo, este trabalho fornece dados taxonômicos e funcionais para uma região cujas florestas são pouco estudadas no Rio Grande do Sul, isto é, as áreas de predomínio de formações campestres, como a região de mosaico campo-floresta.

Referências Bibliográficas

Pillar, V.D., Duarte, L.D.S., Sosinski, E.E., & Joner, F. 2009. Discriminating trait-convergence and trait-divergence assembly patterns in ecological community gradients. *Journal of Vegetation Science* 20: 334–348.

Apêndices

Apêndice 1. Dados de atributos foliares por espécie por habitat. Valores de atributos correspondem à média de todos os indivíduos coletados por habitat e também por espécie. N° ind - número de indivíduos coletados; SLA - Área Foliar Específica; LDMC – Conteúdo de Matéria Seca; LA - Área Foliar e LT- Espessura foliar.

Espécies	N° ind.	SLA (mm ² /mg)	LDMC (mg/g)	LA (mm ²)	LT (mm)
<i>Acca sellowiana</i>	12	7.52	440.67	1265.52	0.34
<i>Transição</i>	9	6.66	452.23	1058.89	0.37
<i>Floresta</i>	3	10.12	406.01	1885.41	0.25
<i>Achatocarpus praecox</i>	5	17.07	335.63	1157.26	0.18
<i>Floresta</i>	5	17.07	335.63	1157.26	0.18
<i>Actinostemon concolor</i>	3	10.89	447.58	1184.23	0.21
<i>Floresta</i>	3	10.89	447.58	1184.23	0.21
<i>Allophylus edulis</i>	34	13.33	410.90	493.27	0.19
<i>Transição</i>	13	11.99	409.87	349.74	0.21
<i>Floresta</i>	21	14.16	411.53	582.12	0.18
<i>Allophylus guaraniticus</i>	3	9.94	463.66	271.89	0.22
<i>Floresta</i>	3	9.94	463.66	271.89	0.22
<i>Aloysia gratissima</i>	3	10.94	348.37	113.33	0.26
<i>Transição</i>	3	10.94	348.37	113.33	0.26
<i>Annona neosalicifolia</i>	15	20.96	357.09	2409.75	0.14
<i>Floresta</i>	15	20.96	357.09	2409.75	0.14
<i>Apuleia leiocarpa</i>	5	46.68	287.19	1087.75	0.08
<i>Floresta</i>	5	46.68	287.19	1087.75	0.08
<i>Araucaria angustifolia</i>	37	5.62	380.06	136.11	0.48
<i>Transição</i>	18	5.05	386.92	134.04	0.49
<i>Floresta</i>	19	6.15	374.58	138.07	0.47
<i>Aspidosperma australe</i>	3	14.74	399.34	1537.59	0.17
<i>Floresta</i>	3	14.74	399.34	1537.59	0.17
<i>Baccharis dentata</i>	1	14.86	303.31	1525.31	0.22
<i>Floresta</i>	1	14.86	303.31	1525.31	0.22
<i>Baccharis dracunculifolia</i>	3	12.67	370.23	51.61	0.21
<i>Transição</i>	3	12.67	370.23	51.61	0.21
<i>Baccharis uncinella</i>	14	9.17	431.25	23.20	0.26
<i>Transição</i>	14	9.17	431.25	23.20	0.26
<i>Banara tomentosa</i>	12	20.65	332.22	1955.87	0.15
<i>Floresta</i>	12	20.65	332.22	1955.87	0.15
<i>Berberis laurina</i>	4	5.53	514.10	404.83	0.35
<i>Transição</i>	4	5.53	514.10	404.83	0.35
<i>Blepharocalyx salicifolius</i>	37	9.45	451.45	341.19	0.24
<i>Transição</i>	19	8.95	464.05	329.80	0.24
<i>Floresta</i>	18	9.97	438.15	353.20	0.23
<i>Brunfelsia australis</i>	4	20.28	278.06	2232.62	0.18
<i>Floresta</i>	4	20.28	278.06	2232.62	0.18
<i>Brunfelsia uniflora</i>	3	24.33	239.67	2391.49	0.17

Espécies	Nº ind.	SLA (mm ² /mg)	LDMC (mg/g)	LA (mm ²)	LT (mm)
<i>Floresta</i>	3	24.33	239.67	2391.49	0.17
<i>Cabralea canjerana</i>	2	17.35	322.02	2315.49	0.20
<i>Floresta</i>	2	17.35	322.02	2315.49	0.20
<i>Calliandra tweedie</i>	3	23.03	449.84	8.16	0.10
<i>Floresta</i>	3	23.03	449.84	8.16	0.10
<i>Calyptranthes concinna</i>	5	9.43	467.64	1078.11	0.24
<i>Floresta</i>	5	9.43	467.64	1078.11	0.24
<i>Calyptranthes grandifolia</i>	7	8.85	421.10	6782.15	0.29
<i>Floresta</i>	7	8.85	421.10	6782.15	0.29
<i>Transição manesia guazumifolia</i>	5	17.37	428.60	2650.04	0.14
<i>Floresta</i>	5	17.37	428.60	2650.04	0.14
<i>Transição manesia xanthocarpa</i>	8	11.55	449.69	1800.71	0.19
<i>Floresta</i>	8	11.55	449.69	1800.71	0.19
<i>Casearia decandra</i>	23	16.75	502.63	709.81	0.17
<i>Transição</i>	3	15.77	370.08	804.23	0.18
<i>Floresta</i>	20	16.89	524.73	695.64	0.17
<i>Casearia sylvestris</i>	6	13.58	477.33	1540.52	0.17
<i>Floresta</i>	6	13.58	477.33	1540.52	0.17
<i>Celtis brasiliensis</i>	3	11.08	370.60	1583.45	0.25
<i>Transição</i>	3	11.08	370.60	1583.45	0.25
<i>Celtis ehrenbergiana</i>	3	17.20	320.54	653.89	0.18
<i>Floresta</i>	3	17.20	320.54	653.89	0.18
<i>Celtis iguanea</i>	6	11.18	393.64	800.64	0.24
<i>Transição</i>	3	13.35	353.79	623.38	0.21
<i>Floresta</i>	3	9.00	433.49	977.91	0.26
<i>Chomelia obtusa</i>	3	16.44	448.43	422.89	0.14
<i>Floresta</i>	3	16.44	448.43	422.89	0.14
<i>Chrysophyllum gonocarpum</i>	1	13.10	419.62	2827.26	0.18
<i>Floresta</i>	1	13.10	419.62	2827.26	0.18
<i>Chrysophyllum marginatum</i>	12	10.80	397.65	570.79	0.24
<i>Transição</i>	3	9.05	416.54	480.54	0.28
<i>Floresta</i>	9	11.38	391.35	600.87	0.23
<i>Cinnamomum amoenum</i>	4	7.62	441.88	811.85	0.30
<i>Floresta</i>	4	7.62	441.88	811.85	0.30
<i>Cinnamomum glaziovii</i>	2	9.68	403.18	2310.68	0.25
<i>Floresta</i>	2	9.68	403.18	2310.68	0.25
<i>Citharexylum montevidense</i>	18	6.65	431.88	1679.39	0.36
<i>Transição</i>	6	6.22	457.58	1260.40	0.37
<i>Floresta</i>	12	6.86	419.03	1888.88	0.35
<i>Citronella gongonha</i>	3	7.20	453.54	1596.75	0.32
<i>Floresta</i>	3	7.20	453.54	1596.75	0.32
<i>Citronella paniculata</i>	6	6.16	398.43	3333.17	0.43
<i>Floresta</i>	6	6.16	398.43	3333.17	0.43
<i>Clethra scabra</i>	6	7.93	412.97	2251.53	0.31
<i>Transição</i>	3	7.75	416.13	1770.36	0.32

Espécies	Nº ind.	SLA (mm ² /mg)	LDMC (mg/g)	LA (mm ²)	LT (mm)
<i>Floresta</i>	3	8.11	409.81	2732.70	0.30
<i>Clethra uleana</i>	3	15.60	379.21	1335.01	0.24
<i>Floresta</i>	3	15.60	379.21	1335.01	0.24
<i>Coccoloba cordata</i>	6	15.58	342.44	1034.66	0.19
<i>Transição</i>	3	13.43	365.47	662.50	0.21
<i>Floresta</i>	3	17.73	319.40	1406.81	0.18
<i>Condalia buxifolia</i>	9	9.04	415.85	94.13	0.27
<i>Transição</i>	6	8.12	412.40	86.47	0.30
<i>Floresta</i>	3	10.88	422.76	109.43	0.22
<i>Cordia americana</i>	15	12.77	448.58	813.32	0.19
<i>Transição</i>	6	8.70	506.82	728.38	0.23
<i>Floresta</i>	9	15.48	409.75	869.94	0.17
<i>Cordia ecalyculata</i>	1	12.45	347.50	2642.98	0.23
<i>Floresta</i>	1	12.45	347.50	2642.98	0.23
<i>Cryptocaria aschersoniana</i>	3	8.87	487.28	1986.76	0.26
<i>Floresta</i>	3	8.87	487.28	1986.76	0.26
<i>Cupania vernalis</i>	5	12.57	426.73	2468.32	0.19
<i>Transição</i>	1	12.93	437.14	1419.82	0.18
<i>Floresta</i>	4	12.48	424.13	2730.45	0.20
<i>Daphnopsis fasciculata</i>	11	10.25	282.23	4728.27	0.39
<i>Transição</i>	3	8.14	276.90	3898.85	0.50
<i>Floresta</i>	8	11.04	285.79	5039.30	0.31
<i>Daphnopsis racemosa</i>	17	7.91	359.63	855.72	0.41
<i>Transição</i>	17	7.91	359.63	855.72	0.41
<i>Dasyphyllum spinescens</i>	7	18.41	242.66	951.50	0.26
<i>Transição</i>	2	23.63	185.92	720.59	0.23
<i>Floresta</i>	5	16.33	265.36	1043.86	0.27
<i>Dasyphyllum tomentosum</i>	1	8.28	352.88	3139.57	0.34
<i>Floresta</i>	1	8.28	352.88	3139.57	0.34
<i>Diospyros inconstans</i>	6	12.15	387.81	1251.95	0.21
<i>Floresta</i>	6	12.15	387.81	1251.95	0.21
<i>Drimys angustifolia</i>	23	11.72	317.83	918.45	0.28
<i>Transição</i>	8	10.63	330.29	796.22	0.29
<i>Floresta</i>	15	12.30	309.53	983.64	0.28
<i>Drimys brasiliensis</i>	8	7.73	342.77	1994.26	0.38
<i>Transição</i>	3	6.75	356.85	1307.95	0.42
<i>Floresta</i>	5	8.32	334.33	2406.05	0.36
<i>Enterolobium contortisiliquum</i>	6	13.42	441.94	63.02	0.17
<i>Transição</i>	3	12.55	435.69	67.36	0.19
<i>Floresta</i>	3	14.30	448.20	58.68	0.16
<i>Erythroxylum cuneifolium</i>	3	10.13	408.56	363.15	0.24
<i>Floresta</i>	3	10.13	408.56	363.15	0.24
<i>Erythroxylum deciduum</i>	5	16.11	290.73	1405.10	0.22
<i>Floresta</i>	5	16.11	290.73	1405.10	0.22
<i>Esenbeckia grandiflora</i>	2	7.88	364.12	3519.95	0.35

Espécies	Nº ind.	SLA (mm ² /mg)	LDMC (mg/g)	LA (mm ²)	LT (mm)
<i>Floresta</i>	2	7.88	364.12	3519.95	0.35
<i>Eugenia involucrata</i>	6	11.55	414.32	742.42	0.21
<i>Floresta</i>	6	11.55	414.32	742.42	0.21
<i>Eugenia subterminalis</i>	1	12.52	372.78	364.92	0.21
<i>Floresta</i>	1	12.52	372.78	364.92	0.21
<i>Eugenia uniflora</i>	26	11.94	434.75	612.57	0.20
<i>Transição</i>	12	9.49	459.22	564.35	0.23
<i>Floresta</i>	14	14.05	413.78	653.90	0.18
<i>Eugenia uruguayensis</i>	18	7.25	414.21	860.87	0.38
<i>Transição</i>	6	5.77	422.28	752.74	0.52
<i>Floresta</i>	12	7.99	410.17	914.93	0.31
<i>Eupatorium bunifolium</i>	6	7.92	340.92	36.07	0.38
<i>Transição</i>	6	7.92	340.92	36.07	0.38
<i>Ficus luschnathiana</i>	12	8.48	355.64	3659.19	0.34
<i>Floresta</i>	12	8.48	355.64	3659.19	0.34
<i>Gleditsia amorphoides</i>	6	15.24	439.05	158.61	0.15
<i>Floresta</i>	6	15.24	439.05	158.61	0.15
<i>Gochnatia polymorpha</i>	11	7.94	449.42	811.46	0.29
<i>Transição</i>	8	7.37	463.36	754.78	0.30
<i>Floresta</i>	3	9.45	412.25	962.61	0.26
<i>Guettarda uruguensis</i>	7	20.43	369.39	1757.68	0.15
<i>Floresta</i>	7	20.43	369.39	1757.68	0.15
<i>Handroanthus heptaphyllus</i>	6	12.83	436.77	1724.95	0.18
<i>Floresta</i>	6	12.83	436.77	1724.95	0.18
<i>Helietta apiculata</i>	3	10.63	356.67	687.65	0.26
<i>Floresta</i>	3	10.63	356.67	687.65	0.26
<i>Holocalix balansae</i>	3	16.84	445.77	82.61	0.13
<i>Floresta</i>	3	16.84	445.77	82.61	0.13
<i>Ilex dumosa</i>	3	7.46	466.95	453.19	0.32
<i>Transição</i>	3	7.46	466.95	453.19	0.32
<i>Ilex microdonta</i>	18	8.62	431.03	833.70	0.37
<i>Transição</i>	3	6.04	432.19	889.28	0.39
<i>Floresta</i>	15	9.14	430.64	822.58	0.36
<i>Ilex paraguariensis</i>	9	9.70	453.00	2016.75	0.28
<i>Floresta</i>	9	9.70	453.00	2016.75	0.28
<i>Ilex theezans</i>	1	5.47	440.14	2097.84	0.42
<i>Floresta</i>	1	5.47	440.14	2097.84	0.42
<i>Lamanonia ternata</i>	12	13.38	386.16	1356.47	0.20
<i>Floresta</i>	12	13.38	386.16	1356.47	0.20
<i>Laplacea acutifolia</i>	12	10.74	361.36	961.37	0.32
<i>Transição</i>	2	7.73	392.43	951.69	0.34
<i>Floresta</i>	10	11.34	353.59	963.31	0.32
<i>Ligustrum sp.</i>	3	11.89	267.12	727.61	0.35
<i>Transição</i>	3	11.89	267.12	727.61	0.35
<i>Lithraea brasiliensis</i>	24	7.10	435.40	633.29	0.36

Espécies	Nº ind.	SLA (mm ² /mg)	LDMC (mg/g)	LA (mm ²)	LT (mm)
<i>Transição</i>	11	6.36	437.64	645.41	0.43
<i>Floresta</i>	13	7.73	433.51	623.03	0.31
<i>Lithraea molleoides</i>	15	8.49	430.02	375.59	0.28
<i>Transição</i>	6	8.09	448.71	306.05	0.28
<i>Floresta</i>	9	8.75	417.55	421.95	0.28
<i>Luehea divaricata</i>	3	13.34	435.77	3994.68	0.18
<i>Floresta</i>	3	13.34	435.77	3994.68	0.18
<i>Machaerium paraguariense</i>	5	40.74	315.65	1860.82	0.08
<i>Floresta</i>	5	40.74	315.65	1860.82	0.08
<i>Machaonia brasiliensis</i>	4	11.86	449.85	217.05	0.19
<i>Transição</i>	4	11.86	449.85	217.05	0.19
<i>Matayba eleagnoides</i>	3	11.09	387.78	1211.08	0.23
<i>Floresta</i>	3	11.09	387.78	1211.08	0.23
<i>Maytenus muelleri</i>	7	6.42	469.19	677.52	0.34
<i>Transição</i>	3	5.64	470.43	480.98	0.38
<i>Floresta</i>	4	7.00	468.26	824.93	0.31
<i>Miconia cinerascens</i>	4	9.78	388.67	1797.62	0.26
<i>Transição</i>	4	9.78	388.67	1797.62	0.26
<i>Miconia hyemalis</i>	15	7.43	412.72	1492.85	0.32
<i>Transição</i>	15	7.43	412.72	1492.85	0.32
<i>Miconia ramboi</i>	8	8.45	394.22	749.90	0.31
<i>Transição</i>	3	7.45	405.30	722.59	0.33
<i>Floresta</i>	5	9.04	387.57	766.28	0.29
<i>Mimosa scabrela</i>	6	10.64	422.67	83.27	0.32
<i>Transição</i>	3	5.37	410.84	128.67	0.45
<i>Floresta</i>	3	15.92	434.49	37.86	0.19
<i>Myracrodium balansae</i>	7	14.34	411.82	432.76	0.18
<i>Floresta</i>	7	14.34	411.82	432.76	0.18
<i>Myrceugenia alpigena</i>	12	6.22	463.56	550.24	0.35
<i>Transição</i>	6	6.06	476.27	541.25	0.35
<i>Floresta</i>	6	6.37	450.85	559.22	0.35
<i>Myrceugenia cuculata</i>	3	15.14	309.87	837.10	0.21
<i>Floresta</i>	3	15.14	309.87	837.10	0.21
<i>Myrceugenia euosma</i>	22	8.71	412.84	160.58	0.28
<i>Transição</i>	12	8.37	416.03	161.87	0.29
<i>Floresta</i>	10	9.11	409.26	159.04	0.27
<i>Myrceugenia glaucescens</i>	12	5.29	448.00	448.79	0.55
<i>Transição</i>	6	4.60	442.93	375.62	0.72
<i>Floresta</i>	6	5.98	453.08	521.96	0.37
<i>Myrceugenia mesomischa</i>	7	11.10	421.85	602.85	0.22
<i>Floresta</i>	7	11.10	421.85	602.85	0.22
<i>Myrceugenia miersiana</i>	16	12.54	377.80	1613.06	0.23
<i>Floresta</i>	16	12.54	377.80	1613.06	0.23
<i>Myrceugenia myrcioides</i>	6	11.55	323.30	2513.10	0.28
<i>Floresta</i>	6	11.55	323.30	2513.10	0.28

Espécies	Nº ind.	SLA (mm ² /mg)	LDMC (mg/g)	LA (mm ²)	LT (mm)
<i>Myrceugenia oxysepala</i>	7	12.71	344.78	672.32	0.24
Floresta	7	12.71	344.78	672.32	0.24
<i>Myrcia guianensis</i>	13	7.55	424.08	479.59	0.35
Floresta	13	7.55	424.08	479.59	0.35
<i>Myrcia hartwegiana</i>	1	9.09	374.79	407.82	0.29
Floresta	1	9.09	374.79	407.82	0.29
<i>Myrcia oligantha</i>	3	10.37	394.99	245.61	0.25
Floresta	3	10.37	394.99	245.61	0.25
<i>Myrcia palustris</i>	9	7.28	407.18	487.42	0.34
Transição	3	6.54	416.73	421.40	0.37
Floresta	6	7.65	402.41	520.43	0.33
<i>Myrcia retorta</i>	13	5.55	478.76	1215.47	0.41
Transição	3	5.56	507.44	1025.66	0.41
Floresta	10	5.55	469.20	1272.42	0.41
<i>Myrcia selloi</i>	8	17.67	332.19	303.54	0.18
Transição	3	12.10	361.40	250.92	0.23
Floresta	5	21.02	314.66	335.11	0.16
<i>Myrcianthes cisplatensis</i>	14	5.71	469.46	335.94	0.38
Transição	8	5.86	476.64	334.63	0.37
Floresta	6	5.51	459.89	337.70	0.40
<i>Myrcianthes gigantea</i>	3	5.83	436.90	785.83	0.39
Floresta	3	5.83	436.90	785.83	0.39
<i>Myrcianthes pungens</i>	13	7.69	475.15	940.43	0.28
Floresta	13	7.69	475.15	940.43	0.28
<i>Myrciaria delicatula</i>	6	10.52	436.20	191.46	0.22
Floresta	6	10.52	436.20	191.46	0.22
<i>Myrciaria tenella</i>	6	15.94	484.13	98.33	0.13
Transição	3	14.74	491.52	97.38	0.14
Floresta	3	17.13	476.73	99.29	0.12
<i>Myrocarpus frondosus</i>	2	11.08	413.61	1324.58	0.22
Floresta	2	11.08	413.61	1324.58	0.22
<i>Myrrhinium atropurpureum</i>	14	7.88	465.70	415.50	0.28
Transição	8	7.18	486.84	352.50	0.29
Floresta	6	8.82	437.52	499.52	0.27
<i>Myrsine coriacea</i>	30	9.45	370.99	783.65	0.33
Transição	18	8.82	378.83	806.12	0.38
Floresta	12	10.39	361.83	749.94	0.27
<i>Myrsine laetevirens</i>	12	8.61	311.59	777.03	0.38
Transição	6	8.26	322.17	799.46	0.38
Floresta	6	8.95	301.01	754.59	0.38
<i>Myrsine lorentziana</i>	37	8.06	377.65	1422.38	0.34
Transição	18	7.59	380.73	1257.07	0.35
Floresta	19	8.50	375.34	1578.99	0.34
<i>Nectandra grandiflora</i>	5	10.08	479.64	2380.56	0.26
Floresta	5	10.08	479.64	2380.56	0.26

Espécies	Nº ind.	SLA (mm ² /mg)	LDMC (mg/g)	LA (mm ²)	LT (mm)
<i>Nectandra megapotamica</i>	3	10.14	461.56	961.40	0.22
Floresta	3	10.14	461.56	961.40	0.22
<i>Ocotea acutifolia</i>	1	12.30	400.27	1318.64	0.20
Floresta	1	12.30	400.27	1318.64	0.20
<i>Ocotea corymbosa</i>	11	7.94	486.11	978.27	0.26
Floresta	11	7.94	486.11	978.27	0.26
<i>Ocotea elegans</i>	5	8.64	479.78	899.90	0.30
Floresta	5	8.64	479.78	899.90	0.30
<i>Ocotea puberula</i>	3	12.00	408.11	1696.24	0.21
Floresta	3	12.00	408.11	1696.24	0.21
<i>Ocotea pulchella</i>	17	8.29	495.18	733.19	0.25
Transição	3	8.26	492.83	608.97	0.25
Floresta	14	8.29	495.68	759.81	0.25
<i>Parapiptadenia rigida</i>	9	0.30	460.16	19.44	9.08
Transição	3	0.20	498.90	20.09	10.14
Floresta	6	0.34	440.79	19.11	8.56
<i>Phytolacca dioica</i>	5	15.28	186.68	11103.61	0.43
Floresta	5	15.28	186.68	11103.61	0.43
<i>Pinus sp.</i>	3	4.64	376.87	94.43	0.58
Transição	3	4.64	376.87	94.43	0.58
<i>Piptocarpha axillaris</i>	12	7.37	363.47	1819.19	0.39
Transição	4	6.91	371.15	1846.66	0.38
Floresta	8	7.60	357.72	1805.45	0.39
<i>Piptocarpha notata</i>	5	15.53	348.91	1669.23	0.21
Floresta	5	15.53	348.91	1669.23	0.21
<i>Plinia rivularis</i>	3	1.19	465.22	846.80	1.81
Floresta	3	1.19	465.22	846.80	1.81
<i>Podocarpus lambertii</i>	15	7.92	407.24	79.55	0.32
Transição	3	7.45	408.20	93.41	0.34
Floresta	12	8.04	406.98	76.09	0.32
<i>Poecilanthe parviflora</i>	1	11.07	387.24	2012.51	0.23
Floresta	1	11.07	387.24	2012.51	0.23
<i>Pouteria salicifolia</i>	3	7.66	494.61	1142.28	0.26
Floresta	3	7.66	494.61	1142.28	0.26
<i>Prunus subcoriacea</i>	6	10.24	407.61	1463.15	0.24
Floresta	6	10.24	407.61	1463.15	0.24
<i>Psidium cattleianum</i>	11	6.15	373.74	1790.09	0.52
Transição	4	6.48	389.19	1479.29	0.55
Floresta	7	5.96	362.16	1967.69	0.50
<i>Quillaja brasiliensis</i>	17	6.13	404.53	768.24	0.48
Transição	11	5.42	418.83	833.88	0.55
Floresta	6	7.44	378.30	647.90	0.36
<i>Randia ferox</i>	2	14.25	352.31	1923.44	0.20
Floresta	2	14.25	352.31	1923.44	0.20
<i>Rhamnus sphaerosperma</i>	5	17.34	368.25	2178.02	0.18

Espécies	Nº ind.	SLA (mm ² /mg)	LDMC (mg/g)	LA (mm ²)	LT (mm)
<i>Floresta</i>	5	17.34	368.25	2178.02	0.18
<i>Roupala rhombifolia</i>	9	7.14	457.78	1224.21	0.33
<i>Floresta</i>	9	7.14	457.78	1224.21	0.33
<i>Ruprechtia laxiflora</i>	7	3.97	413.49	943.98	1.36
<i>Transição</i>	1	18.17	376.58	608.24	0.15
<i>Floresta</i>	6	1.60	419.65	999.94	1.57
<i>Sapium glandulosum</i>	5	12.40	288.14	2226.14	0.28
<i>Floresta</i>	5	12.40	288.14	2226.14	0.28
<i>Sapium haemospermum</i>	3	9.26	332.59	1829.93	0.33
<i>Transição</i>	3	9.26	332.59	1829.93	0.33
<i>Schinus engleri</i>	3	6.72	444.57	219.15	0.35
<i>Transição</i>	3	6.72	444.57	219.15	0.35
<i>Schinus lentiscifolius</i>	10	5.72	476.83	77.74	0.52
<i>Transição</i>	6	4.52	473.39	67.24	0.68
<i>Floresta</i>	4	7.52	481.99	93.49	0.29
<i>Schinus longifolius</i>	18	6.63	456.26	365.68	0.69
<i>Transição</i>	12	5.58	454.81	325.45	0.91
<i>Floresta</i>	6	8.71	459.17	446.14	0.26
<i>Schinus polygamus</i>	6	7.16	437.84	330.31	0.32
<i>Transição</i>	6	7.16	437.84	330.31	0.32
<i>Scutia buxifolia</i>	18	8.38	516.10	232.12	0.24
<i>Transição</i>	9	8.28	515.79	216.82	0.24
<i>Floresta</i>	9	8.48	516.40	247.43	0.23
<i>Sebastiania brasiliensis</i>	5	12.61	325.88	972.54	0.45
<i>Floresta</i>	5	12.61	325.88	972.54	0.45
<i>Sebastiania commersoniana</i>	12	10.51	429.69	652.72	0.24
<i>Transição</i>	5	9.29	439.15	496.89	0.26
<i>Floresta</i>	7	11.38	422.94	764.03	0.22
<i>Sideroxylon obtusifolium</i>	5	1.43	404.60	570.36	1.77
<i>Floresta</i>	5	1.43	404.60	570.36	1.77
<i>Siphoneugena reitzii</i>	22	8.32	475.76	119.42	0.26
<i>Transição</i>	7	7.63	490.12	127.77	0.27
<i>Floresta</i>	15	8.65	470.02	115.53	0.26
<i>Solanum pseudoquina</i>	2	9.14	341.73	947.19	0.28
<i>Transição</i>	2	9.14	341.73	947.19	0.28
<i>Sorocea bonplandii</i>	3	12.09	426.31	2403.49	0.19
<i>Floresta</i>	3	12.09	426.31	2403.49	0.19
<i>Strychnos brasiliensis</i>	6	1.27	405.90	616.75	2.31
<i>Transição</i>	3	0.78	448.30	543.96	2.88
<i>Floresta</i>	3	1.76	363.50	689.53	1.74
<i>Styrax leprosus</i>	29	7.99	456.58	947.93	0.31
<i>Transição</i>	14	7.39	460.70	825.73	0.36
<i>Floresta</i>	15	8.55	452.73	1061.98	0.26
<i>Syagrus romanzoffiana</i>	1	5.60	504.28	14482.53	0.35
<i>Floresta</i>	1	5.60	504.28	14482.53	0.35

Espécies	Nº ind.	SLA (mm ² /mg)	LDMC (mg/g)	LA (mm ²)	LT (mm)
<i>Symplocos tetrandra</i>	2	18.12	299.69	1000.39	0.18
<i>Floresta</i>	2	18.12	299.69	1000.39	0.18
<i>Symplocos uniflora</i>	8	7.09	367.11	1165.10	0.39
<i>Transição</i>	3	6.33	372.71	1126.08	0.42
<i>Floresta</i>	5	7.55	363.75	1188.51	0.37
<i>Tabernanthera catarinensis</i>	5	14.38	306.37	1661.46	0.24
<i>Transição</i>	3	14.33	314.68	1828.82	0.24
<i>Floresta</i>	2	14.47	293.90	1410.42	0.24
<i>Tibouchina sellowiana</i>	21	12.82	349.97	913.41	0.25
<i>Transição</i>	6	9.41	381.37	600.97	0.28
<i>Floresta</i>	15	14.19	339.50	1038.39	0.23
<i>Trichilia clausenii</i>	6	11.83	464.09	1996.47	0.18
<i>Floresta</i>	6	11.83	464.09	1996.47	0.18
<i>Trichilia elegans</i>	3	1.77	430.42	410.32	1.36
<i>Floresta</i>	3	1.77	430.42	410.32	1.36
<i>Urera baccifera</i>	5	52.02	120.23	107942.56	0.16
<i>Floresta</i>	5	52.02	120.23	107942.56	0.16
<i>Vachellia caven</i>	4	17.72	505.53	1.19	0.12
<i>Transição</i>	4	17.72	505.53	1.19	0.12
<i>Vernonanthura discolor</i>	19	9.11	338.30	3276.24	0.37
<i>Transição</i>	5	8.01	373.27	3579.84	0.36
<i>Floresta</i>	14	9.50	330.53	3167.81	0.37
<i>Vitex megapotamica</i>	14	14.48	394.21	1244.06	0.20
<i>Floresta</i>	14	14.48	394.21	1244.06	0.20
<i>Weinmannia paulliniifolia</i>	13	14.09	672.58	120.96	0.23
<i>Floresta</i>	13	14.09	672.58	120.96	0.23
<i>Xylosma prockia</i>	2	7.22	421.78	385.78	0.33
<i>Transição</i>	2	7.22	421.78	385.78	0.33
<i>Xylosma pseudosalzmanii</i>	2	8.62	443.68	1025.51	0.27
<i>Floresta</i>	2	8.62	443.68	1025.51	0.27
<i>Xylosma schroederi</i>	12	7.36	443.29	702.93	0.32
<i>Transição</i>	6	6.92	430.30	683.20	0.35
<i>Floresta</i>	6	7.80	456.27	722.66	0.29
<i>Xylosma tweediana</i>	36	6.25	469.13	787.98	0.61
<i>Transição</i>	21	5.80	467.08	675.64	0.82
<i>Floresta</i>	15	6.88	472.00	945.26	0.32
<i>Zanthoxylum astrigerum</i>	16	8.42	410.70	893.58	0.30
<i>Transição</i>	6	9.14	398.47	941.97	0.28
<i>Floresta</i>	10	7.98	418.04	864.55	0.31
<i>Zanthoxylum fagara</i>	16	4.93	324.38	159.52	1.66
<i>Transição</i>	6	1.06	349.66	170.79	2.77
<i>Floresta</i>	10	7.24	309.22	152.76	1.00
<i>Zanthoxylum rhoifolium</i>	11	11.18	392.94	353.56	0.24
<i>Floresta</i>	11	11.18	392.94	353.56	0.24

Apêndice 2. Abundância de espécies por UAL (1 e 2) por sítio amostral de transição. EN – Encruzilhada do Sul; HE – Herval; PA – PARNA Aparados da Serra; PM – CPCN Pró-Mata; SF – São Francisco de Assis; SL – Santana do Livramento; ST – Santo Antonio das Missões; SV – Santana da Boa Vista e TA – PE Tainhas.

<i>Espécies</i>	EN1	EN2	HE1	HE2	PA1	PA2	PM1	PM2	SF1	SF2	SL1	SL2	ST1	ST2	SV1	SV2	TA1	TA2
<i>Acca sellowiana</i>	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	1
<i>Allophylus edulis</i>	0	2	5	1	0	0	0	0	0	0	4	1	0	0	0	0	0	0
<i>Aloysia gratissima</i>	0	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0
<i>Araucaria angustifolia</i>	1	13	0	0	0	21	3	1	0	0	0	0	0	0	0	0	5	11
<i>Baccharis dracunculifolia</i>	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
<i>Baccharis uncinella</i>	0	0	0	0	64	76	2	9	0	0	0	0	0	0	0	0	0	0
<i>Berberis laurina</i>	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3	0
<i>Blepharocalyx salicifolius</i>	1	7	13	16	0	0	0	0	0	0	12	29	0	0	0	0	0	0
<i>Casearia decandra</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Casearia sylvestris</i>	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
<i>Celtis brasiliensis</i>	0	0	0	0	0	0	0	0	1	6	0	0	0	0	0	0	0	0
<i>Celtis iguanaea</i>	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
<i>Chomelia obtusa</i>	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0
<i>Chrysophyllum marginatum</i>	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>Citharexylum montevidense</i>	0	0	1	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
<i>Clethra scabra</i>	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Coccoloba cordata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0
<i>Condalia buxifolia</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cordia americana</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	4	0	0
<i>Cupania vernalis</i>	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Daphnopsis fasciculata</i>	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
<i>Daphnopsis racemosa</i>	12	3	5	9	0	0	0	0	0	3	3	1	0	0	1	0	0	0
<i>Dasyphyllum spinescens</i>	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

<i>Espécies</i>	EN1	EN2	HE1	HE2	PA1	PA2	PM1	PM2	SF1	SF2	SL1	SL2	ST1	ST2	SV1	SV2	TA1	TA2
<i>Drimys angustifolia</i>	0	0	0	0	0	3	0	4	0	0	0	0	0	0	0	0	0	0
<i>Drimys brasiliensis</i>	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Enterolobium contortisiliquum</i>	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0
<i>Erythroxylum deciduum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0
<i>Eugenia hyemalis</i>	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0
<i>Eugenia uniflora</i>	0	0	1	1	0	0	0	0	0	28	0	0	15	2	4	19	0	0
<i>Eugenia uruguayensis</i>	0	0	7	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Eupatorium buniifolium</i>	0	0	10	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gochnatia polymorpha</i>	3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Guettarda uruguayensis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0
<i>Helietta apiculata</i>	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0
<i>Ilex dumosa</i>	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
<i>Ilex microdonta</i>	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
<i>Laplacea acutifolia</i>	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Ligustrum sp.</i>	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
<i>Lithraea brasiliensis</i>	9	1	9	29	0	0	0	0	0	0	0	0	0	0	0	0	7	6
<i>Lithraea molleoides</i>	0	0	0	0	0	0	0	0	0	0	5	79	0	0	0	0	0	0
<i>Machaonia brasiliensis</i>	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0
<i>Maytenus muelleri</i>	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>Miconia cinerascens</i>	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
<i>Miconia hyemalis</i>	2	0	0	0	2	0	8	52	0	0	0	0	0	0	0	0	3	0
<i>Miconia ramboi</i>	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
<i>Mimosa scabrella</i>	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Myrceugenia alpigena</i>	0	0	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0
<i>Myrceugenia euosma</i>	0	0	0	0	2	55	11	0	0	0	0	0	0	0	0	0	0	0
<i>Myrceugenia glaucescens</i>	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	1	0

Espécies	EN1	EN2	HE1	HE2	PA1	PA2	PM1	PM2	SF1	SF2	SL1	SL2	ST1	ST2	SV1	SV2	TA1	TA2
<i>Myrcia palustris</i>	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Myrcia retorta</i>	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
<i>Myrcia selloi</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	1	0	0
<i>Myrcianthes cisplatensis</i>	0	0	3	20	0	0	0	0	0	0	0	0	4	0	0	0	0	0
<i>Myrciaria tenella</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
<i>Myrrhinium atropurpureum</i>	4	1	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0
<i>Myrsine coriacea</i>	0	0	0	2	0	9	1	4	0	0	0	2	0	0	0	0	4	0
<i>Myrsine laetevirens</i>	0	0	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Myrsine lorentziana</i>	0	0	0	4	4	9	12	5	0	0	0	0	0	0	0	0	0	0
<i>Nectandra grandiflora</i>	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
<i>Ocotea pulchella</i>	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0
<i>Parapiptadenia rigida</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Pinus sp.</i>	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
<i>Piptocarpha axillaris</i>	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
<i>Podocarpus lambertii</i>	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	7	18	0
<i>Psidium cattleianum</i>	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Quillaja brasiliensis</i>	1	0	1	1	0	0	0	0	0	0	0	4	0	0	0	0	1	0
<i>Ruprechtia laxiflora</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
<i>Sapium glandulosum</i>	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
<i>Sapium haematospermum</i>	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
<i>Schinus engleri</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Schinus lentiscifolius</i>	0	0	0	1	0	0	0	0	1	0	0	4	0	0	0	0	2	5
<i>Schinus longifolius</i>	0	0	1	1	0	0	0	0	1	0	7	1	1	0	1	0	0	0
<i>Schinus polygamus</i>	7	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Scutia buxifolia</i>	0	0	5	4	0	0	0	0	0	0	6	0	0	0	4	3	0	0
<i>Sebastiania commersoniana</i>	9	1	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0
<i>Senegalia bonariensis</i>	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0

<i>Espécies</i>	EN1	EN2	HE1	HE2	PA1	PA2	PM1	PM2	SF1	SF2	SL1	SL2	ST1	ST2	SV1	SV2	TA1	TA2
<i>Siphoneugena reitzii</i>	0	0	0	0	0	4	0	2	0	0	0	0	0	0	0	0	0	0
<i>Solanum mauritianum</i>	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
<i>Solanum pseudoquina</i>	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
<i>Strychnos brasiliensis</i>	0	0	0	0	0	0	0	0	4	0	0	0	1	0	0	0	0	0
<i>Styrax leprosus</i>	2	0	6	8	0	0	0	0	0	0	17	2	0	0	0	0	0	0
<i>Symplocos uniflora</i>	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Tabernaemontana catharinensis</i>	0	0	0	0	0	0	0	0	33	2	0	0	0	0	0	0	0	0
<i>Tibouchina sellowiana</i>	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
<i>Vachellia caven</i>	0	0	0	0	0	0	0	0	0	0	0	0	42	27	2	0	0	0
<i>Vernonanthura discolor</i>	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0
<i>Xylosma prockia</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
<i>Xylosma schroederi</i>	0	7	0	0	0	0	0	0	0	0	4	0	0	0	2	0	0	0
<i>Xylosma tweediana</i>	2	2	6	3	0	0	0	0	0	0	8	0	2	0	2	4	0	0
<i>Zanthoxylum astrigerum</i>	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Zanthoxylum fagara</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0
<i>Zanthoxylum rhoifolium</i>	2	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0

Apêndice 3. Abundância de espécies por UAL (1 e 2) por sítio amostral de floresta. EN – Encruzilhada do Sul; HE – Herval; PA – PARNA Aparados da Serra; PM – CPCN Pró-Mata; SF – São Francisco de Assis; SL – Santana do Livramento; ST – Santo Antonio das Missões e TA – PE Tainhas.

<i>Espécies</i>	EN1	EN2	HE1	HE2	PA1	PA2	PM1	PM2	SF1	SF2	SL1	SL2	ST1	ST2	SV1	SV2	TA1	TA2
<i>Acanthosyris spinescens</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
<i>Acca sellowiana</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	6
<i>Achatocarpus praecox</i>	0	0	0	0	0	0	0	0	0	0	0	0	8	11	0	0	0	0
<i>Actinostemon concolor</i>	0	0	0	0	0	0	0	0	31	0	0	0	0	3	0	0	0	0
<i>Allophylus edulis</i>	1	1	9	5	0	0	0	0	3	5	5	3	3	0	7	3	0	4
<i>Allophylus guaraniticus</i>	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
<i>Annona neosalicifolia</i>	3	4	0	0	0	0	0	0	10	23	0	0	10	13	0	0	0	0
<i>Apuleia leiocarpa</i>	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0
<i>Araucaria angustifolia</i>	2	5	0	0	14	10	26	24	0	0	0	0	0	0	0	0	23	33
<i>Aspidosperma australe</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0
<i>Baccharis dentata</i>	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Banara tomentosa</i>	25	6	0	0	0	0	0	0	0	0	0	0	3	2	0	2	0	0
<i>Blepharocalyx salicifolius</i>	6	11	6	22	0	0	0	0	0	0	24	47	0	0	9	0	0	1
<i>Brunfelsia australis</i>	1	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
<i>Brunfelsia uniflora</i>	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0
<i>Cabralea canjerana</i>	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0
<i>Calliandra tweediei</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
<i>Calythranthes grandifolia</i>	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0
<i>Calythranthes concinna</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6
<i>Campomanesia guazumifolia</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0
<i>Campomanesia xanthocarpa</i>	13	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	5
<i>Casearia decandra</i>	8	1	10	8	5	0	0	2	1	1	0	0	0	0	0	0	9	0
<i>Casearia sylvestris</i>	16	8	0	0	0	0	0	0	6	7	0	0	0	0	0	0	0	0
<i>Celtis brasiliensis</i>	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0

<i>Espécies</i>	EN1	EN2	HE1	HE2	PA1	PA2	PM1	PM2	SF1	SF2	SL1	SL2	ST1	ST2	SV1	SV2	TA1	TA2
<i>Celtis ehrenbergiana</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
<i>Celtis iguanaea</i>	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	1	0
<i>Chomelia obtusa</i>	0	0	0	0	0	0	0	0	5	25	0	0	3	0	0	0	0	0
<i>Chrysophyllum gonocarpum</i>	0	0	0	0	0	0	0	0	3	0	0	0	0	1	0	0	0	0
<i>Chrysophyllum marginatum</i>	6	0	5	0	0	0	0	0	3	1	0	4	0	0	0	0	0	0
<i>Cinnamomum amoenum</i>	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cinnamomum glaziovii</i>	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Citharexylum montevidense</i>	2	1	3	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>Citronella gongonha</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
<i>Citronella paniculata</i>	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Clethra scabra</i>	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Clethra uleana</i>	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0
<i>Coccoloba cordata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0	0	0
<i>Condalia buxifolia</i>	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cordia americana</i>	0	2	0	0	0	0	0	0	8	0	0	0	6	24	0	40	0	0
<i>Cordia ecalyculata</i>	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cryptocaria aschersoniana</i>	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
<i>Cupania vernalis</i>	2	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
<i>Daphnopsis fasciculata</i>	0	0	0	0	0	0	9	2	0	0	0	0	0	0	0	0	0	0
<i>Dasyphyllum spinescens</i>	1	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
<i>Dasyphyllum tomentosum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
<i>Dicksonia sellowiana</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
<i>Diospyros inconstans</i>	10	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Drimys angustifolia</i>	0	0	0	0	21	14	10	24	0	0	0	0	0	0	0	0	0	0
<i>Drimys brasiliensis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	5
<i>Duranta vestita</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Enterolobium contortisiliquum</i>	0	0	0	0	0	0	0	0	0	3	0	0	0	5	0	0	0	0

Espécies	EN1	EN2	HE1	HE2	PA1	PA2	PM1	PM2	SF1	SF2	SL1	SL2	ST1	ST2	SV1	SV2	TA1	TA2
<i>Erythroxylum cuneifolium</i>	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Erythroxylum deciduum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	1
<i>Esenbeckia grandiflora</i>	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
<i>Eugenia hyemalis</i>	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
<i>Eugenia involucrata</i>	5	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
<i>Eugenia subterminalis</i>	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Eugenia uniflora</i>	1	0	13	3	0	0	0	0	4	31	0	0	87	41	33	53	0	0
<i>Eugenia uruguayensis</i>	6	1	22	9	0	0	0	0	0	0	0	0	0	0	1	0	3	0
<i>Ficus luschnathiana</i>	1	1	2	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0
<i>Gleditsia amorphoides</i>	0	0	0	0	0	0	0	0	0	0	0	0	3	2	0	0	0	0
<i>Gochnatia polymorpha</i>	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0
<i>Guettarda uruguayensis</i>	2	0	8	0	0	0	0	0	0	0	0	0	4	0	4	3	0	0
<i>Handroanthus heptaphyllus</i>	0	0	0	0	0	0	0	0	2	2	0	0	1	2	0	0	0	0
<i>Helietta apiculata</i>	0	0	0	0	0	0	0	0	5	3	0	0	0	0	0	0	0	0
<i>Holocalyx balansae</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Ilex microdonta</i>	0	0	0	0	27	23	40	13	0	0	0	0	0	0	0	0	0	0
<i>Ilex paraguariensis</i>	0	0	0	0	5	1	1	0	0	0	0	0	0	0	0	0	0	0
<i>Ilex theezans</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Inga vera</i>	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0
<i>Lamanonia ternata</i>	0	0	0	0	11	1	0	2	0	0	0	0	0	0	0	0	0	0
<i>Laplacea acutifolia</i>	0	0	0	0	4	0	16	3	0	0	0	0	0	0	0	0	0	0
<i>Lithraea brasiliensis</i>	18	1	18	31	0	0	0	0	0	0	0	0	0	0	13	6	19	8
<i>Lithraea molleoides</i>	0	0	0	3	0	0	0	0	0	1	20	51	0	0	0	0	0	0
<i>Luehea divaricata</i>	4	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0
<i>Machaerium paraguariensis</i>	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
<i>Malmeanthus subintegerrimus</i>	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
<i>Matayba elaeagnoides</i>	1	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0

Espécies	EN1	EN2	HE1	HE2	PA1	PA2	PM1	PM2	SF1	SF2	SL1	SL2	ST1	ST2	SV1	SV2	TA1	TA2
<i>Maytenus muelleri</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1
<i>Miconia cinerascens</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
<i>Miconia hyemalis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
<i>Miconia ramboi</i>	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Mimosa scabrella</i>	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Myracrodruon balansae</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	4	0	0	0	0
<i>Myrceugenia alpigena</i>	0	0	0	0	19	8	0	0	0	0	0	0	0	0	0	0	0	0
<i>Myrceugenia cucullata</i>	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Myrceugenia euosma</i>	0	0	0	0	10	92	0	1	0	0	0	0	0	0	0	0	0	0
<i>Myrceugenia glaucescens</i>	0	0	32	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Myrceugenia mesomischa</i>	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	25	58
<i>Myrceugenia miersiana</i>	0	0	0	0	14	19	11	2	0	0	0	0	0	0	0	0	0	0
<i>Myrceugenia myrcioides</i>	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
<i>Myrceugenia oxysepala</i>	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
<i>Myrcia guianensis</i>	0	0	0	0	37	0	19	20	0	0	0	0	0	0	0	0	0	0
<i>Myrcia lajeana</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Myrcia oligantha</i>	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Myrcia palustris</i>	0	0	34	21	0	0	0	0	0	0	0	0	0	0	0	1	0	0
<i>Myrcia retorta</i>	0	0	0	0	0	0	23	51	0	0	0	0	0	0	0	0	0	0
<i>Myrcia selloi</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	1	0	1
<i>Myrcianthes cisplatensis</i>	0	0	14	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Myrcianthes gigantea</i>	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3
<i>Myrcianthes pungens</i>	7	6	0	0	0	0	0	0	0	0	0	0	4	2	0	0	0	0
<i>Myrciaria delicatula</i>	0	0	0	0	9	14	0	0	0	0	0	0	0	0	0	0	0	0
<i>Myrciaria tenella</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	9	0	0
<i>Myrocarpus frondosus</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Myrrhinium atropurpureum</i>	0	0	2	0	1	1	0	0	0	0	0	0	0	0	1	6	2	2

Espécies	EN1	EN2	HE1	HE2	PA1	PA2	PM1	PM2	SF1	SF2	SL1	SL2	ST1	ST2	SV1	SV2	TA1	TA2
<i>Myrsine coriacea</i>	0	0	10	3	0	0	0	0	0	0	9	22	0	0	0	0	1	1
<i>Myrsine laetevirens</i>	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Myrsine lorentziana</i>	11	1	0	0	14	9	1	12	0	0	0	0	0	0	0	0	0	0
<i>Nectandra grandiflora</i>	0	0	0	0	0	0	6	0	3	0	0	0	0	0	0	0	0	0
<i>Nectandra megapotamica</i>	6	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
<i>Ocotea acutifolia</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Ocotea corymbosa</i>	0	0	0	0	19	0	27	8	0	0	0	0	0	0	0	0	0	0
<i>Ocotea elegans</i>	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Ocotea puberula</i>	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0
<i>Ocotea pulchella</i>	3	4	0	0	2	1	0	0	0	3	16	17	0	0	3	1	3	3
<i>Parapiptadenia rigida</i>	0	0	0	0	0	0	0	0	5	7	0	0	1	3	0	0	1	0
<i>Phytolacca dioica</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Piptocarpha axillaris</i>	0	0	0	0	1	0	3	5	0	0	0	0	0	0	0	0	0	0
<i>Piptocarpha notata</i>	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
<i>Plinia rivularis</i>	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
<i>Podocarpus lambertii</i>	0	0	0	0	1	0	4	0	0	7	0	0	0	0	46	12	37	18
<i>Poecilanthe parviflora</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
<i>Pouteria salicifolia</i>	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0
<i>Prunus subcoriacea</i>	1	0	0	1	5	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Psidium cattleianum</i>	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
<i>Quillaja brasiliensis</i>	1	0	0	0	0	0	0	0	0	0	0	10	0	0	3	1	0	1
<i>Randia ferox</i>	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Rhamnus sphaerosperma</i>	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Roupala rhombifolia</i>	0	0	0	0	0	0	10	33	0	0	0	0	0	0	0	0	0	0
<i>Ruprechtia laxiflora</i>	0	0	0	0	0	0	0	0	3	0	0	0	3	3	0	5	0	0
<i>Sapium glandulosum</i>	0	0	0	0	1	1	3	0	0	0	0	0	0	0	0	0	1	0
<i>Schinus lentiscifolius</i>	0	0	0	0	0	0	0	0	0	0	1	12	0	0	0	0	0	3

<i>Espécies</i>	EN1	EN2	HE1	HE2	PA1	PA2	PM1	PM2	SF1	SF2	SL1	SL2	ST1	ST2	SV1	SV2	TA1	TA2
<i>Schinus longifolius</i>	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0
<i>Schinus polygamus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
<i>Scutia buxifolia</i>	0	0	7	5	0	0	0	0	0	0	7	0	0	0	7	12	0	3
<i>Sebastiania brasiliensis</i>	5	0	2	0	0	0	0	0	5	0	0	0	1	0	1	0	0	0
<i>Sebastiania commersoniana</i>	21	35	0	0	0	0	0	0	3	0	0	0	0	0	1	1	2	9
<i>Sideroxylon obtusifolium</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
<i>Siphoneugena reitzii</i>	0	0	0	0	13	115	4	24	0	0	0	0	0	0	0	0	28	3
<i>Solanum pseudoquina</i>	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Sorocea bonplandii</i>	0	1	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0
<i>Strychnos brasiliensis</i>	0	0	0	0	0	0	0	0	0	2	0	0	3	0	0	0	0	0
<i>Styrax leprosus</i>	2	0	33	34	0	0	0	0	0	0	45	37	0	0	8	0	0	0
<i>Syagrus romanzoffiana</i>	0	0	0	1	0	0	0	0	5	0	0	0	0	0	0	0	0	0
<i>Symplocos tetandra</i>	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Symplocos uniflora</i>	6	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	8
<i>Tabernaemontana catharinensis</i>	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0
<i>Tibouchina sellowiana</i>	0	0	0	0	5	7	6	3	0	0	0	0	0	0	0	0	0	0
<i>Trichilia claussenii</i>	12	58	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0
<i>Trichilia elegans</i>	1	0	0	0	0	0	0	0	2	0	0	0	0	4	0	0	0	0
<i>Urera baccifera</i>	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
<i>Vernonanthura discolor</i>	0	0	0	0	2	3	3	1	0	0	0	0	0	0	0	0	1	0
<i>Vitex megapotamica</i>	4	0	17	1	0	0	1	8	6	0	0	0	0	0	0	0	1	0
<i>Weinmannia paulliniifolia</i>	0	0	0	0	3	3	2	1	0	0	0	0	0	0	0	0	0	0
<i>Xylosma schroederi</i>	0	0	0	9	0	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>Xylosma tweediana</i>	0	0	4	3	0	0	0	0	0	0	1	1	0	0	13	1	1	0
<i>Zanthoxylum astrigerum</i>	0	4	6	1	0	0	0	0	0	0	7	12	0	0	0	0	0	0
<i>Zanthoxylum fagara</i>	0	0	8	4	0	0	0	0	0	0	6	0	0	2	0	0	0	0
<i>Zanthoxylum rhoifolium</i>	0	0	2	0	0	0	1	0	0	0	0	1	0	0	1	0	2	0

Apêndice 4. Abundância relativa de espécies (%) em unidades de floresta e transição.

Família	Espécies	Floresta	Transição
Achatocarpaceae	<i>Achatocarpus praecox</i>	0.52	0
Anacardiaceae	<i>Lithraea brasiliensis</i>	3.11	4.57
	<i>Lithraea molleoides</i>	2.04	6.29
	<i>Myracrodruon balansae</i>	0.14	0
	<i>Schinus engleri</i>	0	0.07
	<i>Schinus lentiscifolius</i>	0.44	0.97
	<i>Schinus longifolius</i>	0.08	0.97
	<i>Schinus polygamus</i>	0.03	1.12
Annonaceae	<i>Annona neosalicifolia</i>	1.72	0
Apocynaceae	<i>Aspidosperma australe</i>	0.11	0
	<i>Tabernaemontana catharinensis</i>	0.14	2.62
Aquifoliaceae	<i>Ilex dumosa</i>	0	0.15
	<i>Ilex microdonta</i>	2.81	0.22
	<i>Ilex paraguariensis</i>	0.19	0
	<i>Ilex theezans</i>	0.03	0
Araucariaceae	<i>Araucaria angustifolia</i>	3.73	4.12
Arecaceae	<i>Syagrus romanzoffiana</i>	0.16	0
Asteraceae	<i>Baccharis dentata</i>	0.03	0
	<i>Baccharis dracunculifolia</i>	0	0.15
	<i>Baccharis uncinella</i>	0	11.30
	<i>Eupatorium buniifolium</i>	0	1.12
	<i>Gochnatia polymorpha</i>	0.22	0.37
	<i>Malmeanthus subintegerrimus</i>	0.03	0
	<i>Piptocarpha axillaris</i>	0.25	0.15
	<i>Piptocarpha notata</i>	0.05	0
	<i>Vernonanthura discolor</i>	0.27	0.45
Berberidaceae	<i>Berberis laurina</i>	0	0.37
Bignoniaceae	<i>Handroanthus heptaphyllus</i>	0.19	0
Boraginaceae	<i>Cordia americana</i>	2.18	0.60
	<i>Cordia ecalyculata</i>	0.03	0
Canabaceae	<i>Celtis brasiliensis</i>	0.03	0.52
	<i>Celtis ehrenbergiana</i>	0.03	0
	<i>Celtis iguanaea</i>	0.16	0.15
Cardiopteridaceae	<i>Citronella gongonha</i>	0.08	0
	<i>Citronella paniculata</i>	0.11	0
Celastraceae	<i>Maytenus muelleri</i>	0.08	0.07
Clethraceae	<i>Clethra scabra</i>	0.11	0.07
	<i>Clethra uleana</i>	0.08	0
Cunoniaceae	<i>Lamanonia ternata</i>	0.38	0
	<i>Weinmannia paulliniifolia</i>	0.25	0
Dicksoniaceae	<i>Dicksonia sellowiana</i>	0.03	0
Ebenaceae	<i>Diospyros inconstans</i>	0.35	0
Erythroxylaceae	<i>Erythroxylum cuneifolium</i>	0.03	0
	<i>Erythroxylum deciduum</i>	0.22	0.52

Família	Espécies	Floresta	Transição
Euphorbiaceae	<i>Actinostemon concolor</i>	0.93	0
	<i>Sapium glandulosum</i>	0.16	0.15
	<i>Sapium haematospermum</i>	0	0.15
	<i>Sebastiania brasiliensis</i>	0.38	0
	<i>Sebastiania commersoniana</i>	1.96	1.80
Fabaceae	<i>Apuleia leiocarpa</i>	0.14	0
	<i>Calliandra tweediei</i>	0.05	0
	<i>Enterolobium contortisiliquum</i>	0.22	0.22
	<i>Gleditsia amorphoides</i>	0.14	0
	<i>Holocalyx balansae</i>	0.03	0
	<i>Inga vera</i>	0.14	0
	<i>Machaerium paraguariensis</i>	0.03	0
	<i>Myrocarpus frondosus</i>	0.03	0
	<i>Parapiptadenia rigida</i>	0.46	0.07
	<i>Poecilanthe parviflora</i>	0.05	0
	<i>Senegalia bonariensis</i>	0	0.22
	<i>Vachellia caven</i>	0	5.31
Lamiaceae	<i>Vitex megapotamica</i>	1.04	0
Lauraceae	<i>Cinnamomum amoenum</i>	0.05	0
	<i>Cinnamomum glaziovii</i>	0.03	0
	<i>Cryptocaria aschersoniana</i>	0.05	0
	<i>Nectandra grandiflora</i>	0.25	0.22
	<i>Nectandra megapotamica</i>	0.19	0
	<i>Ocotea acutifolia</i>	0.03	0
	<i>Ocotea corymbosa</i>	1.47	0
	<i>Ocotea elegans</i>	0.05	0
	<i>Ocotea puberula</i>	0.16	0
	<i>Ocotea pulchella</i>	1.53	0.22
Loganiaceae	<i>Strychnos brasiliensis</i>	0.14	0.37
Malvaceae	<i>Luehea divaricata</i>	0.27	0
Melastomataceae	<i>Miconia cinerascens</i>	0.03	0.22
	<i>Miconia hyemalis</i>	0.03	5.01
	<i>Miconia ramboi</i>	0.08	0.15
	<i>Mimosa scabrella</i>	0.03	0.07
	<i>Tibouchina sellowiana</i>	0.57	0.22
Meliaceae	<i>Cabrlea canjerana</i>	0.14	0
	<i>Trichilia clausenii</i>	2.07	0
	<i>Trichilia elegans</i>	0.19	0
Moraceae	<i>Ficus luschnathiana</i>	0.19	0
	<i>Sorocea bonplandii</i>	0.30	0
Myrtaceae	<i>Acca sellowiana</i>	0.25	0.30
	<i>Blepharocalyx salicifolius</i>	3.43	5.84
	<i>Calyptranthes grandifolia</i>	0.14	0
	<i>Calyptranthes concinna</i>	0.19	0
	<i>Campomanesia guazumifolia</i>	0.08	0

Família	Espécies	Floresta	Transição
Myrtaceae	<i>Campomanesia xanthocarpa</i>	0.63	0
	<i>Eugenia hyemalis</i>	0.05	0.52
	<i>Eugenia involucrata</i>	0.19	0
	<i>Eugenia subterminalis</i>	0.03	0
	<i>Eugenia uniflora</i>	7.25	5.24
	<i>Eugenia uruguayensis</i>	1.14	0.75
	<i>Myrceugenia alpigena</i>	0.74	0.37
	<i>Myrceugenia cucullata</i>	0.03	0
	<i>Myrceugenia euosma</i>	2.81	5.09
	<i>Myrceugenia glaucescens</i>	1.36	0.52
	<i>Myrceugenia mesomischa</i>	2.29	0
	<i>Myrceugenia miersiana</i>	1.25	0
	<i>Myrceugenia myrcioides</i>	0.19	0
	<i>Myrceugenia oxysepala</i>	0.05	0
	<i>Myrcia guianensis</i>	2.07	0
	<i>Myrcia lajeana</i>	0.03	0
	<i>Myrcia oligantha</i>	0.05	0
	<i>Myrcia palustris</i>	1.53	0.15
	<i>Myrcia retorta</i>	2.02	0.07
	<i>Myrcia selloi</i>	0.41	0.67
	<i>Myrcianthes cisplatensis</i>	0.68	2.02
	<i>Myrcianthes gigantea</i>	0.22	0
	<i>Myrcianthes pungens</i>	0.52	0
	<i>Myrciaria delicatula</i>	0.63	0
	<i>Myrciaria tenella</i>	0.49	0.07
	<i>Myrrhimum atropurpureum</i>	0.41	0.60
	<i>Plinia rivularis</i>	0.11	0
	<i>Psidium cattleianum</i>	0.05	0.07
<i>Siphoneugena reitzii</i>	5.10	0.45	
Oleaceae	<i>Ligustrum sp.</i>	0	0.30
Phytolaccaceae	<i>Phytolacca dioica</i>	0.03	0
Pinaceae	<i>Pinus sp.</i>	0	0.15
Podocarpaceae	<i>Podocarpus lambertii</i>	3.41	2.32
Polygonaceae	<i>Coccoloba cordata</i>	0.87	0.22
	<i>Ruprechtia laxiflora</i>	0.38	0.22
Primulaceae	<i>Myrsine coriacea</i>	1.25	1.65
	<i>Myrsine laetevirens</i>	0.14	0.45
	<i>Myrsine lorentziana</i>	1.31	2.54
Proteaceae	<i>Roupala rhombifolia</i>	1.17	0
Quillajaceae	<i>Quillaja brasiliensis</i>	0.44	0.60
Rhamnaceae	<i>Condalia buxifolia</i>	0.08	0.07
	<i>Rhamnus sphaerosperma</i>	0.05	0
	<i>Scutia buxifolia</i>	1.12	1.65
Rosaceae	<i>Prunus subcoriacea</i>	0.22	0
Rubiaceae	<i>Chomelia obtusa</i>	0.90	0.37

Família	Espécies	Floresta	Transição
Rubiaceae	<i>Guettarda uruguensis</i>	0.57	0.22
	<i>Machaonia brasiliensis</i>	0	0.30
	<i>Randia ferox</i>	0.05	0
Rutaceae	<i>Esenbeckia grandiflora</i>	0.05	0
	<i>Helietta apiculata</i>	0.22	0.45
	<i>Zanthoxylum astrigerum</i>	0.82	0.07
	<i>Zanthoxylum fagara</i>	0.54	0.22
	<i>Zanthoxylum rhoifolium</i>	0.19	0.52
Salicaceae	<i>Banara tomentosa</i>	1.04	0
	<i>Casearia decandra</i>	1.23	0.07
	<i>Casearia sylvestris</i>	1.01	0.15
	<i>Dasyphyllum spinescens</i>	0.44	0.07
	<i>Dasyphyllum tomentosum</i>	0.08	0
	<i>Xylosma prockia</i>	0	0.07
	<i>Xylosma schroederi</i>	0.27	0.97
	<i>Xylosma tweediana</i>	0.65	2.17
Santalaceae	<i>Acanthosyris spinescens</i>	0.05	0
Sapindaceae	<i>Allophylus edulis</i>	1.34	0.97
	<i>Allophylus guaraniticus</i>	0.05	0
	<i>Cupania vernalis</i>	0.14	0.07
	<i>Matayba elaeagnoides</i>	0.27	0
Sapotaceae	<i>Chrysophyllum gonocarpum</i>	0.11	0
	<i>Chrysophyllum marginatum</i>	0.52	0.15
	<i>Pouteria salicifolia</i>	0.05	0
	<i>Sideroxylon obtusifolium</i>	0.05	0
Solanaceae	<i>Brunfelsia australis</i>	0.11	0
	<i>Brunfelsia uniflora</i>	0.08	0
	<i>Solanum mauritianum</i>	0	0.07
	<i>Solanum pseudoquina</i>	0.03	0.07
Styracaceae	<i>Styrax leprosus</i>	4.33	2.62
Symplocaceae	<i>Symplocos tetandra</i>	0.03	0
	<i>Symplocos uniflora</i>	0.49	0.30
Theaceae	<i>Laplacea acutifolia</i>	0.63	0.07
Thymelaeaceae	<i>Daphnopsis fasciculata</i>	0.30	0.15
	<i>Daphnopsis racemosa</i>	0	2.77
Urticaceae	<i>Urera baccifera</i>	0.03	0
Verbenaceae	<i>Aloysia gratissima</i>	0	1.80
	<i>Citharexylum montevidense</i>	0.22	0.30
	<i>Duranta vestita</i>	0.03	0
Winteraceae	<i>Drimys angustifolia</i>	1.88	0.52
	<i>Drimys brasiliensis</i>	0.33	0.07
Total de indivíduos		3665	1333