Pereira Gomes, Juliano; Iaschitzki Ferreira, Paula; Michels Dacoregio, Helen; Sartorato
Silva França, Caroline; Higuchi, Pedro; Mantovani, Adelar; Lopes da Costa Bortoluzzi,
Roseli
Demographics and spatial pattern on three populations of Myrtaceae in the Ombrophilous
Mixed Forest

Demographics and spatial pattern on three populations of *Myrtaceae* in the Ombrophilous Mixed Forest

Demografia e padrão espacial de três populações de *Myrtaceae* na Floresta Ombrófila Mista

Juliano Pereira Gomes[I*] Paula Iaschitzki Ferreira[I] Helen Michels Dacoregio[II]
Caroline Sartorato Silva França[II] Pedro Higuchi[III]
Adelar Mantovani[III] Roseli Lopes da Costa Bortoluzzi[III]

ABSTRACT

The aim of this study was to characterize the demographic structure and spatial pattern of *Campomanesia xanthocarpa* (Mart.) O. Berg, *Myrcianthes gigantea* (D. Legrand) D. Legrand and *Myrciaria delicatula* (DC.) O. Berg. Within one hectare of Ombrophilous Mixed Forest, all the three populations' individuals were counted and measured with regard to their height and diameter. From the collected data, the assessment of the demographic structure was realized after the individual's size classification. Spatial pattern was determined by applying the Standardized Morisita's Index. *C. xanthocarpa* and *M. delicatula* showed an inverted-J frequency distribution in the individuals size classes, which differed from *M. gigantea* that did not follow the same pattern. The spatial pattern of *C. xanthocarpa* and *M. delicatula* populations was found mainly to be aggregated; whereas, *M. gigantea* showed spatial randomness. The three *Myrtaceae* populations responded differently with regard to structure and spatial distribution in sites with the same environmental filters.

Key words: *Campomanesia xanthocarpa*, *Myrcianthes gigantea*, *Myrciaria delicatula*.

RESUMO

Objetivou-se caracterizar a estrutura demográfica e o padrão espacial de *Campomanesia xanthocarpa* (Mart.) O. Berg, *Myrcianthes gigantea* (D. Legrand) D. Legrande *Myrciaria delicatula* (DC.) O. Berg, bem como, verificar a influência de variáveis ambientais sobre essas populações. Em um hectare de Floresta Atlântica, todos os indivíduos das três populações foram contados e mensurados quanto à altura e diâmetro. A estrutura demográfica foi avaliada após classificação de tamanho dos indivíduos, o padrão espacial pelo Índice de Morisita Padronizado. *Campomanesia xanthocarpa* e *M. delicatula* apresentaram distribuição de frequência dos indivíduos em classes de tamanho em J invertido, já a espécie *M. gigantea* não seguiu o mesmo comportamento. O padrão espacial das populações de *C. xanthocarpa* e *M. delicatula* foi, predominantemente, agregado e, para *M. gigantea*, o padrão foi aleatório. Verifica-se que as populações de *Myrtaceae* possuem respostas diferenciadas quanto à estrutura e distribuição espacial em sítios com os mesmos filtros ambientais.

Palavras-chave: *Campomanesia xanthocarpa*, *Myrcianthes gigantea*, *Myrciaria delicatula*.

INTRODUCTION

Myrtaceae Juss. contains 145 genera and approximately 5970 species (THE PLANT LIST, 2013) distributed in a pantropical form (McVAUGH, 1968). In Brazil, *Myrtaceae* is represented by 1013 species, of which 778 are endemic. Within the domain of the Atlantic Forest, there are 688 species, in which 74% are endemic to this biome (SOBRAL et al., 2015). Despite the floristic representativeness, ecological and economical importance of *Myrtaceae*, many are disappearing from their natural environment even before scholars can achieve a basic knowledge of their biology (LANDRUM & KAWASAKI, 1997) and ecology (PIZO, 2003; GRESSLER et al., 2006). Thus, *Myrtaceae* are present in lists of endangered species in Brazil. Among the *Myrtaceae* that make up the Atlantic Forest, *Campomanesia xanthocarpa* (Mart.) O. Berg, *Myrcianthes gigantea* (D. Legrand)

[I]Programa de Pós-graduação em Fisiologia Vegetal, Universidade do Estado de Santa Catarina (UDESC), 88035001, Lages, SC, Brasil. E-mail: julianopgomes@yahoo.com.br. *Corresponding author.
[II]Programa de Pós-graduação em Engenharia Florestal, Universidade do Estado de Santa Catarina (UDESC), Lages, SC, Brasil.
[III]Departamento de Engenharia Florestal, Universidade do Estado de Santa Catarina (UDESC), Lages, SC, Brasil.

D. Legrand and *Myrciaria delicatula* (DC.) O. Berg. stand out because of their effective participation in the arboreal community and the limited information about their behavior under natural conditions.

Campomanesia xanthocarpa (Mart.) O. Berg, known as *Guabirobeira* is a frequently observed species and especially abundant in the humid and compacted soils of *submatas dos pinhais* (Araucaria understory), *capões* (vegetation clumping surrounded by grassland) and riparian vegetation (LEGRAND & KLEIN, 1977). The medium sized adult tree has a height of 10-20m and commonly 30-50cm of diameter (LEGRAND & KLEIN, 1977). This species occurs in different regions in Brazil (SOBRAL et al., 2015), as well as in Argentina, Paraguay and Uruguay (LORENZI, 2002). It is characterized by its effective interaction with fauna, which are mainly attracted by the fruit. According to FRISCH & FRISCH (2005), the fruit dispersal is frequently conducted by birds, small mammals, fish and reptiles (CARVALHO & NAKAGAWA, 2000).

Myrcianthes gigantea (D. Legrand) D. Legrand, is a tree considered to be almost exclusive to Ombrophilous Mixed Forest (FOM) with humid soils, occurring isolated or in groups, and described as rare by LEGRAND & KLEIN (1977). The adult tree reaches 15-20m of height and 20-30cm of diameter LEGRAND & KLEIN (1977). This species is considered characteristic of forests in advanced successional stages, where ecological interactions take place between more specialized fauna, typical of well-preserved environments. Its geographical distribution goes from the north of Uruguay (MARCHIORI & SOBRAL, 1997) to southeast Brazil (SOBRAL, 2015).

Showing a widespread dispersion within FOM, *Myrciaria delicatula* (DC.) O. Berg is distributed in an irregular and noncontiguous form (LEGRAND & KLEIN, 1978). The small sized tree is commonly found between 3-5m of height, rarely exceeding it (LEGRAND & KLEIN, 1978). No information was reported regarding the diameter of adult trees in the literature; however, field observations reveal that corresponding adults can be found from 10-20 cm of diameter. This species' occurrence is described for south and southeast regions of Brazil (SOBRAL et al., 2015) and for Paraguay (LEGRAND & KLEIN, 1978; BERNARDI, 1985). According to BERNARDI (1985), the species behaves as shade-tolerant and selective hygrophytes, common in riparian vegetation. Flowering and fruiting occurs in winter, a time when the food supply is otherwise restricted, making it an important source of energy to the fauna.

Little ecological knowledge available about the species mentioned above hinders conservation actions. No recent studies treat the structure and spatial pattern of natural populations (CLARK & EVANS, 1954) and it is currently known that the environment determines the individuals' arrangement in the ecosystem (FORTIN et al., 2002). Both abundance and population structure are especially influenced by environmental heterogeneity and inter- as well as intraspecific interactions (JANZEN, 1970). Knowledge about spatial patterns makes possible the management of potential populations (i.e., multiple use capacities not yet known or explored), as well as establishing the correct size area for conservation of these populations which are essential strategies for biodiversity maintenance.

Thus, the aim of this study was to characterize the demographic structure and spatial pattern of *Campomanesia xanthocarpa*, *Myrcianthes gigantea* and *Myrciaria delicatula*.

MATERIALS AND METHODS

Study area

The study was conducted in São José do Cerrito, Santa Catarina State, in a fragment of 3.8ha, within a remnant of Ombrophilous Mixed Forest (FOM). This forest formation is one of the most representative phytoecological units of the Atlantic Forest biome as a result of the junction between the austral-Andean flora and the tropical Afro-Brazilian flora (IBGE, 2012).

The property's main office is located at the coordinates 27º43"04" S, 50°39"25" W and average altitude of 798m. According to KÖPPEN (1948), the climate is Cfb, with annual mean temperature and precipitation of 16.5°C and 1,600mm, respectively (PANDOLFO et al., 2002). The area belongs to the Caveiras River Watershed and features a predominant Red Nitosol. The João Borges hydroelectric power plant (PCH) and its dam are located in the surrounding area, both small-scale. Extensive cattle farming and cultivation of annual crops are the main land use observed in the surrounding landscape.

Data collection

The data survey was carried out in four permanent plots of 50x50m divided into 100 subplots of 10x10m, which were randomly distributed within the fragment, totaling a sampled area of 1ha. The assessment occurred between April, 2012 and January, 2013, when all individuals of *Campomanesia xanthocarpa*, *Myrcianthes gigantea* and *Myrciaria*

delicatula were registered and marked with numbered aluminum plates. Each individual was measured considering the following dendrometric data: full height (H); diameter at breast height (DBH) for individuals with DBH≥5.0cm at 1.3m above ground; and ground level diameter (GD) in individuals with DBH<5.0cm at 1.3m above ground.

Subsequently, the measured individuals were separated in four different classes. The regenerating individuals were divided according to the classification proposal given by VOLPATO (1994), in which plants up to 1.0m above ground were the first class (Class I), plants >1.0m above ground and ≤3.0m above ground were grouped in the second class (Class II),and plants>3.0m above ground and <5.0cm of DBH were class three (Class III). The fourth class (Class IV) contains the adults and thus all plants with DBH ≥5.0cm. It is worth noting that all classes represent only size distinctions and not the individuals'ontogenetic stages, as no growing or developmental phases were studied at this point.

Data analysis

In order to quantify the demographic structure of the three species, it was calculated the relative and absolute densities of the different demographic classes, as well as the total number of individuals per species and their relative participation in each species population. The study was based in the assessment of native arboreal populations within a small forest fragment of 3,8ha. The sampling area within the fragment totaled 1ha, which represents a sampling intensity superior to 26% of the forest under analysis. Also, it was note the representativeness of the sampled area, since it covered more than one fourth of the forest fragment assessed. The criteria used to proceed with the analysis of sampled individuals had a maximum error of 20%, admissible for inventory of natural populations, and a level of probability of 90%. It is important to emphasize that other relevant research on natural populations and communities use a sampling area of one hectare (LINDENMAIER & BUDKE, 2006; FAJARDO et al., 2014; NGUYEN et al., 2014).

The distribution pattern of each one of the size classes of the studied species using the Standardized Morisita's Index was measured (KREBS, 1999). Size classes with less than five individuals were not submitted to the distribution analysis (Class IV for *M. delicatula*). To sample this class, it may be necessary to make a better sampling effort and/or collect a differentiated distribution of the sampling plots.

All analyses were done with the statistical software R (version 2.2.1 R Development Core Team 2010). The library Vegan was used to calculate the Standardized Morisita's Index.

RESULTS AND DISCUSSION

Demographic structure

The results obtained are the species *Campomanesia xanthocarpa* and *Myrciaria delicatula*, which showed higher abundance in the smaller size classes, and, as the size classes increase, the number of individuals is reduced (Figure 1). The behavior differs for *Myrcianthes gigantea*, which shows a lower density of regenerating individuals when compared to the previous species, as well as a higher abundance of individuals in the biggest class (Figure 1).

The populations of *C. xanthocarpa* and *M. Delicatula* together totaled 90% of the surveyed individuals, presenting a probable representativeness of this species within the *Myrtaceae* community in the assessed remnant of Ombrophilous Mixed Forest. According to CALLEGARO et al. (2012), this result indicated that these species are well adapted to the present vegetation conditions.

The absolute density of *C. xanthocarpa* was 907 individuals per hectare, which were spread across the four classes (Figure 1). Class I has 693indha^{-1} (76.4%) and Class II, 151indha^{-1} (8.3%), showing a high number of regenerating individuals, which is attributed to the seedling bank as described by CHAMI et al. (2011). Populations with high representativeness of individuals in the smaller size
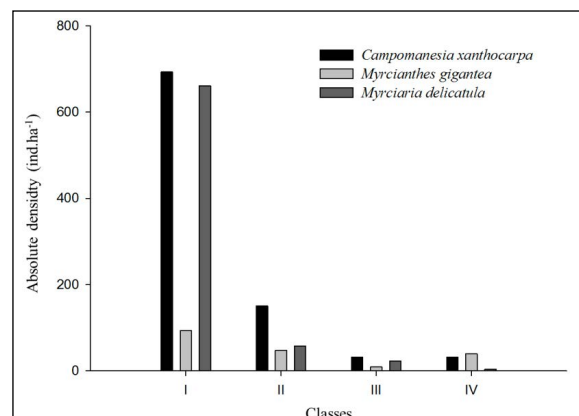

Figure 1 - Frequency distribution divided by size classes for *Campomanesia xanthocarpa*, *Myrcianthes gigantea* and *Myrciaria delicatula* individuals in an Ombrophilous Mixed Forestremnant, São José do Cerrito (SC).

classes are commonly represented by an inverted-J shaped frequency distribution (SCHAAF et al., 2006). This is especially true when considering the species that belong to the secondary or climax ecological group, which use the formation of the seedling bank as an ecological strategy. The inverted-J structure is generally interpreted as a sign of population growth and/or regeneration capacity of the species within the forest (CECCON-VALENTE & NEGRELLE, 2013).

The significant accumulation of *C. xanthocarpa* regenerating individuals in the first class (Class I), followed by a pronounced reduction in the second class, may be related to high mortality rates, considering that the relative density in the second class is 80% lower when compared to the first class. Nonetheless, the density difference in between the two first classes can also be attributed to the time individuals spend in the first class due to the environmental conditions, which can produce a resistance to class transition. The difference may also be due to the high production of fruit and seeds (seed rain), which according to CHAMI et al. (2011) is typical of this species.

The population of *M. gigantea* had 188indha⁻¹, showing higher density for Class I (93 ind.ha⁻¹) with 49.5% of the total individuals. Class II showed reduction of approximately half (25%) of the prior class density (47indiha⁻¹). The third class presented only nine individuals per hectare (4.8%), a value lower than the number of individuals in Class IV, which totaled 39 individuals per hectare (20.7%). Despite the substantial number of adults, which do not fit the inverted-J (Figure 1) frequency distribution, it was observed that the first classes are more abundant than the last ones, indicative of a regeneration bank and self-regenerative potential in the area.

The Ombrophilous Mixed Forest does not commonly present a high number of *M. gigantea* adults (CALLEGARO et al., 2012), which were even described as rare by LEGRAND & KLEIN (1977). Failures in fruit production from one year to the other could have also provoked differences in the life stages of this population, because they are dependent on biotic and abiotic factors that vary randomly. Species that make up the canopy might show some irregular structures, with a scarcity of individuals in intermediate classes, attributed to infrequent recruitment and dependence on certain environmental variables. PILLAR (2003) stated that different patterns of sun exposure can cause variations in population structure, mainly to the contrast generated by northern and southern exposures, as observed in the study site.

Considering all of the studied species, ***Myrciaria delicatula*** was the second most populous with 745indha⁻¹, which were distributed in an inverted-J frequency pattern (Figure 1). This species showed a high number of plants concentrated in Class I, with 661indha⁻¹ (88.7%). Class II density was 58indha⁻¹ (7.8%), which has a reduction of over 90% from the previous class. This high mortality index likely occurred due to the aggregated formation of the seedling bank under the mother plant, which generates a high intraspecific competition. Furthermore, the aggregation of seeds and seedlings close to their matrix plant make them susceptible to a higher mortality rate due to pathogens and specialized herbivores (JANZEN, 1970). The third class had a density of 23indha⁻¹ (3.1%) and likely represents the stage when individuals enter reproductive development, noting that the Class IV contains only one plant (0.4%).

Spatial pattern

Spatial distribution of *C. xanthocarpa* population was found to be aggregated for the majority of the classes (Figure 2). Higher spatial aggregation of individuals in the smaller size classes is commonly found in arboreal species (CONDIT et al., 2000). Nonetheless, it is possible to observe pattern changes in between the different size classes. The aggregated pattern could be a result of microsite spatial variation, showing higher density in patches with better conditions for plant growth and survival. Early on, topography may regulate the population distribution, especially via the amount of solar radiation that reaches the landscape. Furthermore,
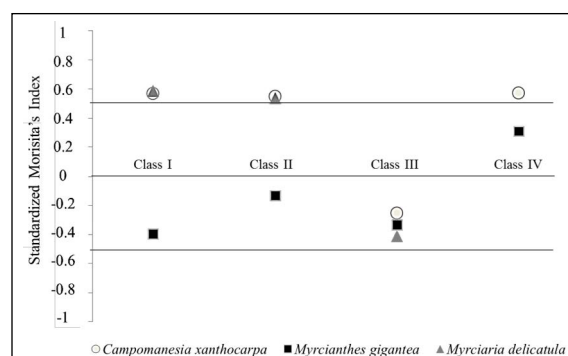

Figure 2 - Spatial distribution according to the Standardized Morisita's Index used in the population classes of three ***Myrtaceae*** species. Values that vary between -0.5 to 0.5 indicate a random distribution; values less than -0.5 indicate a uniform distribution; and values greater than 0.5 indicate an aggregated distribution.

other aspects such as hydric availability and chemical and physical soil properties could also have influenced individuals' distributions.

A random distribution was observed in the **M. gigantea** population for all four classes (Figure 2). This pattern may be linked to the presence of environmental conditions that favor this species' occurrence, since it naturally thrives in humid and shady areas, as it belongs to the late secondary ecological group (CHAMI et al., 2011; CALLEGARO et al., 2012).

The spatial arrangement of this species could also be directly related to seed production and dispersal syndrome. According to VAN DER PIJL (1972), the distribution of propagules promoted by increasing the distance in relation to the source individual (seed shade) reduced the intraspecific competition and the probability of pathogens and predation. In other words the individuals will be less likely to share local processes of equal magnitude (LEGENDRE& FORTIN, 1989), thus there are more isolated distributions.

The population of **M. delicatula** showed a similar behavior to **C. xanthocarpa** (Figure 2)*,* as variations were observed between aggregated and random distribution patterns. The aggregation was mainly seen in the first classes and became random due to population dynamics, especially natural selection. This reduction of aggregation throughout the classes and the life cycle itselfis especially dependent on the density. Once the number of individuals falls, mainly due to intra-specific competition, the aggregation becomes mischaracterized, allowing appearance of a new spatial pattern.

This tendency differs from the study carried out by NASCIMENTO et al. (2001), where the pattern was found to be highly aggregated for individuals with circumference at breast height ≥30cm. Therefore, it is important to emphasize that many behavioral variations are enabled by genetic diversity, which promotes adaptations, allowing organisms to overcome biotic and abiotic adversities and, thus, maintaining the population flow and ensuring the survival of the species.

None of the populations studied showed uniform distribution, which is expected according to BARBOUR et al. (1987), because these distribution patterns are rarely found in natural environments. LEGENDRE & FORTIN (1989) stated that life in general has the tendency to aggregate due to environmental structure and resources availability.

CONCLUSION

Two (**Campomanesia xathocarpa** and **Myrciaria delicatula**) of the three populations studied showed an inverted-J shaped frequency distribution of the size classes. Despite the presence of individuals in every size class in the **Myrcianthes gigantea** population, this species showed overall low density and discrepancies in the frequency distribution and we thus recommend further assessment of this population's dynamics. The continued research would allow for the creation of conservation strategies and, in the long-term, revealed whether there are influences on this species that might intensify demographic decline or initiate a process of phytogeographical advance.

The populations of **C. xanthocarpa** and **M. delicatula** presented, predominantly, an aggregated spatial pattern. The spatial arrangement of all size classes for **M. gigantea** was reported to be random.

REFERENCES

BARBOUR, M.G. et al. **Terrestrial plant ecology**. California: Menlo-Park, 1987. 433p.

BERNARDI, L. Contribución a la dendrologia Paraguaya II. **Boissieria**, v.37, p.75-151, 1985.

CALLEGARO, R.M. et al. Structure of the tree component of a riparian seasonal decidual forest in Jaguari, RS, Brazil. **Ciência Rural**, v.42, p.305-311, 2012. Available from: <http://www.scielo.br/pdf/cr/v42n2/a5212cr5295.pdf>. Accessed: Oct. 23, 2014. doi: 10.1590/S0103-84782012000200019.

CARVALHO, N.M.; NAKAGAWA, J. **Sementes**: ciência, tecnologia e produção. Jaboticabal, São Paulo: FUNEP, 2000. 588p.

CECCON-VALENTE, M.F.; NEGRELLE, R.R.B. **Geonoma gamiova** demography in an area with leaf harvesting. **Ciência Rural**, v.43, p.1218-1222, 2013. Available from: <http://www.scielo.br/pdf/cr/v43n7/a20713cr6425.pdf>. Accessed: Mar. 03, 2014. doi: 10.1590/S0103-84782013000700012.

CHAMI, L.B. et al. Mechanisms of natural regeneration in different environments in the remaining Mixed Rain Forest, São Francisco de Paula, RS. **Ciência Rural**, v.41, p.251-259, 2011. Available from: <http://www.scielo.br/pdf/cr/v41n2/a853cr2730.pdf>. Accessed: Mar. 05, 2015. doi: 10.1590/S0103-84782011000200012.

CLARK, P.J.; EVANS, F.C. Distance to nearest neighbor as a measure of spatial relationship in populations. **Ecology**, v.35, p.445-453, 1954. Available from: <http://onlinelibrary.wiley.com/doi/10.2307/1931034/pdf>. Accessed: Mar. 15, 2015. doi: 10.2307/1931034.

CONDIT, R. et al. Spatial patterns in the distribution of tropical tree species. **Science**, v.288, p.1414-1418, 2000. Available from: <http://science.sciencemag.org/content/288/5470/1414.full-text.pdf+html>. Accessed: Jan. 21, 2015. doi: 10.1126/288.5470.1414.

FAJARDO, C.G. et al. Spatial pattern analysis and demography of two tropical trees in the Brazilian Caatinga. **Pesquisa Florestal Brasileira**, v.34, n.80, p.331-336, 2014.

FORTIN, M.J. et al. Spatial analysis in ecology. In: EL-SHAARAWI, A.H.; PIEGORSCH, W.W. **Encyclopedia of environmetrics**. Chichester: John Wiley & Sons, 2002. p.2051-2058.

FRISCH, J.D.; FRISCH, C.D. **Aves brasileiras e plantas que as atraem**. 3.ed. São Paulo: Dalgas Ecoltec-Ecologia Técnica, 2005. 480p.

GRESSLER, E. et al. Polinização e dispersão de sementes em *Myrtaceae* do Brasil. **Revista Brasileira de Botânica**, v.29, p.509-530, 2006. Available from: <http://www.scielo.br/pdf/rbb/v29n4/01.pdf>. Accessed: Ago. 22, 2014. doi: 10.1590/S0100-84042006000400002.

IBGE (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA). **Manual técnico da vegetação brasileira**: sistema fitogeográfico, inventário das formações florestais e campestres, técnicas e manejo de coleções botânicas, procedimentos para mapeamentos. Rio de Janeiro, 2012. 271p.

JANZEN, D.H. Herbivores and the number of tree species in tropical forests. **American Naturalist**, v.104, p.501-528, 1970. Available from: <http://www.journals.uchicago.edu/doi/pdfplus/10.1086/282687>. Accessed: Mar. 08, 2014 doi: 10.1086/282687.

KÖPPEN, W. **Climatologia con uno estudio de los climas de la tierra**. México: Fondo Cultura Econômica, 1984. 479p.

KREBS, C.J. **Ecological methodology**. Amsterdam, Holland: Addison Wesley, 1999. 620p.

LANDRUM, L.R.; KAWASAKI, M.L. The genera of *Myrtaceae* in Brazil – an illustrated synoptic treatment and identification keys. **Brittonia**, v.49, p.508-536, 1997. Available from: <http://link.springer.com/article/10.2307%2F2807742>. Accessed: Apr. 05, 2015. doi: 10.2307%2F2807742.

LEGENDRE, P.; FORTIN, M.J. Spatial pattern and ecological analysis. **Vegetation**, v.80, p.107-138, 1989.

LEGRAND, C.D.; KLEIN, R.M. Myrtáceas: 17. Myrciaria, 18. Pseudocaryophyllus, 19. Blepharcalyx, 20. Espécies suplementares. 21. Espécies cultivadas, 22. Generalidades: chave dos gêneros. Concepto geral das Mirtácea. In: REITZ, P.R. **Flora ilustrada catarinense**. Itajaí: Herbário Barbosa Rodriques, 1978. p.730-876.

LEGRAND, C.D.; KLEIN, R.M. Myrtáceas: 8. Campomanesia, 9. Feijoa, 10. Briota, 11. Myrrhinium, 12. Hexachlamys, 13. Siphoneugena, 14. Myrcianthes, 15. Neomitranthes, 16. Psidium. In: REITZ, P.R. **Flora ilustrada catarinense**. Itajaí: Herbário Barbosa Rodriques, 1977. p.572-730.

LINDENMAIER, D.; BUDKE, J.C. Florística, diversidade e distribuição espacial das espécies arbóreas em uma floresta estacional na bacia do rio Jacuí, sul do Brasil. **Pesquisas Botânica**, v.57, p.193-216, 2006.

LORENZI, H. **Árvores brasileiras**: manual de identificação e cultivo de plantas arbóreas nativas do Brasil. Nova Odessa: Instituto Plantarum, 2002. ISBN 85-86714-14-3.

MCVAUGH, R. The tropical American *Myrtaceae* – An interim report. **Taxon**, v.17, p.354-418, 1968.

NASCIMENTO, A.R.T. et al. Structure and spatial distribution patterns of tree species in a Mixed Ombrophylous forest sample in Nova Prata, RS. **Ciência Florestal**, v.11, p.105-119, 2001. Available from: <http://coral.ufsm.br/cienciaflorestal/artigos/v11n1/art10v11n1.pdf>. Accessed: Dec. 10, 2014. doi: 10.5902/19805098.

NGUYEN, H. et al. Spatial patterns and demographics of *Streblus macrophyllus* trees in a tropical evergreen forest, Vietnam. **Journal of Tropical Forest Science**, v.26, n.3, p.309-319, 2014.

PANDOLFO, C. et al. **Atlas climatológico digital do Estado de Santa Catarina**. Florianópolis: Epagri, 2002. 182p.

PILLAR, V.D. Dinâmica de expansão florestal em mosaicos de floresta e campos no sul do Brasil. In: CABIDO, M. **Ecossistemas brasileiros**: manejo e conservação. Fortaleza: Expressão Gráfica e Editora, 2003. p.209-216.

PIZO, M.A. Seed deposition pattern and survival of seeds and seedlings of two Atlantic Forest *Myrtaceae* species. **Revista Brasileira de Botânica**, v.26, p.371-377, 2003. Available from: <http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0100-84042003000300010>. Accessed: Jan. 22, 2015. doi: 10.1590/S0100-84042003000300010.

R DEVELOPMENT CORE TEAM, **R**: a language and environment for statistical computing. Vienna, Austria: the R Foundation for Statistical Computing, 2010. ISBN: 3-900051-07-0.

SCHAAF, L.B. et al. Diametric structure changes in ombrophyllous mixed forest between 1979 and 2000. **Revista Árvore**, v.30, p.283-295, 2006. Available from: <http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0100-67622006000200016>. Accessed: Jan. 22, 2015. doi: 10.1590/S0100-67622006000200016.

SOBRAL, M. et al. *Myrtaceae*. In: **Lista de espécies da flora do Brasil**. Rio de Janeiro: Jardim Botânico do Rio de Janeiro, 2015.

THE PLANT LIST. **A working list of all plant species**. 2013. Available from: <http://www.theplantlist.org/>. Accessed: Feb. 15, 2015.

VAN DER PIJL. **Principles of dispersal in higher plants**. New York: Springer-Verlag, 1972. 215p.

VOLPATO, M.M.L. **Regeneração natural em uma floresta secundária no domínio de Mata Atlântica**: uma análise fitossociológica. 1994. 123f. Dissertação (Mestrado em Ciência Florestal) - Universidade Federal de Viçosa, Viçosa, MG.