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MYRTACEAE NO SUL DA MATA ATLÂNTICA: A FLORA ALTOMONTANA DO PARQUE NACIONAL DE SÃO JOAQUIM, RELAÇÕES FLORÍSTICAS E CONDICIONANTES GEOCLIMÁTICOS

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Este trabalho é dedicado aos meus pais
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"There is no such thing as purely *objective* observation. Your observation, to be interesting, *i.e.* to be significant, must be *subjective*. The sum of what the writer of whatever class has to report is simply some human experience, whether he be poet or philosopher or man of science. The man of most science is the man most alive, whose life is the greatest event. Senses that take cognizance of outward things merely are of no avail. It matters not where or how far you travel, - the farther commonly the worse, - but how much alive you are.

(Henry David Thoreau)

RESUMO

A Mata Atlântica é um dos domínios mais importantes do País por conter grande biodiversidade e estar sujeita a pressões antrópicas. Myrtaceae é uma das famílias de espécies arbóreas mais ricas deste domínio. A Mata Atlântica é dividida biogeograficamente em duas regiões: uma norte e uma sul. O Parque Nacional de São Joaquim está dentro do domínio da Mata Atlântica na porção sul e é constituído por florestas pluvial e nebular, latifoliada, mista lati-aciculifoliada e campos de altitude. O objetivo deste trabalho foi descrever a flora de Myrtaceae na parte altomontana do Parque Nacional de São Joaquim e comparar as composições florísticas de Myrtaceae em diferentes áreas da região sul da MA e os fatores geoclimáticos que podem influenciar a distribuição das espécies. Foram apresentadas descrições, ilustrações e chave de identificação para as espécies de Myrtaceae encontradas no Parque Nacional de São Joaquim. A partir de uma base de dados de presença e ausência de 254 espécies de Myrtaceae em 42 áreas compilada a partir da literatura foram feitas análises de dissimilaridade de Jaccard e análise multivariada de ordenação (RDA). Um Teste de Mantel foi feito para avaliar a autocorrelação espacial e um Teste de Moran para avaliar a autocorrelação espacial e riqueza de espécies. Para as áreas altomontanas do Parque Nacional de São Joaquim sete gêneros e 16 espécies de Myrtaceae foram registrados. Na porção sul da MA a composição de Myrtaceae varia grandemente de uma área para outra, com alta porcentagem de espécies restritas geograficamente e baixa porcentagem de espécies comuns entre áreas. Há uma diferenciação na composição específica de Myrtaceae relacionada à altitude. O clima tropical ou subtropical também influencia a composição de espécies de Myrtaceae. Os principais preditores da variação específica em Myrtaceae no sul da Mata Atlântica foram: altitude, precipitação do mês mais chuvoso, sazonalidade da temperatura e distância do Oceano Atlântico.

Palavras-chave: Myrtaceae. Mata Atlântica. Região Neotropical. Florística. Flora. Análise multivariada. Fatores geoclimáticos.

ABSTRACT

The Atlantic Forest is one of the most important domains in Brazil for having great biodiversity and being threatened by anthropic pressures. Myrtaceae is one of the families of arboreal species that are richest in this domain. The Atlantic Forest is divided biogeographically in two regions: one north and one south. The Parque Nacional de São Joaquim is part of the Atlantic Forest Domain and is constituted by rain and cloud broadleaved and mixed needle and broadleaved forest and highland grasslands. The objective of this work was to describe the flora of Myrtaceae in the upper highlands of Parque Nacional de São Joaquim and to compare the floristic composition of Myrtaceae of different areas in the southern region of the Atlantic Forest and the geoclimatic variables influencing it. Descriptions, illustration and identification keys of the Myrtaceae species found in the upper highlands of Parque Nacional de São Joaquim were presented. Jaccard dissimilarity analysis and multivariate ordination analysis (RDA) were performed with data of presence and absence of 254 species of Myrtaceae in 42 areas compiled from the literature available. A Mantel Test was performed to evaluate spatial autocorrelation and a Moran Test to evaluate the spatial autocorrelation and species richness. Seven genera and 16 species were registered for Parque Nacional de São Joaquim. Myrtaceae composition varies greatly from one area to another in the south of the Atlantic Forest. There is a high percentage of species restricted geographically and a low percentage of common species. There is a difference in specific composition of Myrtaceae related to altitude. The separation between the tropical and subtropical region affects the presence and absence of Myrtaceae species. The main predictors of the specific variation in Myrtaceae in the south of the Atlantic Forest were: altitude, precipitation of the wettest month, temperature seasonality and the distance from the Atlantic Ocean.

Keywords: Myrtaceae. Atlantic Forest. Neotropics. Neotropic Region. Floristic analysis. Flora. Multivariate analysis. Geoclimatic factors.

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INTRODUÇÃO

A Mata Atlântica é altamente rica em espécies e contém elevado endemismo, são 15.001 espécies nativas de plantas com semente das quais 7.432 são endêmicas (BRAZIL FLORA GROUP 2015). Este domínio fitogeográfico foi considerado internacionalmente como um *hotspot* mundial de biodiversidade (MYERS et al. 2000). Originalmente a Mata Atlântica (deste ponto em diante chamada de MA) ocupava uma área de cerca 1.363.000 km^2, 15% do território nacional, e estendia-se ao longo de 3.300 km da costa brasileira (HIROTA 2005). A sua largura varia ao longo de sua extensão, na porção sul pode alcançar o leste do Paraguai e o nordeste da Argentina. Porém seus hábitats têm sido destruídos por pressões antrópicas desde a colonização do Brasil (VIANA & TABANEZ 1996). Perto de 92% da área original da MA foi destruída e somente aproximados 100.000 km^2 permanecem (HIROTA 2005). A biodiversidade ainda remanescente dessa formação vegetal importante necessita ser melhor estudada para que ações adequadas para sua conservação sejam propostas. O domínio da MA inclui todas as formações florestais entre as florestas pluviais da costa e o corredor de formações secas do interior, Cerrado, Caatinga e Chaco (EISENLOHR & OLIVEIRA-FILHO 2015). Além das formações florestais, também é composta por maguezais e restingas, campos de altitude, e afloramentos rochosos (FIASCHI & PIRANI 2009).

Existem as seguintes fisionomias altomontanas diferentes na MA, as florestas pluvial e nebular latifoliadas e mistas lati-aciculifoliadas (IBGE 2012; a nomenclatura dos tipos de vegetação seguem OLIVEIRA-FILHO 2009). No Sul do Brasil segundo o IBGE (2012) as florestas altomontanas encontram-se acima de 1.000 m. A floresta mista lati-aciculifoliadas (Mata com *Araucaria*) ocorre atualmente no Planalto Meridional em lugares como o Parque Nacional dos Aparados da Serra, na divisa do Rio Grande do Sul e Santa Catarina, e na crista do Planalto no Parque Nacional de São Joaquim em Santa Catarina, mas apresenta disjunções florísticas nas Serras do Mar e da Mantiqueira (IBGE 2012). O primeiro capítulo do presente trabalho concentra-se nas áreas altomontanas do PNSJ pela falta de acesso às áreas mais baixas do PNSJ e também pela realidade do tempo hábil de dois anos para desenvolver uma dissertação de mestrado. É possível que se fosse desenvolvido o projeto para as Myrtaceae de todo o PNSJ, dois anos não fosse tempo suficiente pela alta quantidade de espécies.

Em muitos trabalhos abordando a composição florística da MA, Myrtaceae aparece como a família mais rica ou uma das mais ricas, com maior número de espécies arbóreas (FALKENBERG 2003; FALKENBERG & VOLTOLINI 1995; KOEHLER et al. 2002; MARTINI et al. 2007; PEREIRA-SILVA et al. 2007; MEIRELES et al. 2008; MARTINS-RAMOS et al. 2011; HIGUCHI et al. 2012). Em vários desses estudos observa-se a presença de espécimes indeterminadas de Myrtaceae, pois a família é considerada difícil na identificação, com espécies muito parecidas entre si. Daí surge a necessidade de conhecer melhor esta família abundante na MA, com trabalhos de descrição da flora de Myrtaceae.

Bünger et al. (2014) comparou a composição das espécies de Myrtaceae em diferentes localidades na Cadeia do Espinhaço e as variáveis geoclimáticas que influenciam essa distribuição. Até o presente não existem estudos parecidos sobre Myrtaceae no sul da MA. Compreender a variação na composição florística de espécies de Myrtaceae através do espaço geográfico aprofunda o conhecimento de padrões fitogeográficos na família recentes e passados (GENTRY 1982; PRANCE 1982 OLIVEIRA-FILHO & FONTES 2000; EISENLOHR & OLIVEIRA-FILHO 2015). Estudos sobre a distribuição geográfica das espécies quando conectados a estudos filogenéticos são importantes para o entendimento dos padrões biogeográficos (FIASCHI & PIRANI 2009). Um padrão biogeográfico observado é uma diferenciação biótica na MA que separa o domínio em dois setores: norte e sul, de acordo com análise parcimoniosa de endemismo (BATES et al. 1998; COSTA et al. 2000).

Os principais fatores geoclimáticos que influenciam a composição florística da MA são a sazonalidade das chuvas, temperatura e altitude (OLIVEIRA-FILHO & FONTES 2000). O número de dias com geada por ano parece ter influência na composição florística das matas nebulares e outras variáveis como evapotranspiração potencial e distância do Oceano Atlântico também ajudam a compreender variações na composição florísticas dentro deste domínio (EISENLOHR & OLIVEIRA-FILHO 2015).

1.1 OBJETIVOS

- Descrever a flora de Myrtaceae das regiões altomontanas do Parque Nacional de São Joaquim e apresentar ilustrações, chave de identificação e comentários. Contribuir para o conhecimento da flora do Parque.

- Comparar a composição florística de espécies de Myrtaceae entre localidades na porção sul da MA e buscar quais fatores geoclimáticos estão relacionados à variação de espécies.

CAPÍTULO I

Myrtaceae in the upper highlands of Parque Nacional de São Joaquim (Santa Catarina – Brazil)

Myrtaceae in the upper highlands of Parque Nacional de São Joaquim (Santa Catarina – Brazil)

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Resumo

Muitos trabalhos sobre a composição florística da Mata Atlântica mostram que Myrtaceae é a família mais rica ou uma das mais ricas em número de espécies. No sul do Brasil Myrtaceae está presente nas formações florestais principalmente, nas florestas pluviais latifoliadas e mistas lati-aciculifoliadas (Mata com *Araucaria*) e nas florestas estacionais semi-deciduais. O objetivo desse estudo foi realizar o tratamento florístico das espécies de Myrtaceae encontradas no Parque Nacional de São Joaquim, com o intuito de contribuir para o conhecimento de sua flora. Foram registrados sete gêneros e 16 espécies de Myrtaceae: *Acca* (1 sp.), *Blepharocalyx* (1 sp.), *Eugenia* (1 sp.), *Myrceugenia* (9 spp.), *Myrcia* (2 spp.), *Myrrhinium* (1 sp.) e *Siphoneugena* (1 sp.). São apresentadas descrições, ilustrações, chave de identificação para as espécies encontradas e comentários sobre gêneros e espécies.

Abstract

Many works that address the floristic composition of the Atlantic Forest show that Myrtaceae is the richest or one of the richest families in number of arboreal species. In Southern Brazil, Myrtaceae is present mainly in forest formations, in the rain and cloud broadleaf and mixed kneedle and broadleaf forests, and seasonal semi-deciduous forests. The objective of this study was to survey the Myrtaceae of Parque Nacional de São Joaquim, in order to contribute with the knowledge of its flora. It was found seven genera and 16 species of Myrtaceae: *Acca* (1 sp.), *Blepharocalys* (1 sp.), *Eugenia* (1 sp.), *Myrceugenia* (9 sp.), *Myrcia* (2 sp.), *Myrrhinium* (1 sp.) and *Siphoneugena* (1 sp.). Descriptions, illustrations, identification key and commentaries were presented about genera and species.

Introduction

Myrtaceae encompasses 142 genera and more than 5500 species (Wilson 2011). Today Myrtaceae presents a pantropical distribution with extension to subtropical and temperate zones, however the family occurs predominantly on the Southern Hemisphere (Thornhill *et al.* 2015). Important characteristics of Myrtaceae are flaky bark, simple trichomes with one or two cells, leaves with entire margins that contain sparse pellucid glands, half inferior to inferior ovaries, usually numerous stamens, internal phloem vestured pits on the xylem vessels and the presence of terpenes as secondary metabolites (Wilson *et al.* 2001).

According to Wilson *et al.* (2005) Myrtaceae is constituted by two subfamilies, Psiloxyloideae (with two genera, *Psiloxylon* Thouars. ex Tul. and *Heteropyxis* Harv.) and Myrtoideae (with all remaining Myrtaceae genera). Myrtoideae is composed of 15 tribes. One of these tribes is Myrteae, which includes all the neotropical species in the family, with exception of the Chilean *Metrosideros stipularis* (Hook. & Arn.) Hook. f. from Metrosidereae (McVaugh 1968; Lucas *et al.* 2005). Myrteae is comprised of exclusively fleshy fruited Myrtaceae, with 49 genera and *c.* 2500 species (Lucas *et al.* 2007). Candolle (1826) sudivided Myrteae based on embryo characteristics. These subgroups were treated by Berg (1855, 1856a, 1856b, 1857, 1858, 1859) as subtribes that today are recognized as: Myrtinae O.Berg, Myrciinae O.Berg and Eugeniinae O.Berg. However these subtribes are artificial and many genera do not fit this classification (McVaugh 1968). A phylogenetic analysis of Myrteae by Lucas *et al.* (2005) concluded that the tribe itself and the subtribe Myrciinae are monophyletic (that is Myrciinae is monophyletic when removing *Myrceugenia*), while subtribes Eugeniinae and Myrtinae are polyphyletic. Seven clades were proposed by Lucas *et al.* (2007) in Myrteae but formal suprageneric categories have not yet been established.

In Brazil Myrtaceae is represented by 23 genera and 1032 species (Sobral *et al.* 2016). In many works that address the floristic composition of the Atlantic Forest, Myrtaceae appears as the richest or one of the richest families in number of arboreal species (e.g. Falkenberg & Voltolini, 1995; Koehler *et al.* 2002; Falkenberg, 2003; Martini *et al.* 2007; Pereira-Silva *et al.* 2007; Meireles *et al.* 2008; Martins-Ramos *et al.* 2011; Higuchi *et al.*, 2012). In the *Inventário florístico florestal de Santa Catarina*, Myrtaceae appears as the second richest family in the *Araucaria* forest (Gasper *et al.* 2013).

Legrand & Klein (1967, 1969a, 1969b, 1970, 1971a, 1971b, 1972, 1977, 1978) in their monograph of Myrtaceae for the *Flora Ilustrada de Santa Catarina (FIC)* concentrated on a general approach for the entire state, the upper highlands of Parque Nacional de São Joaquim were not explored with a more intense effort. Mattos (1957) did an inventory of the Myrtaceae species from the city of São Joaquim in Santa Catarina.

Tropical and subtropical highland forests are ecosystems that deserve to be studied in depth. Tropical highlands cloud forests are one of the world's most threatened ecosystems (Hamilton *et al.* 1995) The objective of this study was to survey the Myrtaceae of the upper highland areas (above 1000 m) of Parque Nacional de São Joaquim (PNSJ), presenting descriptions, illustrations, an identification key to species and commentaries about the morphological variation within species and similarities and differences between species, geographic distribution, habitat and phenology. The overall goal is to contribute to the knowledge of PNSJ's flora.

Material and Methods

Study Area

Parque Nacional de São Joaquim (28º03'-18'S, 49º20'-39'W) comprises 49,300 ha situated in the municipalities of Urubici, Bom Jardim da Serra, Orleans and Grão Pará, in Santa Catarina, Brazil. It was created in 1961 to preserve the *Araucaria* forests that were in an intense process of destruction by the exploration of timber. The vegetation types in Parque Nacional de São Joaquim are rain and cloud broadleaf and mixed kneedle and broadleaf (*Araucaria* forests) lower highland, highland and upper highland forests, and highland grasslands (Alarcon & Silva, 2007). The terrain is formed by basalt and sandstone formations (Ministério do Meio Ambiente 2016). The headwaters of important rivers of Santa Catarina like Canoas, Pelotas and Tubarão are located at PNSJ, which is a loading and unloading area of the aquifer Guarani. The average yearly temperature is 12ºC (Ministério do Meio Ambiente, 2016). The climate in the region according to the Köppen-Geiger classifications is Cfa subtropical humid, oceanic without a dry season, with hot summers (Peel *et al.* 2007). The minimum altitude is 300 m.a.s.l. and the maximum altitude is 1,826 m.a.s.l. (Ministério do Meio Ambiente 2016).

Methodology

Five expeditions for collecting specimens were performed between July 2014 and February 2015. The specimens were deposited in the Herbarium FLOR. In addition to specimens collected for the present study, materials from FURB, HAS, HBR, ICN, MBM, PACA, RB, SPF, and UPCB (herbaria acronyms according to Thiers, continuously updated) were also analysed. Species descriptions were based on specimens collected by the authors and other collectors in the area of study, and when these were insufficient, additional specimens from other areas were analysed, and included under specimens analysed. The morphological terminology follows Radford (1976) and taxonomic works specific for the family (Landrum & Kawasaki, 1997; Landrum, 1981, 1986). The description of genera was based on specific literature of the group and on specimens collected (Landrum & Kawasaki, 1997; Landrum, 1981, 1986).The names of the species and genera followed the most recent synonyms used by Sobral *et al.* (2015).

Flower pedicels were measured from the point of insertion in the twig or inflorescence peduncle and the base of the hypanthium. The inflorescence peduncle was measured for the point of insertion in the twig to where the inflorescence begins to branch. The hypanthium was measured from the base to the summit of the ovary.

Results and Discussion

Seven genera and 16 species of Myrtaceae were found in the upper highlands of Parque Nacional de São Joaquim: *Acca* O.Berg (1 sp.), *Blepharocalyx* O.Berg (1 sp.), *Eugenia* L. (1 sp.), *Myrceugenia* O.Berg (9 spp.), *Myrcia* DC. (2 sp.), *Myrrhinium* Schott (1 sp.) and *Siphoneugena* O.Berg (1 sp.).

The Myrtaceae genus with the highest number of species in PNSJ, *Myrceugenia*, usually grows on moderately cool, wet climates in temperate and subtropical areas of South America (Landrum 1981). Giehl and Jarenkow (2012) found diversification higher than expected by chance for Myrtaceae and Myrceugenia in the subtropics. The subtropical climate of PNSJ and the conditions that the high altitude provides of cooler temperatures and high humidity seem to contribute to the high diversity of *Myrceugenia* in PNSJ. In Brazil, *Myrceugenia* occurs mostly along the eastern edge of the *Planalto Meridional* and along the coast from Rio de Janeiro to Porto Alegre (Landrum 1981).

The species *Myrceugenia hamoniana* is considered endangered to be extinct (CNCFLORA 2016).

The majority of Myrtaceae species found in PNSJ are distributed through Southern and Southeastern Brazil, however, *Blepharocalyx salicifolius* O.Berg presents a wide distribution throughout the South, Southeast, Northeast, and Center-West of Brazil (Sobral *et al.* 2016)

Vieira (2010) surveyed the Myrtaceae of upper highlands of Serra do Quiriri in Garuva, in the north of Santa Catarina. The author registered the occurrence of 10 genera and 26 species of Myrtaceae: *Myrceugenia* (7 spp.), *Myrcia* (7 spp.), *Eugenia* (4 spp.), *Psidium* L. (2 spp.), *Siphoneugena* (1 sp.), *Blepharocalyx* (1 sp.), *Calyptranthes* Sw. (1 sp.), *Myrciaria* O.Berg (1 sp.), *Pimenta* Lindl. (1 sp.), and *Plinia* L (1 sp.). So the genus with higher number of species in Serra do Quiriri was also *Myrceugenia*. The genera *Calyptranthes, Myrciaria, Pimenta, Psidium* and *Plinia* were not registered for the upper highlands of PNSJ. Serra do Quiriri is located in the southern portion of Serra do Mar and the upper highlands of PNSJ are situated on the Serra Geral. In Table I there is a comparision of the species composition of Myrtaceae between the upper highlands of Serra do Quiriri and the upper highlands of Parque Nacional de São Joaquim.

Myrceugenia hamonina (Mattos) Sobral found in this study was not present in the *FIC*, all the other species are treated in the *FIC*, yet some with a synonym different than the one used in the present study. Mattos (1957) in his study about the Myrtaceae of the municipality of São Joaquim recorded species that were not recorded in the present study. Other species recorded in the present study that were not registered by Mattos were: *Eugenia handroi* (Mattos) Mattos, *Myrceugenia acutata* D.Legrand, *M. hamoniana*, *M. miersiana* (Gardner) D.Legrand & Kausel, *M. pilotantha* (Kiaersk) L.R. Landrum and *Myrcia aethusa* (O.Berg) N. Silveira. In the time of Mattos' study part of PNSJ was still within the limits of São Joaquim municipality. In the present days, Parque Nacional de São Joaquim is no longer in the territory of the municipality. Urubici and Bom Jardim da Serra were separated from São Joaquim later in 1957 and in 1962, respectively. The Park's territory that was in São Joaquim now lies in Urubici and Bom Jardim da Serra. Part of São Joaquim's terrritory is bellow 1,000 m, which might explain the differences in species registered.

Table I: Species of Myrtaceae that are shared between the upper highlands of Serra do Quiriri (Vieira, 2010) and the upper highlands Parque Nacional de São Joaquim, species that were only registered for the upper highlands of Serra do Quiriri, and that were only registered for the upper highlands of PNSJ.

PNSJ and Serra do Quiriri	**Serra do Quiriri**	**PNSJ**
Blepharocalyx salicifolius O.Berg	*Calypthranthes concinna* DC.	*Acca sellowiana* (O.Berg) Burret
Myrceugenia alpigena (DC) Landrum	*Eugenia neomyrtifolia* Sobral	*Eugenia handroi* (Mattos) Mattos
Myrceugenia hamoniana (Mattos) Sobral	*Eugenia nutans* O.Berg	*Myrceugenia acutata* D.Legrand,
Myrceugenia myrcioides (Cambess.) O.Berg	*Eugenia pluriflora* DC.	*Myrceugenia euosma* (O.Berg)
Myrceugenia pilotantha (Kiaersk.) Landrum	*Eugenia sclerocalyx* D.Legrand	*Myrceugenia miersiana* (Gardner) D.Legrand
Myrceugenia regnelliana (O.Berg) D.Legrand & Kausel	*Myrceugenia rufescens* (DC.) D.Legrand & Kausel	*Myrceugenia oxysepala* (Burret) D.Legrand & Kausel
Myrcia aethusa (O.Berg) N.Silveira	*Myrceugenia seriatoramosa* (Kiaersk.) D.Legrand & Kausel	*Myrrhinium atropurpureum* Schott.
Myrcia hartwegiana (O.Berg) Kiaersk.	*Myrcia guianensis* (Aubl.) DC.	
Siphoneugena reitzii D.Legrand.	*Myrcia lajeana* D.Legrand	
	Myrcia pulchra (O.Berg) Kiaersk.	
	Myrcia rupicula D.Legrand	
	Myrcia squamata (Mattos & D.Legrand) Mattos	
	Myrciaria delicatula DC. O.Berg	
	Pimenta pseudocaryophyllus (Gomes) Landrum	
	Plinia cordifolia (D.Legrand) Sobral	
	Psidium cattleianum Sabine	
	Psidium ovale (Spreng.) Burret	

Identification key to the species of Myrtaceae from Parque Nacional de São Joaquim

1. Leaf blades narrowly elliptic (Fig. 5h); calyx closed on the bud; hypanthium prolonged forming a tubular structure with the calyx, spliting along a circunference on the apex of the ovary (Fig. 5g), leaving a circular scar on the fruit (Fig. 5i)... 7.1 *Siphoneugena reitzii*

1'. Leaf blades elliptic, obovate, ovate, lanceolate, oblanceolate and obtrullate, and if narrowly elliptic it appears combined with these other shapes; calyx open on the bud; calyx usually starting at the apex of the ovary where the hypanthium ends; calyx usually persistent on the fruit.

2. Petals fleshy; Stamens red, filaments stiff (Fig. 1a; 2a).

3. Leaf blades ovate or obovate (Fig. 1a), adaxially sparsely pubescent to lanuginose, abaxially lanuginose; solitary flower (Fig. 1a); petals 2.1-2.2 x 1.8-2.1 cm; Stamens 60-90…….. 1.1 *Acca sellowiana*

3'. Leaf blades narrowly elliptic, glabrous on both surfaces; inflorescence dichasium, solitary or aggregated in a bracteate shoot; petals *c.* 0.5 x 0.4 cm; stamens 4-8 (Fig. 5f)…… 6.1 *Myrrhinium atropurpureum*

2'. Petals laminar; Stamens white or cream-coloured, filaments flexible (Fig. 1f).

4. Inflorescence a fascicle (Fig. 1f), a dichasium or a panicle (Fig 1b, 5a, 5d).

5. Young twigs cylindrical; leaf blades ovate or elliptic, apex acute or obtuse, base cunneate; Inflorescence a fascicle; fruits 1-2.3 cm in diameter (Fig. 1g-h, 2d)…….. 3.1 *Eugenia handroi*

5'. Young twigs flattened; leaf blades lanceolate, narrowly elliptic (Fig. 1c-d), obovate, elliptic (Fig. 5c), apex obtuse, rounded or acuminate and caudate, base attenuate

to cunneate; inflorescence dichasium or panicle; fruit 0.4-0.8 cm in diameter.

6. Young twigs glabrous; leaf blades lanceolate, apex acuminate and caudate (Fig. 1c-d, 2c); ovary with *c.* 10 ovules per locule…. 2.1 *Blepharocalyx salicifolius*

6'. Young twigs pubescent to densely pubescent; leaf blades lanceolate, narrowly elliptic, elliptic, or obovate (Fig. 5c); ovary with 2-3 ovules per locule.

7. Leaf blades lanceolate or narrowly elliptic; inflorescence one dichasium or a panicle (Fig. 5a); bracteoles lanceolate; thecal arrangement with pollen sacs at the same level; ovary 3-locular..... 5.1 *Myrcia aethusa*

7'. Leaf blades obovate or elliptic; inflorescences panicle; bracteoles trullate; thecal arrangement with pollen sacs at slightly different levels (Fig. 5b); ovary 2-locular…… 5.2 *Myrcia hartwegiana*

4'. Solitary flowers.

8. Leaf blades mostly obovate (Fig. 3f, 4n), rarely elliptic, adaxially glabrous; flower pedicel 1-2 mm long (Fig. 3g); calyx lobes and bracteoles resemble each other, bracteoles lanceolate (Fig. 3g, 4n), 4-7 mm long, calyx lobes lanceolate or triangular, *c.* 4 mm long…….. 4.7 *Myrceugenia oxysepala*

8'. Leaf blades elliptic, narrowly elliptic, oblanceolate, rarely obovate, adaxially with very few scattered trichomes to pubescent throughout the blade or sparsely pubescent along the midrib; flower pedicel 2-15 mm long; calyx lobes and bracteoles do not resemble each other, bracteoles 0.9-5 mm long, calyx lobes 1.4–6 mm long.

9. Leaf blades mostly obtrullate (Fig. 2h, 4d), sometimes obovate (Fig. 4e), oblanceolate (Fig.

4f) or narrowly elliptic; bracteoles deltate or very widely ovate (Fig. 4g).. 4.2 *Myrceugenia alpigena*

9'. Leaf blades elliptic, narrowly elliptic, obovate, never obtrullate; bracteoles ovate, triangular, narrowly triangular or lanceolate.

10. Calyx lobes exceed the globe of petals in bud (Fig. 4i), calyx lobes usually 1.2-2 times as long as wide.

11. Leaf blade apex acuminate or acute; trichomes throughout the plant only dibrachiate; flower pedicel 5-15 mm long.

12. Petioles 1.1-2 mm long; leaf blades 1.3-2 x 0.4-0.6 cm, narrowly elliptic (Fig. 2j), one flower on the axil of leaves (Fig. 2j-l), buds *c.* 4 x 2-3 mm; bracteoles ovate or lanceolate, *c.* 2 x 1-1.5 mm; ovaries 2-locular…… ……. 4.3 *Myrceugenia euosma*

12'. Petioles 3-6 mm long; leaf blades 3.5-11 x 1.5-3.6 cm, obovate or elliptic (Fig. 3b-c), flowers 1-3 on the axil of leaves; buds 5-9 x 3-9 mm (Fig. 3e); bracteoles lanceolate (Fig. 4l), narrowly triangular or triangular, 2.2-5 x 0.7-3 mm; ovaries 3-4 locular (Fig. 4m)..... ..... 4.6 *Myrceugenia myrcioides*

11'. Trichomes throughout the plant simple and dibrachiate; leaf blade apex acute or obtuse, never acuminate; pedicel 3-5 mm long.

13. Trichomes yellowish to golden-brown, nearly all simple but some

dibrachiate, appressed or erect; leaf blades with trichomes tortuous and erect abaxially, secondary and intramarginal veins distinctly prominent (Fig. 4k)……..... ..... 4.5 *Myrceugenia miersiana*

13’. Trichomes reddish-brown, simple and dibrachiate, only appressed; leaf blades with trichomes slightly tortuous, usually appressed abaxially, secondary and intramarginal veins impressed..... ..... 4.8 *Myrceugenia pilotantha*

10’. Calyx lobes shorter than the globe of petals in bud (Fig. 4a), calyx lobes usually 0.8-1 time as long as wide.

14. Young twigs distinctly flattened; leaf blades 2.6-4.6 x 1-1.6 cm (Fig. 4b-c); pedicel glabrous, 11-23 mm long; bracteoles glabrous; calyx lobes 1.4-1.7 mm long…… 4.1 *Myrceugenia acutata*

14’. Young twigs flattened to cylindrical; leaf blades 0.7-2.3 x 0.2-1.2 cm; pedicel sparsely pubescent to pubescent, 2-13 mm long; bracteoles pubescent; calyx lobes 1.2-1.4 mm long.

15. White and golden-brown trichomes throughout the plant, appressed; petioles 1.3-1.9 x 0.3-0.5 mm; leaf blades narrowly elliptic (Fig. 3a, 4j), 3-6 times as long as wide, apex acute or obtuse; pedicel 2.4-3.4 mm long; bracteoles lanceolate; calyx lobes deltate with rounded apex, *c.* 1.2

times as long as wide…… …… 4.4 *Myrceugenia hamoniana*

15’. White and reddish-brown trichomes throughout the plant, some erect, some appressed; petioles 1.7-2.7 x 0.6-0.9 mm; leaf blades elliptic (Fig. 4p-q) or obovate, *c.* 1.9 times as long as wide, apex acuminate to acute; pedicel 2-13 mm long, bracteoles ovate; calyx lobes very widely ovate or shallowly deltate, 0.8-1.2 times as long as wide 4.9…… …….. *Myrceugenia regnelliana*

1. ***Acca*** O.Berg, Linnaea 27: 138. 1856.

Shrubs or trees. Trichomes simple, often tortuous. Flowers solitary or a three flower dichasium, sometimes aggregated in bracteate shoots; calyx lobes 4, sub-circular or oblong; petals reddish to pink, fleshy when mature; bracteoles persistent or caducous; stamens 60-90, stiff, dark red; locules 2-4, 6-60 ovules per locule. Fruit a globose or ellipsoidal berry; seeds several; Embryo myrtoid.

Acca comprises three species, with two of them occurring in the Peruvian Andes, and one species in Brazil: *Acca sellowiana* (O.Berg) Burret. This species occurs throughout all three states of Southern Brazil (Paraná, Santa Catarina and Rio Grande do Sul) (Landrum & Kawasaki 1997).

1.1 ***Acca sellowiana*** (O.Berg) Burret, Repert. Spec. Nov. Regni. Veg. 50: 59. 1941.

Fig. 1a; 2a.

Shrubs or trees, 1.9-4 m high. Young twigs flattened, sparsely pubescent to lanuginose. Trichomes white, tortuous or straight, appressed or erect. Petioles 4.3-6.4 x 0.9-1.5 mm, canaliculate, pubescent adaxially; leaf blades 3.1-4.7 x 1.6-2.8 cm, ovate or obovate, chartaceous to subcoriaceous, dark green to dark brownish-green adaxially, lighter shade of green or brownish-green abaxially, adaxially pubescent along the midrib, sparsely pubescent throughout the blade, lanuginose when young, abaxial surface lanuginose; base cuneate, apex obtuse or rounded; midrib canaliculate adaxially, prominent abaxially, secondary veins 5 to 8 pairs, brochidodromous, impressed adaxially, slightly prominent abaxially, intramarginal vein 1.4-1.9 mm from the margin. Flowers solitary, pedicel 10-13 x 1.2-1.7 mm, with scattered trichomes to lanuginose; buds 11.1-14.6 x 1-10 mm, lanuginose; bracteoles 3-3.7 x 0.6-1.1 mm, lanceolate, persistent; hypanthium 9.2-10 x 4.5-4.8 mm, lanuginose, cotyliform; calyx open in bud, imbricate, calyx lobes 5.3-8.5 x 5.6-7.7 mm, very widely ovate or very widely obovate, adaxially glabrous, concave, abaxially lanuginose; petals 4, 2.1-2.2 x 1.8-2.1 cm, very widely obovate, adaxially concave and glabrous, abaxially glabrous, white and pink; stamens stiff, thecal arrangement oblique; ovary *c.* 4.4 x 2.8 mm, 4-locular, *c.* 22 ovules per

locule. Berry green, 4.8-5.5 x 4-4.9 cm, calyx persistent in fruit; seeds numerous, *c.* 3 mm in diameter.

Geographic distribution: According to Landrum (1986) *A. sellowiana* occurs in grasslands and *Araucaria* forests of Southern Brazil in the states of Santa Catarina and Rio Grande do Sul, and also in the "quebradas" (narrow mountain passes) in Uruguay. Sobral *et al.* (2016) indicate the distribution of this species from Rio de Janeiro and São Paulo through all Southern Brazilian states. However, the records of *A. sellowiana* in São Paulo and Rio de Janeiro are sporadic, and usually are of cultivated specimens collected on farms. So the phytogeographic domains where this species occurs are the Atlantic Forest and the Pampa (Sobral *et al.* 2016). According to Legrand & Klein (1977) the distribution of *A. sellowiana* is from the northern half of Uruguay through Rio Grande do Sul, Santa Catarina and Paraná. In the upper highlands of PNSJ *A. sellowiana* is abundant in the Campos de Santa Bárbara in Urubici, in an altitude of *c.* 1,400 m.a.s.l. The species occurs near the river margins, inside the *Araucaria* forest.

Comments: It flowers between October and December and the fruits appear from February to May.

Specimens analysed: BRAZIL. SANTA CATARINA. Urubici, 09.XI.2001, *G. Hatschbach et al. 72530* (MBM); 15.V.2004, fr., *J.M. Silva & L.R. Lima 4057* (MBM); 16.X.2004, fl., *G. Hatschbach et al. 78101* (MBM); 15.XII.2008, fl., *J.M. Silva et al. 7151* (MBM); 3.IV.2009, fr., *M. Verdi et al. 2000* (FURB); 07.IV.2009, fr., *M. Verdi et al. 1911* (FURB); 4.XI.2013, fl., *A.C. Cervi et al. 10047* (RB); 30.X.2014, *M.A. Wagner et al. 128* (FLOR); 24.11.2014, b. and fl., *M.A. Wagner et al. 143* (FLOR); 09.02.2015, fr., *M.A. Wagner et al. 169* (FLOR).

Figure 1 – a. *Acca sellowiana* (O.Berg) Burret – twigs with flower buds, flowers and older flower without petals. b-d. *Blepharocalyx salicifolius* (Kunth) O.Berg– b. inflorescence with flower buds, flowers and flower without petals; c. leaf adaxially; d. leaf abaxially; e. myrtoid embryos. f-i. *Eugenia handroi* (Mattos) Mattos – f. inflorescence with flower buds, flowers and flower without petals; g. young fruit; h. mature fruit; i. eugenioid embryo (a. *M.A. Wagner* 144; b-d. *P. Fiaschi* 4445; e. *O. Bueno* 4296; f. *R.M. Klein* 7597; g. *R.M. Klein* 8682; h. *R. Reitz* 8380; i. *R.M. Klein* 8682).

2. *Blepharocalyx* O.Berg, Linnaea 27: 412. 1856.

Shrubs or trees. Trichomes simple. Solitary flowers, or with 3-35 flowers in a dichasium or a panicle. Flower tetramerous, calyx open in the bud with 4 lobes or closed and tearing into 4 equal lobes, calyx caducous at anthesis leaving a square scar on the fruit; 4 petals, white to cream coloured; stamens flexible, cream coloured; ovary 2-locular, 4-11 ovules per locule. Fruit with 1-11 seeds, embryo myrtoid.

Blepharocalyx occurs from the Caribbean to Chile. There are three species of *Blepharocalyx* in Brazil: *Blepharocalyx eggersii* (Kiaersk.) Landrum from Amazonas, *Blepharocalyx myriophyllus* (Casar.) Morais & Sobral from the Serra do Caraça in Minas Gerais and *Blepharocalyx salicifolius* (Kunth) O.Berg in the South, Southeast, Center-West and Northeast of Brazil (Landrum & Kawasaki 1997; Sobral *et al.* 2016).

2.1 *Blepharocalyx salicifolius* (Kunth) O.Berg, Linnaea 27: 413. 1856.

Fig. 1b-e, 2b-c

Trees, 8-16 m high. Young twigs glabrous, flattened. Petioles 3-7.7 x 0.4-0.7 mm, adaxially canaliculate, glabrous on both surfaces; leaf blades 4-5.8 x 1.2-1.8 cm, lanceolate, chartaceous, bright green on both surfaces, adaxially glabrous to sparsely pubescent and ciliolate when young, abaxially glabrous to sparsely pubescent along midrib, very small pellucid glands visible throughout; base attenuate, apex strongly acuminate and caudate; midrib impressed with proximal portion slightly canaliculate adaxially, prominent abaxially, secondary veins *c.* 25 pairs, impressed on both surfaces, intramarginal vein 0.2-0.4 mm from the margin. Inflorescence a single dichasium or panicle, *c.* 7 flowers, peduncle 13-15 x 0.5-0.6 mm, glabrous, secondary branches of dichasium 4-10 mm long; buds 2.8-3.3 x 1.7-2.6 mm; bracteoles 3.9-5 x 0.4-0.6 mm, narrowly triangular or lanceolate, caducous; calyx imbricate, lobes 2.4-2.6 x 1.4-1.8 mm, ovate, adaxially strongly concave, ciliate and pubescent, abaxially sparsely pubescent to glabrous; petals *c.* 2.4 x 1.7 mm, obovate, ciliate, pubescent on both surfaces; hypanthium 2.1-2.5 x 2-2.4 mm, glabrous, cotyliform; stamens flexible, thecal arrangement parallel; ovary *c.* 0.7 x 0.8 mm, *c.* 10 ovules per locule. Fruit spheroid, 4-5.4 mm in diameter, calyx caducous leaving square scar; seeds 1-4, 2.9-3.6 x 2.1-2.9 mm.

Geographic distribution and habitat: According to Landrum (1986) *Blepharocalyx salicifolius* occurs in Brazil (from the states of Goiás to Rio Grande do Sul), Paraguay, Uruguay, Argentina, Bolivia and Ecuador. Sobral *et al.* (2016) affirmed that *B. salicifolius* also occurs in Bahia, Distrito Federal, Goiás, Mato Grosso do Sul, and Mato Grosso states. *Blepharocalyx salicifolius* occurs in the phytogeographic domains Caatinga, Cerrado, Atlantic Forest and Pampa (Sobral *et al.* 2016). In the State of Santa Catarina it occurs in riparian forests, in *Araucaria forests* with a moist soil, and in depressions of the terrain and requires medium to high exposure to light (Legrand & Klein, 1978). In Parque Nacional de São Joaquim it occurs in riparian forests. In the upper highlands of PNSJ it occurs in riparian *Araucaria* forests in the Campos de Santa Bárbara in an altitude of 1,351 m.a.s.l and in other areas of the Park in altitudes between 1,000 and 1,139 m.a.s.l.

Comments: Blepharocalyx salicifolius is not abundant in PNSJ. It flowers in December and the fruits appear from February to April.

Specimens analysed: BRAZIL. SANTA CATARINA. Urubici, 17.II.1995, *G. Hatschbach et al. 61720* (MBM); 08.XII.2000, fl., *G. Hatschbach et al. 71695* (MBM)**;** 10.XII.2000, fl., *G. Hatschbach et al. 71758* (MBM); 09.II.2007, *O.S. Ribas. & G. Hatschbach*, *7534* (MBM); 3.IV.2009, fr., *M. Verdi et al. 2006* (FURB); 24.XI.2014, b., *M.A. Wagner et al. 145* (FLOR); 11.XII.2014, b. and fl., *P. Fiaschi et al. 4445* (FLOR).

Additional material examined: BRAZIL. SANTA CATARINA. Campos Novos, 12.II.1981, fr., *S. Sohn & J.M. Campos 30* (FLOR).

3. *Eugenia* L., Sp. Pl. 1: 470. 1753.

Trees or shrubs. Hairs simple or dibrachiate. Inflorescence usually a bracteate shoot with long or abbreviated rachis, sometimes uniflorous and rarely a dichasium, flowers 4 or 5-merous, calyx on bud open or closed and tearing regularly or irregularly; ovary 2-locular, ovules 2 to numerous per locule; fruit crowned by calyx lobes, remnants of calyx or circular scar, embryo a solid mass, eugenioid (Landrum & Kawasaki 1997).

The genus occurs from Mexico and the Caribbean to Northern Argentina (Landrum & Kawasaki 1997). There are approximately 388 species of *Eugenia* in Brazil (Sobral *et al*., 2016).

There are records of two species of *Eugenia* near the borders of PNSJ. Two of these records are of *Eugenia handroi* (Mattos) Mattos in the city of Urubici. One of these records is for Campo dos Padres, an area very close and similar (similar altitude) to Morro da Igreja in PNSJ. The other record is for the city of Urubici in 1,600 m.a.s.l., but there is not more information as to where in the city of Urubici. So the description of *Eugenia handroi* was included in this work, even though it is not abundant in the area and was not collected by the authors within the borders of the PNSJ. There is one record of *Eugenia uniflora* L. (*G. Hatschbach 78124*, MBM) for Cachoeria do Avencal in an area near the limits of PNSJ. As there is only one record of this species in an area outside the PNSJ and it is a species commonly cultivated for its fruit and as ornamental, the authors chose not to include this species in the current work.

3.1 *Eugenia handroi* (Mattos) Mattos, Loefgrenia 105: 2. 1995.

Fig. 1f-i, 2d

Treelet, *c.* 2.5 m high. Trichomes, simple, tortuous or straight, very small and erect or longer and appressed, white or yellow. Young twigs cylindrical, sparsely pubescent. Petioles 3.5-4 x 0.5-0.8 mm, adaxially pubescent, canaliculate, abaxially very sparsely pubescent to glabrous; leaf blades 2.1-3.2 x 1.3-1.6 cm, ovate to elliptic, chartaceous to subcoriaceous, when dried dark brown adaxially, and a lighter shade abaxially, adaxial surface glabrous, abaxial surface pubescent proximally along the midrib; base cuneate, apex acute to obtuse; adaxially midrib impressed and slightly canaliculate proximally, abaxially prominent, secondary veins *c.* 10 pairs, adaxially impressed, abaxially impressed to very slightly prominent, intramarginal vein 0.9-1 mm from the margin. Inflorescence fascicles, 4 to 6 flowers per inflorescence, fascicle rachis *c.* 1 x 1 mm, flower pedicel 2-10 x 0.5 mm, pubescent; buds *c.* 3.1 x 3.4 mm; bracteoles 1.1 x 0.9 mm, deltate, pubescent, ciliate, concave adaxially, slightly keeled abaxially, caducous; calyx open in bud, lobes 4 or 5, imbricate, 1.0-1.1 x 1.2-1.8 mm, deltate to shallowly triangular, ciliate, adaxially concave, and glabrous, abaxially pubescent; petals 4 or 5, diameter *c.* 3.7 mm, circular, ciliate, adaxially glabrous, concave, abaxially slightly pubescent; hypanthium *c.* 1.1 x 0.9 mm, pubescent to lanate, obdeltoid; stamens flexible, thecal arrangement parallel; ovary *c.* 1.0 x 0.5 mm, *c.* 2 ovules per locule. Berry red when mature, spheroid, 1-2.3 cm in

diameter, very sparsely pubescent to glabrous, greenish-yellow, calyx in fruit persistent or caducous leaving circular scar, one seed, *c.* 5.7 mm in diameter.

Geographic distribution and habitat: The species occurs in all three states of Southern Brazil (Rio Grande do Sul, Santa Catarina and Paraná) and in São Paulo, Rio de Janeiro and Espírito Santo states, in the Atlantic Forest domain (Sobral *et al.* 2016). This tree occurs in high altitudes of Serra da Mantiqueira, in the Serra do Mar and in the eastern border of the Planalto Meridional. It is a species that preferentially occurs on soils with high humidity and indirect exposition to light, occurring inside or in the margins of *Araucaria* Forests (Legrand & Klein 1977).

Comment: The authors did not collect this species, but records were found of the species in Urubici collected by Mattos in 1981 and in Campo dos Padres by Mota *et al.* in 2012. Campo dos Padres is an upper highland area near Morro da Igreja. Both areas have very similar characteristics of vegetation and altitude. So *E. handroi* is not abundant in the upper highlands of PNSJ but it was concluded there is high probability that it occurs there. It flowers around October and the fruits appear in February. It occurs in altitudes between 1500 and 1600 m.a.s.l.

Specimens analysed: BRAZIL. SANTA CATARINA. Urubici, 22.X.1981, fl., *J. Mattos 22773* (MBM); 14.II.2012, fr., *N.F.O. Mota et al. 2528* (RB).

Additional material examined: BRAZIL. PARANÁ. Quatro Barras, 30.X.2003, fr., *F.F. Mazine-Capelo et al. 951* (MBM); RIO DE JANEIRO. São Pedro da Aldeia, 3.XII.2001, fr., *C. Farney et al. 4452* (SPF); SANTA CATARINA. Florianópolis, 2.IV.1970, fr., *R.M. Klein & A. Bresolin 8682* (MBM).

Figure 2 – a. *Acca sellowiana* - flower. b-c. *Blepharocalyx salicifolius* – b. flower; c. twig with leaves, flowers and buds. d. *Eugenia handroi*– fruit. e-g. *Myrceugenia acutata* – e. fruit; f. flowers; g. twig with leaves and buds. h-i. *Myrceugenia alpigena*– h. twig with leaves and immature fruits; i. flowers disposed on a row on the axil of a leaf. j-l. *Myrceugenia euosma*– j. twig with leaves and flowers; k. fruit; l. flower. (Photographs: a, b, c, e, g, h, i, j and k *P. Fiaschi*; d. *E.S. Alves*; f and l. *M.A. Wagner*).

4. ***Myrceugenia*** O.Berg Linnaea 27:131. 1856

Trees or shrubs. Most species with dibrachiate hair. Usually solitary flowers, less often a dichasium or a bracteate shoot, the peduncles usually superimposed on a row in the axil of leaves or bracts; bracteoles usually persistent until fruit matures; flowers 4-merous; calyx in bud usually open, or in two species closed and falling as a calyptra; stamens flexible, thecal arrangement parallel; ovary 2-4 locular, 2 to 20 ovules per locule. Fruit crowned by the calyx lobes or caducous leaving a circular scar. Embryo myrcioid.

Myrceugenia occurs from tropical in higher altitudes to subtropical Brazil and Southern Chile (Landrum & Kawasaki, 1997; Murillo-A *et al.* 2016). Approximately 32 species occur in Brazil (Sobral *et al.* 2016).

4.1 ***Myrceugenia acutata*** D.Legrand, Darwiniana 11(2): 351. 1957.

Fig. 2e-g, 4a-c

Shrubs, treelets or trees, 1,6-4 m high. Trichomes dibrachiate and simple, appressed reddish-brown. Young twigs distinctly flattened, sparsely pubescent. Petioles 3-4.1 x 0.7-0.8 mm, adaxially canaliculate and pubescent on both surfaces; leaf blades 2.6-4.6 x 1-1.6 cm, narrowly elliptic to elliptic, coriaceous, dark green or brownish-green adaxially, a lighter shade of green or brownish-green abaxially, adaxial surface glabrous to very sparsely pubescent along midvein, abaxial surface glabrous to very sparsely pubescent; base attenuate to cuneate, margin straight, apex acuminate to acute; midrib proximal portion canaliculate, distal portion slightly impressed adaxially, prominent abaxially, secondary veins 5 to 12 pairs, inconspicuous adaxially, impressed abaxially, intramarginal vein usually inconspicuous, when visible 0.2-0.3 mm from the margin. Flowers solitary, pedicel 11-23 x 0.4-0.5 mm, glabrous; buds 2.8-4.3 x 1.6-1.9 mm; bracteoles 0.9-1.4 x 0.7-0.8 mm, ovate to triangular, glabrous, persistent; calyx open and smaller than the globe of petals in bud, valvate, lobes 1.4-1.7 x 1.5-1.6 mm, deltate to shallowly deltate, adaxially very sparsely pubescent, abaxially puberulent; petals *c.* 2.9 x 2.5 mm, widely obovate, adaxially strongly concave and glabrous, abaxially glabrous; hypanthium 1.4-1.6 x 1.2-1.3 mm, densely pubescent, obconic; ovary *c.* 0.6 x 0.7 mm, 2-locular, with 3 to 6 ovules per locule. Berry purple-black, ellipsoid to broadly

ellipsoid, 7-7.7 x 4.5-5.2 mm, sparsely puberulent, calyx persistent, seeds 1 or 2, *c.* 3.8 x 3 mm.

Geographic distribution and habitat: *Myrceugenia acutata* is distributed through Southern Brazil and also in the states of São Paulo and Rio de Janeiro, in the Atlantic Forest domain (Sobral *et al.* 2016). This species occurs in humid and shady environments (Legrand & Klein 1970). In the upper highlands of PNSJ *M. acutata* occurs in Campos de Santa Bárbara in riparian *Araucaria* forests, where the altitude is *c.* 1,400 m.a.s.l., and in Morro da Igreja, in cloud forests where the altitude is *c.* 1700 m.a.s.l.

Comments: Landrum (1981) considers *Myrceugenia ovata* (Hooker & Arnott) Berg as having four varieties: *M. ovata* var. *ovata* and *M. ovata* var. *nannophyla* (Burret) Landrum from Chile, and *M. ovata* var. *gracilis* (Burret) Landrum, and *M. ovata* var. *acutata* (D.Legrand) Landrum from Brazil. Phylogenetic analyses based on chloroplast and nuclear DNA sequences inquired the relationship within *Myrceugenia* and between this genus, *Blepharocalyx* and *Luma* A. Gray, showing that the varieties of *M. ovata* that occur in Chile are from a different clade than the ones that occur in Brazil (Murillo-A *et al.* 2012; Murillo-A *et al.* 2013). Therefore, *Myrceugenia ovata* var. *acutata and Myrceugenia ovata* var. *gracilis* are here called by its previous names, as Legrand (1957) and Legrand & Kausel (1953) considered them, *Myrceugenia acutata* D.Legrand and *Myrceugenia regnelliana* D.Legrand & Kausel respectively.

In PNSJ the two species, *M. acutata* and *M. regnelliana* are very similar; leaves in *M. acutata* are longer and wider, 2.6-4.6 x 1-1.6 cm (*vs.* 0.7-2.3 x 0.3-1.2 cm in *M. regnelliana*). Leaves are elliptic to narrowly elliptic in *M. acutata* (*vs.* elliptic to obovate in *M. regnelliana*). Leaf vestiture abaxially in *M. acutata* is glabrous to very sparsely pubescent (*vs.* sparsely pubescent to pubescent in *M. regnelliana*). The flower pedicel in *M. acutata* is longer, 11-23 x 0.4-0.5 mm (*vs.* 2-13 x 0.2-0.4 mm in *M. regnelliana*).

The species flowers and bears fruit from September through December.

Specimens analysed: BRASIL. SANTA CATARINA. Bom Jardim da Serra, 24.XII.1982, *A. Krapovickas & Schinini 38288* (HAS); Urubici, 22.I.1960, *J. Mattos 7488* (HAS); 4.XII.1992, *D.B. Falkenberg & F.A. Silva Filho 5866* (FLOR); 21.IX.2014, b. and fr., *M.A. Wagner & P.*

Fiaschi 125 (FLOR); 30.X.2014, b., fl. and fr., *M.A. Wagner et al. 126* (FLOR); 26.XI.2014, *M.A. Wagner et al. 158* (FLOR); 26.XI.2014, *M.A. Wagner et al.* 159 (FLOR).

4.2 ***Myrceugenia alpigena*** (DC.) Landrum, Brittonia 32 (3): 372. 1980.

Fig. 2h-I, 4d-h

Shrubs and trees, 0.5 to 5 m high. Trichomes simple and dibrachiate, white, yellow or reddish-brown, appressed. Young twigs flattened, pubescent to densely pubescent. Petioles 2-6.3 x 0.7-1 mm, adaxially canaliculate, pubescent on both surfaces; leaf blades 2-5.7 x 0.9-2.2 cm, mostly obtrullate but also obovate, oblanceolate or narrowly elliptic, coriaceous, discolour, dark brownish-green adaxially, lighter brownish-green to light brown abaxially, adaxial surface glabrous, abaxial surface pubescent to densely pubescent specially along the midrib; base attenuate, apex acute; midrib proximal portion canaliculate, distal portion slightly impressed adaxially, prominent abaxially, secondary veins 9-11 pairs, sometimes inconspicuous to impressed on both surfaces, intramarginal vein inconspicuous. Solitary flowers, 1-3(-4) in the axil of leaves disposed on a row; pedicel 8-13 x 0.6-0.8 mm, flattened and pubescent; flower buds 2-3.7 x 1.5-3.6 mm, bracteoles 1.5-2.1 x 1.2-2 mm, very widely ovate to deltate, concave adaxially, keeled abaxially, persistent; calyx open in bud, imbricate, lobes 1.7-2.7 x 1.5-2.7 mm, very widely ovate to widely ovate, adaxially sparsely pubescent to pubescent towards the apex, concave, abaxially sparsely pubescent to pubescent; petals *c.* 3 mm in diameter, cream coloured very widely obovate, adaxially concave and glabrous, abaxially glabrous; hypanthium 1-2.1 x 1.5-2.6 mm, densely pubescent, depressed obovoid; ovary 1.5-1.7 x 1.5-2 mm, 3-4 locular, with 3 to 9 ovules per locule. Berry brown when imature, dark purple to black when mature, obloid to spheroid, 2.9-5 x 3.5-6 mm, pubescent, calyx persistent; seeds 1-4, 3-4 x 2.5-4 mm.

Geographic distribution and habitat: According to Landrum (1981), *M. alpigena* ranges from the north of Minas Gerais to Rio Grande do Sul, and as far west as Distrito Federal. According to Sobral *et al.* (2016) *M. alpigena* also occurs in the State of Bahia in North-eastern Brazil. The phytogeographic domains where this species occur are the Caatinga, the Cerrado and the Atlantic Forest (Sobral *et al.* 2016). In the

upper highlands of PNSJ *M. alpigena* occurs in altitudes of 1,400-1,730 m.a.s.l. In the area of Morro da Igreja it occurs in the cloud forests and on mountainside forests. It is present on the trails to Pedra Furada and to the headspring of Rio Pelotas. The species occurs on the rio Pelotas headspring margins. It is also present in Campos de Santa Bárbara in *Araucaria* forests and in Bom Jardim da Serra, on the forest edges, near marshes and rocky outcrops.

Comment: In PNSJ *M. alpigena* flowers between November and February. Imature green fruits were recorded in September and October, and mature fruits in November.

Specimens analysed: BRAZIL. SANTA CATARINA. Bom Jardim da Serra*,* 04.I.1960*, J. Mattos 7099 (HAS); I.1971, J. Mattos 16208* (HAS); II.1989, b. and fl., *M. Sobral et al. 6450* (MBM); Urubici, 21.I.1960, *J. Mattos 7266* (HAS); 16.II.1995, fl., *G. Hatschbach et al. 61650* (MBM); 03.IV.2009, *M. Verdi et al. 1938* (FURB); 27.IV.2009, *M. Verdi & A.L. Gasper 2073* (FURB); 20.IX.2014, fr., *M.A. Wagner & P. Fiaschi 108* (FLOR); 20.IX.2014, fr., *M.A. Wagner & P. Fiaschi 109* (FLOR); 20.IX.2014, fr., *M.A. Wagner & P. Fiaschi 120* (FLOR); 21.IX.2014, fl., *M.A. Wagner & Pedro Fiaschi 124* (FLOR); 31.X.2014, fr., *M.A. Wagner et al. 134* (FLOR); 31.X.2014, fr., *M.A. Wagner et al. 138* (FLOR); 26.XI.2014, b. and fr., *M.A. Wagner et al. 152* (FLOR); 10.II.2015, fl., *M.A. Wagner et al. 178* (FLOR); 11.II.2015, fl., *M.A. Wagner et al. 181* (FLOR).

Additional material examined: BRAZIL. PARANÁ. São José dos Pinhais, 20.XII.1967, fl., *G. Hatschbach 18158* (MBM); RIO GRANDE DO SUL. São Francisco de Paula, 19.XII.1950, *A. Sehnem 5135* (PACA); Taquarí, 8.XII.1957, fl., *Camargo 2695 (PACA);* SANTA CATARINA. São Joaquim, VII.1965*, J. Mattos 13016* (HAS); 28.II.1966, *J. Mattos 13413* (HAS); São José do Serrito, 26.III.2008, b., *M. Verdi & F.E. Carneiro 501* (PACA).

4.3 ***Myrceugenia euosma*** (O.Berg.) D.Legrand, A. Mus. Hist. Nat. Montevideo ser. 2, 4 (11): 40. 1936.

Fig. 2j-l; 4i

Shrubs or trees 1.5 to 3.5 m high. Trichomes dibrachiate, reddish-brown or white. Young twigs flattened, densely pubescent.

Petioles 1.1-2 x 0.6-0.8 mm, adaxially canaliculate, pubescent on both surfaces; leaf blades 1.3-2 x 0.4-0.6 cm, narrowly elliptic, chartaceous, dark green adaxially, light brown abaxially, adaxial surface glabrous to sparsely puberulent along midrib, abaxial surface densely pubescent, punctuations very small black dots on abaxial surface; base attenuate, apex acuminate to acute; midrib entirely canaliculate to only canaliculate proximally adaxially, prominent abaxially, secondary veins 7-13 pairs, inconspicuous adaxially, inconspicuous to impressed abaxially, intramarginal vein 0.3-0.5 mm from the margin. Solitary flowers, flower pedicel 5-13 x 0.4-0.8 mm; buds *c.* 4 x 2-3 mm, calyx on bud open; bracteoles *c.* 2 x 1-1.5 mm, lanceolate or ovate, keeled, persistent; calyx with lobes longer than the globe of petals in the bud, valvate, *c.* 3 x 2 mm, triangular, adaxially concave, sparsely pubescent, abaxially pubescent; petals *c.* 2.5 x 3.5 mm, depressed obovate, adaxially concave and glabrous, abaxially glabrous; hypanthium *c.* 2 x 2 mm, densely pubescent, obdeltoid; ovary *c.* 1.4 x 1.5 mm, 2-locular, with 5 to 6 ovules per locule. Berry red or purple when mature, broadely ellipsoid, *c.* 6 x 5 mm, pubescent with thin appressed dibrachiate reddish-brown trichomes, calyx persistent, seeds 1 or 2, 2.2-4.1 x 1.7-3.1 mm.

Geographic distribution and habitat: According to Landrum (1981) *M. euosma* is distributed in the Southern States of Brazil and also in Uruguay, Northern Argentina and Southeastern Paraguay. Sobral *et al.* (2016) also mention São Paulo in the distribution of *M. euosma.* It is common in the eastern border of *Planalto Meridional*. The only domain where *M. euosma* is present is the Atlantic Forest (Sobral *et al.* 2016). This species requires a humid soil and good exposure to light (Legrand & Klein 1970). *Myrceugenia euosma* is abundant in the upper highlands of PNSJ on the river margins and in *Araucaria* forests in Campos de Santa Bárbara. In Morro da Igreja *M. euosma* occurs in cloud forests, along the trails to Pedra Furada and on the mountainside on the trail towards the headspring of Rio Pelotas. It also occurs on the riparian forest along the headspring of this river and near Cascata Véu de Noiva. The species occurance in PNSJ ranges from 1,380-1615 m.a.s.l.

Comments: In PNSJ *M. euosma* and *M. regnelliana* are very similar in their vegetative parts, making it difficult to distinguish them in the field. It is possible to separate them by the leaf apex acuminate to acute in *M. euosma* (vs. acute to rounded in *M. regnelliana*). Calyx lobes are longer than the globe of petals in the bud for *M. euosma* (vs. smaller in *M.*

regnelliana). Hypanthium and calyx lobes are equally pubescent in *M. euosma* (vs. calyx lobes much less pubescent than the hypanthium in *M. regnelliana*).

Myrceugenia euosma flowers between October and November. There are records of immature fruits in September and in February, and of mature fruits in November.

Specimens analysed: BRAZIL, SANTA CATARINA. Bom Jardim da Serra, 9.XII.2010, *M. Verdi* 5858 (FURB); Urubici, 07.XII.2000, fl., *G. Hatschbach et al. 71605* (MBM); 10.X.2001, fl., *G. Hatschbach et al*. 72588 (RB); 14.XII.2004, fl., *E. Barbosa & E.M. Cunha 1001* (MBM); 16.XI.2007, *L. Sevegnani*, FURB 5412, (FURB); 7.XII.2013, fl., *P. Fiaschi 4064* (FLOR); 19.IX.2014, fr., *M.A. Wagner & P. Fiaschi 102* (FLOR); 20.IX.2014, b. and fr., *M.A. Wagner & P. Fiaschi 118* (FLOR); 20.IX.2014, b. and fr., *M.A. Wagner & P. Fiaschi 119* (FLOR); 20.IX.2014, fr., *M.A. Wagner & P. Fiaschi 121* (FLOR); 21.IX.2014, fr., *M.A. Wagner & P. Fiaschi* 125 (FLOR); 31.X.2014, b., *M.A. Wagner et al. 131* (FLOR); 31.X.2014, b., *M.A. Wagner et al. 136* (FLOR); 01.XI.2014, b. and fr., *M.A. Wagner et al. 140* (FLOR); 01.XI.2014, b. and fl., *M.A. Wagner et al. 141* (FLOR); 25.XI.2014, fl. and fr., *M.A. Wagner et al.* 147 (FLOR); 25.XI.2014, fl. and fr., *M.A. Wagner et al. 148* (FLOR); 03.I.2015, *A.A. de Oliveira* 953 (FURB); 09.II.2015, b. and fr., *M.A. Wagner et al. 175* (FLOR); 10.II.2015, fr., *M.A. Wagner et al. 179* (FLOR); 11.II.2015, fr., *M.A. Wagner et al. 180* (FLOR); 11.II.2015, fl., *M.A. Wagner et al. 183* (FLOR).

Additional material examined: BRAZIL, SANTA CATARINA. Bom Retiro, 10.II.1981, fr., *S. Sohn & J.M. Campos 1* (FLOR); Campos Novos, 12.II.1981, fr., *S. Sohn & J.M. Campos 31* (FLOR).

4.4 *Myrceugenia hamoniana* (Mattos) Sobral, Phytotaxa 8: 53. 2010.

Fig. 3a, 4j

Shrubs, 1.5 to 3.7 m high. Trichomes simple and dibrachiate, white and golden-brown, appressed. Young twigs flattened to cylindrical, sparsely to densely pubescent. Petioles 1.3-1.9 x 0.3-0.5 mm, canaliculate and glabrous adaxially, glabrous to pubescent abaxially; leaf blades 0.7-1.4 x 0.2-0.4 cm, 3-6 times as long as wide, narrowly elliptic, coriaceous, green or brown adaxially, lighter shade of green or brown abaxially, adaxial surface glabrous to sparsely

pubescent, abaxial surface glabrous to pubescent, punctuations very small black dots on abaxial surface; base cuneate, the apex acute to obtuse; midrib inconspicuous to slightly canaliculate proximally adaxially, slightly prominent abaxially, secondary veins inconspicuous, about 5-10 pairs when visible, inconspicuous adaxially, inconspicuous to slightly prominent abaxially, intramarginal vein inconspicuous. Solitary flowers, pedicel 2.4-3.4 x 0.3-0.4 mm, pubescent; buds 1.8-2 x 1.6-2 mm; bracteoles *c.* 1.6 x 0.5 mm, lanceolate, concave and pubescent at the base adaxially, pubescent abaxially, persistent; calyx open with lobes shorter than the globe of petals in the bud, valvate, lobes *c.* 1.4 x 1.2 mm, deltate, with rounded apex, slightly ciliate, adaxially slightly concave and glabrous, abaxially sparsely pubescent; petals 2.3-2.7 x 2.1-2.8 mm, very widely obovate, adaxially strongly concave and glabrous, abaxially glabrous; hypanthium *c.* 1.4 x 1.2 mm, pubescent, obconic; ovary *c.* 0.9 x 0.8 mm, 2-locular, 3-5 ovules per locule. Berry spheroid, *c.* 5.7 x 5.2 mm, sparsely pubescent, black or brown, calyx in fruit persistent, one seed, 3-4.1 x 2.4-3.3 mm.

Geographic distribution and habitat: *Myrceugenia hamoniana* occurs in Santa Catarina and in São Paulo in the Atlantic Forest domain (Sobral *et al.* 2016). It may be restricted to small geographic areas (Landrum 1981). In the upper highlands in PNSJ it occurs in cloud forests near Morro da Igreja, in altitudes between 1,650 and 1,730 m.a.s.l.

Comments: In PNSJ *Myrceugenia hamoniana* can be mistaken with *M. regnelliana*. Trichomes are white and golden-brown, appressed in *M. hamoniana* (*vs.* white and reddish-brown, some erect and some appressed in *M. regnelliana*), leaf blades narrowly elliptic and 3-6 times longer than wide in *Myrceugenia hamoniana* (*vs.* elliptic or obovate and 1.5-2.3 times longer than wide in *M. regnelliana*). Flower pedicel is 2.4 to 3.4 mm long in *M. hamoniana* (vs. 2-13 mm in *M. regnelliana*), the bracteoles are lanceolate (*vs.* ovate), and the calyx lobes are deltate (*vs.* very widely ovate to shallowly deltate).

There are records of *M. hamoniana* flowering on February, and bearing fruit in September.

Specimens analysed: BRAZIL. SANTA CATARINA. Urubici, 18.X.2004, *G. Hatschbach 78199* (RB); 20.IX.2014, fr., *M.A. Wagner*, & *P. Fiaschi* 110 (FLOR); 11.II.2015, b. and fl., *M. A. Wagner et al.* 185 (FLOR).

4.5 ***Myrceugenia miersiana*** (Gardner) D.Legrand & Kausel, Comun. Bot. Mus. Hist. Nat. Montevideo 2(28): 8. 1953.

Fig. 4k

Trees *c.* 4 m high. Trichomes mostly simple, some dibrachiate, yellowish to golden-brown, appressed and erect, some curled and very thin. Young twigs flattened and pubescent. Petioles 5-6 x 0.9-1 mm, adaxially canaliculate and densely pubescent on both sides; leaf blades 4.5-6 x 1.8-2.6 cm, obovate to elliptic, chartaceous to subcoriaceous, dark green adaxially, lighter green to brownish green abaxially, both surfaces pubescent, more densely so along the midrib, trichomes tortuous and erect abaxially on leaf blades; base cuneate, apex acute to obtuse; midrib proximal portion canaliculate, distal portion slightly impressed adaxially, distinctly prominent, abaxially, secondary veins 6-15 pairs, impressed adaxially, distinctly prominent abaxially, intramarginal vein 0.5-0.8 mm from the margin, distinctly prominent. Solitary flowers, pedicel 3-5 x 0.5-0.8 mm densely pubescent; buds *c.* 7 x 4.3 mm; bracteoles 2.9-4.2 x 1-2.1 mm, lanceolate to triangular, keeled, persistent; calyx open in the bud, imbricate, lobes 3.7-4.8 x 3.2-3.9 mm, deltate to widely ovate, adaxially pubescent to lanate, slightly concave, abaxially pubescent to lanate; petals 3.9-5.5 x 4.3-5.5 mm, very widely obovate to circular, ciliate, adaxially glabrous, slightly concave, abaxially pubescent; hypanthium *c.* 3 x 4.7 mm, densely pubescent, shallowly obdeltoid; ovary *c.* 1.6 x 1.9 mm, 4-locular, *c.* 8 ovules per locule. Berry dark purple, spheroid, *c.* 7 mm in diameter, sparsely pubescent, calyx persistent, seeds 3-4, *c.* 5.1 x 4.5 mm.

Geographic distribution and habitat: This species is distributed throughout all states of Southern and Southeastern Brazil and also in Bahia in the Atlantic Forest domain (Sobral *et al.* 2016). It occurs in *Araucaria* forests on the eastern edge of Planalto Meridional and also in the coastal rainforest. It occurs preferentially in high humidity soils and shady environments (Legrand & Klein 1970; Landrum 1981). It occurs in cloud forests of Morro da Igreja in an altitude of *c.* 1,750 m.a.s.l.

Comments: In general *Myrceugenia miersiana* and *Myrceugenia pilotantha* are very similar. What distinguish them are the secondary veins and intramarginal veins that are distinctly prominent in *M. miersiana* (*vs.* very slightly impressed in *M. pilotantha*). *M. miersiana*

trichomes are yellow to golden-brown (vs. reddish-brown in *Myrceugenia pilotantha*), nearly all simple but some dibrachiate (*vs.* simple and dibrachiate in similar proportion in *M. pilotantha*), appressed or erect (vs. usually only appressed in *M. pilotantha*), and trichomes abaxially on leaf blades tortuous and erect (vs. slightly tortuous and not erect in *M. pilotantha*).

Myrceugenia miersiana flowers in February.

Specimens analysed: BRAZIL. SANTA CATARINA. Campos Novos, 11.IV.1963, fl., *R. Reitz & R.M. Klein 14617* (FLOR); Urubici, 16.II.1995, fl., *G. Hatschbach et al. 61656* (MBM).

Additional material examined: BRAZIL. PARANÁ. Tijucas do Sul, 18.IX.1997, fr., *J. M. Silva et al.* 1971 (FLOR).

4.6 *Myrceugenia myrcioides* (Cambess.) O.Berg, Linnaea 27: 134. 1856.

Fig.3b-e, 4l-m

Shrubs or trees, 2.5-10 m high. Trichomes dibrachiate, white and reddish-brown, appressed. Young twigs flattened, pubescent. Petioles 3-6 x 0.8-1.2 mm, adaxially canaliculate, sparsely pubescent to pubescent on both surfaces; leaf blades 3.5-11 x 1.5-3.6 cm, obovate to elliptic, chartaceous to coriaceous, greyish-green adaxially, reddish-brown or light green abaxially, adaxial surface sparsely pubescent, specially along midrib, abaxial surface sparsely pubescent to pubescent; base attenuate, apex acute to acuminate; midrib adaxially canaliculate, abaxially prominent, secondary veins 12-24 parallel pairs, impressed adaxially, prominent abaxially, intramarginal vein *c.* 1 mm from the margin. Solitary flowers, 1-3 superimposed on a row in the axil of leaves, flower pedicel 7-15 x 0.6-1.2 mm, flattened, pubescent; buds 5-9 x 3-9 mm; bracteoles 2.2-5 x 0.7-3 mm, triangular, narrowly triangular or lanceolate, persistent or caducous; calyx open with lobes exceeding the globe of petals in bud, valvate, lobes 2.5-6 x 3-4 mm, ovate to triangular, adaxially concave, glabrous to pubescent, abaxially glabrous to pubescent; petals 5-8 mm in diameter, asymmetrically obovate, adaxially concave and glabrous to pubescent towards the apex, abaxially slightly pubescent to pubescent; hypanthium 3-4 x 4-5 mm, pubescent, depressed obovoid to broadly cuneiform; ovary *c.* 2 x 2.5 mm, 3-4-locular, *c.* 6 ovules per locule. Berry black, purple or grey, ellipsoid to

spheroid, 1.1-1.7 x 0.5-1.6 cm, pubescent, calyx in fruit accrescent, seeds 1-2, 4-6 x 2.3-3.5 mm.

Geographic distribution and habitat: This species occurs on all states of South and Southeastern Brazil in the Atlantic Forest domain (Landrum 1981; Sobral *et al.* 2016). *Myrceugenia myrcioides* is more abundant in coastal rainforests, but is also present on *Araucaria* forests in the Planalto Meridional where it favours moist soils and shady environments inside the forests (Legrand & Klein 1970). In the upper highlands of PNSJ this species is common in high altitudes (*c.* 1,615 m.a.s.l.), in cloud forests on the mountainside in Morro da Igreja and in riparian forests in Campos de Santa Bárbara.

Comments: There are variations in leaf and flower size among individuals of this species in PNSJ. Individuals with smaller leaves, *c.* 3 cm long, brownish, pubescent abaxially, buds *c.* 5 x 3 mm, and persistent bracteoles agree with *M. myrcioides* var. *myrcioides*. Others have longer leaves, *c.* 5 cm long, sparsely pubescent, buds 5-9 x 5-9 mm, bracteoles caducous and agree with *M. myrcioides* var. *acrophylla* (O.Berg) D.Legrand. The two varieties are quite set and they occur near eachother. There seems not to be interemediate specimens in PNSJ.

Myrceugenia myrcioides flowers in February and bears fruit from July to Setember.

Specimens analysed: BRASIL. SANTA CATARINA. Grão Pará, 10.III.2005, fl., *G. Hatschbach et al. 78966* (MBM); Orleans, 31.XII.1959. fr., *J. Mattos 7117* (HAS); 23.VI.1971, fl., *R.M. Klein 9533* (FLOR); Urubici, 20.I.1960, *J. Mattos 7198* (HAS); 22.X.1981, *J. Mattos 22767* (HAS); 14.IV.1982, fr., *J. Mattos 23294* (HAS); 1982, fr., *J. Mattos 23295* (HAS); 23.IV.1985, fr., *J. Mattos 24195* (HAS); 19.V.1990, fr., *D.B. Falkenberg 5367* (ICN); 07.IV.1991, fr., *G. Hatschbach et al. 55323* (MBM); 18.VIII.1991, fr., *G. Hatschbach & J. M. Silva 55678* (RB); 16.II.1995, *G. Hatschbach et* al. *61666* (MBM); 14.V.2004, fr., *J.M. Silva & L.R. Lima* 4045 (RB); 14.5.2004, fl., *J.M. Silva & L.R. Lima 4048* (RB); 03.IV.2009, fl., *M. Verdi et al. 1945* (FURB); 03.IV.2009, fl., *M. Verdi et al. 1946* (FURB); 7.IV.2009, fr., *M. Verdi et al. 1705* (RB); 23.IV.2009, fl., *M. Verdi et al. 2014* (FURB); 23.IV.2009, fr., *M. Verdi et al. 2027* (FURB); 27.IV.2009, fr., *M. Verdi & A.L. Gasper 2070* (FURB); 27.IV.2009, *L. Sevegnani*, FURB 13696 (FURB); 08.III.2010, fl., *M. Verdi et al. 3800* (FURB); 29.III.2013, fr., *G. Felitto & P. Larocca 548* (MBM); 03.I.2015, *A.A. de Oliveira 1045*

(FURB); 20.VII.2014, fr., *M.A. Wagner et al. 94* (FLOR); 22.VII.2014, fr., *M.A. Wagner et al. 95* (FLOR); 22.VII.2014, fr., *M.A. Wagner et al. 96* (FLOR); 22.VII.2014, fr., *M.A. Wagner et al. 97* (FLOR); 4.III.2014, fl., *P. Fiaschi et al. 4181* (FLOR); 4.III.2014, b., *P. Fiaschi et al. 4183* (FLOR); 4.III.2014, fl., *P. Fiaschi et al. 4189* (FLOR); 20.IX.2014, fr., *M.A. Wagner & P. Fiaschi 116* (FLOR); 11.II.2015, b. and fl., *M.A. Wagner et al. 186* (FLOR); 11.II.2015, b. and fl., *M.A. Wagner et al. 188* (FLOR).

Additional material examined: BRAZIL. PARANÁ. Morretes, 12.II.1985, fl., *G. Hatschbach & J.F. Zelma 48901* (FLOR); 30.V.1985, fr., *P.I. Oliveira & J. Cordeiro 910* (FLOR); 8.XI.1990, fl., *O.S. Ribas & J. Cordeiro 251* (FLOR); SANTA CATARINA. Itajaí, 10.III.1955. fl., *R.M. Klein 1187* (FLOR); Vidal Ramos, 7.III.1958, fl., *R. Reitz & R.M. Klein 6586* (FLOR).

4.7 ***Myrceugenia oxysepala*** (Burret) D.Legrand & Kausel, Comun. Bot. Mus. Hist. Nat. Montevideo 2(28): 5. 1953.

Fig. 3f-j; 4n

Shrubs or small trees 1.5-3 m high. Trichomes dibrachiate and simple, appressed, white or reddish-brown. Young twigs flattened, sparsely pubescent to pubescent. Petioles 2-3 x 0.9-1.1 mm, adaxially canaliculate pubescent on both surfaces; leaf blades 2.1-3.4 x 0.8-1.8 cm, mostly obovate rarely elliptic, coriaceous, dark green adaxially, light green abaxially, adaxially glabrous, abaxially sparsely pubescent, more densely so along the midrib; base attenuate, margin slightly revolute, apex acute to rounded; midrib canaliculate adaxially, prominent abaxially, secondary veins 8-12 parallel pairs, impressed adaxially, slightly prominent abaxially, intramarginal vein 0.5-1 mm from the margin. Solitary flowers, pedicel 1-2 x 0.8-1.2 mm; buds *c.* 4 x 2.5 mm, pubescent, bracteoles 4-7 x 1.5-2 mm, lanceolate, concave adaxially, persistent; calyx open in the bud, valvate, lobes *c.* 4 x 2.5 mm, lanceolate to triangular, adaxially concave and glabrous, abaxially pubescent; petals *c.* 4 x 3 mm, asymmetrically obovate, adaxially concave and glabrous, abaxially glabrous, white; hypanthium *c.* 2 x 2 mm, pubescent, broadly obovoid; ovary *c.* 2 x 2 mm, 2-3-locular, 6 ovules per locule; Berries purple when mature, spheroid, *c.* 4 mm in diameter, pubescent, calyx persistent in the fruit; seeds 1 or 2, *c.* 2.5 x 1.5 mm.

Geographic distribution and habitat: *Myrceugenia oxysepala* is distributed throughout the states of Southern Brazil and in Minas Gerais and São Paulo. However, *M. oxysepala* is more common in the southern part of Santa Catarina state and in Rio Grande do Sul. It is present in the Atlantic Forest domain (Sobral *et al.* 2016). It occurs in *Araucaria* forests and cloud forests of the Planalto Meridional (Landrum 1981; Legrand & Klein 1970; Sobral *et al.* 2016). In the upper highlands in PNSJ, it can be found in Morro da Igreja on the trails to Pedra Furada and to the headspring of the Rio Pelotas and in Campos de Santa Bárbara, in altitudes between 1,330-1,530 m.a.s.l., in cloud forests, *Araucaria* forests and riparian forests.

Comments: *Myrceugenia oxysepala* and *M. euosma* often occur together and could be confused with each other. *Myrceugenia oxysepala* has larger leaves (2.1-3.4 x 0.8-1.8 cm long) obovate or elliptic with a rounded (rarely acute) apex (vs. smaller (1.3-2 x 0.4-0.6 cm long) narrowly elliptic leaves with an acuminate to acute apex in *M. euosma*). Bracteoles and calyx lobes in *M. oxysepala* are v similar to each other, lanceolate to triangular, 4-7 mm long, while in *M. euosma* they are shorter (*c.* 2 mm long) and different from each other, bracteoles are lanceolate to ovate and calyx lobes triangular. Flowers appear to be sessile in *M. oxysepala* (peduncle 1-2 mm long) and in *M. euosma* the peduncle is 5-13 mm long.

Myrceugenia oxysepala flowers from November through February and bears fruit from September to November.

Specimens analysed: BRAZIL, SANTA CATARINA. Bom Jardim da Serra. 26.III.1981, *J. Mattos* 22340 (HAS); II.1989, fl., *M. Sobral et al. 6471* (FLOR); Urubici, 12.XI.1964, fr., *J. Mattos 12131* (RB); 04.XII.1992, fr., *D.B. Falkenberg & F.A.S. Filho 5869 (*FLOR); 4.III.2014, fl. and fr., *P. Fiaschi et al. 4188* (FLOR); 19.IX.2014, fr., *M.A. Wagner & P. Fiaschi 103* (FLOR); 19.IX.2014, fr., *M.A. Wagner & P. Fiaschi 104* (FLOR); 19.IX.2014, fr., *M.A. Wagner & P. Fiaschi 105* (FLOR); 19.IX.2014, fr., *M.A. Wagner & P. Fiaschi 106* (FLOR); 21.IX.2014, fr., *M.A. Wagner & P. Fiaschi 123* (FLOR); 31.X.2014, fr., *M.A. Wagner et al. 132* (FLOR); 9.II.2015, fl., *M.A. Wagner et al. 172* (FLOR); 9.II.2015, fl., *M.A. Wagner et al. 173* (FLOR); 11.II.2015, fl., *M.A. Wagner et al. 188* (FLOR).

4.8 *Myrceugenia pilotantha* (Kiaersk.) Landrum, Brittonia 32(3): 374. 1980

Fig. 4o

Shrub or small trees 1-12 m high. Trichomes simple and dibrachiate, reddish brown, appressed. Young twigs flattened, pubescent. Petioles 4.5-7.5 x 0.8-1 mm, pubescent and cylindrical; leaf blades 3.6-4.4 x 1.4-1.9 cm, obovate to elliptic, chartaceous, dark green adaxially, brownish-green abaxially, adaxial surface very sparsely pubescent, pubescent along midrib, abaxial surface pubescent, denser along the midrib, trichomes slightly tortuous, usually appressed abaxially on leaf blades; base attenuate, apex acute; midrib excurrent, canaliculate adaxially, prominent abaxially, secondary veins 11-14 pairs, inconspicuous, abaxially slightly impressed, intramarginal vein 0.5-1 mm from the margin. Solitary flowers, pedicel 3-4 x 0.8-0.9 mm, cylindrical and pubescent; buds *c.* 5 x 4 mm; bracteoles *c.* 4 x 1 mm, narrowly triangular, caducous; calyx open in the bud, valvate, calyx lobes *c.* 3.7 x 4 mm, triangular, pubescent on both surfaces; petals *c.* 4 mm in diameter, very widely ovate, adaxially concave and glabrous, abaxially pubescent; hypanthium *c.* 2 x 2 mm, pubescent, broadly obdeltoid; ovary *c.* 1.5 x 1 mm, 2-locular, 6-8 ovules per locule. Berry dark purple, spheroid to obovoid, *c.* 1 x 0.7 cm, pubescent, calyx persistent in the fruit; 2 or 3 seeds, *c.* 4 x 2.5 mm.

Geographic distribution and habitat: *Myrceugenia pilotantha* occurs near the Atlantic coast from Rio Grande do Sul to Bahia in the Cerrado and Atlantic Forest (Sobral *et al.* 2016). This species favours moist soils and altitudes between 250 and 1,650 m. It occurs in cloud forests and *Araucaria* forests, but it seems to be more abundant in coastal rainforests (Landrum 1981; Legrand & Klein, 1970; Sobral *et al.* 2016). In the upper highlands of PNSJ *M. pilotantha* is found in the area of Morro da Igreja, near the headspring of the River Pelotas and in Bom Jardim da Serra, in altitudes between 1,350-1,700 m.a.s.l.

Comments: Landrum (1981) mentioned that *M. pilotantha* could sometimes have leaf blades 3-4 times longer than its width. The specimens observed here varied from 2.3 to 2.6 times longer than its width. *Myrceugenia pilotantha* can be confused with *M. miersiana*, their differences are described under the description of the latter.

In PNSJ *M. pilotantha* flowers from January bears fruit in September.

Specimens analysed: BRAZIL. SANTA CATARINA. Urubici, 20.IX.2014, fr., *M.A. Wagner & P. Fiaschi 114* (FLOR); 20.IX.2014, fr., *M.A. Wagner & P. Fiaschi 115* (FLOR); 20.IX.2014, fr., *M.A. Wagner & P. Fiaschi 116* (FLOR);
Additional material examined: BRAZIL. SANTA CATARINA. Bom Jardim da Serra, 31.I.1985, *D.B. Falkenberg & P.E. Berry* 2300 (RB); II.1989, fl., *M. Sobral et al. 6461* (FLOR); Urubici, 24.I.1957, fl., *B. Rambo* PACA 60049 (PACA); 24.V.1991, fl. and fr., *D.B. Falkenberg 5494* (FLOR); 24.V.1991, fr., *D.B. Falkenberg* 5494 (FLOR); 03.IV.2009, *M. Verdi et al. 1923* (FURB); 03.IV.2009, *M. Verdi et al. 1925* (FURB); 03.04.2009, fl., *M. Verdi 1939* (FURB); 23.IV.2009, *M. Verdi et al. 2570* (FURB); 03.I.2015, *A. A. de Oliveira 966* (FURB).

4.9 *Myrceugenia regnelliana* (O.Berg) D.Legrand & Kausel, Comun. Bot. Mus. Hist. Nat. Montevideo 2 (28): 11. 1953.

Fig. 3k-l; 4p-q

Shrubs, treelets and trees, 1-6.5 m high. Trichomes simple and dibrachiate, white and reddish-brown, some erect and some appressed. Young twigs flattened to cylindrical, pubescent. Petioles 1.7-2.7 x 0.6-0.9 mm, adaxially canaliculate and pubescent on both surfaces; leaf blades 0.7-2.3 x 0.3-1.2 cm, elliptic to obovate, coriaceous, dark green to brownish-green adaxially, lighter shade of green or brownish-green abaxially, adaxial surface glabrous to sparsely pubescent, specially along midrib, abaxial surface pubescent in younger leaves, scattered and fewer in older leaves; base attenuate to cuneate, the apex acuminate to acute; midrib slightly canaliculate proximally to impressed distally or slightly canaliculate throughout adaxially, prominent abaxially, secondary veins *c.* 10 pairs, inconspicuous adaxially, inconspicuous to slightly prominent abaxially, intramarginal vein 0.1-0.4 mm from the margin. Solitary flowers, pedicel 2-13 x 0.2-0.4 mm sparsely pubescent, buds 2.2-3.3 x 1.2-2.1 mm; bracteoles 1.3-1.4 x 0.4-0.7 mm, ovate, adaxially concave and pubescent proximally, abaxially pubescent and keeled, persistent; calyx open with lobes shorter than the globe of petals in the bud, valvate, lobes 1-2 x 1.3-1.6 mm, very widely ovate to shallowly deltate, adaxially concave and glabrous to sparsely puberulent, abaxially very sparsely pubescent; petals 1.8-2.5 x 1.9-3

mm, very widely obovate to circular, adaxially glabrous, concave, abaxially glabrous; hypanthium 1.3-1.5 x 1.1-1.4 mm, densely pubescent, obdeltoid; ovary *c.* 0.5 x 0.6 mm, 2-locular, with 4 to 7 ovules per locule. Berry dark brown, ellipsoid, 4-9 x 3.4-7.6 mm, sparsely puberulent, calyx persistent, seeds 1-4, 3.7-4.5 x 2.2-3.5 mm, embryo myrcioid.

Geographic distribution and habitat: *Myrceugenia regnelliana* is distributed throughout Southern Brazil and Southeastern Brazil, except in Espírito Santo, in all these states it occurs in the Atlantic Forest domain (Sobral *et al.* 2016). It grows in cloud forests and *Araucaria* forests in the eastern part of Planalto Meridional. This species favours moist soils (Legrand & Klein 1970; Landrum 1981; Sobral *et al.* 2016) and in the upper highland areas of PNSJ it occurs in *Araucaria* forests and it is abundant on the edges of cloud forests in areas with a good exposure to light, in altitudes between 1,367-1,729 m.a.s.l.

Comments: *Myrceugenia regnelliana* is similar to *M. acutata* and *M. hamoniana*, and the characters that differentiate them are discussed previously under these species descriptions. In the upper highlands of PNSJ *M. regnelliana* flowers and bears fruit between September and November.

Specimens analysed: BRAZIL. SANTA CATARINA. Bom Jardim da Serra, 31.I.1985, fr., *D.B. Falkenberg & P.E. Berry 2301* (RB); Urubici, 12.XII.1964, fl., *J. Mattos 12134* (RB); 01.II.2010, *L. Sevegnani* FURB 17178 (FURB); 01.I.2010, *L. Sevegnani* FURB 33937 (FURB); 4.III.2014, fl., *P. Fiaschi et al 4176* (FLOR); 19.IX.2014, b. and fr., *M.A. Wagner & P. Fiaschi 99* (FLOR); 19.IX.2014, b. and fr., *M.A. Wagner & P. Fiaschi 100* (FLOR); 20.IX.2014, fr., *M.A. Wagner & P. Fiaschi 106* (FLOR); 20.IX.2014, fr., *M.A. Wagner & P. Fiaschi 109* (FLOR); 20.IX.2014, fr., *M.A. Wagner & P. Fiaschi 111* (FLOR); 20.IX.2014, fr., *M.A. Wagner & P. Fiaschi 121* (FLOR); 30.X.2014, fr., *M.A. Wagner et al. 127* (FLOR); 30.X.2014, b. and fl., *M.A. Wagner et al. 129* (FLOR); 31.X.2014, b. and fl., *M.A. Wagner et al. 132* (FLOR); 31.X.2014, fr., *M.A. Wagner, et al. 134* (FLOR); 31.X.2014, fr., *M.A. Wagner et al. 136* (FLOR); 26.XI.2014, fr., *M.A. Wagner et al. 153* (FLOR); 26.XI.2014, fr., *M.A. Wagner et al. 154* (FLOR); 26.XI.2014, fr., *M.A. Wagner et al. 155* (FLOR); 26.XI.2014, *M.A. Wagner et al. 156* (FLOR); 26.XI.2014, *M. A. Wagner et al.157* (FLOR).

Additional material examined: BRAZIL. RIO GRANDE DO SUL. Cambará do Sul, XII.1983, fl., *M. Sobral & J.R. Stehmann 2675* (FLOR); SANTA CATARINA. Matos Costa, 8.XII.1962, fl., *R.M. Klein 3553* (FLOR); Papanduva, 13.XI.1962, fl., *R.M. Klein 3968* (FLOR); São Francisco do Sul, 21.XII.1960, fl., *R. Reitz & R.M. Klein 10466* (FLOR); 21.XII.1960, fl., *R. Reitz & R.M. Klein 10490* (FLOR).

Figure 3. – a. *Myrceugenia hamoniana*– twig with fruit and leaves. b-e *Myrceugenia myrcioides*– b. fruit; c. twig with leaves and fruits; d. flowers; e bud; f-j. *Myrceugenia oxysepala* – f. twig with leaves and fruits; g-i. flower with calyx lobes and bracteoles similar; j. fruit. k-l. *Myrceugenia regnelliana* – k. twig with flowers and leaves; l. fruit. (Photographs: a, b, d, e, k and l. *M.A. Wagner*; c. *J. Silveira*; f, g, h and j. *P. Fiaschi*. i. *M. Palácio*).

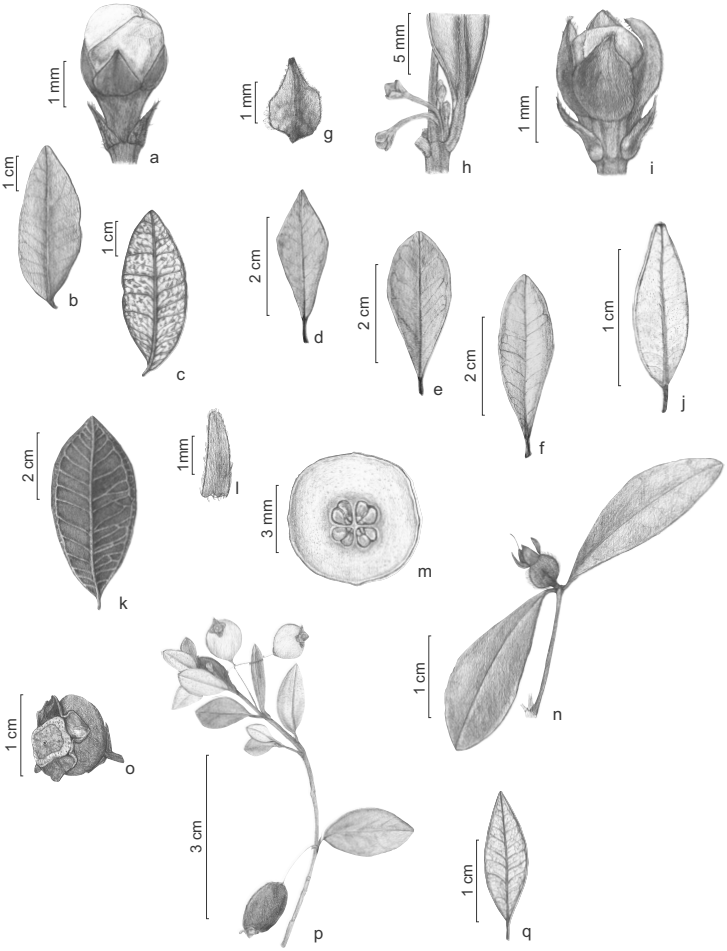

Figure 4 – a-c. *Myrceugenia acutata*– a. flower bud; b. leaf, adaxial surface; c. leaf, abaxial surface. d-h. *Myrceugenia alpigena*– d-f. variations in leaf morphology, adaxial surface - d. obtrullate leaf; e. obovate leaf; f. narrowly elliptic leaf; g. bracteole; h. flower buds disposed on a row in leaf axil. i. *Myrceugenia euosma*– flower bud. j. *Myrceugenia hamoniana*– leaf, abaxial surface. k. *Myrceugenia miersiana* – leaf, abaxial surface. l-m *Myrceugenia myrcioides* – l. bracteole; m. horizontal section of ovary. n. *Myrceugenia oxysepala* – twig with leaves and fruit. o. *Myrceugenia pilotantha* - fruit. p-q. *Myrceugenia regnelliana* – p. twig with

leaves and fruits; q. leaf, abaxial surface, variation in morphology from the previous example in p. (a-c. *M.A. Wagner* 127; d-g. *M.A. Wagner* 113; h. *M.A. Wagner* 149; i. *M.A. Wagner* 141; j. *M.A. Wagner* 186; k. *R. Reitz* 12856; l. *M.A. Wagner* 96; m. *P. Fiaschi* 4189; n. *M.A. Wagner* 172; o. *MA. Wagner* 115; p-q. *M.A. Wagner* 137).

5. ***Myrcia*** DC., Dict. Class. Hist. Nat. 11: 406. 1827.

Trees or shrubs. Hairs simple or dibrachiate. Inflorescence panicles; flowers usually 5-merous, rarely 4-merous; calyx open in bud; stamens flexible; ovaries 2-3(-4) locular, with 2 ovules per locule. Seeds 1-4 or more, embryo myrcioid.

The distribution of *Myrcia* is from Mexico and the Caribbean to Northern Argentina (Landrum & Kawasaki 1997). There are approximately 260 species of *Myrcia* in Brazil (Sobral *et al.* 2016).

5.1 ***Myrcia aethusa*** **(**O.Berg) N. Silveira, Roessleria 7(1): 67. 1985.

Fig. 5a

Shrubs and small trees, 4-10 m high. Trichomes simple, slender, white, yellowish or reddish-brown. Young twigs flattened, densely pubescent. Petioles 3.3-5 x 0.9-1.3 mm, adaxially canaliculate, pubescent on both surfaces; leaf blades 3.5-4.3 x 1.1-1.5 cm, lanceolate to narrowly elliptic, chartaceous to subcoriaceous, dark reddish-brown adaxially and light yellowish-brown abaxially when dried, adaxial surface pubescent along the midrib, abaxial surface sparsely pubescent throughout the blade, pubescent along the midrib, densely pubescent when leaves are very young; the base attenuate to cuneate, apex acuminate or caudate; midrib canaliculate proximally to impressed distally on the adaxial surface, prominent abaxially, secondary veins *c.* 15 pairs, impressed adaxially, slightly prominent abaxially, intramarginal vein 0.4 to 0.9 mm from the margin. Inflorescence one dichasium or a panicle in the axil of leaves, with 3-15 flowers, inflorescence peduncle 12.1-15.4 x 0.5-0.6 mm, glabrous to sparsely pubescent, secondary branches of dichasium or panicle 4.1-6.2 mm; buds 2-3.3 x 1.9-3.1 mm; bracteoles 1-2.5 x 0.4 mm, lanceolate, ciliate, sparsely pubescent and slightly concave adaxially, keeled abaxially, caducous; calyx, imbricate, lobes 5, 0.8-1.3 x 1.4-1.8 mm, shallowly triangular, ciliate in the margins, adaxially pubescent, abaxially glabrous; petals 5, 3.4-3.6 x 2.2-2.3 mm, obovate, glabrous on both surfaces; hypanthium *c.* 1.8 x 2.7 mm, glabrous, shallowly obpyramidal; stamens with thecal arrangement parallel, ovary *c.* 0.7 x 0.9 mm, 3-locular. Berry dark purple when mature, spheroid, 5.5-8.6 mm in diameter, glabrous, calyx persistent, seeds 1-3, 5.4-3.5 mm in diameter.

Geographic distribution and habitat: *Myrcia aethusa* occurs in all states of Southern and Southeastern Brazil in the Atlantic Forest domain

(Sobral *et al.* 2016). It can be found in cloud forests and it is abundant in the rainforest of the Atlantic slopes. This species seems to be rare in the upper highlands of PNSJ. There is one record of *M. aethusa* near the highway SC 370 towards Grão Pará, one of the municipalities in which territory the PNSJ is located, at 1040 m. This highway passes very close to the northern boarder of PNSJ. Nonetheless, Legrand & Klein (1969b) describe it as a species present in areas of high declivity, so there is probability that *Myrcia aethusa* is more abundant on PNSJ on the high declivity slopes facing the Atlantic, along the Planalto escarpment. The species favours slightly moist soils and good exposition to light (Legrand & Klein 1969b; Sobral *et al.* 2016).

Specimens analysed: BRAZIL. SANTA CATARINA. Grão Pará, 12.I.1987, b., *D.B. Falkenberg et al. 4308* (FLOR).

Additional material examined: BRASIL. SANTA CATARINA. Florianópolis, 17.I.1967. fl., *R.M. Klein 7098* (FLOR); Governador Celso Ramos, 16.XI.1971, fl., *R.M. Klein 9891* (FLOR); Palhoça, 22.IX.1971, fr., *R.M. Klein & A. Bresolin 9741* (FLOR);

5.2 ***Myrcia hartwegiana*** (O.Berg) Kiaersk., Enum. Myrt. Bras. 109. 1893.

Fig. 5b-e

Small trees, *c.* 2 m high. Trichomes simple, white or reddish-brown. Young twigs flattened, pubescent near the apex, sparsely pubescent to glabrous towards the base of the twig. Petioles 2-4 x 0.9-1.4 mm, adaxially canaliculate, pubescent on both surfaces; leaf blades 2.3-5.5 x 1.1-1.8 cm, obovate to elliptic, chartaceous, darker brownish-green adaxially, a lighter shade abaxially, adaxial surface with scattered trichomes, older leaves glabrous, abaxial surface with scattered trichomes, denser along midvein, older leaves glabrous; base attenuate to cuneate, apex rounded; midrib canaliculate proximally, impressed distally adaxially, prominent abaxially, secondary veins 8-10 pairs, slightly impressed adaxially, invisible to prominent abaxially, intramarginal vein prominent, 0.8-1.2 mm from the margin. Inflorescence one panicle subtended by caducous bract in the axil of leaves, with 8 to 10 flowers; peduncle 8-18 x 0.5-0.7 mm pubescent; secondary branches of panicle 0.5-1 mm; buds 2.1-2.2 x 2 mm, pubescent, bracteoles 1.5-2 x 0.8-0.9 mm, trullate, caducous; calyx

imbricate, lobes 5, 0.8-1.1 x 1.1-1.9 mm, shallowly triangular, adaxially and abaxially pubescent; petals 5, 3-3.7 x 2-3 mm, very widely obovate, adaxially concave and glabrous, abaxially pubescent, petals white; hypanthium 1.5-2 x 1.5-2.5 mm, densely pubescent, very widely obovoid; vertical displacement of thecae, pollen sacs of anthers at slightly different levels; ovary 0.6-1 x 0.8-1.1 mm, 2-locular. Fruit spheroid, *c.* 4 mm in diameter, pubescent, calyx persistent; seed 1, 2-3 x 3 mm, embryo myrcioid.

Geographic distribution and habitat: *Myrcia hartwegiana* occurs in *Araucaria* forests. In the Planalto Merdional it is an important species in capões, typical vegetation in Southern Brazil formed by an assemblage of trees surrounded by grasslands, but it also occurs in the Atlantic coastal rainforest (Legrand, 1967). In the upper highlands of PNSJ it occurs in altitudes closer to 1000 m, and it is uncommon in higher altitudes. According to Sobral *et al.* (2016), *M. hartwegiana* is distributed in all states of Southern and Southeastern Brazil except for Espírito Santo and is present in the Atlantic Forest domain.

Specimens analysed: BRAZIL. SANTA CATARINA. Urubici, 10.X.2001. *G. Hatschbach et al. 72594* (RB); 28.XII.2006, *L. Sevegnani FURB 5410* (FURB); 01.XI.2014, fr., *M.A. Wagner et al. 142* (FLOR).

Additional material examined: BRAZIL. MINAS GERAIS. Joaquim Felício, 15.I.2007, fl., *P.L. Viana & A.M. Teles 3307* (RB); PARANÁ: Campo Tenente, 25.I.1968, fl., *G. Hatschbach & C. Koczicki 18482* (FLOR); Quatro Barras, 12.IV.1988, fl., *J.M. Silva & J. Cordeiro 522* (FLOR); SANTA CATARINA. Benedito Novo, 8.II.1973, fl., *A. Bresolin & Roco 698* (FLOR); Palhoça, 03.V.1956, fl., *R. Reitz & R.M. Klein 3214* (FLOR).

6. *Myrrhinium* Schott, Syst. Veg. 4 (2): 404. 1827.

Shrubs or trees. Hairs simple. Inflorescence a dichasium with 3 to 7 flowers, solitary or assembled in groups of 2 to 8 on short bracteate shoots; flowers 4-merous; calyx open on the bud; petals red, pink or purplish, fleshy when mature, stamens 4-8, stiff and red; ovary 2-locular, 5-14 ovules per locule. Fruit crowned by calyx, seeds 1-4, embryo myrtoid.

Myrrhinium is a monotypic genus with a wide geographic distribution, from Rio de Janeiro to Uruguay and Northern Argentina, reaching Colombia through the Andes (Landrum 1986).

6.1 ***Myrrhinium atropurpureum*** Schott, Syst. Veg. 4(2): 404. 1827.

Fig. 5f

Shrub or trees, 2-4 m high. Trichomes white. Young twigs flattened to cylindrical, glabrous to pubescent. Petioles 2.2-4.2 x 0.8-1.2 mm, glabrous; leaf blades 3.2-4.9 x 1.1-1.9 cm, narrowly elliptic, coriaceous, bright green on adaxial surface, lighter green on abaxial surface, adaxial and abaxial surfaces glabrous, with very small puctuations on abaxial surface; base attenuate, apex acuminate; midrib impressed adaxially, prominent abaxially, secondary veins *c.* 10 pairs, slighlty impressed adaxially, inconspicuous to slightly impressed abaxially, intramarginal vein 0.4 to 0.8 mm from the margin. Inflorescence peduncle 1.8-7.5 x 0.8-2.2 mm, glabrous, secondary branching 3.8-5.9 mm long, flower pedicel *c.* 1.8 mm long; buds 3.2-4.8 x 1.8-2.4 mm; bracteoles *c.* 0.9 x 0.9 mm, triangular, persistent; calyx valvate, lobes 0.7-0.9 x 1.5-1.7 mm, shallowly triangular, adaxially glabrous, ciliolate, abaxially glabrous; petals *c.* 5.1 x 4.1 mm, widely obovate, glabrous on both surfaces; hypanthium *c.* 2.6 x 1.6 mm, glabrous, cotyliform; stamens 4-8, erect, thecal arrangement parallel; ovary *c.* 2 x 1.1 mm, *c.* 9 ovules per locule. Berry green when immature, spheroid, *c.* 4.9 x 4.8 mm, glabrous, calyx persistent, seeds 3, 3.5 x 2.8 mm.

Geographic distribution and habitat: In Brazil, *Myrrhinium atropurpureum* is distributed in Southern Brazil, and in São Paulo, Rio de Janeiro and Espírito Santo and it is present in the Atlantic Forest and in the Pampa (Sobral *et al.* 2016). It occurs on the edges of *Araucaria* forests. In the upper highlands of PNSJ *M. atropurpureum* is not an abundant species.

Comments: In the upper highlands of PNSJ *M. atropurpureum* flowers in September and October.

Specimens analysed: BRAZIL. SANTA CATARINA. Urubici, 11.XI.2001, *G. Hatschbach et al. 72644* (MBM); 25.X.2011, fl., *L. Sevegnani 10* (FURB); 3.IX.2013, fl., *P. Fiaschi et al. 3976* (FLOR).

Additional material examined: BRAZIL. RIO GRANDE DO SUL. Caxias do Sul, 6.X.2013, *M. Grizzon & L.C.V. Carrés 212* (FLOR); Jaquirana, 27.II.2013, fr., *M. Grizzon 196* (FLOR); Santa Vitória do Palmar, 25.II.1984, fr., *F.A. Silva Filho* & *A. Reis, 71* (FLOR).

7. *Siphoneugena* O.Berg, Linnaea 27: 344. 1856.

Shrubs or trees. Trichomes simple. Inflorescence a bracteate shoot, glomerule or fascicle; flowers 4-merous; hypanthium prolonged and tubular beyond the ovary, and contracted near summit of the ovary, circumscissile and falling with the calyx after anthesis leaving circular scar on the fruit; calyx in the bud open or closed, tearing irregularly or calyptrate; ovary 2-locular, ovules usually (2-)3-5(-7) per locule. Eugenioid embryo, divided in 2 separate plano-convex cotyledons.

Siphoneugena is dispersed from the Caribbean to Southern Brazil (Landrum & Kawasaki 1997). In Brazil there are 9 species of the genus (Sobral *et al.* 2016).

7.1 *Siphoneugena reitzii* D.Legrand, Sellowia 8: 78. 1957.

Fig. 5g-i

Shrubs or trees, 1.8 to 10 m high. Trichomes white. Young twigs slightly flattened, sparsely puberulent to puberulent. Petioles 2.5-3.2 x 0.6-0.7 mm, adaxially canaliculate and pubescent on both surfaces; leaf blades 1.7-2.9 x 0.5-1 cm, narrowly elliptic, chartaceous, discolor, darker brownish-green adaxially, lighter brownish-green abaxially, adaxial surface glabrous to sparsely pubescent, specially along midrib, abaxial surface glabrous, punctuations very small dots on abaxial surface; base attenuate, apex acuminate; midrib impressed adaxially, prominent abaxially, secondary veins 10-14 pairs, inconspicuous adaxially, slightly impressed abaxially, intramarginal vein 0.2-0.3 mm from the margin. Inflorescence usually a bracteate shoot in the axil of leaves, 1-3 flowers, peduncle 1.7-2 x 0.5-0.7 mm, glabrous, pedicel 1 mm long; buds *c.* 4 x 1.8 mm, glabrous, bracteoles *c.* 0.5 x 0.5 mm, deltate, persistent; calyx closed in bud, calyx lobes *c.* 1 x 1.3 mm, square, adaxially puberulent, abaxially puberulent on the margins; petals *c.* 1.2 x 1.6 mm, very widely obovate, adaxially puberulent, abaxially glabrous; hypanthium *c.* 3.3 x 1.5 mm, glabrous, oblong to obovoid; stamens flexible, thecal arrangement parallel; ovary *c.* 1.3 x 1.2 mm,

with 3 or 4 ovules per locule. Berry red, circular, *c.* 4 x 5 mm, glabrous, seed 1, *c.* 3.6 mm diam.

Geographic distribution: *Siphoneugena reitzii* is distributed through Southern and Southeastern Brazil in the Atlantic Forest (Legrand & Klein 1977; Sobral *et al.* 2016). In the upper highlands of PNSJ *Siphoneugena reitzii* was collected near the Cachoeira Véu de Noiva, at an altitude of approximately 1,000 m. The species is not abundant throughout PNSJ.

Specimens analysed: BRAZIL. SANTA CATARINA. Urubici, 27.IV.2009, *M. Verdi & A.L. Gasper 2062* (FURB); 22.VII.2014, fl., *D.B. Falkenber 7992* (FLOR); 01.XI.2014, fr., *M.A. Wagner et al. 139* (FLOR).

Additional material examined: BRAZIL. RIO GRANDE DO SUL: Jaquirana, 27.II.2013, b. and fl., *M. Grizzon 199* (FLOR); SANTA CATARINA. Faxinal dos Guedes, 27.II.1964, fl., *R.M. Klein 4812* (FLOR); Palhoça, 05.IV.1972, fl., *A. Bresolin 547* (FLOR).

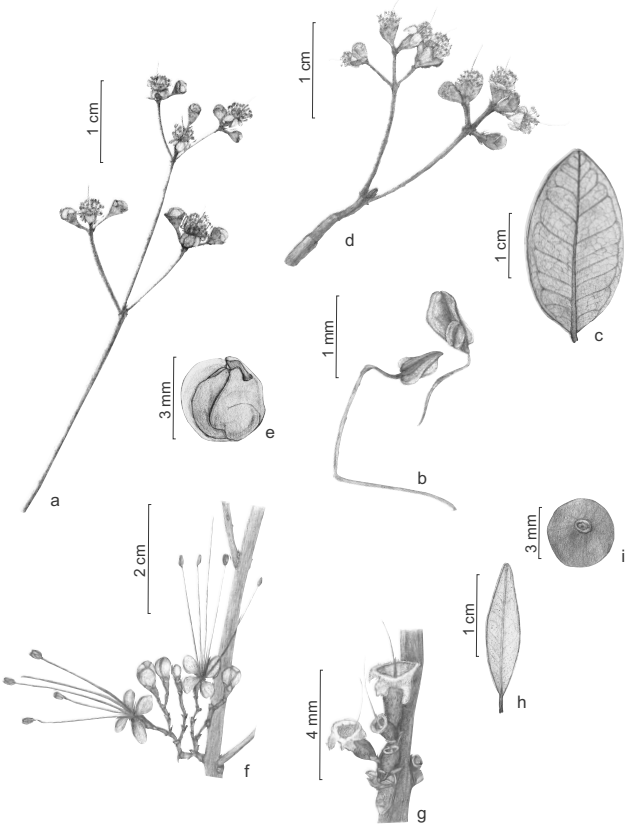

Figure 5 – a. *Myrcia aethusa*- panicle; b-e. *Myrcia hartwegiana*- b. stamens; c. leaf, abaxial surface; d. panicle; e. myrcioid embryo. f. *Myrrhinium atropurpureum*- dichasium on short bracteate shoot. g-i. *Siphoneugena reitzii*- g. fascicle; h. leaf, abaxial surface; i. fruit. (a. *R.M. Klein* 7098; b. and d. *A. Bresolin* 698; c. and e. *M.A. Wagner* 142; f. *M. Grizzon* 212; g. *A. Bresolin* 547; h. and i. *M.A. Wagner*)

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CAPÍTULO II

Floristic composition and effect of geoclimatic variables on the southern Atlantic Forest - Myrtaceae

Floristic composition and effect of geoclimatic variables on southern Atlantic Forest - Myrtaceae

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Abstract

Questions: The Atlantic Forest is a diverse rainforest in the Neotropics and a very important diversity hotspot in the world. The Atlantic Forest is divided biogeographically into north and south. Myrtaceae is one of the families with tree species with higher richness in the Atlantic Forest but the differences and similarities in Myrtaceae species composition throughout the different areas of the southern portion of the Atlantic Forest domain are not well know. What triggers the patterns of Myrtaceae species composition in the different areas? How the similarity in species composition of Myrtaceae varies with geographic proximity in the southern Atlantic Forest?
Location: Southern and Southeastern Brazil.
Methods: We built a database with presence and absence of species of Myrtaceae for 42 localities with data from the literature available. We compiled data on the geoclimatic variables for each locality. We performed Jaccard dissimilarity analysis for the localities and cophenetic correlation. The significance of the groupings obtained through the Jaccard dissimilarity analysis was tested using similarity profile analyses. Initially Pearson correlation analysis and variance inflation factors analysis were used to evaluate the multicollinearity between the different geoclimatic variables. Then it was performed a redundancy analysis (RDA) with a more succinct set of variables. A Mantel test was performed to evaluate the spatial autocorrelation between the areas and a Moran test to evaluate spatial autocorrelation and species richness.
Results: Total richness of species of Myrtaceae in the southern Atlantic Forest sites compiled was 254 species and 17 genera, with 750 occurrences. The average pair-wise dissimilarity between communities of Myrtaceae in different localities in the southern AF was 94.18%. Jaccard dissimilarity analysis and similarity profile analyses presented six groups of localities that were statistically relevant. Main predictors of the variation of Myrtaceae composition in the southern Atlantic Forest were altitude, precipitation of wettest month, temperature seasonality and distance from the ocean.
Conclusion: Composition of Myrtaceae varies greatly from one area to another in the southern Atlantic Forest, with a high percentage of geographically restricted species and a low percentage of common species among sites. There is a differentiation in Myrtaceae species composition related to altitude. Areas of higher altitude may share species occurrence even if they are not geographically close. The

difference in climate, tropical or subtropical influences Myrtaceae composition.

Introduction

Biodiversity hotspots are areas where extraordinary accumulation of endemic species coincides with extreme loss of habitat (Myers et al. 2000). Brazil's Atlantic Forest domain is considered one of these hotspots (Myers et al. 2000; Laurance 2009). The Atlantic Forest domain (from here on called AF) is very rich in species number (approximately 15.001 species of seed plants) and contains high numbers of endemism (7.432 endemic seed plants) (BRAZIL FLORA GROUP 2015). In a study about the distribution of 127 tree species, each with at least part of their range in the Atlantic rainforest of eastern Brazil, 53% proved to be endemic to the coastal AF (Mori et al. 1981).

The AF domain stretches along the Brazilian coast from Rio Grande do Norte to Rio Grande do Sul (Mori et al. 1981). Its width in the southern part can reach Eastern Paraguay and Northern Argentina (Galindo-Leal & Câmara 2005; Oliveira-Filho et al. 2006). Originally, the AF occupied an area of c. 1,363,000 km^2, 15% of the Brazilian territory (Hirota 2005). However, anthropic pressures have destroyed its habitats since the beginning of the process of colonization (Viana & Tabanez 1996). Close to 92% of the original AF was devastated and only approximately 100,000 km^2 still exists (Hirota, 2005). The AF domain includes the following vegetation physiognomies: evergreen tropical rainforest, semi-deciduous tropical forest, subtropical forests, mangroves, shrubby restinga, grasslands and rocky outcrops (Oliveira-Filho & Fontes 2000; Fiaschi & Pirani 2009).

The AF domain presents a floristic differentiation from the coastal rainforest and the semi-deciduous forest hinterland (Oliveira-Filho & Fontes 2000). The main geoclimatic factors that affect the floristic composition of the AF are rainfall seasonality, temperature and altitude (Oliveira-Filho & Fontes 2000). There are correlations between floristic composition and the rainfall gradient from rainforests to hinterland semi-deciduous forests and the altitude gradient from lowland to upper highland forests (Oliveira-Filho & Fontes 2000). The number of days of frost per year seems to have an effect on floristic composition similar to altitude, and helps to explain the singularity of species composition in the cloud forests (Falkenberg & Voltolini 1995; Falkenberg 2003; Bertoncello et al. 2011; Eisenlohr & Oliveira-Filho 2015). Other variables like potential evapotranspiration and shortest

distance from the ocean also help explain the floristic variations between rain and semi-deciduous forests (Eisenlohr & Oliveira-Filho 2015).

Myrtaceae is one of the families with the highest number of species in the AF Domain (Falkenberg & Voltolini 1995; Koehler 2001; Falkenberg 2003; Martini et al. 2007; Pereira-Silva et al. 2007; Meireles et al. 2008; Martins-Ramos et al. 2011; Higuchi et al. 2012). The Espinhaço Mountain Range in Eastern Brazil is partly constituted by rainforests and semi-deciduous forests that belong to the AF Domain. Myrtaceae is also one of the richest families in these forests. There is a strong relationship of rainfall and temperature variation with a north to south floristic gradient of Myrtaceae species along the Espinhaço Range (Bünger et al. 2014). There are no studies similar to this in the Espinhaço Range for the southern portion of the AF domain, that correlates the geoclimatic variables with composition of species of Myrtaceae.

Comprehension of floristic variation throughout geographic space deepens the understanding of recent and past phytogeographic patterns (Gentry 1982; Prance 1982; Oliveira-Filho & Fontes 2000; Eisenlohr & Oliveira-Filho 2015). Studies that provide information on the geographic distribution of species are important for understanding biogeographic patterns when connected to phylogenetic studies (Fiaschi & Pirani 2009). One biogeographic pattern that is found in the AF is a biotic differentiation between two sectors, the northern and the southern, according to parsimony analyses of endemicity (Bates et al. 1998; Costa et al. 2000). Taking into consideration the tree flora, the separation area between these two sectors is around Campos dos Goitacazes (RJ), where the climate is drier and the semi-deciduous forest reaches the coast (Oliveira-Filho & Fontes 2000). Also, towards the northern portion of the Atlantic Forest, the mountain ranges occur further from the coast, particulary north of the Rio Doce basin influencing the floristic composition (Oliveira-Filho & Fontes 2000).

The objective of this study is to understand patterns in species composition of Myrtaceae throughout the southern AF. For such we used data from the authors research in the upper highlands subtropical forests in Parque Nacional de São Joaquim (Santa Catarina), to compare with the species composition of Myrtaceae in other areas of the southern AF. The following research questions guided this work:

1. How does geographic proximity influences species composition of Myrtaceae in southern AF areas?
2. Which geoclimatic variables mostly affect the species composition of Myrtaceae in the southern AF?

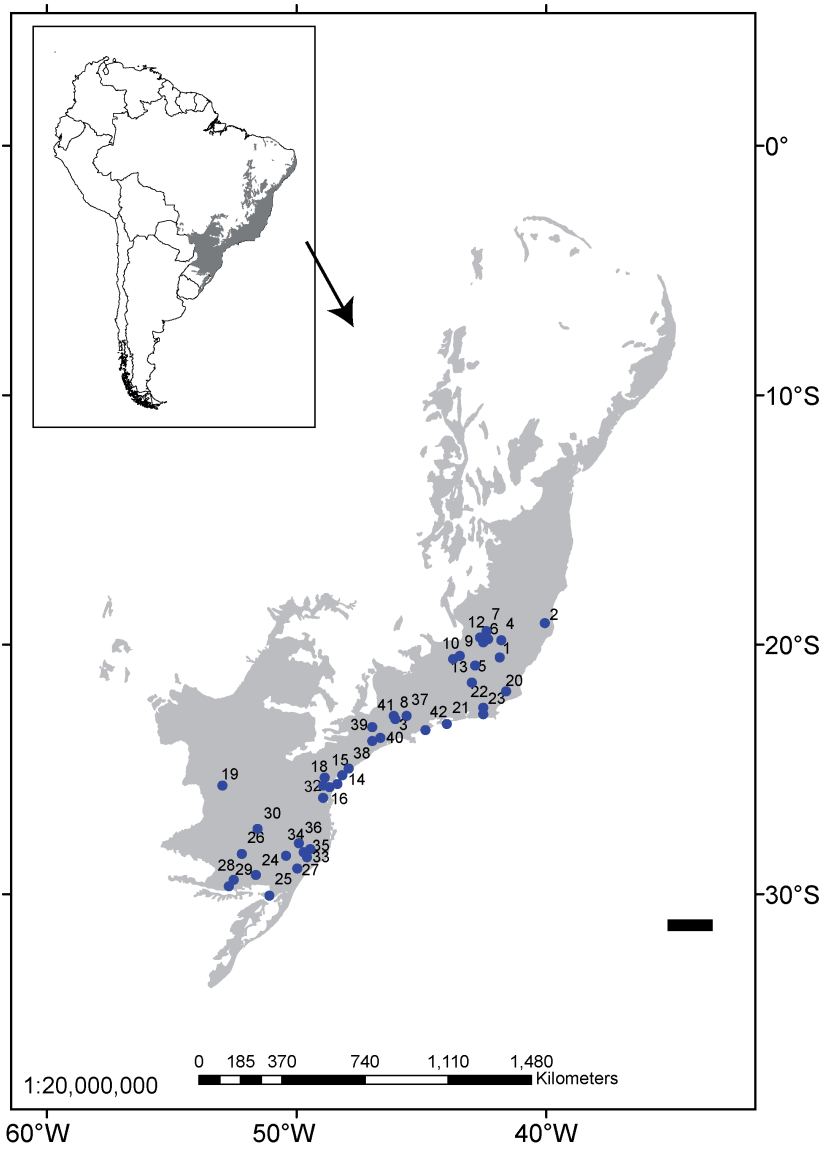
Methods

The Data Set

We created a matrix of presence and absence of 254 species of Myrtaceae in 42 different locations of the southern portion of the AF in South and Southeastern Brazil, with data from the literature available (Appendix I Table 2 and Figure 1). We standardized the names by updating nomenclatural synonyms following the database Lista de espécies da flora do Brasil from Jardim Botânico do Rio de Janeiro (by Sobral et al. 2016 <http://floradobrasil.jbrj.gov.br/jabot/floradobrasil/FB10648> Accessed on: 14 May 2016.)

Given the fact that the matrix of presence and absence of species was built with data from different sources, it is important to acknowledge that these studies had different methodologies. The sampling areas are of different sizes, varying between 0,004 to 370 km^2. In the studies where the sampling areas are smaller, some less abundant species might be left out. Some studies are floristic surveys and others are Myrtaceae floras of a determinate area.

Figure 1 The 42 localities throughout the southern Atlantic Forest domain in Southern and Southeastern Brazil for which floristic surveys or Myrtaceae floras were available. For localities names see Appendix I Table 2.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The 30 geoclimatic variables for each location were extracted from the database NeoTropTree (Oliveira-Filho 2014). The list of the 30 geoclimatic variables used in the analyses and their codes can be found on Table 4, Appendix III.

Species richness, dissimilarity analysis and grouping significance analysis

At first the data was explored descriptively through the richness and the Jaccard index of dissimilarity for the species of Myrtaceae in each locality. We separated the different altitudes of the localities in quotas (in m.a.s.l.): ≤ 50, > 50 and ≤ 100, > 100 and ≤ 200 and so forth, with intervals of 100 m until > 1500. Distances of each locality from the Atlantic Ocean were also separated in quotas (in km): ≤ 50, > 50 and ≤ 100, and so forth with intervals of 50 until > 300. We explored the data through the Jaccard index of dissimilarity for each altitudinal and distance from the ocean quota. Analyses of cophenetic correlation were performed in order to evaluate the dendrograms obtained and the consistency of the groupings pattern. Cophenetic correlation coefficients values close to one indicated better representation (Legendre & Legendre 1998). The significance of the groupings obtained from Jaccard dissimilarity analyses were tested, using a level of significance $p \leq 0.05$, through the test of similarity profile analyses (SIMPROF) (Clarke et al. 2008).

The classification of the vegetation physiognomies followed Oliveira-Filho (2009).

Ordination analysis and selection of predictive models

Initially Pearson correlation analysis and variance inflation factors analysis (VIF) were used (Fox & Monette 1992; Legendre & Legendre 1998) in order to evaluate the multicollinearity of the predictive variables, so that only the variables with VIF ≤ 10 were kept. Then, with the obtained subset of predictive variables not inflated, we performed a redundancy analysis (RDA) (Legendre & Legendre 1998) followed by an automatic stepwise model building for constrained ordination methods (ordistep) (Blanchet et al. 2008). The significance of the best model and of the variables that composed it were evaluated based on 999 permutations adopting a level of significance of $p \leq 0.05$ (Legendre & Legendre 1998).

Analysis of the spatial autocorrelation

A Mantel test was performed based on 999 permutations to evaluate the spatial autocorrelation of Myrtaceae composition among localities (Legendre & Legendre 1998). We also performed a Moran test to evaluate the spatial autocorrelation of species richness (Legendre and Legendre 1998; Legendre et al. 2015), for both analysis with a spatial matrix of distance obtained via geographic data (Legendre et al. 2015).

R and packages

We used the program R (R Core Team 2016) to develop the analyses, through vegan (Oksanen et al. 2013 - Vegan: Community Ecology Package R package version 2.0-7. http://CRAN.R-project.org/package=vegan), clustsig (Whitaker and Christman 2010 - clustsig: Significant Cluster Analysis. R package version 1.0 http://CRAN.Rproject.org/package=clustsig), pvclust (Ryota and Shumodaira 2011 - pvclust: Hierarchical Clustering with P-Values via Multiscale Bootstrap Resampling. R package version 1.2-2. http://CRAN.R-project.org/package=pvclust), HH (Heiberger 2013 - HH: Statistical Analysis and Data Display: Heiberger and Holland. R package version 2.3-42. http://CRAN.R-project.org/package=HH) and ade4 (Dray and Dufour 2007) packages.

Results

Richness, dissimilarity analysis and groupings significance analysis

The total richness of species of Myrtaceae throughout the different localities in the southern portion of the AF was 254 species (with 750 occurrence records) and 17 genera. The richest genera were *Eugenia* (79 species), *Myrcia* (65 species) and *Myrceugenia* (24 species), which together accounted for 66% of the species of Myrtaceae compiled. Five genera were represented by only one species: *Acca, Accara, Blepharocalyx, Myrrhinium* and *Pimenta*.

The richest locality was Reserva Biológica do Japi, with 47 species, followed by Parque Estadual do Itacolomi, with 45 species, and Área de Proteção Ambiental de Macaé de Cima, with 44 species. The localities with less species were Mata do Rio Vermelho, RPPN UNISC (Sinimbu) and Reserva Fazenda Sacramento, all with just three species. The average number of species per locality was 18 species. The species that showed wider distribution were *Myrciaria floribunda* and *Myrcia*

splendens, both occurring in 18 localities, and *Blepharocalyx salicifolius* and *Campoanesia guaviroba*, both occurring in 14 localities.

The average dissimilarity between species compositon of Myrtaceae in different localities in the southern AF was 94.18% (varying between 38.1% and 100%). The cophenetic correlation coefficient was r = 0.85.

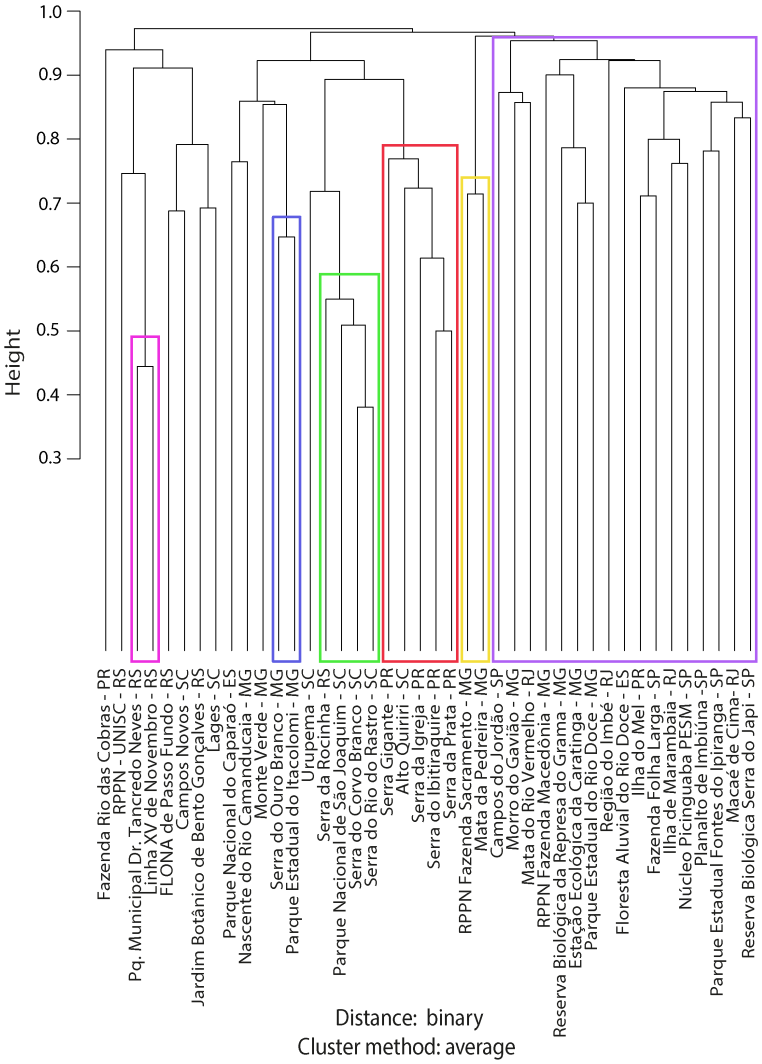

Figure 2 - Jaccard dissimilarity analysis and grouping significance for localities. The colored rectangles illustrate the groupings that were statistically significant.

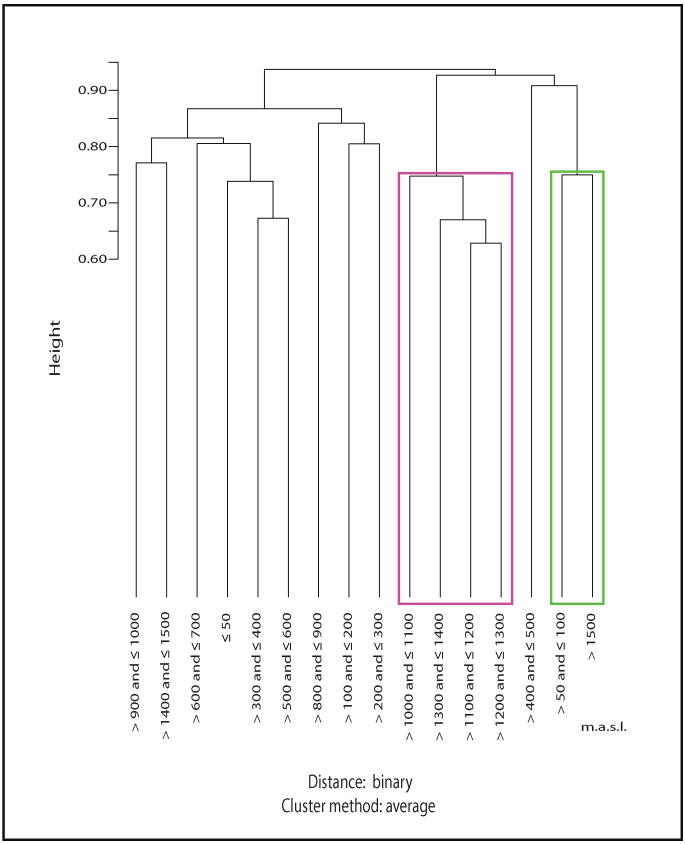

Figure 3 - Jaccard dissimilarity analysis and grouping significance for altitude quotas. The pink and green rectangles illustrate the groupings that were statistically significant. Altitude in m.a.s.l.

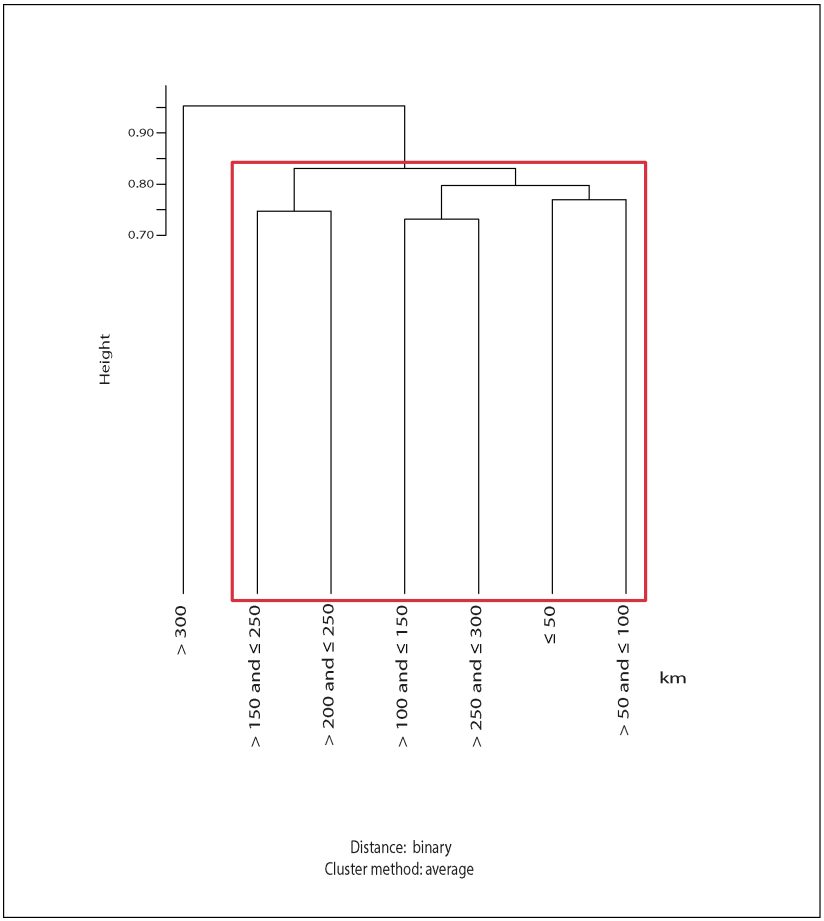

Figure 4 - Jaccard dissimilarity analysis and grouping significance for altitude quotas. The red rectangle illustrate the groupings that was statistically significant. Distances in km.

The Jaccard dissimilarity analysis and similarity profile analyses showed that there are six statistically different groups in relation to the composition of species of Myrtaceae in the data obtained from the Atlantic Forest (Figure 2A).

Group I – composed of two lower tableland areas, Parque Municipal Dr. Tancredo Neves and Linha XV de Novembro, situated in the interior of Rio Grande do Sul in Southern Brazil, constituted of semi-deciduous forests, and a seasonally cold, subtropical climate. These localities share *Eugenia verticillata* and *Myrcianthes pungens*.

Group II – composed of lower highland and upper highland areas in Southeastern Brazil, with a tropical climate and evergreen broadleaved forests: Ouro Branco and Ouro Preto respectively, both in Minas Gerais. The species shared by the two locations are: *Blepharocalyx salicifolius, Calyptranthes pulchella, Campomanesia adamantium, Campomanesia pubescens, Eugenia ligustrina, Myrceugenia alpigena, Myrcia amazonica, Myrcia laruotteana, Myrcia obovata, Myrcia retorta, Myrcia splendens, Myrcia subverticillaris, Myrcia venulosa, Psidium firmum and Siphoneugena crassifolia.*

Group III – This group is formed by four lower highland, upper highland and tableland summit areas of subtropical climate in Southern Brazil: Serra da Rocinha, in Rio Grande do Sul state, and Lages, Serra do Corvo Branco and Serra do Rio do Rastro in Santa Catarina state. This group includes subtropical forests like evergreen broadleaved dwarf forest and evergreen needle-broadleaved Forest (*Araucaria* forest). Species shared by these locations are: *Myrceugneia euosma, M. alpigena, M. oxysepala, M. pilotantha, M. regnelliana, Myrcia guianensis, M. oligantha, Myrrhinium atropurpureum* and *Siphoneugena reitzii.*

Group IV – This group is composed of five lower and upper highland areas in Serra do Mar, with subtropical climate: Serra Gigante, Serra da Igreja, Serra do Ibitiraquire and Serra da Prata, in Paraná state, and Alto Quiriri in Santa Catarina state. The main vegetation physiognomies in these areas are evergreen broadleaved forest and evergreen broadleaved dwarf-forest. Common species for these locations are: *Blepharocalyx salicifolius*, *Myrcia pulchra*, *Pimenta pseudocaryophyllus* and *Siphoneugena reitzii*.

Group V – This group is composed of two areas of semi-deciduous forests, of lower and upper hills in Minas Gerais state with a tropical climate: Reserva Fazenda Sacramento and Mata da Pedreira. The common species in these locations are: *Eugenia florida* and *Myrciaria floribunda*.

Group VI – This group is composed of 17 areas that are very different from each other in altitude and forest types. They are all in Southeastern Brazil and in the tropical thermic realm, except for Ilha do Mel in Paraná, which is subtropical. The species that are common between these areas are: *Campomanesia guaviroba, Myrcia splendens, Myrcia spectabilis* and *Myrciaria floribunda.*

The dissimilarity values between altitudinal quotas was 89.1% on average (varying between 62.9% and 98.3%), with cophenetic correlation of r = 0.88. The analyses resulted in two statistically significant groups (Figure 2B), one containing the quotas between > 1000 and ≤ 1400 m.a.s.l., and a second containing the quotas > 50 and ≤ 100 m.a.s.l. and > 1500 m.a.s.l.. The average dissimilarity per quota of distance to the Atlantic Ocean was 84.7 % (varying between 73.2% and 97.3%), with a cophenetic correlation of r = 0.91. (Figure 2C). The analyses resulted in only one statistically significant group containing the quotas ≤ 300 km from the ocean.

Ordination analysis and selection of predictive models

Through the variance inflation factors analysis VIF, it was verified that in the group of predictive variables there was multicollinearity. Therefore, after exclusion of the redundant variables, the subset contained the following variables: (1) altitude, (2) distance from the ocean, (3) mean diurnal temperature range, (4) temperature seasonality, (5) mean temperature of wettest quarter, (6) mean temperature of driest quarter, (7) precipitation of wettest month, (8) severity of water deficit period, (9) cloud cover, (10) cloud interception and (11) actual evapotranspiration. With this subset of 11 predictive variables, the RDA analysis with selection of models explained 41.32% of the total variation of Myrtaceae species composition in different localities. There was a better model based on the RDA, which explained 34.85% of the total variation (Figure 3). In this better model three variables were eliminated (mean temperature of wettest quarter, mean temperature of driest quarter, and cloud interception) and only 6% of the variation in the data explanation was reduced. The model with 34.85% of the explanation included (1) altitude, (2) precipitation of wettest month, (3) temperature seasonality, (4) distance from the ocean, (5) severity of water deficit period, (6) actual evapotranspiration, (7) mean diurnal temperature range and (8) cloud cover. The explanation values of the first two components (the first two and principal axes of the ordination) were 9.96% and 6.61% respectively, amounting to 16.57%

of the variation and the model was statistically significant [F = 2.21; df = 41; p = 0.05]. All the variables of the model were statistically significant (Table 1). The main predictors of the variation of Myrtaceae composition throughout different localities in the southern Atlantic Forest were altitude, precipitation of wettest month, temperature seasonality and distance from the ocean (Table 1).

Figure 5. Redundancy Analysis (RDA) to evaluate Myrtaceae species composition among different localities in the southern Atlantic Forest in relation to non-multicolinear geoclimatic predictors. For localities names see Appendix I Table 2; Species codes are found in Appendix II Table 3; Predictors codes are in Appendix III.

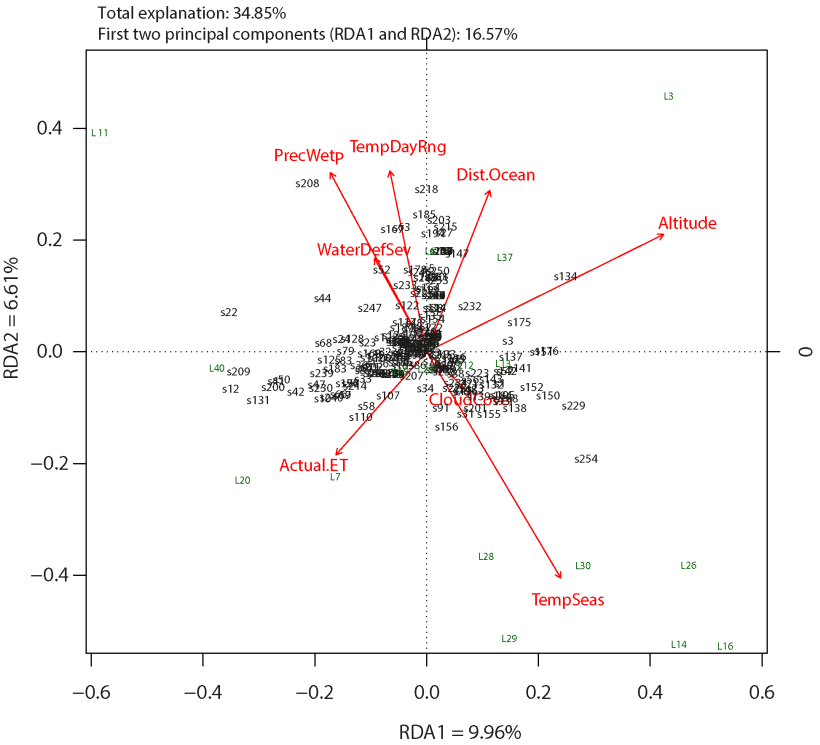
Total explanation: 34.85%
First two principal components (RDA1 and RDA2): 16.57%
PrecWetp
TempDayRng
Dist.Ocean
Altitude
WaterDefSev
CloudCD9
Actual.ET
TempSeas
RDA2 = 6.61%
RDA1 = 9.96%
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.4
−0.2
0.0
0.2
0.4
0.6
0

Table 1. Significance of predictive variables of Myrtaceae composition variation, resulting from RDA analysis followed by an automatic stepwise model building for constrained ordination methods (ordistep)

Variables	Df	F	p
Altitude	1	3.4375	0.001
PrecWetP	1	2.9943	0.001
TempSeas	1	2.3103	0.001
Dist.Ocean	1	2.1958	0.002
WaterDefSev	1	1.9196	0.003
Actual.ET	1	1.8121	0.011
TempDayRng	1	1.5382	0.025
CloudCover	1	1.4657	0.035
Residual	33		

In ordination, the RDA1 axis is positively related to altitude and temperature seasonality and negatively related to precipitation of wettest month and actual evapotranspiration (Figure 3). In RDA1, the main species placed positively in the axis were *Myrceugenia alpigena*, *M. oxysepala, M. pilotantha, Myrcia hartwegiana, Myrrhinium atropurpureum* and *Siphoneugena reitzii*. The main species placed negatively in the axis were *Calyptranthes lucida, Campomanesia guaviroba, Marlierea tomentosa* and *Myrcia spectabilis*. The ordination of the localities for the RDA1 axis was positive for Nascente do Rio Camanducaia (MG), Serra da Igreja (PR), Serra Gigante (PR), Linha XV de Novembro (RS), RPPN UNISC (RS), Campos Novos (SC) and Campos do Jordão (SP). The ordination of the localities for the RDA1 axis was negative for Parque Estadual do Rio Doce (MG); Região do Imbé (RJ) and Parque Estadual Fontes do Ipiranga (SP).

The second principal component (RDA2) had a positive influence of mean diurnal temperature range, precipitation of wettest month and distance from the ocean and a negative influence of temperature seasonality and actual evapotranspiration (Figure 3). The species on the positive portion of this axis were *Myrcia splendens* and *M. venulosa* and to the negative portion of the axis were *Myrcia aethusa* and *Siphoneugena reitzii*. The main localities related to the positive portion of the RDA2 axis were Nascente do Rio Camanducaia (MG), Parque Estadual do Rio Doce (MG) and Campos do Jordão (SP) and to

the negative portion of the RDA2 were Serra Gigante (PR); Serra da Igreja (PR); Região do Imbé (RJ), Floresta Nacional de Passo Fundo (RS), RPPN UNISC (RS), Linha XV de Novembro (RS), Campos Novos (SC).

Analysis of spatial autocorrelation

The average distance among localities was 619.4 km (± 415.6), ranging from 9.9 to 1,730.8 km. The composition of Myrtaceae species was not autocorrelated spatially [Mantel test value r = -0.45; significance p = 1], and species richness was also not autocorrelated [Moran test observed Mobs = 0.01; Moran test expected Mexp = -0.02; standard deviation sd = 0.05; significance p = 0.56].

Discussion

Seven hundred and fifty occurrences, 254 species and 17 genera of Myrtaceae were registered for the southern AF in this study. In Brazil there are 1032 species and 32 genera of Myrtaceae, in the AF domain alone there are 707 species and 20 genera. There are 576 species and 19 genera of Myrtaceae in the portion of the AF that lies in Southeastern Brazil and 254 species and 18 genera in Southern Brazil (Sobral et al 2016 <http://floradobrasil.jbrj.gov.br/jabot/floradobrasil/FB10648> Accessed on: 14 May 2016.).

Tropical vegetation regions present high species richness and a considerable proportion of geographically restricted species (Gentry 1995). In this study 40 % of the 254 species registered for the southern AF occurred in only one locality. Only 2 species of the 254 (0.8 %) reached as much as 18 localities of the 42 total (42% of all localities). This high percentage of geographically restricted species, and small percentage of common species contributes to the high dissimilarity between localities obtained in the dissimilarity analysis of Jaccard. The southern area of the AF domain showed to be richer in Myrtaceae species than the Espinhaço Range. While in this study it was found 254 species and 17 genera of Myrtaceae, a similar study in the Espinhaço range presented 199 species and 15 genera of Myrtaceae (Bünger et al. 2014).

Five genera presented only one species: *Acca, Accara, Blepharocalyx, Myrrhinium* and *Pimenta*. *Acca sellowiana* and *Pimenta pseudocaryophyllus* are the only species of these genera that occur in Brazil. *Accara* and *Myrrhinium* are monotypic genera. There are three

species of *Blepharocalyx* in Brazil, one that occurs in the Amazon, *Blepharocalyx myriophyllus* (Casar.) Morais & Sobral from the Serra do Caraça in Minas Gerais and *Blepharocalyx salicifolius*, in South, Southeastern, and Center-Western regions and in the state of Bahia(Sobral et al 2016 <http://floradobrasil.jbrj.gov.br/jabot/floradobrasil/FB10648> Accessed on: 14 May 2016).

As mentioned before, in the realm of this study, of the 254 species and the 42 localities, some appear restricted to certain areas. *Accara elegans*, endemic to the southern portion of the Espinhaço Range (Landrum 1990), was registered in Ouro Branco, Minas Gerais. *Acca sellowiana* and *Myrrhinium atropurpureum* were restricted to high altitude localities in the Serra Geral. In this study *Pimenta pseudocaryophyllus* and *Myrceugenia* appear restricted to high altitudes throughout the southern AF domain. *Siphoneugena reitzii* was restricted to high altitude localities in Serra do Mar and Serra Geral.

The most widely distributed genera, *Eugenia, Myrcia* and *Myrceugenia*, comprise more than 66% of the Myrtaceae flora of the southern portion of the AF studied here. *Eugenia* and *Myrcia* are genera with a high number of species in Brazil, 338 and 261 respectively, while *Myrceugenia* is a smaller genus with 32 species in Brazil (Sobral et al 2016 <http://floradobrasil.jbrj.gov.br/jabot/floradobrasil/FB10648> Accessed on: 14 May 2016.) *Myrceugenia* usually grows on moderately cool, wet climates in temperate and subtropical areas of South America (Landrum 1981; Murillo-A et al. 2016). In this study *Myrceugenia* was common in high altitude areas of tropical and subtropical climate.

The richest areas in Myrtaceae species were Reserva Biológica do Japi (SP), Parque Estadual do Itacolomi (MG) and Aréa de Proteção Ambiental de Macaé de Cima (RJ). It is interesting to note that tropical upper highland evergreen forests constituted these areas.

Two of the areas with less species were those of semi-deciduous forests Fazenda Sacramento (MG) and RPPN UNISC (RS). The floristic composition of the semi-deciduous tropical forest is a subset of the coastal evergreen tropical forest, composed of a group of species that can withstand the climatic differences and seasonality (Oliveira-Filho & Fontes 2000).

Three groups that resulted from Jaccard's dissimilarity analysis (Groups II, III and IV) represent highland and tableland summit areas and are closely related in the dendrogram, Group II in Serra do Espinhaço in Minas Gerais, Group III in Serra Geral in Santa Catarina, and Group IV in Serra do Mar in Paraná and Northern Santa Catarina.

The altitude gradient affects the floristic composition along the AF domain (Oliveira-Filho & Fontes 2000; Nettesheim et al 2010). The variations in altitude are strongly correlated with an internal differentiation in species composition either in evergreen rainforest as in the semi-deciduous forests (Oliveira-Filho et al. 2005). In the ordination analysis, altitude appears in the positive portion of the RDA1 axis. Some of the localities that appeared in the positive portion of the axis were high altitude areas in Serra do Mar in Paraná and Serra do Espinhaço in Minas Gerais and São Paulo.

The dissimilarity analysis of different altitudinal quotas presented two significant groups (Figure 2B): one that included the localities >1000 and ≤ 1400 m.a.s.l. and another that included the localities > 50 and ≤ 100 m.a.s.l. and > 1500 m.a.s.l. The group with localities between > 1000 and ≤ 1400 m.a.s.l. corroborates the Jaccard dissimilarity analysis Groups II, III and IV, that there is a differentiation in species of Myrtaceae above 1000 m.a.s.l. and indicates a certain floristic similarity between them, even if they are not close geographically. The other unlikely group, that included lowland (> 50 and ≤ 100 m.a.s.l.) and upper highlands (> 1500 m.a.s.l.) quotas was formed because the localities of Mata Rio Vermelho (RJ), with altitude 63 m.a.s.l., and Campos do Jordão (SP), with altitude 1535 m.a.s.l., both share *Myrcia splendens*, a species that occurs in 42% of all localities.

In South America the tropics tend to be richer in species than the subtropics, a fact that is related to temperature and precipitation and the inability (cold intolerance) of the lineages in the tropics to withstand the subtropics (Giehl & Jarenkow 2012; Oliveira-Filho et al. 2013). Group VI that resulted from the Jaccard dissimilarity analysis was composed of 17 localities that varied in altitude and forest types, but they all had in common the tropical climate (all in Southeastern Brazil) except for one area in Paraná with a subtropical climate, a maritime climatic regime and coastal elevation range.

There is a latitudinal differentiation in the AF domain that makes the evergreen rainforests and the semi-deciduous forests of each latitude more similar to each other in floristic composition, than other forests of the same type further away (Oliveira-Filho & Ratter 1995; Oliveira-Filho & Fontes 2000; Oliveira-Filho et al. 2005). There were two groups of semi-deciduous forests from the Jaccard dissimilarity analysis, Group I in Rio Grande do Sul and Group II in Minas Gerais, but even though they are both of the same forest type they are distant from each other in the dendrogram. It is possible that the species compositions of these localities are more closely related to that of the

coastal evergreen tropical forests in the same latitude than to other semi-deciduous forests further away.

However, in the present study the composition of Myrtaceae species was not significantly affected by geographic distance. This result goes in the opposite direction than the scientific studies previously cited that included more plant families (Oliveira-Filho & Fontes 2000; Eisenlohr & Oliveira-Filho 2015). Maybe if more localities were included in the analysis the results would be different, because of the possibility that large gaps between localities could have affected the results.

The similarity analysis of quotas with different distances from the Atlantic Ocean showed one significant group with localities ≤ 300 km (Figure 2C). The only locality that is not within this group is Fazenda Rio das Cobras (PR) where the vegetation is of semi-deciduous forest. This analysis also could have benefited from an inclusion of more areas in the data set. Nonetheless, this grouping pattern could be related to the gradient of rainfall from the coast to the hinterlands that affects the vegetation composition, with a pattern of diminishing richness towards the interior (Oliveira-Filho and Fontes 2000; Fundação de Pesquisas Florestais do Paraná 2001; Eisenlohr & Oliveira-Filho 2015).

The ordination analysis showed that the main predictors to explain the variation in Myrtaceae species composition in the southern part of the AF domain were: altitude, precipitation of wettest month, temperature seasonality and distance from the ocean. Annual rainfall and rainfall seasonality are important variables for explaining species richness in Neotropical forests (Clinebell II et al. 1995). The latitudinal differentiation of the floristic composition in the AF domain mentioned earlier is due to variations in rainfall regime and temperature (Oliveira-Filho & Ratter 1995; Oliveria-Filho & Fontes 2000; Oliveira-Filho et al. 2005). The variables precipitation of wettest month and temperature seasonality are related to rainfall regime and temperature. Annual rainfall and its seasonality influenced the floristic composition of areas in the portion of the AF domain that lies in Southeastern Brazil (Kamino et al. 2008; Nettesheim et al 2010; Santos et al. 2011) .

The RDA1 axis was positive for temperature seasonality. Some localities that were in the positive portion of the RDA1 axis are in the hinterland, constituted by semi-deciduous forests with a subtropical climate affected by a cold season. The variation of tree species composition in the different forest types on the subtropical climate portion of the southern AF is importantly related to extremes of low temperature (Oliveira-Filho et al. 2013).

Actual evapotranspiration was one of the 8 variables of the model based on the RDA, which explained 34.85% os the compositon of Myrtacea species in the south of the AF. It appeared on the negative portion of both RDA axes. In the subtropical portion of the southern AF actual evapotranspiration and minimum temperature are significantly correlated with species richness (Oliveira-Filho et al. 2013). In this region there is a pattern of lessening species richness with diminishing minium temperatures and actual evapotranspiration (Rambo 1961; Smith 1962; Waechter & Jarenkow 2003; Oliveira-Filho et al. 2013).

Conclusion

The composition of Myrtaceae species varies greatly from one area to another in the southern AF, with a high percentage of geographically restricted species and a low percentage of common species. There is a differentiation in Myrtaceae species composition related to altitude, probably due to similar conditions and history. Areas of higher altitude may share species occurrence even if they are not near geographically. Climate, wether tropical or subtropical influences the species distribution in Myrtaceae. The main predictors of the variation in Myrtaceae species composition in the southern part of the AF domain are: altitude, precipitation of wettest month, temperature seasonality and distance from the ocean.

It would be interesting to include the entire AF domain, and Eastern Paraguay and Northern Argentina, with a higher number of localities and a standard methodology with wide sampling areas. One possibility would be to use data from herbaria and from databases like speciesLink.

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Appendix I

Table 2: Summary of all the 42 southern Atlantic Forest areas studied in Southern and Southeastern Brazil.

	Location	Latitude	Longitude	Elevation (m.a.s.l.)	Genera	Species	Reference
1	Parque Nacional do Caparaó, Alto Caparaó, ES	-20.441	-41.844	1481	5	9	(Mazine & Souza 2008)
2	Floresta Estacional Semidecidual Aluvial do Rio Doce, Linhares, ES	-19.159	-40.022	50	10	35	(Rolim et al. 2006)
3	Nascente do Rio Camanducaia, Camanducaia, MG	-22.785	-46.104	1337	7	12	(França & Stehmann 2004)
4	Estação Ecológica da Caratinga, Caratinga, MG	-19.721	-41.823	576	7	31	(Lombardi & Gonçalves 2000; Gonçalves & Lombardi 2004)
5	Reserva Biológica da Represa do Grama, Descoberto, MG	-21.424	-42.953	752	5	22	(Forzza et al. 2014)
6	Morro do Gavião, Dionísio, MG	-19.8	-42.535	323	4	5	(França & Stehmann 2013)

7	Reserva Particular do Patrimônio Natural Fazenda Macedônia, Ipaba, MG	-19.341	-42.403	285	4	6	(França & Stehmann 2013)
8	Monte Verde, MG	-22.871	-46.08	1420	8	23	(Meireles et al. 2014)
9	Serra do Ouro Branco, Ouro Branco, MG	-20.483	-43.683	1429	10	24	(Santos & Sano 2012)
10	Parque Estadual do Itacolomi, Ouro Preto, MG	-20.434	-43.501	1402	12	45	(Bünger et al. 2012)
11	Parque Estadual do Rio Doce, Marliéria, MG	-19.684	-42.618	576	6	21	(Gonçalves & Lombardi 2004; França & Stehmann 2013; Lombardi & Gonçalves 2000)
12	Reserva Particular do Patrimônio Natural Fazenda Sacramento, Pingo D'Água, MG	-19.723	-42.428	274	3	3	(França & Stehmann 2013)
13	Mata da Pedreira, Viçosa, MG	-20.778	-42.873	719	3	6	(Marangon et al. 2003)
14	Serra Gigante, Guaraqueçaba, PR	-25.144	-48.156	1043	6	10	(Scheer & Mocochinsky 2009)
15	Serra do Ibitiraquire, Campina	-25.251	-48.826	1331	4	7	(Scheer & Mocochinsky 2009)

	Grande do Sul, PR						
16	Serra da Igreja, Morretes, PR	-25.609	-48.859	1257	4	7	(Scheer & Mocochinski 2009)
17	Ilha do Mel, Paranaguá, PR	-25.51	-48.353	22	9	29	(Lima et al. 2015)
18	Serra da Prata, Morretes, PR	-25.627	-48.691	1286	7	14	(Scheer & Mocochinsky 2009)
19	Fazenda Rio das Cobras, Quedas do Iguaçu, PR	-25.558	-52.979	487	3	6	(Viani et al. 2011)
20	Região do Imbé, Parque Estadual do Desengano, Campos dos Goitacazes, RJ	-21.805	-41.65	230	4	9	(Moreno et al. 2003)
21	Ilha de Marambaia, Mangaratiba, RJ	-23.079	-43.978	561	10	36	(Nettesheim et al. 2012)
22	Macaé de Cima, Nova Friburgo, RJ	-22.441	-42.569	1424	11	44	(Barroso & Peron 1994)
23	Mata Rio Vermelho, Rio Bonito, RJ	-22.717	-42.544	63	2	3	(Carvalho et al. 2007)
24	Jardim Botânico de Bento Gonçalves, Bento Gonçalves, RS	-29.185	-51.611	623	10	20	(Cenci et al. 2013)
25	Parque Municipal Doutor	-29.951	-51.094	45	5	8	(Troian et al. 2011)

	Tancredo Neves, Cachoeirinha, RS						
26	Floresta Nacional de Passo Fundo, Passo Fundo, RS	-28.287	-52.189	724	8	12	(Sühs 2013)
27	Serra da Rocinha, São José dos Ausentes, RS	-28.857	-50.014	1113	4	12	(Falkenberg 2003)
28	RPPN UNISC, RS	-29.406	-52.545	315	1	3	(Sühs & Budke 2011)
29	Linha XV de Novembro, RS	-29.573	-52.671	305	3	6	(Jarenkow & Waechter 2001)
30	Campos Novos, SC	-27.32	-51.526	587	5	9	(Higuchi et al. 2012)
30	Lages, SC	-28.35	-50.4	990	8	14	(Higuchi et al. 2012)
31	Serra do Corvo Branco, Urubici, SC	-28.101	-49.469	1484	6	17	(Falkenberg 2003)
32	Alto Quiriri, Garuva SC	-26.025	-48.954	1200	10	26	(Vieira 2010)
34	Parque Nacional de São Joaquim, Urubici, SC	-28.169	-49.68	1475	8	21	(Falkenberg 2003; Wagner & Fiaschi 2016 – see Chapter 1)
35	Serra do Rio do Rastro, Bom Jardim da Serra, SC	-28.432	-49.588	1426	6	17	(Falkenberg 2003)
36	Fazenda das Nascentes, SC	-27.903	-49.882	1498	7	16	(Martins-Ramos et al. 2011)
37	Campos do Jordão, SP	-22.766	-45.622	1535	3	5	(Pereira-Silva et al. 2007)

38	Fazenda Folha Larga, Cananéia SP	-24.904	-47.947	157	6	29	(Urbanetz et al. 2010)
39	Planalto de Ibiúna, Cotia, SP	-23.772	-46.971	983	9	27	(Durigan et al. 2008)
40	Parque Estadual Fontes do Ipiranga, São Paulo, SP	-23.656	-46.625	802	7	12	(Tanus et al. 2012)
41	Reserva Biológica do Japi, Jundiaí, SP	-23.23	-46.973	923	10	47	(Lombardi et al. 2012)
42	Parque Estadual da Serra do Mar, Núcleo Picinguaba, Ubatuba, SP	-23.318	-44.81	305	8	42	(Gomes et al. 2011)

Appendix II

Table 3: Species of Myrtaceae found in the southern Atlantic Forest compiled in this study from the literature available and their respective codes from.

Species	**code**	**Species**	**code**
Acca sellowiana	s1	*Eugenia batingabranca*	s36
Accara elegans	s2	*Eugenia biflora*	s37
Blepharocalyx salicifolius	s3	*Eugenia bimarginata*	s38
Calyptranthes brasiliensis	s4	*Eugenia blastantha*	s39
Calyptranthes clusiifolia	s5	*Eugenia bocainensis*	s40
Calyptranthes concinna	s6	*Eugenia brasiliensis*	s41
Calyptranthes detecta	s7	*Eugenia brevistyla*	s42
Calyptranthes fusiformis	s8	*Eugenia burkartiana*	s43
Calyptranthes glazioviana	s9	*Eugenia cerasiflora*	s44
Calyptranthes grandifolia	s10	*Eugenia capitulifera*	s45
Calyptranthes lanceolata	s11	*Eugenia copacabanensis*	s46
Calyptranthes lucida	s12	*Eugenia cuprea*	s47
Calyptranthes obovata	s13	*Eugenia dodonaeifolia*	s48
Calyptranthes pulchella	s14	*Eugenia ellipsoidea*	s49
Calyptranthes rubella	s15	*Eugenia excelsa*	s50
Calyptranthes rufa	s16	*Eugenia flamingensis*	s51
Calyptranthes strigipes	s17	*Eugenia florida*	s52
Campomanesia adamantium	s18	*Eugenia francavilleana*	s53
Campomanesia dichotoma	s19	*Eugenia fusca*	s54
Campomanesia espiritosantensis	s20	*Eugenia gracillima*	s55
Campomanesia eugenioides	s21	*Eugenia handroana*	s56
Campomanesia guaviroba	s22	*Eugenia handroi*	s57
Campomanesia guazumifolia	s23	*Eugenia involucrata*	s58
Campomanesia laurifolia	s24	*Eugenia kleinii*	s59
Campomanesia phaea	s25	*Eugenia lambertiana*	s60
Campomanesia prosthecesepala	s26	*Eugenia leonorae*	s61
Campomanesia pubescens	s27	*Eugenia leptoclada*	s62
Campomanesia rufa	s28	*Eugenia ligustrina*	s63
Campomanesia sessiliflora	s29	*Eugenia longipedunculata*	s64
Campomanesia simulans	s30	*Eugenia mansoi*	s65
Campomanesia xanthocarpa	s31	*Eugenia melanogyna*	s66
Eugenia acutata	s32	*Eugenia monosperma*	s67
Eugenia astringens	s33	*Eugenia mosenii*	s68
Eugenia bacopari	s34	*Eugenia multicostata*	s69
Eugenia bahiensis	s35	*Eugenia myrcianthes*	s70

Species	**code**	**Species**	**code**
Eugenia neoglomerata	s71	*Marlierea angustifolia*	s113
Eugenia neolaurifolia	s72	*Marlierea clausseniana*	s114
Eugenia neomyrtifolia	s73	*Marlierea estrellensis*	s115
Eugenia neosilvestris	s74	*Marlierea eugeniopsoides*	s116
Eugenia neoverrucosa	s75	*Marilierea excoriata*	s117
Eugenia nutans	s76	*Marlierea glabra*	s118
Eugenia oblongata	s77	*Marlierea involucrata*	s119
Eugenia oeidocarpa	s78	*Marlierea laevigata*	s120
Eugenia pisiformis	s79	*Marlierea martinelli*	s121
Eugenia platyphylla	s80	*Marlierea obscura*	s122
Eugenia platysema	s81	*Marlierea obversa*	s123
Eugenia pluriflora	s82	*Marlierea parvifolia*	s124
Eugenia prasina	s83	*Marlierea racemosa*	s125
Eugenia pruinosa	s84	*Marlierea regeliana*	s126
Eugenia pruniformis	s85	*Marlierea reitzii*	s127
Eugenia punicifolia	s86	*Marlierea silvatica*	s128
Eugenia pyriflora	s87	*Marlierea suaveolens*	s129
Eugenia pyriformis	s88	*Marlierea teuscheriana*	s130
Eugenia ramboi	s89	*Marlierea tomentosa*	s131
Eugenia rostrata	s90	*Myrceugenia acutiflora*	s132
Eugenia rostrifolia	s91	*Myrceugenia acutata*	s133
Eugenia rotundicosta	S92	*Myrceugenia alpigena*	s134
Eugenia sclerocalyx	s93	*Myrceugenia.brevipedicellata*	s135
Eugenia selloi	s94	*Myrceugenia.campestrils*	s136
Eugenia sonderiana	s95	*Myrceugenia cucullata*	s137
Eugenia speciosa	s96	*Myrceugenia euosma*	s138
Eugenia sphenophylla	s97	*Myrceugenia franciscensis*	s139
Eugenia stigmatosa	s98	*Myrceugenia gertii*	s140
Eugenia stiptata	s99	*Myrceugenia glaucescens*	s141
Eugenia subavenia	s100	*Myrceugenia glaucescens* X *M. regnelliana*	s142
Eugenia subundulata	s101	*Myrceugenia hamoniana*	s143
Eugenia sulcata	s102	*Myrceugenia hoehnei*	s144
Eugenia supraaxillaris	s103	*Myrceugenia kleinii*	s145
Eugenia tenuipedunculata	s104	*Myrceugenia mesomischa*	s146
Eugenia ternatifolia	s105	*Myrceugenia miersiana*	s147
Eugenia umbrosa	s106	*Myrceugenia myrcioides*	s148
Eugenia uniflora	s107	*Myrceugenia ovalifolia*	s149
Eugenia uruguayensis	s108	*Myrceugenia oxysepala*	s150
Eugenia vattimoana	s109	*Myrceugenia pilotantha*	s151
Eugenia verticillata	s110	*Myrceugenia regnelliana*	s152
Marlierea acuminatissima	s111	*Myrceugenia rufescens*	s153
Marlierea affinis	s112	*Myrceugenia scutellata*	s154

Species	**code**	**Species**	**code**
Myrceugenia seriatoramosa	s155	*Myrcia perforata*	s197
Myrcia aethusa	s156	*Myrcia plusiantha*	s198
Myrcia amazonica	s157	*Myrcia pubiflora*	s199
Myrcia anacardiifolia	s158	*Myrcia pubipetala*	s200
Myrcia anceps	s159	*Myrcia pulchra*	s201
Myrcia brasiliensis	s160	*Myrcia racemosa*	s202
Myrcia citrifolia	s161	*Myrcia retorta*	s203
Myrcia clavija	s162	*Myrcia riodocensis*	s204
Myrcia coelosepala	s163	*Myrcia rufipes*	s205
Myrcia crocea	s164	*Myrcia rupicula*	s206
Myrcia dichrophylla	s165	*Myrcia selloi*	s207
Myrcia eriocalyx	s166	*Myrcia splendens*	s208
Myrcia eriopus	s167	*Myrcia spectabilis*	s209
Myrcia eugeniopsoides	s168	*Myrcia squamata*	s210
Myrcia fenzliana	s169	*Myrcia stictophylla*	s211
Myrcia flagellaris	s170	*Myrcia subcordata*	s212
Myrcia follii	s171	*Myrcia subverticillaris*	s213
Myrcia glazioviana	s172	*Myrcia tijucensis*	s214
Myrcia glabra	s173	*Myrcia tomentosa*	s215
Myrcia grandifolia	s174	*Myrcia undulata*	s216
Myrcia guianensis	s175	*Myrcia vauthiereana*	s217
Myrcia hartwegiana	s176	*Myrcia venulosa*	s218
Myrcia hatschbachii	s177	*Myrcia vittoriana*	s219
Myrcia hebepetala	s178	*Myrcia warmingiana*	s220
Myrcia heringii	s179	*Myrcianthes gigantea*	s221
Myrcia hexasticha	s180	*Myrcianthes pungens*	s222
Myrcia ilheosensis	s181	*Myrciaria delicatula*	s223
Myrcia insigniflora	s182	*Myrciaria disticha*	s224
Myrcia isaiana	s183	*Myrciaria floribunda*	s225
Myrcia lajeana	s184	*Myrciaria glomerata*	s226
Myrcia laruotteana	s185	*Myrciaria strigipes*	s227
Myrcia laxiflora	s186	*Myrciaria tenella*	s228
Myrcia lineata	s187	*Myrrhinium atropurpureum*	s229
Myrcia lutescens	s188	*Neomitranthes glomerata*	s230
Myrcia montana	s189	*Neomitranthes stictophylla*	s231
Myrcia multiflora	s190	*Pimenta pseudocaryophyllus*	s232
Myrcia mutabilis	s191	*Plinia cauliflora*	s233
Myrcia neoblanchetiana	s192	*Plinia cordifolia*	s234
Myrcia oblongata	s193	*Plinia edulis*	s235
Myrcia obovata	s194	*Plinia involucrata*	s236
Myrcia oligantha	s195	*Plinia martinelli*	s237
Myrcia palustris	s196	*Plinia peruviana*	s238

Species	**code**	**Species**	**code**
Plinia rivularis	s239		
Psidium cattleianum	s240		
Psidium firmum	s241		
Psidium grandifolium	s242		
Psidium guineense	s243		
Psidium myrtoides	s244		
Psidium robustum	s246		
Psidium rufum	s247		
Psidium sartorianum	s248		
Siphoneugena crassifolia	s249		
Siphoneugena densiflora	s250		
Siphoneugena dussii	s251		
Siphoneugena guilfoyleiana	s252		
Siphoneugena kiaerskoviana	s253		
Siphoneugena reitzii	s254		

Appendix III

Table 4: List of geoclimatic variables used in the analyses.

1	Altitude	Altitude of iste centre (m)
2	Alt SRTM	Altitude of site centre (m) given by SRTM (Shuttle Radar Topography Mission)
3	Dist Ocean	Distance from the ocean
4	TempAnn	Annual mean temperature (°C)(World Clim B1)
5	TempDayRng	Mean Diurnal Range (Mean(perio max-min)) (°C) (World Clim B2)
6	Isotherm	Isotyhermality (B2/B7) WorldClim B3
7	TempSeas	Temperature Seasonality (100*Standard deviation monthly temp) (°C) (WorldClim B4)
8	TempMax	Maximum Temperature of Warmest Month (°C) (World Clim B5)
9	TempMin	Minimum Temperature of Coldest Month (°C) (World Clim B6)
10	TempAnnRng	Temperature Annual Range (B5-B6) (°C) (WorldClim B7)
11	TempWet	Mean temperature of wettest quarter (°C) (WorldClim B8)
12	TempDry	Mean Temperature of driest quarter (°C) (WorldClim B9) °C
13	TempWarm	Mean Temperature of warmest quarter (°C) (WorldClim B10)
14	TempCold	Mean temperature of coldest quarter (°C) (WorldClim B11)
15	PrecAnn	Annual Precipitation (mm) (WorldClim B12)
16	PrecWetP	Precipitation of wettest month (mm) (WorldClim B13)
17	PrecDryP	Precipitation of driest month (mm) (WorldClim B14)
18	PrecSeas	Precipitation seasonality (coefficient of variation) (WorldClim B15)
19	PrecWetQ	Precipitation of wettest quarter (mm) (WorldClim B16)
20	PrecDryQ	Precipitation of driest quarter (mm) (WorldClim B17)
21	PrecWarm	Precipitation of warmest quarter (mm)

		(WorldClim B18)
22	PrecCold	Precipitation of coldest quarter (mm) (WorldClim B19)
23	WaterDefDur	Duration of the Water Deficit Period from Walter Climate Diagrams (Walter & Lieth 1967) (days)
24	WaterDefSev	Severity of the Water Deficit Period from Walter Climate Diagrams (Walter & Lieth 1967) (mm)
25	DaysFrost	Number of days with frost
26	Cloud Cover	Fraction of the sky obscured by clouds when observed from a particular location
27	CloudItcp	Cloud Interception or Horizontal Precipitation
28	PotentialET	Potential evapotranspiration
29	ActualET	Actual evapotranspiration
30	Aridity Index	Global aridity index

3 DICUSSÃO GERAL

Foram encontrados no Parque Nacional de São Joaquim sete gêneros e 16 espécies de Myrtaceae: *Acca* (1 sp.), *Blepharocalyx* (1 sp.), *Eugenia* (1 sp.), *Myrceugenia* (9 sp.), *Myrcia* (2 sp.), *Myrrhinium* (1 sp.) e *Siphoneugena* (1 sp.). *Myrceugenia* foi o gênero mais rico. Espécies de *Myrceugenia* são comuns em locais de altitude elevada e de temperaturas mais baixas (LANDRUM, 1981). A maioria das espécies de Myrtaceae encontradas no PNSJ tem a distribuição ao longo do Sul e Sudeste do Brasil, entretanto, *Blepharocalyx salicifolius* apresenta distribuição mais ampla, no Sul, Sudeste, Nordeste e Centro-Oeste do Brasil (SOBRAL et al. 2015).

Foram encontradas 254 espécies e 17 gêneros de Myrtaceae nas 42 áreas do Sul e Sudeste do Brasil através da compilação de dados encontrados em artigos publicados. Há um alta dissimilaridade entre as diferentes áreas de MA em relação a composição específica de Myrtaceae. Cinco gêneros apresentaram somente uma espécie: *Acca*, *Accara* Landrum, *Blepharocalyx*, *Myrrhinium* e *Pimenta* Lindl.. Os gêneros distribuídos mais amplamente foram: *Eugenia*, *Myrcia* e *Myrceugenia*, os quais compõe 66% da flora de Myrtaceae na porção sul da MA.

Duas áreas de floresta ombrófila densa e floresta ombrófila mista na Serra da Mantiqueira foram as mais ricas em espécies de Myrtaceae. Já as áreas mais pobres foram aquelas constituídas por florestas estacionais semi-deciduais. Existe uma diferenciação na composição florística das florestas ombrófilas densas para a florestas estacionais semi-deciduais no interior influenciada pelo regime de chuva e a sazonalidade, as florestas mais próximas da costa tendem a ser mais ricas (OLIVEIRA-FILHO & FONTES 2000; EISENLOHR & OLIVEIRA FILHO 2015).

Três grupos no dendrograma que resultaram das análises de Jaccard e perfil de similaridade representaram áreas de grande altitude, estes grupos apareceram muito próximos entre si. A análise de dissimilaridade entre quotas de altitude apresentou um grupo contendo áreas >1000 e ≤ 1400 m.a.s.l.. O gradiente altitudinal afeta a composição florística em geral no domínio da MA (OLIVEIRA-FILHO & FONTES 2000).

A região tropical tende a ser mais rica em espécies que a região subtropical, um fato relacionado a temperatura, precipitação e à inabilidade (intolerância ao frio) das linhagens tropicais para conquistar as regiões subtropicais (GIEHL & JARENKOW 2012; OLIVEIRA-

FILHO et al. 2013). Há um diferenciação latitudinal no domínio da MA que aproxima a composição florística da floresta ombrófila densa e da floresta semi-decidual de cada latitude (OLIVEIRA-FILHO & FONTES 2000b; OLIVEIRA-FILHO et al. 2005; OLIVEIRA-FILHO & RATTER, 1995). Um dos grupos que resultaram das análises de Jaccard e perfil de similaridade está de acordo com esses padrões, reunindo 17 áreas de clima tropical, exceto por uma área na região subtropical porém de clima marítimo. Os dois grupos de floresta semi-decidual que surgiram dessas análises aparecem distantes em relação a sua composição florística e estão distantes geograficamente.

A análise de ordenação mostrou que os principais preditores para explicar a variação específica de Myrtaceae no sul da MA foram: altitude, precipitação do mês mais chuvoso, sazonalidade da temperatura e distância do oceano. A diferenciação latitudinal na composição florística da MA está relacionada ao regime de chuvas e à temperatura. (OLIVEIRA-FILHO & RATTER 1995; OLIVERIA-FILHO & FONTES 2000; OLIVEIRA-FILHO et al. 2005). Precipitação anual e sazonalidade das chuvas demonstraram influenciar a composição florística da porção da MA que está no Sudeste do Brasil (SANTOS et al. 2011).

Altitude já foi mencionada anteriormente como um fator importante na diferenciação da composição específica de Myrtaceae. Quanto a sazonalidade da temperatura, a variação na combinação de espécies arbóreas nos diferentes tipos de floresta na MA Subtropical está fortemente relacionada com extremos de temperatura baixa (OLIVEIRA-FILHO et al. 2013). Evapotranspiração real foi uma das variáveis parte do modelo RDA que explicou uma porcentagem da variação florística de Myrtaceae. Na região subtropical da MA a evapotranspiração real e a temperatura mínima estão significativamente correlacionadas com riqueza de espécies (OLIVEIRA-FILHO et al. 2013).

4 CONCLUSÃO

- Foram encontrados nas regiões altomontana do Parque Nacional de São Joaquim sete gêneros e 16 espécies de Myrtaceae
- A composição de Myrtaceae varia grandemente de uma área para outra no sul da MA, com alta porcentagem de espécies restritas geograficamente e baixa porcentagem de espécies comuns.

- Há uma diferenciação na composição específica de Myrtaceae relacionada à altitude.
- O clima, se tropical ou subtropical tem influência na composição específica de Myrtaceae.
- Os principais preditores da variação específica em Myrtaceae no sul da Mata Atlântica são: altitude, precipitação do mês mais chuvoso, sazonalidade da temperatura e distância do Oceano Atlântico.
- Seria interessante fazer um estudo que incluísse áreas de toda a MA, incluindo a região norte do domínio, o Leste do Paraguai e o Norte da Argentina, com maior número de áreas e uma metodologia padronizada para inferir melhor sobre o papel da proximidade geográfica, e encontrar ainda outras variáveis e padrões além dos tratados aqui.
- Analisar como processos evolutivos podem explicar a distribuição e riqueza de Myrtaceae na Mata Atlântica.

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