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PLANTAS

Ana Flávia Augustin

**CONSERVAÇÃO DE ESPÉCIES DE MYRTALES ENDÊMICAS DA MATA  
ATLÂNTICA DO SUL DO BRASIL: UMA ABORDAGEM INTEGRATIVA COM  
ENFOQUE EM ESPÉCIES DE *Myrceugenia* (MYRTACEAE)**

Florianópolis

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Orientadora: Prof.a Mayara Krasinski Caddah, Dr.a  
Coorientadora: Prof.a Duane Fernandes Lima, Dr.a.

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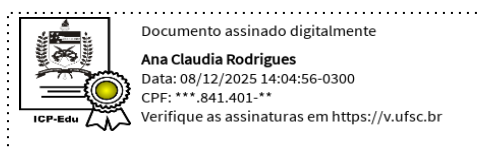
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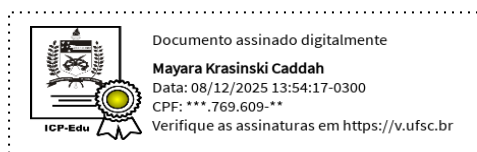
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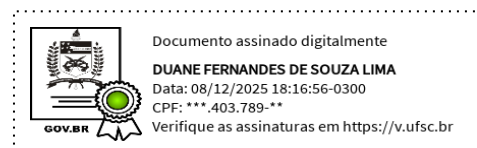
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Coordenação do Programa de Pós-Graduação



Prof.a Mayara Krasinski Caddah, Dr.a  
Orientadora



Prof.a Duane Fernandes Lima, Dr.a  
Coorientadora

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“You cannot get through a single day without having an impact on the world around you. What you do makes a difference, and you have to decide what kind of difference you want to make.”

**Jane Goodall**

## RESUMO

A biodiversidade, que abrange a variedade de organismos, suas relações ecológicas e os ambientes onde vivem, encontra-se sob forte pressão antrópica, com taxas de extinção aceleradas. Nesse contexto, listas vermelhas, tanto globais como a da União Internacional para a Conservação da Natureza (IUCN) como regionais, têm papel central na avaliação do risco de extinção de espécies e no direcionamento de ações de conservação. Espécies raras são mais susceptíveis às mudanças de hábitat e geralmente estão associadas a categorias de ameaça, devido a sua natureza restrita e pouca informação disponível. Ferramentas que visam a obtenção de dados de espécies em risco vêm se tornando cada vez mais úteis, como a modelagem de distribuição de espécies e a genética da conservação. Em Santa Catarina, no Sul do Brasil, a lista oficial da flora ameaçada (2014) apresenta lacunas metodológicas e taxonômicas, não refletindo adequadamente a realidade local. Este trabalho investigou o status de conservação de espécies da ordem Myrtales para o estado de Santa Catarina (Capítulo I), com ênfase em duas espécies raras e endêmicas de *Myrceugenia* (Myrtaceae) da Mata Atlântica — *M. basicordata* e *M. joinvillensis* (Capítulos II e III) — integrando abordagens taxonômicas, modelagem de distribuição e genética da conservação. No Capítulo I, foram avaliadas 47 espécies de Myrtales em Santa Catarina, das quais mais de 60% enquadraram-se em categorias de ameaça da IUCN, número seis vezes superior ao registrado na lista estadual. O resultado reforça a importância de avaliações taxonômicas para a atualização de listas regionais. No Capítulo II, a modelagem de distribuição mostrou que ambas as espécies apresentam áreas potenciais restritas à Serra do Mar e porção costeira da região sul e sudeste do Brasil, especialmente próximo da divisa entre os estados de Santa Catarina e Paraná, com significativa sobreposição a regiões urbanizadas e vulneráveis às mudanças climáticas. A projeção de cenários futuros revelou declínio das áreas adequadas, reforçando a urgência de esforços de conservação. No Capítulo III, análises genéticas apontaram moderada diversidade e diferenciação entre as populações em ambas as espécies, com sinais de redução populacional em *M. basicordata*. Uma avaliação utilizando os critérios e categorias da IUCN foi procedida para as duas espécies, com base em todos os dados obtidos, sendo que ambas foram categorizadas como “Em Perigo” (EN). A integração das três abordagens evidenciou a vulnerabilidade de Myrtales em Santa Catarina e forneceu subsídios para ações de conservação *in situ* e *ex situ*, atualização de listas vermelhas e planejamento territorial. O estudo destaca a necessidade de ampliar registros de campo e implementar medidas específicas para proteger a flora ameaçada da Mata Atlântica do sul do Brasil.

**Palavras-chave:** Genética da conservação, IUCN, modelos de distribuição de espécies, taxonomia.

## ABSTRACT

Biodiversity, which encompasses the variety of organisms, their ecological interactions, and the environments in which they inhabit, is under intense human pressure, with extinction rates accelerating worldwide. In this context, Red Lists, both global, such as that of the International Union for Conservation of Nature (IUCN), and regional, play a central role in assessing extinction risk and guiding conservation strategies. Rare species are especially vulnerable to habitat change and are often associated with threatened categories due to their restricted distributions and the limited information available about them. Additional tools aiming at improving knowledge of species at risk, such as species distribution modeling and conservation genetics, have also become increasingly valuable. In Santa Catarina, southern Brazil, the official threatened flora list (2014) contains methodological and taxonomic gaps, failing to adequately reflect local realities. This study investigated the conservation status of species within the order Myrtales in Santa Catarina (Chapter I), with special focus on two rare and endemic species of *Myrceugenia* from the Atlantic Forest — *M. basicordata* and *M. joinvillensis* (Chapters II and III) — through an integrated approach combining taxonomy, species distribution modeling, and population genetics. In Chapter I, 47 Myrtales species occurring in Santa Catarina were assessed, of which more than 60% fell into IUCN threat categories, a figure six times higher than that reported in the state's official list. These results highlight the importance of taxonomic evaluations for updating regional Red Lists. Chapter II applied distribution modeling, which revealed that both *Myrceugenia* species have restricted potential ranges along the Serra do Mar and coastal areas from southern and southeastern Brazil, specifically near the border between the states of Santa Catarina and Paraná, with substantial overlap in urbanized regions and sites highly vulnerable to climate change. Future climate scenarios predicted further contraction of suitable habitats, underscoring the urgency of conservation measures. Chapter III focused on genetic analyses, which indicated moderate diversity and differentiation among populations, with signs of population decline in *M. basicordata*. Based on these findings, both species were categorized as Endangered (EN) under IUCN criteria. The integration of taxonomy, distribution modeling, and population genetics revealed the high vulnerability of Myrtales in Santa Catarina and provided critical guidance for *in situ* and *ex situ* conservation, Red List updates, and spatial planning. This work emphasizes the need to expand field records and implement targeted actions to safeguard the threatened flora of the Atlantic Forest.

**Keywords:** Conservation genetics, IUCN, species distribution models, taxonomy.

## RESUMO EXPANDIDO

### Introdução

A biodiversidade engloba a riqueza e a variação de todos os organismos vivos que compõem o planeta, estando relacionada não somente às formas de vida destes organismos, mas também às relações biológicas entre eles, a sua diversidade genética, e ao próprio ambiente em que vivem. O dinamismo da biodiversidade do planeta é natural, marcado por perdas e ganhos na riqueza de espécies ao longo das eras geológicas. Porém, a ação humana tem acelerado de forma significativa o ritmo de extinções das espécies, tornando a conservação um ponto crucial para sobrevivência a longo prazo. Diferentes órgãos e instituições buscam monitorar a perda da biodiversidade ao redor do mundo. Uma das principais instituições com este objetivo é a IUCN - *International Union for Conservation of Nature*. Criada em 1964 com o intuito de se tornar uma fonte de informações internacional sobre o *status* de conservação das espécies do mundo, a Lista Vermelha da IUCN usa uma abordagem sistemática baseada em critérios e dados robustos para acessar os diferentes níveis de ameaça que estas espécies enfrentam. As espécies raras são frequentemente associadas a categorias de ameaça, pois, devido a sua natureza restrita, estão mais susceptíveis às pressões ambientais e eventos estocásticos e, assim, à extinção. Ainda, espécies raras são frequentemente negligenciadas devido à sua baixa amostragem, não sendo incluídas em diversas análises ecológicas, sendo muitas vezes chamadas de “espécies invisíveis”. Uma das ferramentas importantes para a conservação de espécies ameaçadas é a inclusão dos táxons em listas vermelhas. Em Santa Catarina, Sul do Brasil, a mais recente, e ainda vigente, sobre a flora ameaçada é a *Lista Oficial das Espécies da Flora Ameaçada de Extinção de Santa Catarina*, publicada em 2014 pelo Conselho Estadual do Meio Ambiente - CONSEMA. Entretanto, além de desatualizada, essa lista não foi elaborada por especialistas e apresenta sérios problemas taxonômicos. Outras ferramentas relevantes para obter informações sobre espécies raras, que também contribuem para sua conservação *in situ* e *ex situ*, incluem a modelagem de distribuição de espécies, utilizada para identificar áreas potenciais de ocorrência, e a genética de populações aplicada à conservação (genética da conservação). A ordem Myrtales é uma das maiores ordens dentre as angiospermas e engloba nove famílias botânicas, das quais seis ocorrem no Brasil: Combretaceae, Lythraceae, Melastomataceae, Myrtaceae, Onagraceae e Vochysiaceae. São plantas com ampla distribuição, predominantemente na região Neotropical. Dos 399 gêneros que compõem a ordem globalmente, as seis famílias que ocorrem no Brasil concentram 374. Myrtaceae é uma das famílias botânicas mais ricas do país, contando com cerca de 130 gêneros e mais de 5.500 espécies no mundo. No Brasil, Myrtaceae é característica principalmente da Mata Atlântica e apresenta um importante papel na manutenção e na restauração da biodiversidade das comunidades. Dentro de Myrtaceae, o gênero *Myrceugenia* apresenta 35 espécies que ocorrem no Brasil. A grande maioria das espécies brasileiras está presente no domínio da Mata Atlântica, com alto grau de endemismo. Recentemente, duas espécies do gênero foram descobertas, endêmicas da Mata Atlântica e com distribuição restrita à porção nordeste do estado de Santa Catarina, no Sul do Brasil: *Myrceugenia basicordata* F.C.S. Vieira, Molz e Sobral e *M. joinvilensis* F.C.S. Vieira. Tais espécies são consideradas raras e ameaçadas devido a sua distribuição limitada e poucos registros, e não estão incluídas na lista oficial da flora ameaçada para Santa Catarina, assim como outras dentro da ordem Myrtales que ocorrem no estado. Este trabalho, portanto, divide-se em três capítulos: **Capítulo I**, intitulado “A importância de uma lista vermelha taxonomicamente verificada: um estudo de caso da lista vermelha regional de Santa Catarina no sul do Brasil”; **Capítulo II**, intitulado: “Modelagem de distribuição de espécies de duas espécies raras de Myrtaceae endêmicas da Mata Atlântica brasileira: desafios em conservar ‘espécies invisíveis’”; e **Capítulo III**, intitulado: “Genética da conservação de duas espécies raras e endêmicas de *Myrceugenia* (Myrtaceae) da Mata Atlântica brasileira”.

## Objetivos

O objetivo geral deste trabalho foi investigar o panorama atual das espécies ameaçadas da Mata Atlântica no sul do Brasil, avaliando o estado de conservação e o nível de ameaça de espécies de Myrtales para Santa Catarina, com ênfase em duas espécies raras e endêmicas de *Myrceugenia*. Para tanto, foram utilizados princípios e métodos de taxonomia (Capítulo I), modelagem de distribuição (Capítulo II), genética de populações (Capítulo III), além dos critérios propostos pela IUCN (Capítulos I e III).

## Materiais e métodos

Os métodos foram organizados em três abordagens, específicas para cada capítulo. **Capítulo I:** (a) *Critérios de seleção das espécies*: As espécies avaliadas quanto ao status de conservação foram filtradas na plataforma Flora e Funga do Brasil. Selecionaram-se apenas espécies nativas, endêmicas da Mata Atlântica e com ocorrência restrita ao Sul do Brasil. (b) *Validação taxonômica*: Após a definição da lista, os registros foram consultados nas bases de dados Global Biodiversity Information Facility (GBIF), Specieslink e Herbário Virtual – Re flora, compilados em planilha Excel e verificados manualmente, com apoio de especialistas ou empréstimos de material quando necessário. (c) *Avaliações segundo a IUCN*: As localidades de cada espécime foram confirmadas ou inferidas a partir de imagens de satélite em alta resolução (Google Earth). Para espécies endêmicas de Santa Catarina seguiram-se as diretrizes globais da IUCN; para aquelas também presentes em outros estados e/ou países, aplicaram-se as diretrizes regionais. Mapas de riqueza de espécies e imagens foram elaborados com o pacote monogafaR (R v. 4.5.1) e QGis v. 3.28.7. **Capítulo II:** (a) *Coleta de dados biológicos e delimitação da área*: Os registros das duas espécies de *Myrceugenia* foram obtidos em plataformas digitais (Specieslink e Re flora) e em coleções de Myrtaceae nos principais herbários do Sul e Sudeste do Brasil, buscando novos registros em materiais indeterminados ou sob outros táxons. Dada a escassez de dados (10 registros para *M. basicordata* e seis para *M. joinvillensis*), a área de estudo foi delimitada às regiões de floresta ombrófila densa (Mata Atlântica) do Sul e Sudeste do país. (b) *Dados abióticos*: As 19 variáveis bioclimáticas do Worldclim foram recortadas para a área de interesse no QGis v. 3.28.7. Utilizaram-se dados do presente (1970 – 2000) e quatro cenários futuros (2021 – 2040 e 2081 – 2100, intermediário e pessimista), em resolução de 30 arc-segundos. Para verificar colinearidade, realizou-se análise de componentes principais (PCA) em R v. 4.5.1 com o pacote *flexsdm*. (c) *Modelos de distribuição de espécies (SDMs)*: As análises foram conduzidas no *flexsdm* em R. Definiu-se uma área acessível de 300 km para ambas as espécies, excluindo ilhas oceânicas. Os modelos foram gerados pelo algoritmo Maxent. **Capítulo III:** (a) *Coleta de dados e trabalho de campo*: Após identificar as populações existentes de *M. basicordata* e *M. joinvillensis*, realizaram-se expedições entre 2022 e 2023 na região de Joinville e cidades próximas (nordeste de SC). Foram coletadas folhas jovens de 102 indivíduos (50 e 52 de cada espécie, respectivamente), desidratadas em sílica-gel. (b) *Extração de DNA e sequenciamento de alta cobertura (HTS)*: O DNA total foi extraído pelo protocolo CTAB. Uma amostra de cada espécie, com qualidade de DNA confirmada, foi enviada para sequenciamento genômico em plataforma Illumina. (c) *Desenvolvimento de marcadores SSRs*: Os microssatélites foram desenvolvidos no GMATA v. 2.3, considerando apenas marcadores nucleares de contigs distintos. Os primers foram testados virtualmente (GMATA e SPCR v. 3.0) e em laboratório (20 pares por espécie). Após validação, 12 marcadores por espécie foram selecionados para genotipagem, amplificados por PCR com técnica M13. (d) *Análise de fragmentos e interpretação*: As análises foram realizadas em ABI 3500xL Genetic Analyzer e interpretadas no GeneMapper 6. Sete marcadores informativos por espécie foram escolhidos para análises de genética de populações. (e) *Genética de populações*: As análises incluíram diversas métricas de diversidade e diferenciação genética, testes de gargalo populacional (*Bottleneck*) e estimativas de tamanho efetivo populacional.

## Resultados e discussão

Os seguintes resultados foram obtidos, de acordo com cada capítulo: **Capítulo I:** Foram avaliadas 47 espécies de Myrtales com ocorrência em Santa Catarina. Destas, 30 (>63%) enquadraram-se em alguma categoria de ameaça da IUCN, concentradas sobretudo ao norte do estado, entre Santa Catarina e Paraná. Esse número é seis vezes superior ao registrado para o grupo na lista do CONSEMA (2014). Entre as 16 espécies de Melastomataceae, 10 foram classificadas como ameaçadas: uma criticamente ameaçada (CR), cinco em perigo (EN) e três vulneráveis (VU). Das demais categorias, cinco foram consideradas menos preocupante (LC) e uma com dados deficientes (DD). Das 26 espécies de Myrtaceae, 18 foram classificadas como ameaçadas (cinco CR, oito EN e cinco VU), além de uma como DD e três como LC. Para Onagraceae, quatro espécies foram avaliadas, sendo uma CR e três DD. Vochysiaceae teve uma única representante, classificada como CR. Já Lythraceae e Combretaceae não apresentaram espécies na plataforma Flora e Funga do Brasil dentro dos critérios estabelecidos no trabalho. Os resultados ressaltam a importância da taxonomia na elaboração e atualização das listas vermelhas regionais. O uso de listas desatualizadas compromete processos como o licenciamento ambiental e impacta diretamente a atuação de empresas públicas e privadas na interface entre expansão urbana e conservação ambiental. Outro ponto crítico refere-se à distribuição das áreas protegidas no estado, que não contempla adequadamente a concentração de espécies ameaçadas na região costeira, principalmente na divisa com o Paraná. Destaca-se também o elevado número de espécies endêmicas (14/47), das quais 10 estão ameaçadas. Espécies classificadas como DD merecem especial atenção, visto que podem estar ameaçadas, apesar da falta de dados. Dessa forma, medidas específicas de conservação da flora catarinense tornam-se urgentes. O estudo reforça ainda a abertura da comunidade científica a parcerias com instituições e órgãos governamentais para contribuir com o levantamento de dados e elaboração de estratégias de conservação. **Capítulo II:** Ambas as espécies de *Myrceugenia* do estudo apresentaram distribuição potencial restrita, com habitats adequados concentrados na Serra do Mar, especialmente na divisa entre Santa Catarina e Paraná. *Myrceugenia basicordata* apresentou área de adequabilidade aproximada de 3 mil km<sup>2</sup>, com 42% inseridos em áreas protegidas, enquanto *M. joinvillensis* alcançou 6 mil km<sup>2</sup>, sendo 44% em áreas protegidas. Contudo, o uso e cobertura da terra revelaram limitações adicionais, pois grande parte das áreas potenciais corresponde a zonas urbanas e pastagens. Assim, apenas 55% da área adequada de *M. basicordata* e 74% de *M. joinvillensis* permanecem florestadas. Novos esforços de coleta devem priorizar áreas próximas às ocorrências conhecidas, bem como a Serra Dona Francisca (norte de SC) e a Serra do Tabuleiro (sul do estado). Em todos os cenários futuros simulados observou-se declínio das áreas de adequabilidade, especialmente nos cenários pessimistas de mudanças climáticas para o final do século. As principais ameaças para ambas as espécies incluem a presença de habitats adequados em regiões desprotegidas ou apenas parcialmente protegidas, a expansão urbana e os próprios efeitos das mudanças climáticas. Este é o primeiro estudo a aplicar modelagem de distribuição de espécies ao gênero *Myrceugenia*. **Capítulo III:** As análises genéticas revelaram diversidade e diferenciação moderadas em ambas as espécies. *Myrceugenia basicordata* apresentou menor diversidade que *M. joinvillensis*. Entre as quatro populações amostradas (Finder, Cubatão, Quiriri e Santa Galo), as duas primeiras apresentaram menor diversidade. Cubatão mostrou  $F_{IS}$  positivo e alelos exclusivos, sugerindo certo grau de isolamento; no entanto, não houve clara diferenciação, com formação de três *clusters*. Testes de *bottleneck* indicaram redução populacional para essa espécie. Já *M. joinvillensis* apresentou maior diversidade genética em termos gerais. Entre suas quatro populações (Barragem, Jurapê, Mutucas e Monte Crista), Barragem e Jurapê registraram os menores índices de diversidade. As análises indicaram dois a quatro *clusters*, sugerindo maior diferenciação genética. Para *M. basicordata*, foi observado que a diversidade aumenta a medida em que as populações se afastam de zonas urbanas, possivelmente pela redução de polinizadores nestas áreas. Com base

nos dados de distribuição e genética, ambas as espécies foram classificadas como EN segundo critérios da IUCN. Foram sugeridas ações de conservação *ex situ* e *in situ*, abrangendo medidas de curto (1–2 anos) e longo prazo (3–10 anos).

### **Considerações finais**

Este trabalho evidenciou que o número e o grau de ameaça das espécies catarinenses estão subestimados há pelo menos 10 anos. Essas espécies apresentam habitats reduzidos, concentrados especialmente nas regiões costeiras do estado, ainda mais limitados pela expansão urbana e por outras atividades, como agropecuária e a mineração. Apesar de algumas espécies ainda apresentarem variabilidade genética relativamente favorável, com níveis moderados de diversidade e diferenciação, indícios de endogamia e de redução histórica populacional sugerem que algumas de suas populações não são naturalmente pequenas, e que esse patrimônio genético pode ser perdido caso não existam políticas públicas suficientemente eficazes para garanti-lo a longo prazo, particularmente em cenários de mudanças climáticas.

**Palavras-chave:** Genética da conservação, IUCN, modelos de distribuição de espécies, taxonomia.

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## APRESENTAÇÃO

Este documento apresenta três seções principais, conforme orientações do modelo de tese do PPGFAP: (1) **Introdução geral**, englobando os temas principais abordados - conservação da biodiversidade, espécies ameaçadas e raras, listas vermelhas e a taxonomia, modelagem de distribuição de espécies, genética da conservação, a ordem Myrtales e a família Myrtaceae, bem como os objetivos do projeto; (2) **Desenvolvimento**, dividido em três capítulos, dos quais um (Capítulo I) encontra-se em sua primeira versão, e dois (Capítulo II e III) encontram-se já publicados; e (3) **Considerações finais**. Todos os capítulos publicados estão formatados de acordo com as normas da respectiva revista. A introdução geral e capítulo I estão formatados conforme normas da Associação Brasileira de Normas Técnicas.

## INTRODUÇÃO GERAL

A biodiversidade engloba todos os organismos que compõem o planeta, suas diferentes formas de vida, suas relações biológicas, sua diversidade genética, e o próprio ambiente em que vivem (WWF, 2023). Sem a biodiversidade, a subsistência humana no planeta não seria possível (Dasgupta e Levin, 2023; Prakash e Verma, 2022). Há séculos, a ação humana tem acelerado de forma significativa o ritmo das extinções de espécies e a consequente perda da biodiversidade, em decorrência do aumento da temperatura global e mudanças ambientais (Christenhusz e Govaerts, 2025; Johnson *et al.*, 2017; Lindsay *et al.*, 2024). Das cerca de 374 mil espécies de plantas conhecidas (Christenhusz e Byng, 2016), estima-se que mil tenham sido registradas como extintas desde o século XVIII (Christenhusz e Govaerts, 2025). Esse número, porém, está provavelmente subestimado devido à falta de taxonomistas, aos cortes de financiamento e à existência de espécies ainda não descritas pela ciência (Engel *et al.*, 2021; Christenhusz e Govaerts, 2025). Evidências recentes indicam ainda que, no caso das plantas, as taxas de extinção têm superado as de especiação (Gao *et al.*, 2020) e que, a cada ano, entre 0,01% e 0,1% das espécies desapareçam, uma taxa que pode ser de pelo menos cinco até mil vezes superior à taxa de extinção natural (Christenhusz e Govaerts, 2025; Johnson *et al.*, 2017; WWF, 2023).

Diferentes órgãos e instituições buscam monitorar a perda da biodiversidade ao redor do mundo. Uma das principais instituições com este objetivo é a IUCN - *International Union for Conservation of Nature* (<https://iucn.org/>). Criada em 1964, a Lista Vermelha da IUCN (*IUCN Red List*) usa uma abordagem sistemática baseada em critérios qualitativos e quantitativos para acessar os diferentes níveis de ameaça que estas espécies enfrentam. Estes critérios levam em consideração dados populacionais, de hábitat, de distribuição geográfica (como extensão de ocorrência e área de ocupação), dentre outros. Os estados de conservação dos táxons são então classificados de acordo com as seguintes categorias: extinto (E), extinto na natureza (EW), criticamente em perigo (CR), em perigo (EN), vulnerável (VU), quase ameaçado (NT), e menos preocupante (LC), sendo as categorias CR, EN e VU consideradas categorias de ameaça (IUCN, 2024). Até o momento, a Lista Vermelha da IUCN apresenta dados e avaliações de cerca de 76.800 espécies de plantas, das quais mais de 29.748 (38%) são consideradas ameaçadas de extinção (IUCN Red List, 2025).

As espécies raras são frequentemente categorizadas como ameaçadas por serem muito suscetíveis à fragmentação de hábitat e à extinção (e.g., Davies *et al.*, 2004). Em geral,

apresentam populações pequenas, muitas vezes difíceis de serem encontradas na natureza (e, portanto, com poucas informações disponíveis), são mais vulneráveis a eventos estocásticos, e têm maior dificuldade de recuperação frente a desastres ecológicos (Brown *et al.*, 2023). A raridade pode se manifestar em três dimensões: (1) distribuição geográfica restrita; (2) baixa ocupação (poucos locais adequados para sua sobrevivência dentro da distribuição geográfica); e (3) baixa abundância local. Definir o tipo de raridade é essencial para orientar esforços de manejo e conservação, bem como para decidir quais espécies devem ou não ser incluídas em tais ações (Crisfield *et al.*, 2024). Parte dos critérios da IUCN (IUCN, 2024) para enquadrar espécies em algum grau de ameaça (VU, EN ou CR) considera limites populacionais e de distribuição geográfica, como redução no tamanho populacional (critério A), distribuição geográfica restrita (critérios B e D) e declínio ou tamanho populacional reduzido (critérios C e D). Apesar disso, espécies raras são frequentemente negligenciadas devido à baixa amostragem, ficando de fora de diversas análises ecológicas e tornando-se, assim, “espécies invisíveis” para a ciência e para a sociedade (Trindade e Marques, 2024).

Algumas das estratégias fundamentais para conservação de espécies ameaçadas incluem a inclusão destas em listas vermelhas (*Red lists*), ou seja, inventários elaborados por diferentes órgãos que servem como medida indicadora das tendências e limitações da biodiversidade, e como ponto de partida para guiar esforços de conservação em níveis globais (Harfoot *et al.*, 2021; IUCN Red List, 2025; Moraes *et al.*, 2014), regionais e locais (e.g., Andrade e Freitas, 2021; Chang *et al.*, 2018; CNCFlora, 2025). No Brasil, a elaboração das listas vermelhas nacionais da flora e fauna ficam a cargo do Ministério do Meio Ambiente e Mudança do Clima (MMA, 2025). No caso da flora, elas são coordenadas pelo Centro Nacional da Conservação da Flora (CNCFlora, 2025). Regionalmente, as listas vermelhas ficam a critério dos governos estaduais, com autonomia para usá-las em regulamentações ambientais locais (Moraes *et al.*, 2014).

Em Santa Catarina, região Sul do Brasil, a lista mais recente e em uso sobre a flora ameaçada está discriminada na “Lista Oficial das Espécies da Flora Ameaçada de Extinção de Santa Catarina”, estabelecida pela Resolução 51/2014 do Conselho Estadual do Meio Ambiente de Santa Catarina (CONSEMA, 2014). A resolução cita 313 espécies de plantas, das quais 275 são angiospermas, classificadas em seis categorias de extinção, ameaça ou dados deficientes, de acordo com a IUCN. No entanto, apesar do uso dessas categorias, os critérios técnicos da IUCN não foram adotados na avaliação das espécies. Além disso, a lista encontra-se desatualizada e inclui diversas espécies com problemas taxonômicos, como sinônimos e erros

de grafia nos nomes científicos, evidenciando a falta de informações e a necessidade urgente de revisão e atualização da flora ameaçada para o estado (Caddah e Lima, 2022; Drischel, 2024). A lista publicada pelo CONSEMA foi elaborada sem a colaboração de taxonomistas especialistas nas diferentes famílias, em contraste com outras listas estaduais, como as de São Paulo e do Espírito Santo (São Paulo, 2016; Espírito Santo, 2022; Fraga *et al.*, 2019). Erros de identificação podem levar a escolhas equivocadas na definição de áreas prioritárias para conservação, enquanto confusões taxonômicas podem colocar em risco espécies realmente ameaçadas ou beneficiar indevidamente espécies não prioritárias (Ely *et al.*, 2017). Ainda, falhas na identificação e na delimitação de espécies comprometem a credibilidade de listas vermelhas e, consequentemente, prejudicam ações de conservação da biodiversidade (Costello *et al.*, 2015; Ely *et al.*, 2017).

Outra estratégia útil na conservação de espécies raras/ameaçadas inclui a modelagem de distribuição de espécies (*Species distribution modeling* – SDMs). A junção de fatores bióticos (e.g., registros de ocorrência) e abióticos (e.g., variáveis de temperatura, solo, precipitação) nestas análises permite diversas aplicações, incluindo a predição de distribuição diante de diferentes cenários de mudanças climáticas – passado ou futuro (Castro *et al.*, 2020; Singh *et al.*, 2023), ou busca por novas populações e/ou áreas de interesse para conservação (Fois *et al.*, 2015; Giovanelli *et al.*, 2008; Sáenz-Ceja e Mendoza, 2023). Para espécies raras, SDMs são particularmente úteis na busca por potenciais áreas de distribuição, embora o maior desafio seja a disponibilidade de informações sobre sua ocorrência e a correspondente limitação dos algoritmos para modelar a partir de poucos registros (De Siqueira *et al.*, 2009; Fois *et al.*, 2015; ver mais considerações sobre SDMs em Sillero *et al.*, 2021).

A genética da conservação, ramo que aplica conceitos da genética de populações voltados à conservação da biodiversidade (Frankham *et al.*, 2002), é frequentemente utilizada em estudos com espécies raras ou ameaçadas para subsidiar estratégias de manejo e conservação (e.g. Dardengo *et al.*, 2021; Gargiulo *et al.*, 2019; Monteiro *et al.*, 2022). Algumas das métricas utilizadas nestes estudos, recentemente denominadas de “variáveis essenciais da biodiversidade” (EBVs, na sigla em inglês) como forma de padronizar e facilitar a comparação entre diferentes trabalhos, incluem: (i) diversidade genética; (ii) diferenciação genética; (iii) endogamia; e (iv) tamanho efetivo populacional ( $N_e$ ) (Hoban *et al.*, 2022). Dentre todas, a diversidade genética é um fator determinante para a sobrevivência e o estabelecimento de espécies em seu ambiente, e sua perda pode ocorrer principalmente pela redução do fluxo

gênico entre indivíduos de uma população, frequentemente associada à fragmentação ou à perda de habitats e ecossistemas (Browne e Karubian, 2018; Browne *et al.*, 2015).

A ordem Myrtales (grupo de estudo do Capítulo I) é uma das maiores ordens dentre as angiospermas e engloba nove famílias botânicas, das quais seis ocorrem no Brasil: Combretaceae, Lythraceae, Melastomataceae, Myrtaceae, Onagraceae e Vochysiaceae. São famílias com ampla distribuição, predominantemente na região Neotropical, onde apresentam maior diversidade (APG IV, 2016, Maurin *et al.*, 2021). Dos 399 gêneros que compõem a ordem, as seis famílias que ocorrem no Brasil concentram 374 (Maurin *et al.*, 2021). Dentro deste grupo, Myrtaceae (grupo de estudo dos capítulos II e III) é uma das famílias botânicas mais ricas do país, contando com cerca de 29 gêneros e mais de 1200 espécies (Flora e Funga do Brasil, 2025; Vasconcelos *et al.*, 2017). É característica principalmente da Mata Atlântica e do Cerrado com grande importância ecológica: seus representantes são frequentemente usados em trabalhos de corredores ecológicos e regeneração de áreas degradadas (Fagundes *et al.*, 2016); fornecem alimento para animais através dos seus frutos ao longo de todo ano (Staggemeier *et al.*, 2017) e é uma das principais fontes de pólen para abelhas nativas (Martins *et al.*, 2023).

Dentro de Myrtaceae, *Myrceugenia* apresenta 47 espécies na América do Sul, destas, 35 espécies ocorrem no Brasil (POWO, 2025; Vieira e Meireles, 2025). A grande maioria das espécies brasileiras (mais de 90%) está presente no domínio da Mata Atlântica, mas também no Cerrado, Pampa e Caatinga (Vieira e Meireles, 2025). Recentemente, duas espécies do gênero foram descobertas, endêmicas da Mata Atlântica e com distribuição restrita à porção nordeste do estado de Santa Catarina (SC): *Myrceugenia basicordata* F.C.S. Vieira, Molz e Sobral (Fig. 1A) e *Myrceugenia joinvilensis* F.C.S. Vieira (Fig. 1B), ambas arvoretas de 1,5 até 3 m de altura, que ocorrem em ambientes de floresta ombrófila densa submontana/montana. A primeira é conhecida apenas em poucas áreas florestadas próximas à zona urbana de Joinville, cidade mais populosa de SC (IBGE, 2025), a ca. de 200 m de altitude (Sobral *et al.*, 2019). A segunda, ocorre na orla das montanhas da Mata Atlântica, especialmente na Serra do Mar do nordeste de Santa Catarina, em altitudes entre 400 e 700 m (Vieira, 2020). Ambas são consideradas raras e ameaçadas devido as suas distribuições limitadas e poucos registros, e, por terem sido descritas após 2014, não estão incluídas na lista oficial da flora ameaçada para Santa Catarina, assim como outras espécies da ordem Myrtales que ocorrem no estado.

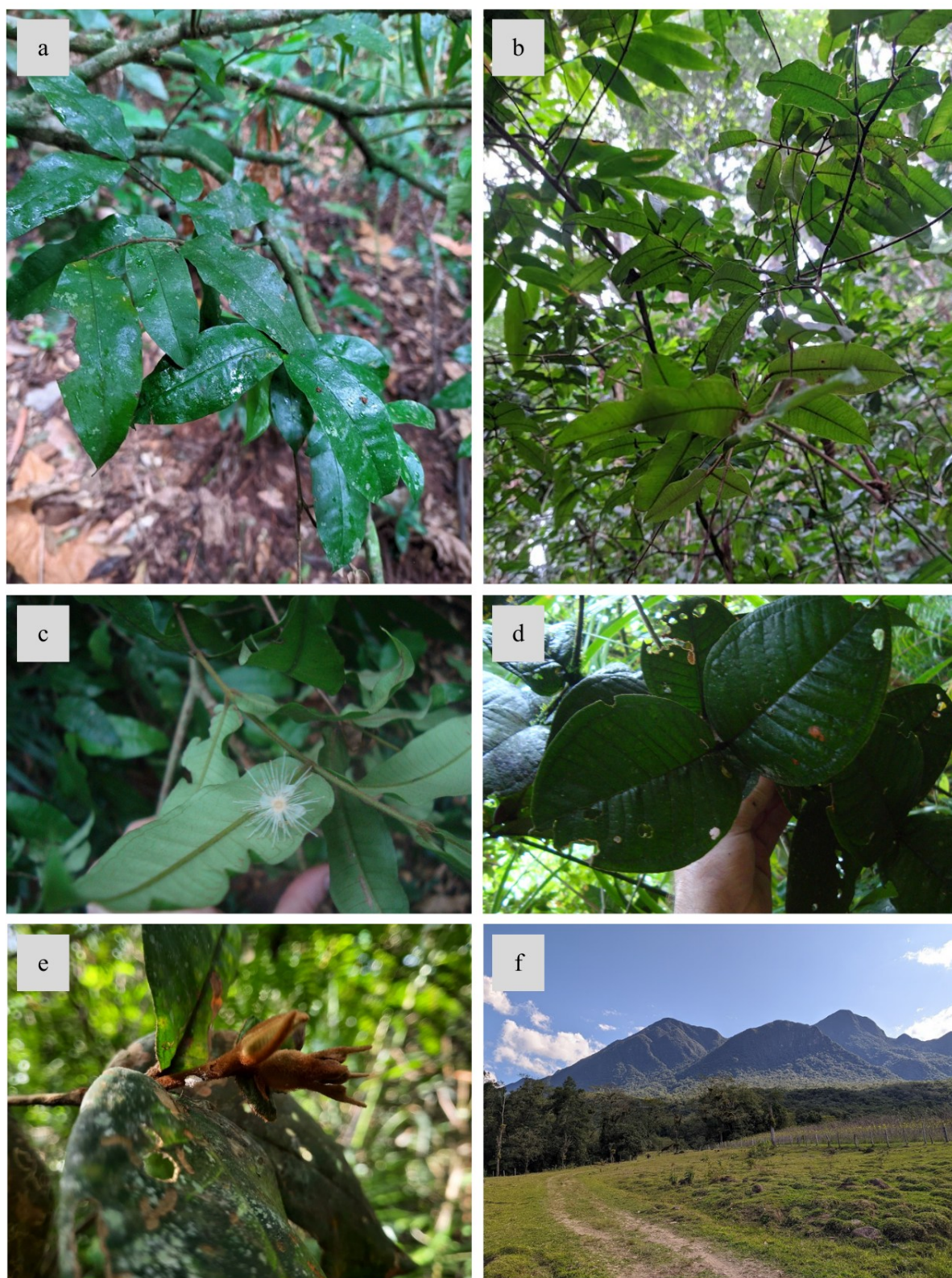


Fig. 1. A – C *Myrceugenia basicordata*; C - imagem por F.C.S. Vieira (adaptado), disponível em *Flora e Funga do Brasil*. D – E *Myrceugenia joinvillensis*; D - imagem por F.C.S. Vieira (adaptado), disponível em *Flora e Funga do Brasil*. F – Trilha de acesso ao Pico Jurapê, local de coleta de *Myrceugenia joinvillensis* em Joinville, SC.

## OBJETIVOS

O objetivo geral deste trabalho foi investigar o panorama atual das espécies ameaçadas da Mata Atlântica no sul do Brasil, avaliando o estado de conservação e o nível de ameaça de espécies de Myrtales para Santa Catarina, com ênfase em duas espécies raras e endêmicas de *Myrceugenia*. Para isso, foram aplicados princípios e métodos de taxonomia, modelagem de distribuição de espécies, genética da conservação e os critérios propostos pela IUCN. A seguir, são apresentados os objetivos específicos:

1. Delimitar o panorama atual do estado de conservação das espécies de Myrtales em Santa Catarina, evidenciando as espécies mais vulneráveis segundo os critérios da IUCN;
2. Identificar potenciais áreas de ocorrência (presente e futura) e lacunas de amostragem para duas espécies raras e endêmicas de *Myrceugenia*, contribuindo para o refinamento do conhecimento sobre sua distribuição geográfica no Sul e Sudeste do Brasil;
3. Determinar os padrões de diversidade e diferenciação genética de populações de duas espécies raras e endêmicas de *Myrceugenia*, avaliando quais populações apresentam maior vulnerabilidade genética e ambiental;
4. Interpretar as relações entre diversidade genética, distribuição geográfica e vulnerabilidade à extinção, visando compreender os fatores que influenciam o risco de conservação dessas espécies de *Myrceugenia*;
5. Estabelecer diretrizes e prioridades de conservação para as duas espécies de *Myrceugenia* em Santa Catarina, com base nos resultados obtidos sobre seu estado de ameaça, distribuição atual e potencial, e diversidade genética.

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## CAPÍTULO I

### **The importance of taxonomically verified red lists: a case study of the regional red list of Santa Catarina, southern Brazil**

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Autores: Ana Flávia Augustin, Daniele R. Drischel, Gabriela Goebel, Gabriela M. Cardoso, Okesanna E. Puhale, Duane Fernandes Lima e Mayara Krasinski Caddah

#### ABSTRACT

Red lists are essential tools for biodiversity conservation, serving as key indicators of the current status and trends of global biodiversity. In Santa Catarina State, southern Brazil, the most recent and still active red list of plant species is the Official List of Threatened Plant Species of Santa Catarina, established by Resolution 51/2014 (hereafter the CONSEMA list). This list is outdated, was not developed by specialists, and contains several taxonomic inconsistencies, compromising its effectiveness. Here, we aimed to (i) reassess the conservation status of Myrtales species occurring in Santa Catarina based on IUCN guidelines and taxonomic validation, (ii) identify hotspots of threatened Myrtales species and determine whether their occurrences fall within protected areas, and (iii) discuss the importance of taxonomically verified red lists for future conservation policies. Through taxonomic validation, we examined 992 specimens representing 47 species, of which 30 (63.8%) were classified as threatened. This number is six times greater than that recorded in the 2014 CONSEMA list, despite focusing on a single order of the southern Brazilian flora. Species richness maps revealed that threatened Myrtales species are mainly distributed along the eastern region of Santa Catarina, particularly near the border with Paraná, and that most records lie outside protected areas. Our results highlight the importance of taxonomically verified lists for accurately assessing species threat status and demonstrate that threatened species remain underestimated in the state. We also emphasize the need to expand protected areas and strengthen partnerships between research institutions and government agencies to enhance long-term biodiversity conservation.

**KEYWORDS:** Atlantic Forest, conservation, IUCN, Myrtales.

#### INTRODUCTION

Red lists are essential tools for biodiversity conservation, serving primarily as indicators of the current status and trends of global biodiversity, and as a starting point for guiding conservation efforts (IUCN, 2025; Moraes *et al.*, 2014). Recent studies have reinforced their relevance for monitoring biodiversity loss and informing conservation strategies at global (e.g., Harfoot *et al.*, 2021), regional (e.g., Andrade and Freitas 2021), and local scales (e.g., Chang *et al.*, 2018; Gonçalves *et al.*, 2023). Currently, the most widely used red list is the International Union for Conservation of Nature's Red List (IUCN Red List, 2025), which defines nine

categories based on a set of quantitative and qualitative criteria, applicable at different levels. The categories are: extinct (EX), extinct in the wild (EW), critically endangered (CR), endangered (EN), vulnerable (VU), near threatened (NT), least concern (LC), data deficient (DD), and not evaluated (NE) (IUCN, 2024; IUCN, 2010). In this sense, the IUCN Red List has become the global standard for extinction risk assessment, providing a framework that is increasingly adopted and adapted by different countries and regions.

In Brazil, the development of red lists falls under the responsibility of the Ministry of the Environment and Climate Change (MMA, 2025). For plants, these lists are officially coordinated by the National Center for Flora Conservation (CNCFlora, 2025), aligned with the IUCN categories and criteria. At the local level, the creation of red lists falls within the competence of state governments, which have the autonomy to apply them in local environmental regulations (Moraes *et al.*, 2014). In this sense, two major issues compromise the effectiveness of red lists: (i) the lack of a standardized methodology for their development, and (ii) the absence of integration or communication between different lists, which can lead to serious misinterpretation of the data (Bender *et al.*, 2012; Moraes *et al.*, 2014).

In the state of Santa Catarina, southern Brazil, the most recent red list of plant species is the Official List of Threatened Plant Species of Santa Catarina, established by Resolution 51/2014 of the State Environmental Council (*Lista Oficial das Espécies da Flora Ameaçada de Extinção de Santa Catarina*, CONSEMA, 2014, hereafter the CONSEMA list). It was likely organized considering the database from the Barbosa Rodrigues Herbarium (HBR) (Reis *et al.*, 2011), which is the oldest plant collection of the state (Thiers, 2025), and the IUCN threat categories. The baseline list of threatened species was drawn from the “*Relatório sobre as espécies da flora catarinense ameaçadas de extinção*” from 2012 (not published). Neither the methodology adopted, nor the baseline list of species was made available. The CONSEMA list includes 313 plant species, 275 of which are angiosperms, categorized in six IUCN-based levels (E, EX, CR, EN, VU and DD) (CONSEMA, 2014; IUCN, 2024). Despite using these categories, the list did not follow the technical criteria established by IUCN for the assessments. Additionally, the list is evidently outdated (IUCN, 2025; Nic Lughadha *et al.*, 2020) and contains numerous taxonomic issues, including synonyms and misspelled scientific names, highlighting a lack of accurate information and an urgent need for revision (Driscoll, 2024; Caddah and Lima, 2022).

The case of Santa Catarina illustrates how taxonomic expertise should be a fundamental pillar in the development of official red lists. The list published by CONSEMA was created without the involvement of specialists, unlike those from other Brazilian states such as São Paulo and Espírito Santo (São Paulo, 2016; Espírito Santo, 2022; Fraga *et al.*, 2019). Misidentification can lead to misguided decisions when defining conservation priorities, while taxonomic confusion can either harm genuinely threatened species or inappropriately favor non-priority ones (Ely *et al.*, 2017). Moreover, flaws in species identification and delimitation undermine the credibility of red lists and, consequently, compromise biodiversity conservation efforts (Costello *et al.*, 2015; Ely *et al.*, 2017).

The order Myrtales, one of the largest among flowering plants (APG, 2016; Moonlight *et al.*, 2024), includes six families in Brazil: Combretaceae, Lythraceae, Melastomataceae, Myrtaceae, Onagraceae, and Vochysiaceae (FFB, 2025). According to the CONSEMA list, 11 species within this order are considered threatened of extinction (five species as vulnerable) or presumably extinct (six) in Santa Catarina: Combretaceae (one species, *Terminalia reitzii* Exell), Lythraceae (one, *Lafoensia nummularifolia* A.St.-Hil), Melastomataceae (five, *Clidemia neglecta* D.Don.,; *Leandra cardiophylla* Cogn.; *Leandra niederleinii* Cogn.; *Leandra urbaniana* Cogn. and *Tibouchina nitida* (Graham) Cogn.), and Myrtaceae (four, *Campomanesia hirsuta* Gardner; *Eugenia pachyclada* D.Legrand; *Eugenia pseudomalacantha* D.Legrand and *Myrceugenia smithii* Landrum) (CONSEMA, 2014; names according to FFB, 2025). *Terminalia reitzii* and four other species are synonyms, while *Lafoensia nummularifolia* is incorrectly spelled (FFB, 2025). Given this context, we aimed to (i) reevaluate the conservation status of Myrtales species occurring in the state of Santa Catarina based on IUCN guidelines and taxonomic validation, (ii) identify hotspots of threatened species of Myrtales in the state and verify whether these records occur within protected areas, and (iii) to discuss the importance of a taxonomically verified red list for future conservation policies. Here, we also present an updated red list of threatened Myrtales species for the state, along with a practical workflow that may assist in regional assessments of other plant groups.

## MATERIAL AND METHODS

### *Species selection criteria*

We selected the families within the order Myrtales that occur in Brazil as the focus of our study because (1) this group is the main area of expertise of our research group, (2)

represents some of the largest Brazilian plant genera (Moonlight *et al.*, 2024), and (3) these families have been frequently updated on the Flora e Funga do Brazil platform (hereafter FFB, <https://floradobrasil.jbrj.gov.br/>).

As our primary data source, we used the FFB platform to obtain information on Myrtales species occurring in the state of Santa Catarina, which is completely inserted within the Atlantic Forest domain (Salerno and Müller, 2011). Evaluating all 397 Myrtales species reported for the state (FFB, 2025) would be an overly demanding task. Therefore, to maximize the assessment of potentially threatened species, we applied specific filters based on biogeographic and endemism criteria, selecting only species endemic to the Atlantic Forest of southern Brazil by applying the following filters on the FFB search: “family (each Myrtales family filtered separately)” | “Endemics to Brazil” | “Native in Brazil” | “Only occur in South” | “Only occur in the Atlantic Rainforest”. This focus on endemics is justified by the higher likelihood of extinction risk typically associated with species that have restricted distributions (Harnik *et al.*, 2012; Manes *et al.*, 2021; Salles *et al.*, 2019). We then verified each recorded species to confirm its occurrence specifically in Santa Catarina. Species found only in other states from southern Brazil (Paraná or Rio Grande do Sul) were excluded. Intraspecific categories (e.g., subspecies and varieties) were not considered in the assessments.

We also consulted other recent taxonomic literature and databases (e.g., Plants of the World Online - <https://powo.science.kew.org/> and Specieslink - <https://specieslink.net/search/>) for each family to confirm and update species distribution and endemism. Based on this filtering and updating processes, we obtained a final list including 47 species of Myrtales that are endemic to southern Brazil and occur in the state of Santa Catarina: Myrtaceae (26 spp.), Melastomataceae (16 spp.), Onagraceae (four spp.), and Vochysiaceae (one sp.). Combretaceae and Lythraceae did not include any species that matched our criteria. In total, 22 species were excluded (SI “*Apêndice A*” of this thesis for more details).

### *Taxonomic validation*

After compiling the list of taxa, we consulted major online biodiversity databases for herbarium specimen records, including the Global Biodiversity Information Facility (GBIF, <https://www.gbif.org/>), Specieslink (<https://specieslink.net/search/>), and the Herbário Virtual - Reflora (<https://floradobrasil.jbrj.gov.br/reflora/herbarioVirtual>). All records were compiled into an Excel spreadsheet and manually verified for taxonomic identification/confirmation.

When necessary, we consulted additional taxonomic specialists, requested loans of specimens, and/or visited herbaria in person (FLOR, FURB, HBR and MBM, acronyms according to Thiers 2025). Finally, we considered reliable those records that were (i) identified by specialists and/or verified by us, and (ii) from sites with remaining vegetation. Older records were retained when the collecting sites still have vegetation, and the taxonomic identification was reliable.

Taxonomic nomenclature followed the FFB database. For Melastomataceae, we also followed the circumscription proposed by Michelangeli *et al.* (2019) and consulted the Melastomataceae website (<http://www.melastomataceae.net/>).

#### *Species assessments based on IUCN guidelines*

We followed the Guidelines of the IUCN Red List Categories and Criteria (IUCN, 2024) to assess the conservation status of the selected species. Since some species are restricted to the state of Santa Catarina, we applied the global assessment guidelines to them. However, for species with a broader distribution, we conducted a regional assessment following the Guidelines of the IUCN Red List Criteria at Regional and National Levels (IUCN, 2010).

We evaluated species information across all IUCN criteria. However, we focused primarily on Criterion B (geographic range), given its historical prevalence in plant assessments (Le Breton *et al.*, 2019; Levin *et al.*, 2022; Marsh *et al.*, 2023). Extent of Occurrence (EOO) and Area of Occupancy (AOO) were calculated using the Geospatial Conservation Assessment Tool (GeoCAT) (Bachman *et al.*, 2011). Since all species would qualify for a threat category based on AOO due to their restricted sampling, we relied especially on EOO as the key metric for the final assessment (Brummit *et al.*, 2015; Nic Lughadha *et al.*, 2019). We only considered AOO for final assessment when EOO was zero. Species with only a few records (one or two) were analyzed case-by-case. For instance, when a species was known only from the type material and/or from historical records, the DD category was assigned, as recommended by the IUCN (IUCN, 2024).

We verified all locality information from the databases mentioned above. When such information was incorrect or unavailable on the database, we inferred it from the locality descriptions provided in the herbarium labels, using high-resolution satellite imagery (Google LLC, 2025). Initially, we used coordinates from municipality centroids as a first approximation to assess species conservation status. When preliminary results indicated that a species might fall into a threat category, we refined the coordinates using more precise locality information.

Records with unclear locality information or from sites that no longer have remaining vegetation were excluded.

We generated species richness maps using the “mapDiversity” function from the monographaR package (Reginato, 2016) in R version 4.5.1 (R Core Team, 2025) to identify hotspots of Myrtales species within Santa Catarina. For this analysis, we included only the species classified under threat categories. Grids with a resolution of 0.5 degrees ( $\approx 50 \times 50$  km) were used. To verify whether the records were located within protected areas, we used shapefiles of protected areas in the Atlantic Forest obtained from the Brazilian Protected Areas Panel (*Painel de Unidades de Conservação Brasileira*, <https://cnuc.mma.gov.br/powerbi>). Final adjustments were made in QGIS version 3.28.7 (QGIS Development Team, 2023).

## RESULTS

We assessed 992 specimens representing 47 species (see SI “*Apêndice B*” of this thesis for more details). Of these, 14 were evaluated at the global level (endemics to Santa Catarina), and 33 at the regional level. In both cases, most species were classified under some threat category. At the global level, we assessed four as CR, five as EN, one as VU, and four as DD. At the regional level, four were classified as CR, nine as EN, and seven as VU, while four were classified as NT, eight as LC, and one as DD (Table 1, Fig. 1).

For the 26 Myrtaceae species, 18 were classified in threat categories: five CR (*Eugenia quiriri*, *E. reitziana*, *Myrceugenia foveolata*, *Myrcia garuvana*, and *Myrcianthes riparia*), eight EN (*Curitiba prismatica*, *Eugenia mattosii*, *E. neotristis*, *E. pachyclada*, *E. pseudomalacantha*, *E. rotundicosta*, *Myrceugenia basicordata*, and *Myrceugenia joinvillensis*), and five VU (*Campomanesia littoralis*, *Eugenia joenssonii*, *E. sclerocalyx*, *Myrceugenia mesomischa*, and *Neomitranthes cordifolia*). Not threat categories were composed by seven species: four NT (*Campomanesia reitziana*, *Eugenia rostrifolia*, *Neomitranthes gemballae*, and *Plinia cordifolia*), three LC (*Myrcia hatschbachii*, *Myrciaria plinioides*, and *Psidium longipetiolatum*), and one species was classified as DD (*Eugenia angelyana*), as it presented only one record (the type material).

Among the 16 Melastomataceae species assessed, 10 were classified in threat categories: one CR (*Chaetogastra cristaensis*), six EN (*Chaetogastra cisplatensis*, *C. cordeiroi*, *Miconia luctatoris*, *Pleroma dusenii*, *P. ramboi* and *P. setosociliatum*), and three VU (*Miconia planifilamentosa*, *M. ulei*, and *Pleroma kleinii*). Six species were classified in non-threatened

categories, including five LC (*Chaetogastra rupestris*, *Miconia catharinensis*, *M. ramboi*, *M. riograndensis*, and *Pleroma pilosum*). With only two records, *Miconia dusenii* was included in the DD category.

For the four Onagraceae species assessed, one was classified as CR (*Ludwigia litoranea*) and three were considered DD (*Ludwigia humboldtiana*, *L. irregularis*, and *Oenothera catharinensis*). *Ludwigia humboldtiana* and *L. irregularis* presented only one record (the type materials), while *Oenothera catharinensis* was classified as DD due to taxonomic inconsistencies. For Vochysiaceae, only one species matched our filter and was classified as CR (*Callisthene kuhlmannii*).

Species richness maps indicated that threatened Myrtales species are mainly distributed along the eastern region of Santa Catarina, particularly near the border between Santa Catarina and Paraná (Fig. 2). Melastomataceae showed a higher concentration of threatened species in the southern part of the state, in mountain regions (four species), whereas Myrtaceae had more threatened species in the northeastern region (seven species).

## DISCUSSION

Of the 367 Myrtales species occurring within the state of Santa Catarina across the four families – Melastomataceae (125), Myrtaceae (207), Onagraceae (29), and Vochysiaceae (6) – we identified 30 threatened species (63.8%) among the 47 species assessed (12.8% of 367). The CONSEMA list (2014), likely based on a different taxonomic source (*Anais Botânicos do Herbário Barbosa Rodrigues*, Reis *et al.*, 2011), had previously recognized only five threatened species (1.4% of 367). Therefore, our analysis found more than six times the number of threatened species listed by CONSEMA (Table 2), revealing a substantial underestimation of threatened taxa in the official list and stressing the need for updated, taxonomically verified assessments to inform effective conservation planning.

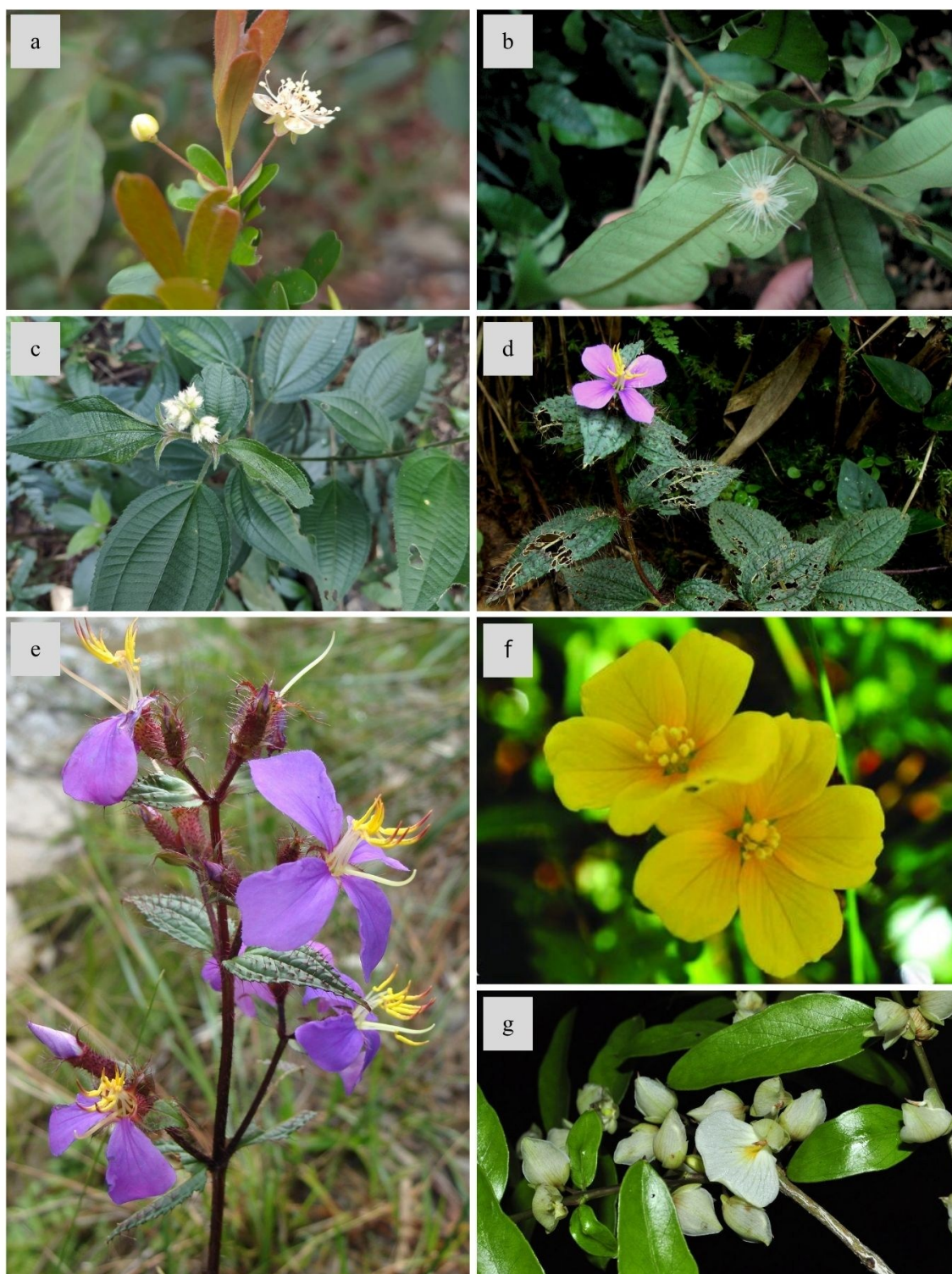


Fig. 1. Threatened species of Myrtales. (A–B) Myrtaceae; (C–E) Melastomataceae; (F) Onagraceae; and (G) Vochysiaceae. (A) *Eugenia mattsosii* (EN), photo by Gabriela Goebel. (B) *Myrceugenia basicordata* (EN), photo by F.C.S. Vieira (adapted), available at *Flora e Funga do Brasil*. (C) *Miconia ulei* (VU), photo by Gabriela Goebel. (D–E) *Chaetogastra cristaensis* (CR), photo by F.S. Meyer (adapted), available at *Flora e Funga do Brasil*. (F) *Ludwigia litoranea* (CR), photo adapted from Pesamosca and Boldrini (2015). (G) *Callisthene kuhlmannii* (CR), photo by G.H. Shimizu (adapted), available at *Flora e Funga do Brasil*.

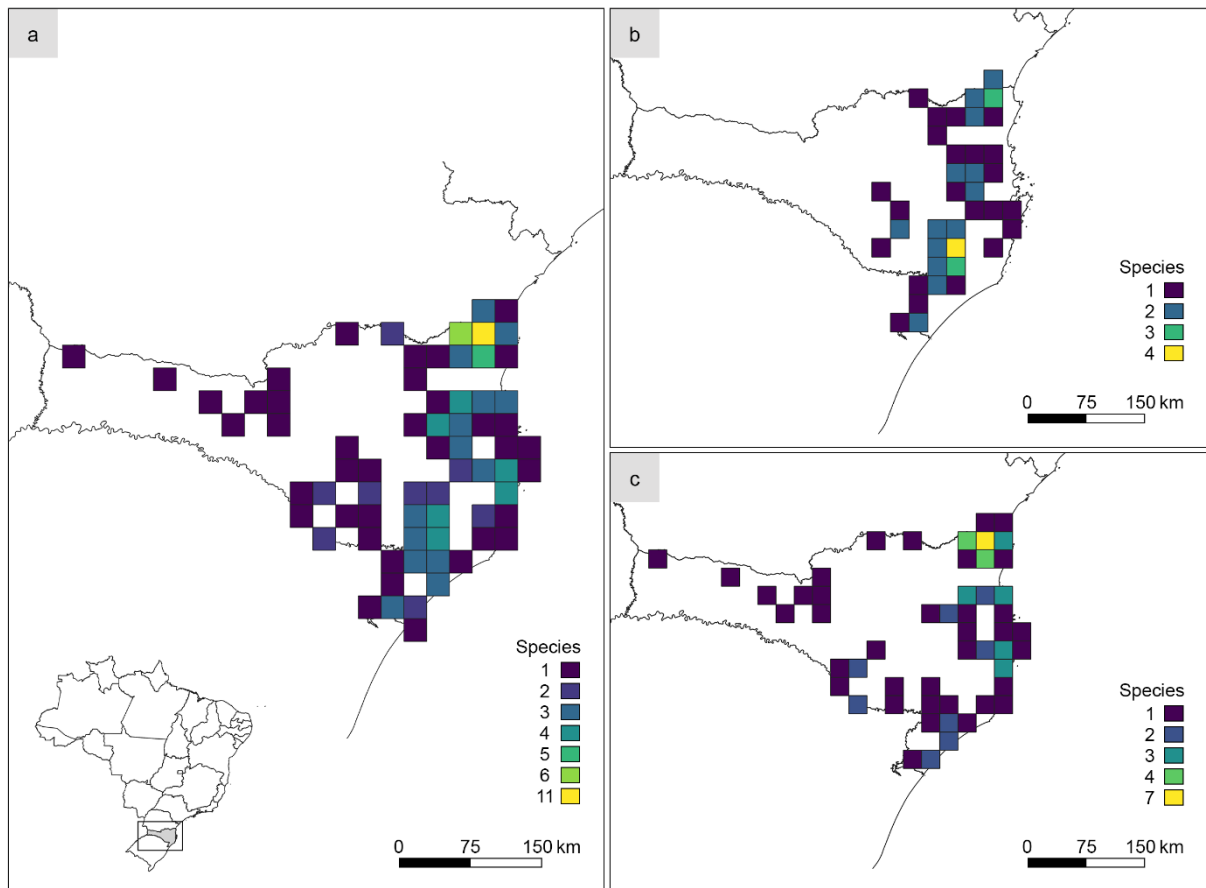


Fig. 2. Richness maps of threatened species. Records of all species included in any threatened category (vulnerable, endangered, or critically endangered) were considered. (A) Threatened species of Myrtales, including all four families assessed in this study. (B) Threatened species of Melastomataceae. (C) Threatened species of Myrtaceae.

#### *Notes on taxonomic verification and conservation categories*

The Myrtaceae family, widely known for its species of economic and ecological importance (Lucas and Bünger, 2016; Saber *et al.*, 2024), comprises 207 species in the state of Santa Catarina. Twenty-six met our filter criteria and were assessed, representing 12.5% of its diversity in the state. Five species were classified as CR: *Eugenia quiriri* and *E. reitziana*, both endemic to Santa Catarina (FFB, 2025), have only two confirmed records. *Eugenia quiriri* was described in 2019, but its records date back to 2001 and 2008; since then, no further records have been made (Sobral *et al.*, 2019). *Eugenia reitziana* was described in 1981, with records from 1952 and 1956, and has not been collected since then. *Myrceugenia foveolata* occurs in Santa Catarina and Rio Grande do Sul, with five confirmed records from only two nearby localities. *Myrcia garuvana* was described in 2022 (Vieira *et al.*, 2022) and has six confirmed records: five in Garuva, in areas of difficult access (*Morro Monte Crista*), and one in Joinville. There are no records in protected areas, and the small EOO (4 km<sup>2</sup>) justifies the category.

Finally, *Myrcianthes riparia*, described in 2012 (Sobral *et al.*, 2012), has four confirmed records, the most recent from 2007, all collected in the same locality (*Capão Alto*, in riparian forests).

Myrtaceae also included one species classified as DD, *Eugenia angelyana*, endemic to Santa Catarina. The species is known from a single record (the type material), collected in 1971 in Palhoça, in a protected area (*Morro do Cambirela, Parque Estadual da Serra do Tabuleiro*), justifying its categorization as DD. It has not been recorded since then.

Two species of Myrtaceae globally classified as EN (*Myrceugenia basicordata* and *Myrceugenia joinvillensis*) were also categorized based on conservation genetic analyses (Augustin *et al.*, 2025). *Myrceugenia basicordata* also fitted under criterion C (small population and decline) due to its lower genetic diversity and the historical decline suggested by the genetic results (Augustin *et al.*, 2025). Similarly, *Miconia ulei* (Melastomataceae) was considered vulnerable (also under C criterion), based on field observations conducted for genetic purposes (Goebel *et al.*, in prep.). Two records of *M. ulei* were excluded from the assessments because the populations no longer exist, as the species was not found during field surveys (CRI 6287 and CRI 5097; see SI Table 1 for more details). The first habitat had been converted into a housing development, and the second into a banana plantation (GG and MKC observations, Goebel *et al.*, in prep.).

The Melastomataceae, one of the largest and richest families in the Brazilian flora (Ulloa *et al.*, 2022), comprises 125 species occurring in the state of Santa Catarina (FFB, 2025), of which we assessed 16 (12.8%) that matched our filters. Within this family, one species was classified as CR: *Chaetogastra cristaensis*, a terrestrial subshrub endemic to Santa Catarina, restricted to high-altitude grasslands and ombrophylous forests (Meyer *et al.*, 2025). Digital databases list 15 records of *C. cristaensis*, all restricted to a single locality in Serra do Quiriri, Garuva, occurring at elevations between 870 and 1,000 m (Meyer and Goldenberg, 2016). This area is under increasing pressure from tourism-related activities, such as camping expansion and the use of native wood for campfires (Meyer and Goldenberg, 2016). Additionally, climate change represents a significant threat, as it may drastically modify the microhabitats typical of these highland ecosystems (Drischel, 2024; Helmer *et al.*, 2019). The species authors also preliminarily classified the species as CR, under the A2 criterion (Meyer and Goldenberg, 2016).

We classified one species of Melastomataceae as DD: *Miconia dusenii*, a terrestrial subshrub endemic to Brazil, occurring in the states of Santa Catarina and Paraná, and inhabiting ombrophylous forests (Baumgratz *et al.*, 2025). The species was described in 1891 and has one heterotypic synonym: *Leandra microphylla* Cogn. (Baumgratz *et al.*, 2025; Michelangeli *et al.*, 2019). It is not included in the red list of Paraná (Sampaio *et al.*, 2020) and has not been assessed by CNCFlora. With only two confirmed records, both from the same locality in São Francisco do Sul and being nomenclatural type materials, we inferred that the current information regarding the species and their circumscription is not sufficient to categorize it in some IUCN threat category.

For the 29 species of Onagraceae occurring in Santa Catarina, we assessed four of them (13%), considering the filters used. One was classified as CR: *Ludwigia litoranea*, a terrestrial herb that grows in the coastal forests of Rio Grande do Sul and Santa Catarina (FFB, 2025). In Santa Catarina, it has four confirmed records from two different locations, ranging from 1971 to 2017. The other three species of the family were classified as DD. *Ludwigia humboldtiana* and *L. irregularis* are two recently described species, each with only one record (type material), from Corupá and Ascurra, respectively (Funez *et al.*, 2020; Funez *et al.*, 2021). Finally, the other species classified as DD was *Oenothera catharinensis*, endemic to the state, with nine confirmed records ranging from 1974 to 2021. Although more information is available for this species, we decided to maintain it in the DD category due to taxonomic uncertainties regarding its circumscription. Some specialists consider *O. catharinensis* a synonym of *O. mollissima* L. (which is not endemic to Brazil) (Falkenberg, 1988; but see Farias *et al.*, 2024; FFB, 2025, for a different interpretation). A taxonomic study proposing the synonymization of these species is in preparation (Cardoso and Caddah, in prep.).

Vochysiaceae comprises six species occurring in Santa Catarina. We evaluated one of them (16%), which was classified as CR. *Callisthene kuhlmannii* is a tree that grows in ombrophilous forests in Santa Catarina and Paraná (Shimizu *et al.*, 2025). It shows a severely fragmented distribution, with only four confirmed records from two different locations in Santa Catarina, ranging from 1957 to 2018, none of which is within protected areas.

Of the 11 species listed as vulnerable or presumably extinct in the CONSEMA list, three were retained in our evaluations: *Eugenia pachyclada* and *E. pseudomalacantha* (Myrtaceae), both previously classified as VU in the CONSEMA list and now updated to EN in our assessment, and *Callisthene kuhlmannii* (Vochysiaceae), which changed from VU to CR.

All other Myrtales species mentioned in the CONSEMA list presented either taxonomic issues (e.g., synonymy), or a broader distribution (e.g., southeastern Brazil), which likely excluded them from our filter in the FFB platform. Additionally, it is worth noting that 38 of the 47 Myrtales species assessed had already been formally described and were known to science prior to 2014 (sometimes as a different genus combination, see Table 1), the year that the CONSEMA list was published. Only nine species were described after that date.

#### *Implications for state public policies*

Our results highlight that traditional taxonomy (identification based primarily on the morphology of organisms; Arguelles and Martínez-Goss, 2020), combined with specialist expertise, remains an essential tool for supporting conservation efforts. Using this approach, we identified six times more threatened species compared to the CONSEMA list published in December 2014, and our efforts are not isolated. The CONSEMA list has been the main focus of other studies aiming at updating the state's threatened flora, drawing the attention of state leadership, and shedding light on the importance of allocating resources to such efforts (see Drischel 2024 and Drischel and Caddah, in prep., for broader approaches; Elias *et al.*, 2019 for narrower approaches within the palm family).

The use of a problematic red list has practical impacts on environmental licensing. The CONSEMA list is the current reference for public and private organizations when conducting projects that directly affect urban expansion and habitat protection in the state (as established by State Law 14.675/2009, Santa Catarina 2009). It is currently used alongside the federal red list (Portaria MMA Nº 148/2022, published in June of 2022 as “*Lista Oficial de Espécies da Flora Brasileira Ameaçadas de Extinção*”, MMA, 2022) to assess threatened flora and their respective conservation status, always adopting the most restrictive category when differences arise. However, outdated scientific names in the CONSEMA list and differences in the criteria for conservation status assessments pose daily challenges for environmental professionals. For instance, a species may be considered threatened at the regional scale (as interpreted by IUCN 2010) but still be excluded from the CONSEMA red list due to methodological inconsistencies.

The importance of having an accurate and up-to-date regional red list is critical for guiding species selection and prioritizing endemic and/or threatened species in restoration efforts (e.g., Oliveira *et al.*, 2021). It is also important to note that Brazil is a global reference for generating reliable scientific data through taxonomic approaches and offers powerful, free,

and user-friendly tools for assessing red lists at all scales (BFG 2022). For instance, the FFB platform, extensively used in this study, was established in 2015 in response to Target 1 of the Global Strategy for Plant Conservation under the Convention on Biological Diversity (BFG, 2022; Forzza *et al.*, 2010; GSPC-CBD, <https://www.cbd.int/>). Through this platform, a total of 53,554 species are currently recognized (native, naturalized, and cultivated), including 36,985 angiosperms (FFB, 2025). Considering this progress, it is essential that regional red lists are periodically updated (each 5-10 years, IUCN, 2025; Nic Lughadha *et al.*, 2020). Earlier lists, such as the CONSEMA list, although not poorly constructed, were produced when the knowledge of the flora had not yet been fully systematized in the FFB, which was only consolidated after 2015.

Herbarium collections are also valuable sources of evidence for documenting species occurrences (Christenhusz and Gouverts, 2025; Nic Lughadha *et al.*, 2019). Our work, as well as other studies with similar goals (see also Elias *et al.*, 2019), relied heavily on herbarium specimens that we examined either physically or digitally. However, with the decline in taxonomist training (Engel *et al.*, 2021) and the growing difficulties in maintaining collections, keeping herbaria functional increasingly depends on public policies and institutional partnerships for conservation measures (Eckert *et al.*, 2024; Gasper *et al.*, 2020; Thiers *et al.*, 2024). In Santa Catarina, there are at least 10 different herbaria collections, including FLOR (Florianópolis), JOI (Joinville), FURB (Blumenau), HBR (Itajaí), CRI (Criciúma) and others (SBB, 2025; Thiers, 2025). We consulted all of them, personally or digitally, for updating the Myrtales threatened species list.

#### *Implications for conservation of threatened species of Santa Catarina*

We identified that the threatened Myrtales species in the state of Santa Catarina are primarily located along the eastern portion of the state, particularly near the border with Paraná (see Fig. 2). This may suggest a knowledge gap regarding the local flora in the western part of the state, especially within the Melastomataceae family (Fig. 2b). Melastomataceae still presented a hotspot of threatened species in the southern region of the state, at high-altitude vegetation around the São Joaquim National Park (with 3-4 species). Additionally, most of these species are not found within protected areas (Fig. 3). According to the Brazilian Protected Areas Panel, Paraná has a much larger protected area coverage, nearly 14,000 km<sup>2</sup> compared to about 6,000 km<sup>2</sup> in Santa Catarina. Taken together, these findings highlight the urgent need to expand and better distribute protected areas in Santa Catarina.

We also detected a high number of endemic species in the state. Of the 47 species assessed, 14 (about 29%), mostly Myrtaceae, are endemic to Santa Catarina, and 10 are threatened to some degree. This is not surprising, as the state has already been identified as an endemism hotspot for some *Myrcia* species (Murray-Smith *et al.*, 2009). Melastomataceae is also known for specialization processes that have led to high levels of endemism in the Atlantic Forest (Nery *et al.*, 2023). Because many of these endemic species are also threatened, their persistence depends largely on conservation actions implemented within the state (e.g., the distribution of protected areas mentioned above), reinforcing the implications for conservation of Santa Catarina's threatened species.

## CONCLUSION

We presented here a taxonomically verified list of 47 Myrtales species assessed for the state of Santa Catarina, most of which are categorized as threatened and primarily concentrated in the eastern portion of the state. Our results reinforce the importance of taxonomically verified lists as a foundation for a more accurate identification of the threat status of species, ensuring that conservation priorities are based on reliable data. Taken together, our findings highlight how threatened species are still underestimated in the state and emphasize the need for Santa Catarina's red list to be periodically updated.

Moreover, we stress that the state must expand and improve the distribution of its protected areas, particularly because there are still significant sampling and conservation gaps in the western region. We also provided new insights into how classic taxonomy remains an essential tool and can effectively inform public policies for conservation. Finally, we emphasize that the scientific community is open to and actively encourages partnerships between research institutions and government agencies, as these collaborations are essential to strengthen conservation strategies and ensure the long-term protection of biodiversity.

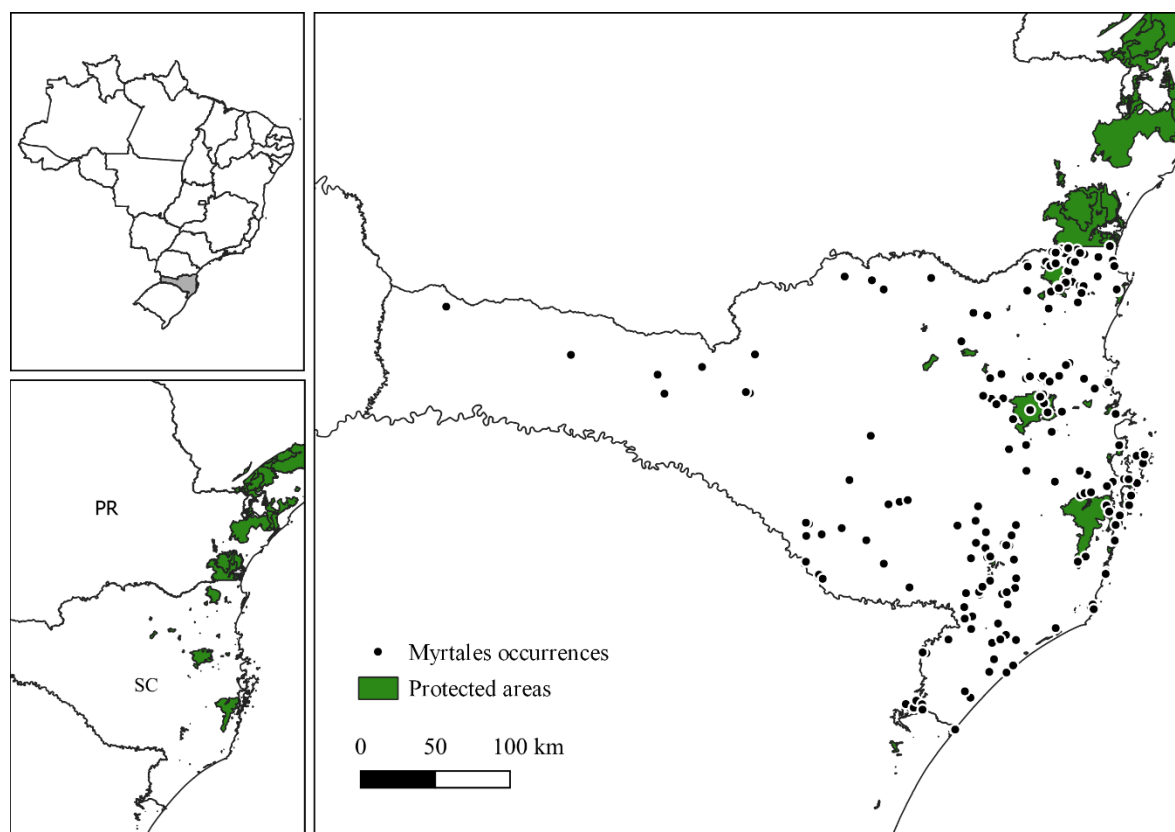


Fig. 3. Occurrences of threatened Myrtales species in Santa Catarina. Green areas represent protected areas. PR = Paraná; SC = Santa Catarina.

Table 1. Species assessed based on the IUCN category and criteria, information about their year of publication, metrics of EOO and AOO according to GeoCAT, final category, final assessment and type of assessment.

| Species                                                           | Year of publication | EOO        | AOO | Category | Criteria for threatened assessment | Type of assessment | Endemic to SC? |
|-------------------------------------------------------------------|---------------------|------------|-----|----------|------------------------------------|--------------------|----------------|
| <b>Melastomataceae</b>                                            |                     |            |     |          |                                    |                    |                |
| <i>Chaetogastra cisplatensis</i> (Cogn.) P.J.F.Guim. & Michelang. | 1885*               | 702.010    | 12  | EN       | B1ab(iii)                          | R                  | N              |
| <i>Chaetogastra cordeiroi</i> F.S.Mey. & R.Goldenb.               | 2016                | 222.329    | 16  | EN       | B1ab(ii,iii)                       | R                  | N              |
| <i>Chaetogastra cristaensis</i> F.S.Mey & R.Goldenb.              | 2016                | 15.008     | 20  | CR       | B1ab(i,ii,iii)                     | G                  | Y              |
| <i>Chaetogastra rupestris</i> (Cogn.) P.J.F.Guim. & Michelang.    | 1891*               | 3,6025.673 | 80  | LC       | -                                  | R                  | N              |
| <i>Miconia ulei</i> (Cogn.) R.Goldenb.                            | 1891*               | 8,678.75   | 52  | VU       | B2ab(iii), C2a(i)                  | G                  | Y              |
| <i>Miconia catharinensis</i> (Cogn.) R.Goldenb.                   | 1891*               | 5,2427.544 | 72  | LC       | -                                  | R                  | N              |
| <i>Miconia luctatoris</i> (Wurdack) R.Goldenb.                    | 1962*               | 200.815    | 16  | EN       | B1ab(iii)                          | G                  | Y              |
| <i>Miconia dusenii</i> (Cogn.) R.Goldenb.                         | 1891*               | -          | -   | DD       | -                                  | R                  | N              |
| <i>Miconia planifilamentosa</i> (Brade) R.Goldenb.                | 1957*               | 1,7731.44  | 56  | VU       | B1ab(iii)                          | R                  | N              |
| <i>Miconia ramboi</i> Brade                                       | 1957                | 51,748.414 | 104 | LC       | -                                  | R                  | N              |
| <i>Miconia riograndensis</i> (Brade) R.Goldenb.                   | 1962*               | 4,7345.288 | 96  | LC       | -                                  | R                  | N              |
| <i>Pleroma dusenii</i> (Cogn.) P.J.F.Guim. & Michelang.           | 1910*               | 1,068.514  | 28  | EN       | B1ab(iii)                          | R                  | N              |
| <i>Pleroma kleinii</i> (Wurdack) P.J.F.Guim. & Michelang.         | 1962*               | 14,859.556 | 56  | VU       | B1ab(iii)                          | R                  | N              |
| <i>Pleroma pilosum</i> (Cogn.) P.J.F.Guim. & Michelang.           | 1888*               | 28,792.488 | 140 | LC       | -                                  | R                  | N              |
| <i>Pleroma ramboi</i> (Brade) P.J.F.Guim. & Michelang.            | 1958*               | 3,496.035  | 88  | EN       | B1ab(iii)                          | R                  | N              |
| <i>Pleroma setosociliatum</i> (Cogn.) F.S.Mey. & F.B. Matos       | 1910*               | 1,076.603  | 24  | EN       | B1ab(iii)                          | R                  | N              |
| <b>Myrtaceae</b>                                                  |                     |            |     |          |                                    |                    |                |
| <i>Campomanesia littoralis</i> D.Legrand                          | 1961                | 5,774.196  | 104 | VU       | B1b(iii)                           | R                  | N              |
| <i>Campomanesia reitziana</i> D.Legrand                           | 1957                | 3,6070.343 | 132 | NT       | -                                  | R                  | N              |
| <i>Curitiba prismatica</i> (D.Legrand) Salywon & Landrum          | 2007                | 283.215    | 16  | EN       | B1ab(iii,iv)                       | R                  | N              |
| <i>Eugenia angelyana</i> Mattos                                   | 1989                | -          | -   | DD       | -                                  | G                  | Y              |
| <i>Eugenia joenssonii</i> Kausel                                  | 1971                | 6,860.726  | 40  | VU       | B1ab(iii)                          | R                  | N              |
| <i>Eugenia mattosii</i> D.Legrand                                 | 1961                | 390.567    | 40  | EN       | B1ab(iii)                          | G                  | Y              |

|                                                                   |      |            |     |    |                         |   |   |
|-------------------------------------------------------------------|------|------------|-----|----|-------------------------|---|---|
| <i>Eugenia neotristis</i> Sobral                                  | 1995 | 1,845.293  | 32  | EN | B1ab(iii)               | R | N |
| <i>Eugenia pachyclada</i> D.Legrand                               | 1961 | 2,293.606  | 16  | EN | B1ab(iii)               | G | Y |
| <i>Eugenia pseudomalacantha</i> D.Legrand                         | 1969 | 430.598    | 16  | EN | B1ab(iii)               | R | N |
| <i>Eugenia quiriri</i> Sobral & F.C.S.Vieira                      | 2019 | 0          | 8   | CR | B2ab(iii, iv)           | G | Y |
| <i>Eugenia reitziana</i> D.Legrand                                | 1961 | 0          | 4   | CR | B2ab(iii, iv)           | G | Y |
| <i>Eugenia rostrifolia</i> D.Legrand                              | 1957 | 21,942.919 | 36  | NT | -                       | R | N |
| <i>Eugenia rotundicosta</i> D.Legrand                             | 1977 | 501.055    | 12  | EN | B1ab(iii)               | R | N |
| <i>Eugenia sclerocalyx</i> D.Legrand                              | 1961 | 5,689.828  | 40  | VU | B1ab(iii)               | R | N |
| <i>Myrceugenia basicordata</i> F.C.S.Vieira, Molz & Sobral        | 2019 | 166.967    | 20  | EN | B1ab(iii,iv);<br>C2a(i) | G | Y |
| <i>Myrceugenia foveolata</i> (O.Berg) Sobral                      | 1986 | 0          | 8   | CR | B2ab(iii, iv)           | R | N |
| <i>Myrceugenia joinvillensis</i> F.C.S.Vieira                     | 2020 | 72.950     | 20  | EN | B1b(iii,iv)             | G | Y |
| <i>Myrceugenia mesomischa</i> (Burret) D.Legrand & Kausel         | 1953 | 12,002.957 | 48  | VU | B1b(iii)                | R | N |
| <i>Myrcia garuvana</i> F.C.S.Vieira & Sobral                      | 2022 | 4.239      | 12  | CR | B1ab(iii, iv)           | G | Y |
| <i>Myrcia hatschbachii</i> D.Legrand                              | 1961 | 43,727.653 | 132 | LC | -                       | R | N |
| <i>Myrcianthes riparia</i> Sobral <i>et al.</i>                   | 2012 | 0          | 8   | CR | B1ab(iii)               | R | N |
| <i>Myrciaria plinioides</i> D.Legrand                             | 1961 | 23,180.120 | 72  | LC | -                       | R | N |
| <i>Neomitranthes cordifolia</i> (D.Legrand) D.Legrand             | 1977 | 12,703.505 | 48  | VU | B1b(iii)                | R | N |
| <i>Neomitranthes gemballae</i> (D.Legrand) D.Legrand              | 1977 | 11,867.968 | 44  | NT | B1b(iii)                | R | N |
| <i>Plinia cordifolia</i> (D.Legrand) Sobral                       | 1994 | 10,485.529 | 64  | NT | B1b(iii)                | R | N |
| <i>Psidium longipetiolatum</i> D.Legrand                          | 1961 | 48,046.350 | 60  | LC | -                       | R | N |
| <b>Onagraceae</b>                                                 |      |            |     |    |                         |   |   |
| <i>Ludwigia humboldtiana</i> Funez, D.M.Farias, Hassemer & Gasper | 2020 | 0          | 4   | DD | B2ab(iii)               | G | Y |
| <i>Ludwigia litoranea</i> Cocc. & Boldrini                        | 2015 | 34.553     | 12  | CR | B1ab(iii, iv)           | R | N |
| <i>Ludwigia irregularis</i> Funez, Hassemer, D.M.Farias & Gasper  | 2021 | 0          | 4   | DD | B2ab(iii)               | G | Y |
| <i>Oenothera catharinensis</i> Cambess.                           | 1829 | 7,968.653  | 36  | DD | B2ab(iii)               | G | Y |
| <b>Vochysiaceae</b>                                               |      |            |     |    |                         |   |   |
| <i>Callisthene kuhlmannii</i> H.F.Martins                         | 1988 | 0          | 8   | CR | B2ab(iii, iv)           | R | N |

Notes: EOO = Extent of Occurrence; AOO = Area of Occupancy; R = Regional; G = Global; Y = Yes; N = No; \* Indicates year of publication of the basionym of the species, according to FFB and Tropicos database (<https://www.tropicos.org/>).

Table 2. Comparison between the species assessments conducted in this study and the official endangered species list of CONSEMA (2014).

| Myrtales family | CR | EN | VU | DD | NT | LC | Reference    |
|-----------------|----|----|----|----|----|----|--------------|
| Melastomataceae | 0  | 0  | 1  | 0  | 0  | 0  | CONSEMA 2014 |
|                 | 1  | 6  | 3  | 1  | 0  | 5  | This study   |
| Myrtaceae       | 0  | 0  | 3  | 0  | 0  | 0  | CONSEMA 2014 |
|                 | 5  | 8  | 5  | 1  | 4  | 3  | This study   |
| Onagraceae      | 0  | 0  | 0  | 0  | 0  | 0  | CONSEMA 2014 |
|                 | 1  | 0  | 0  | 3  | 0  | 0  | This study   |
| Vochysiaceae    | 0  | 0  | 1  | 0  | 0  | 0  | CONSEMA 2014 |
|                 | 1  | 0  | 0  | 0  | 0  | 0  | This study   |
| Total           | 0  | 0  | 5  | 0  | 0  | 0  | CONSEMA 2014 |
|                 | 8  | 14 | 8  | 5  | 4  | 8  | This study   |

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## CAPÍTULO II

### Species distribution modeling of two rare endemic Myrtaceae from the Brazilian Atlantic Forest: challenges in conserving “invisible species”

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Autores: Ana Flávia Augustin, Duane Fernandes Lima, Fábio C. S. Vieira e Mayara Krasinski Caddah

#### Abstract

Rare species are more susceptible to environmental changes, often face a high risk of extinction, and suffer from a lack of general geographic and biological data. Finding new populations of these species and understanding how future climate change will affect their distributions are crucial for conservation purposes. We investigated the potential distribution of two rare species of *Myrceugenia* (Myrtaceae) from the Atlantic Forest of southern Brazil, evaluated how these regions are inserted in protected areas (PAs), analyzed land-use patterns in these areas and investigated how the distribution will possibly behave in future climate change scenarios. Species distribution models (SDMs) were built using Maxent with the flexsdm package, across the dense ombrophilous forest (Atlantic Forest domain). As results, we identified few areas of high suitability for both species in the current scenario, concentrated in coastline regions. Between 42–44% of the suitability areas are inserted within PAs, but most are partially protected areas, where some land use and human activity are allowed. Suitable habitats are even more limited when land-use information is considered. Future scenarios reveal an alarming situation, with projections indicating a significant loss of suitable climatic niches for both species, potentially leading to their near-complete extinction within the next century. This is the first study encompassing SDMs for *Myrceugenia*. Our results are particularly relevant to expand the knowledge of species with few empirical data since they can guide new collections, support solid assessments of extinction risk, and guide protectionist decisions from competent agencies in the medium and long term.

**Keywords:** Climate change, conservation, dense ombrophilous forest, *Myrceugenia*, SDMs.

#### INTRODUCTION

Biodiversity conservation has become increasingly essential in the face of worrying environmental scenarios caused by human action (Johnson et al. 2017). The consequences of these actions for species are numerous and include fragmentation and habitat loss, reduction in population size, loss of genetic variability and the ability of these organisms to adapt to environmental changes (Nic Lughadha et al. 2020; Vranckx et al. 2012; Wilson et al. 2016). Rare species, including those that have become rare due to recent population declines or are historically rare due to geographical isolation, present an even more complex problem, since they generally suffer from a generalized lack of information (e.g., distribution in a specific region or responses to disturbances in their environment) (Marcer et al. 2013; Mashburn et al. 2023). Due to these constraints, rare species are more susceptible to habitat fragmentation and extinction, as already supported through empirical data (e.g., Davies et al. 2004).

Rare species are essential in nature and can contribute to ecosystems in multiple ways: through interactions with other species, by occupying specific niches, or by utilizing resources not used by other organisms (Dee et al. 2019). Furthermore, it is estimated that the loss of rare species may reduce the functional richness and specialization of tropical communities more severely than the loss of common species (Leitão et al. 2016). The extinction of a single species can compromise entire chains of biological interrelationships, disrupting multiple ecological processes (Leitão et al. 2016; Sodhi et al. 2009). Despite their ecological relevance, rare species are often underrepresented in ecological and conservation approaches, largely due to the difficulty in obtaining sufficient data for analysis. For this reason, they have been referred to as “invisible species” (Crisfield et al. 2024; Trindade and Marques, 2024).

The most usual strategy for *in situ* conservation of wild species is the protection of their natural habitats, which, in practice, implies turning these areas into legally protected areas (PAs) (Gonçalves-Souza et al. 2021). In Brazil, PAs, primarily categorized as integral protection units (IPUs) or sustainable use units (SUUs) (Brasil, 2000; SNUC, 2024), have been frequently criticized for the way in which their spatial distribution is planned, often failing to encompass areas of high ecological relevance for effective biodiversity conservation (Fonseca and Venticinque, 2018; Oliveira et al. 2017; Salvio and Gomes, 2018). Furthermore, the delimitation of these areas is traditionally based on the known distribution of species, without considering potential distribution scenarios (Marcer et al. 2013). Species distribution modeling (SDMs) is a well-established and widely applied tool for generating ecologically relevant data, particularly useful for estimating the potential distribution of rare/poor known species, which could guide targeted surveys and inform conservation priorities (e.g., de Siqueira et al. 2009; Fois et al. 2015; Marcer et al. 2013).

Ongoing and future climate change, in addition to habitat loss due to deforestation, is an obstacle to the survival of species worldwide (Christenhusz and Govaerts 2024; Weiskopf et al. 2020). The spatial distribution of plant species in different regions is expected to change in response to future climate change, with a general tendency toward decreasing areas suitable for occupation (e.g., Castro et al. 2020 in South America; Costion et al. 2015 in Australia; Forester et al. 2013 in the USA; Casazza et al. 2014 in Europe). Beyond range shifts, climate change affects biodiversity in multiple ways, including altered community composition, phenological mismatches, and increased extinction risk (Bellard et al. 2012; Urban 2015; Weiskopf et al. 2020). This scenario is especially critical for species with naturally restricted or highly fragmented distributions (e.g., Breslin et al. 2020). Understanding how climate change will influence the geographic distribution of species is essential for conservation planning, and it is recommended that, when available, such information be incorporated into species extinction risk assessments (IUCN, 2012).

Myrtaceae Juss. is among the richest flowering plant families in the whole world (Christenhusz and Byng, 2016) and it is especially diverse in the Brazilian Atlantic Forest (BFG, 2015), a biodiversity hotspot (Myers et al. 2000). It is the group of woody plants with the most significant number of endemic species in that domain (Stehmann et al. 2009). Among rare species of Myrtaceae from the Brazilian Atlantic Forest, two were recently described and are suspected to be threatened with extinction (Bachman et al. 2024), although no detailed risk assessments are available. *Myrceugenia basicordata* F.C.S.Vieira, Molz and Sobral (Sobral et al. 2019) and *Myrceugenia joinvillensis* F.C.S. Vieira (Vieira, 2020) are known to occur in small areas of the Atlantic Forest,

more specifically in dense ombrophilous forest phytophysiognomy, in the northeastern region of the state of Santa Catarina, Southern Brazil. Considering the knowledge gaps regarding rare species in Brazil and their conservation, we applied species distribution modeling with the following objectives: (i) to estimate the potential distribution of two rare species and identify priority areas for future surveys; (ii) to assess the overlap between their potential distribution, legally protected areas and land-use patterns; (iii) to explore their potential distribution under different future climate change scenarios; and (iv) to discuss potential mitigation measures for conserving these species in the face of climate change.

## MATERIAL AND METHODS

### Species of interest

The species selected for the study are the only ones of the genus *Myrceugenia* endemic to the state of Santa Catarina (South Brazil). Due to the few records of occurrence and their geographically restricted populations, these species are considered rare and threatened. According to one of the specialists in the group (FCSV, initials of one of the authors), these species do not present taxonomic circumscription issues, and their records are reliable data sources.

*Myrceugenia basicordata* is a shrub up to 2 m high. It is currently restricted to a few forested areas close to the urban area of the municipality of Joinville/SC. It usually occurs on slopes at an altitude of about 200 m, in the understory of the dense submontane ombrophilous forest (Sobral et al. 2019), in the Serra do Mar in the northeast of Santa Catarina. *Myrceugenia joinvillensis* is a shrub or tree up to 3 m high. It occurs on the edges of the Atlantic Forest mountains, in the Serra do Mar of northeastern Santa Catarina, at altitudes between 400 and 700 m (Vieira, 2020).

We used the same ecological aspects described for Myrtaceae species to make some decisions during the analyses, as there is no specific information for *M. basicordata* and *M. joinvillensis* within the literature. For example, both species present berry fruits (Vieira and Meireles, 2024), therefore we assumed that seed dispersal is mainly performed by birds and monkeys, such as for other Myrtaceae species (Gressler et al. 2006). This was relevant when considering the accessible area for both species (see SDMs section below).

### Biological data collection and delimitation of the study area

Data collection and revision were conducted by consulting the occurrences in online digital platforms: Specieslink (<https://specieslink.net/>), Re flora (<https://floradobrasil.jbrj.gov.br/>), and the Global Biodiversity Information Facility - GBIF (<https://www.gbif.org/>). We also analyzed Myrtaceae collections from major herbaria in southern and southeastern Brazil, either in person (EFC, FLOR, HBR, ICN, JOI, MBM, and UPCB) or remotely through digital photographs (FURB, RB, and SPF), to search for potential new occurrence records among undetermined, non-digitized, or misidentified specimens (herbarium acronyms according to Thiers (2025)). Additionally, we searched non-conventional platforms such as iNaturalist (<https://www.inaturalist.org/>) for potential new records. No new records were found.

A total of 10 occurrence records were found for *Myrceugenia basicordata* and six for *M. joinvillensis*. We included all occurrence records available for each species, including distinct coordinates even when located within the same locality. All data obtained from digital platforms were manually confirmed, filtered, cleaned, and selected to ensure quality data for modeling. Each point was verified using high-resolution satellite images (Google LLC, 2024). This dataset represents the entire known distribution of both species (SI Table 1).

Given the scarcity of records, certain ecological aspects (e.g., seed dispersal and habitat preferences such as altitude), and literature recommendations suggesting that wide areas may include non-relevant regions for species-environment interactions (Sillero et al. 2021), we defined our area of interest as the dense ombrophilous forest, which is a vegetation type within the Atlantic Forest domain, from southern and southeastern Brazil, for modeling.

### Collection and processing of abiotic data

Vegetation shapefiles corresponding to dense ombrophilous forest were obtained from the “Instituto Brasileiro de Geografia e Estatística” database (IBGE, 2025). The shapes of PAs filtered for the Atlantic Forest were obtained from the “Painel de Unidades de Conservação Brasileiras” (MMA, 2025). Land-use and land-cover layers were obtained from the 9th Collection of the MapBiomas Project – Collection 9 of the Annual Land Use and Land Cover Mapping Series of Brazil, based on satellite images from 2023 (MapBiomas, 2025). Minor adjustments, area calculations and final figures were performed in QGIS v. 3.28.7 (QGIS Development Team, 2023).

Nineteen bioclimatic variables “[i.e. BIOCLIM variables, see Booth (2024) for further explanations)] from the Worldclim database were used to analyze species current distribution (Fick and Hijmans, 2017). Layers have been selected at a resolution of 30 arc-seconds ( $\approx 1 \text{ km}^2$ ) for 1970–2000 (see all the variables in <https://www.worldclim.org/data/bioclim.html>). All 19 raster layers were cut for the dense ombrophilous forest from the southern and southeastern Brazil using the geoprocessing software QGIS v. 3.28.7 (QGIS Development Team, 2023) in the WGS 84 coordinate system.

The bioclimatic variables of two distinct periods were used for future climate simulations (2021–2040, for immediate actions considerations, and 2081–2100, to be aligned with global climate changes agreements). We selected two different scenarios for each period, called “shared socioeconomic pathways” (SSPs) of the “Coupled Model Intercomparison Project Phase 6” (CMIP6 – <https://wcrp-cmip.org/cmip-phase-6-cmip6/>): an intermediate (SSP 2–4.5), involving a gradual increase in global temperature of up to 3°C by the year 2100, and a pessimistic (SSP 5–8.5), involving an increase of up to 5°C (Eyring et al. 2016; Riahi et al. 2017). We did not select the optimistic scenario (SSP 1–2.6) because it is not the most feasible socioeconomic pathway, as the temperature of the Earth has already increased by 1.5°C since the pre-industrial period (NASA, 2025). For all simulations, we used climate projections from the MIROC6 (Model for Interdisciplinary Research on Climate version 6) general circulation model, provided by the Worldclim database at a resolution of 30 arc-seconds. MIROC6 is part of the CMIP6 suite and is frequently applied in ecological modeling studies, especially in the southern hemisphere, including Brazil, due to its performance and availability of high-resolution data (e.g., Barrientos-Díaz et al. 2024; Simões et al. 2020).

We performed a principal component analysis (PCA) using the `correct_colinvar` function from the ‘flexsdm’ package version 1.3.6 (Velazco et al. 2022) in R version 4.5.1 (R Core Team, 2025) to reduce collinearity among all bioclimatic variables. The PCA was conducted using the current climatic conditions and future climate scenarios were then projected onto the same PCA space. We selected the first four principal components (PCs), which together explained over 96% of the total variance, to use in subsequent analyses.

### **Species distribution models (SDMs)**

We used the ‘flexsdm’ package version 1.3.6 (Velazco et al. 2022) in R version 4.5.1 (R Core Team, 2025) for all SDM analyses. After several simulations, we adopted the same protocol for both species, based on their reduced number of records (described below). The same ‘flexsdm’ parameters and functions were used for analyses under both current and future climatic conditions.

We used a buffer of 300 km around the occurrence points to define the accessible area for both species (`calib_area` function), which, from a conservative perspective, represents the regions accessible to the species during the most recent time period (Barve et al. 2011). We excluded islands near the studied area from the analyses, as they could represent dispersal barriers for the species and interfere with model interpretations. Background points were created adjusting the number of points to 12,000 (compared to the default of 10,000), which represents approximately 20% of the resolution and size of the studied area (Whitford et al. 2024). We implemented the leave-one-out cross validation method (Pearson et al. 2007) for data partitioning, where the number of partitions is equal to the number of records.

We used the modeling algorithm Maximum Entropy (Maxent) for all current and future analyses, which was fitted and validated by `tun_max` and predicted by `sdm_predict` functions. Maxent is widely used for modeling approaches and is particularly known for presenting good performance with small sample sizes (e.g., Fois et al. 2015; Rhoden et al. 2017; Wisz et al. 2008). The `tun_max` function permits fitting Maxent with tuning approach, a recommended option over standard versions that involve “forcing” the algorithm to test the best hyperparameters combination for the dataset (Bao et al. 2022; Fourcade 2021; Velazco et al. 2022). We created a grid test, including two classes: linear (l) and linear-quadratic (lq), and three regularization multipliers: 1, 2.5, and 3. The metric used for selecting the best hyperparameters was the default TSS (true skill statistic). Binary maps (i.e., 0, 1 – used for area calculations and comparisons among different scenarios) were built using a threshold at which sensitivity and specificity were equal (`equal_sens_spec`).

Model performance was evaluated and assessed without threshold pre-definition. We prioritized two different metrics (one dependent and the other independent of threshold, respectively): the true skill statistic (TSS) and area under curve (AUC), to be comparable with different studies (e.g., Andrella et al. 2023; Gaem et al. 2024). TSS measures model accuracy by accounting for both sensitivity and specificity and ranges from -1 to 1, with values closer to 1 indicating better performance (Allouche et al. 2006; Velazco et al. 2022). While AUC measures the ability of models to discriminate between presences and background, ranging from 0 to 1, with values closer to 1 indicating perfect discrimination (Fielding and Bell 1997).

## RESULTS

### Contribution of environmental variables and model validation

Based on the PCAs, the most significant environmental variables for the area of interest (including current and future scenarios) were temperature annual range (Bio7; PC4), average temperature of the coldest quarter (Bio11; PC1), precipitation seasonality (Bio15; PC2), and precipitation of the wettest quarter (Bio16; PC3). The first four principal components explained approximately 96% of the total environmental variation, with PC1 alone accounting for 44.6%.

A regularization multiplier of 1 and a linear-quadratic class were recovered as the best parameters for our dataset. All models showed good performance for TSS and AUC, as well as other metrics available in the ‘flexsdm’ package (see SI Table 2 for more details). Models generated for *M. basicordata* showed values of 0.95 for both metrics. For *Myrceugenia joinvillensis*, models yielded values of 0.92 for both metrics.

### Current potential distribution, PAs and land use

The models for the two species were analyzed separately (Fig. 1). Both *M. basicordata* and *M. joinvillensis* exhibited a limited potential distribution. Suitable habitats were concentrated in the eastern Serra do Mar, mainly near the Santa Catarina–Paraná border, extending north toward São Paulo, with smaller fragments in Rio de Janeiro and Espírito Santo for *M. joinvillensis* (Figs. 1b and 1d). For *M. basicordata*, the binary map (threshold = 0.57) indicated a suitable area of 3,002 km<sup>2</sup> (Figs. 1a and 1b). For *M. joinvillensis*, the binary map (threshold = 0.45) suggested a total suitable area of 6,515 km<sup>2</sup> (Figs. 1c and 1d).

The proportion of suitable areas within PAs was similar for *M. basicordata* and *M. joinvillensis*. Of the total suitable area for *M. basicordata* (3,002 km<sup>2</sup>), only 42% (1,286 km<sup>2</sup>) is located within PAs (Fig. 2a), 31% of which (403 km<sup>2</sup>) within IPUs. For *M. joinvillensis* (6,515 km<sup>2</sup>), the percentage of suitable area within PAs was around 44% (2,920 km<sup>2</sup>), with 40% of this (1,177 km<sup>2</sup>) within IPUs (Fig. 2c).

Land-use data indicate that suitable areas for both species are even more restricted, as they encompass urban zones, grasslands, and pasturelands (Figs. 2b and 2d). For *M. basicordata*, whose suitable habitats include the Joinville region (Fig. 2b), its potential distribution comprises urban zones (5% of suitable areas) and grasslands and pasturelands (7%). Only 55% (1,655 km<sup>2</sup>) of its potential distribution corresponds to natural forests. For *M. joinvillensis*, urban zones account for 1% of suitable areas, grasslands and pasturelands for 5%, and natural forests correspond to 74% (4,835 km<sup>2</sup>). Furthermore, forested areas with high habitat suitability are primarily concentrated in the state of Paraná for both species. Based on these results, areas near the known occurrences of the species, particularly along the border between the states of Santa Catarina and Paraná, including APA Serra Dona Francisca, APA Guaratuba, and Serra do Tabuleiro National Park (in southern Santa Catarina), were identified as promising sites for future surveys.

### Future potential distribution

All future simulations indicated potential decrease in suitable areas for *Myrceugenia basicordata* and *M. joinvillensis* when compared to the potential distribution in the present (Table 1; Fig. 3; SI Fig. 1). In the

intermediate scenario (SSP2–4.5), *Myrceugenia basicordata* showed a reduction of 38% (remaining suitable area of 1,849 km<sup>2</sup>) for 2021–2040 and 43% (1,705 km<sup>2</sup>) for 2081–2100. Within these suitable areas, 86% (1,608 km<sup>2</sup>) and 95% (1,629 km<sup>2</sup>), respectively, were located inside natural forests, representing additional reductions of 3% and 2% when considering only forest remnants. Smaller fractions of suitable areas were projected in urban zones (<1%) and in pasturelands/grasslands (about 1%). Under the pessimistic scenario (SSP5–8.5), the reductions were stronger: 76% (714 km<sup>2</sup>) for 2021–2040 and 90% (825 km<sup>2</sup>) for 2081–2100. In this case, 97% (697 km<sup>2</sup>) and 90% (747 km<sup>2</sup>), respectively, of the suitable areas remained in natural forests, but the reduction within forests reached 58% and 55%. The remaining areas were distributed in mosaics of land uses, with negligible proportions in urban or pasture zones.

For *Myrceugenia joinvillensis*, the intermediate scenario (SSP2–4.5) projected reductions of 21% (5,105 km<sup>2</sup>) for 2021–2040 and 25% (4,876 km<sup>2</sup>) for 2081–2100. Within these areas, 75% (3,853 km<sup>2</sup>) and 73% (3,592 km<sup>2</sup>), respectively, overlapped with natural forests, representing reductions of 21% and 26% when considering only forest remnants. Urban zones contained about 1% of suitable areas, while pasturelands/grasslands accounted for 4%. In the pessimistic scenario (SSP5–8.5), reductions were stronger: 49% (3,296 km<sup>2</sup>) for 2021–2040 and 59% (2,664 km<sup>2</sup>) for 2081–2100. Suitable areas within forests accounted for 74% (2,455 km<sup>2</sup>) and 62% (1,674 km<sup>2</sup>), corresponding to reductions of 50% and 97% when restricted to forests. The remainder was distributed mainly across mosaics of land uses, with only minor fractions in urban and pasture zones. By the end of the century, both species exhibited a latitudinal shift of suitable habitats toward the southern portion of Santa Catarina (Figs. 3d, 3e, 3i, and 3j).

**Table 1.** Reductions in suitable areas (potential distribution) of *Myrceugenia basicordata* and *M. joinvillensis* under present and future scenarios (SSP2–4.5 and SSP5–8.5). Numbers according to binary maps from species distribution models (see also SI Fig. 1). Values are shown for total suitable areas, suitable areas within natural forests, and their distribution across urban zones, pasturelands/grasslands, and other land-use mosaics.

|                                  |                                        | Present    | SSP 2-4.5  |            | SSP 5-8.5  |            |
|----------------------------------|----------------------------------------|------------|------------|------------|------------|------------|
|                                  |                                        |            | 2021–2040  | 2081–2100  | 2021–2040  | 2081–2100  |
| <i>Myrceugenia basicordata</i>   | Suitable area (km <sup>2</sup> )       | 3,002      | 1,849      | 1,705      | 714        | 825        |
|                                  | Total reduction (%)                    | -          | 38%        | 43%        | 76%        | 72%        |
|                                  | Area of forest (%)                     | 1,655 (55) | 1,608 (86) | 1,629 (95) | 697 (97)   | 747 (90)   |
|                                  | % reduction of forested suitable areas | -          | 3%         | 2%         | 58%        | 55%        |
|                                  | Urban areas (%)                        | 167 (5)    | 17 (0.9)   | 0          | 0          | 0          |
|                                  | Pasturelands/grasslands (%)            | 233 (7)    | 24 (1)     | 17 (0.9)   | 2 (0.2)    | 17 (2)     |
|                                  | Other areas (mosaic of land uses)      | 947        | 200        | 59         | 15         | 61         |
| <i>Myrceugenia joinvillensis</i> | Suitable area (km <sup>2</sup> )       | 6,515      | 5,105      | 4,876      | 3,296      | 2,664      |
|                                  | Total reduction (%)                    | -          | 21%        | 25%        | 49%        | 59%        |
|                                  | Area of forest (%)                     | 4,835 (74) | 3,853 (75) | 3,592 (73) | 2,455 (74) | 1,674 (62) |
|                                  | % reduction of forested suitable areas | -          | 21%        | 26%        | 50%        | 97%        |
|                                  | Urban areas (%)                        | 78 (1)     | 61 (1)     | 61 (1)     | 198 (6)    | 43 (1)     |
|                                  | Pasturelands/grasslands (%)            | 357 (5)    | 233 (4)    | 329 (4)    | 159 (4)    | 227 (8)    |
|                                  | Other areas (mosaic of land uses)      | 1,245      | 958        | 894        | 484        | 720        |

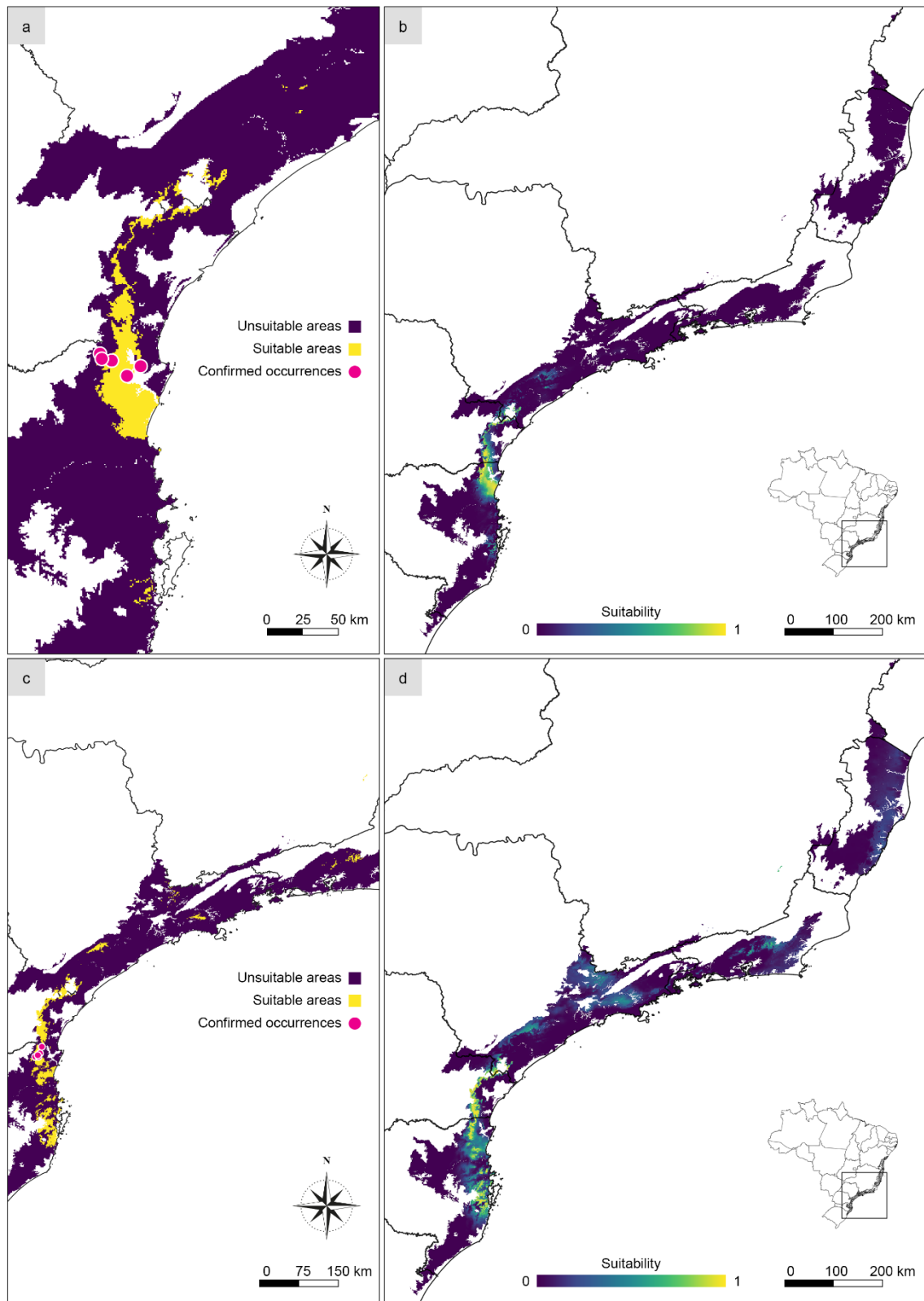


**Fig. 1.** Estimation of the suitable areas for *Myrceugenia basicordata* (a, b) and *M. joinvillensis* (c, d) generated with Maxent algorithm. a, c: Binary maps according to threshold at which sensitivity and specificity are equal (values = 0.57 and 0.45, respectively, for *M. basicordata* and *M. joinvillensis*). b, d: Continuous maps, where the color bars indicate climatic suitability scores, with warmer and cooler colors indicating areas of higher and lower suitability, respectively.

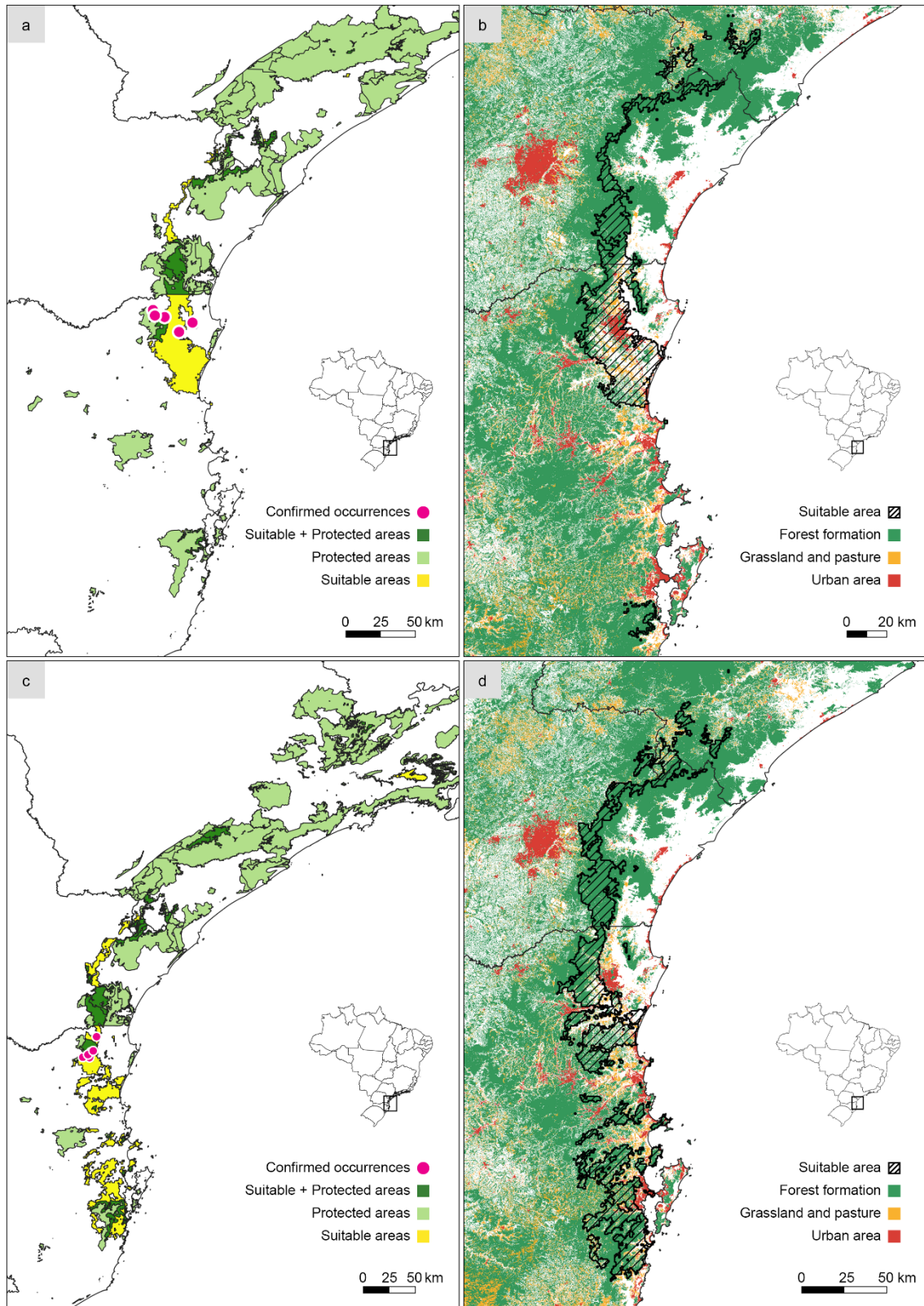


**Fig. 2.** Overlap between protected areas within dense ombrophilous forest in the Atlantic Forest domain and the estimated potential distribution of *Myrceugenia basicordata* (a) and *M. joinvillensis* (c). b and d correspond to land-use information for these areas.

## DISCUSSION

*Myrceugenia basicordata* and *M. joinvillensis* are two rare Myrtaceae species, endemic to a small region of the Atlantic Forest in southern Brazil and at high risk of extinction. We identified limited suitable habitats for both species, about half of which are located within PAs. Land-use information indicated even more restricted areas, especially because the suitable habitats include urban areas and pasturelands, but it highlighted potential new areas for future surveys. Future scenarios showed a decrease in suitable habitats for both species, particularly for *M. basicordata*.

### Current potential distribution, PAs and land use

Our results showed areas of high suitability restricted to the east of the pre-defined area, in stretches of the Serra do Mar mountain range, mainly near the border between the states of Santa Catarina and Paraná, but also reaching areas to the north, near the border with the state of São Paulo. Reduced fragments of suitable habitats were also identified in Rio de Janeiro and Espírito Santo for *M. joinvillensis*. Despite the potential distributions of the two species seems to overlap, *M. basicordata* has been recorded at altitudes of up to 200 m, while *M. joinvillensis* between 600–700 m, demonstrating that the species occupy distinct environments, even when in very close locations.

Currently, *M. basicordata* and *M. joinvillensis* have only two and three known occurrences within PAs, respectively. However, these PAs are part of the more permissive group (APA: ‘Environmental Protection Areas’ and ARIE: ‘Areas of Relevant Ecological Interest’ in English). None of the known records of both species were collected within an IPU. All known populations are small, with few adult individuals that grow close to each other (AFA, DFL, MKC, and FCSV personal observation). Considering the possibility of a sudden anthropogenic event in unprotected or only partially protected areas, such as deforestation, the crowding of individuals is a critical factor since the entire population can be exterminated quickly. For *M. joinvillensis*, for example, there is a mining region close to one specific population, even though this area is within a PA (SUU APA Serra Dona Francisca) (Google LLC, 2024).

Considering the potential areas of present occurrence, our results showed that only 42% (*M. basicordata*) and 44% (*M. joinvillensis*) are inserted within PAs, either of full or partial protection, raising concerns about the present and future of the species. The regions of suitability that overlap with protected areas for both species are concentrated in environmental protection areas (SUUs) and state or municipal parks (IPUs), such as the APA Serra Dona Francisca, Serra do Tabuleiro State Park, and APA Guaratuba, the latter encompassing an extensive area that includes two national parks (Saint-Hilaire/Lange and Guaricana). The Serra do Tabuleiro State Park (IPU) is an endemism hotspot for *Myrcia*, another genus of Myrtaceae (Murray-Smith et al. 2009), and stood out in the areas of high suitability in our study, especially for *M. joinvillensis*. In some cases, the potentially suitable areas are very close to large urban centers, such as the ARIE Morro da Boa Vista and Caieira Municipal Park in Joinville, which is one of the largest cities in southern Brazil (IBGE, 2025), increasing the vulnerability of habitats. Finally, a considerable portion of the extreme Northeast of Santa Catarina presents high suitability for both species but has just a few PAs. This region still has large forested areas (Google LLC, 2024) and deserves conservation attention.

Based on land-use information (Figs. 2b and 2d), areas near the known occurrences of the species, especially along the border between the states of Santa Catarina and Paraná, including APA Serra Dona Francisca, APA Guaratuba, and Serra do Tabuleiro National Park (IPU in southern Santa Catarina), were identified as promising sites for future fieldwork. These regions combine high environmental suitability with well-preserved Atlantic Forest remnants and climatic conditions similar to those of confirmed occurrence sites, potentially favoring the natural dispersal and establishment of *Myrceugenia* species, particularly *M. joinvillensis*. In addition to aiding the detection of new populations, floristic surveys and habitat assessments in these forested areas may help refine SDMs and contribute to the discovery of other species. It is important to note, however, that despite its legal protection status, parts of APA Serra Dona Francisca are subject to pressures from urban expansion and agriculture or pastureland activities (Figs. 2b and 2d), which should be taken into account when prioritizing areas for field exploration.

### Impacts of future climate changes and conservation strategies

Our preliminary results for future simulations suggested that the potential areas of suitability could suffer a continuing reduction considering the simulated areas of current occurrence of the species. Even in intermediate scenarios, in which the global temperature would rise by up to 3°C by 2100, the reduction is quite visible (up by 43%) and may interfere with the survival of the populations. In pessimistic scenarios, where the temperature would rise by up to 5°C by 2100, the hypothesis is that both *M. basicordata* and *M. joinvillensis* could lose at least half of their suitable habitat. The future potential distributions also appeared to shift toward the southern portion of Santa Catarina, becoming restricted to the areas around the Serra do Tabuleiro National Park (Fig. 3). Taken together, these results are unsettling because the planet is already experiencing significant increases in global temperature, and optimistic scenarios (such as SSP 1-2.6, up to 2°C by 2100) are increasingly far from being achieved. Data from the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA) confirm that the surface temperature of the Earth has risen by about 1.5°C above the average since the end of the nineteenth century in the pre-industrial period and the last decade was the warmest on record (NASA, 2025).

Climate changes affect biodiversity in different ways, depending on the biology of species and environmental interactions (e.g., Correa-Lima et al. 2019). For generalist plants, it can be beneficial by making new environments more accessible (e.g., Bello et al. 2021). However, for rare or geographically restricted species, it may increase extinction risk in the medium to long term due to direct effects (e.g., habitat fragmentation) and indirect effects (e.g., altered species interactions) that impact habitat conditions (Salimi et al. 2021; Zwiener et al. 2018). For example, *Araucaria angustifolia* (Bertolt.) Kuntze, an iconic pine from South America, may have reduced suitable areas by up to 60% by 2070 (Castro et al. 2020). The cactus *Cochemiea halei* (Brandege) Walton, endemic to two Mexican islands, is liable to lose up to 53% of its natural range in response to global climate changes (Breslin et al. 2020). These two species have a certain niche specificity. Therefore, establishment in new places may be prevented to a greater or lesser extent. This may be the case with the species of *Myrceugenia* studied here since our results showed that only a few future areas will be suitable for the possible occupation of the species. Other studies, including soil data, will also be useful in shedding new light on our results. Contrary to our results, it was recently demonstrated that some Myrtaceae species widely distributed in the Atlantic Forest domain will

have a future geographical distribution similar to that of the present, even with the increase in global temperature (*Campomanesia guazumifolia* (Mart.) O.Berg, *Psidium cattleianum* Sabine and *Eugenia pyriformis* Cambess.; Barriento-Díaz et al. 2024). Notably, these species occur in different environments (Proença et al. 2024), with quite variable soil and climate characteristics, and, therefore, might present lower niche specificity.

Based on our results for *M. basicordata* and *M. joinvillensis*, we consider both species to be strongly dependent on conservation policies to ensure effective protection in nature, which may also be the case for many other species within the Atlantic Forest domain (Leão et al. 2021; Trindade and Marques, 2024; Vancine et al. 2024). Given this alarming scenario, international commitments such as the Paris Agreement, adopted by the Brazilian government (United Nations, 2015), play a crucial role in guiding climate policies that help mitigate habitat loss and biodiversity decline. In this sense, more studies, such as those conducted here, should be carried out with other plant species, across different groups, to provide an increasingly broad panorama that informs and strengthens new environmental protection measures.

### **Challenges in species distribution modeling for rare species**

One of the key methods for selecting priority areas for conservation is to focus on endangered and/or rare species and develop strategies to preserve their habitats. In this context, species distribution modeling has become a powerful tool (Fois et al. 2015; Giovanelli et al. 2008; Sáenz-Ceja and Mendoza, 2023). However, working with a limited number of occurrence records remains a major challenge when studying the distribution of rare species. In such cases, modeling approaches tend to produce inflated values for some metrics (van Proosdij et al. 2016). According to the literature, a minimum of three occurrence records is recommended for narrow-ranged species, and 13 for widespread species. However, these numbers are derived from virtual experiments under ideal and balanced conditions, which are rarely encountered in nature and should be carefully interpreted (van Proosdij et al. 2016). Similar challenges were anticipated in our analyses. To address this, we placed special emphasis on ecological aspects, considering a model biologically accurate when the predicted potential distribution aligned with the actual habitat preferences of the species.

From this perspective, SDM studies involving species with few records have been gradually increasing in recent literature (e.g., Andrella et al. 2023; Gaem et al. 2024). This is particularly important because nearly 30% of native angiosperm and gymnosperm species in the Brazilian Atlantic Forest have fewer than 10 recorded occurrences and are thus considered “invisible species” in modeling analyses (Trindade and Marques, 2024). This gap is especially concerning, as it highlights that species with specific traits, such as restricted distribution within the Atlantic Forest, recent taxonomic recognition, or occurrence along the coastline, are more susceptible to invisibility (Trindade and Marques, 2024). Notably, both *Myrceugenia* species analyzed in this study share these characteristics.

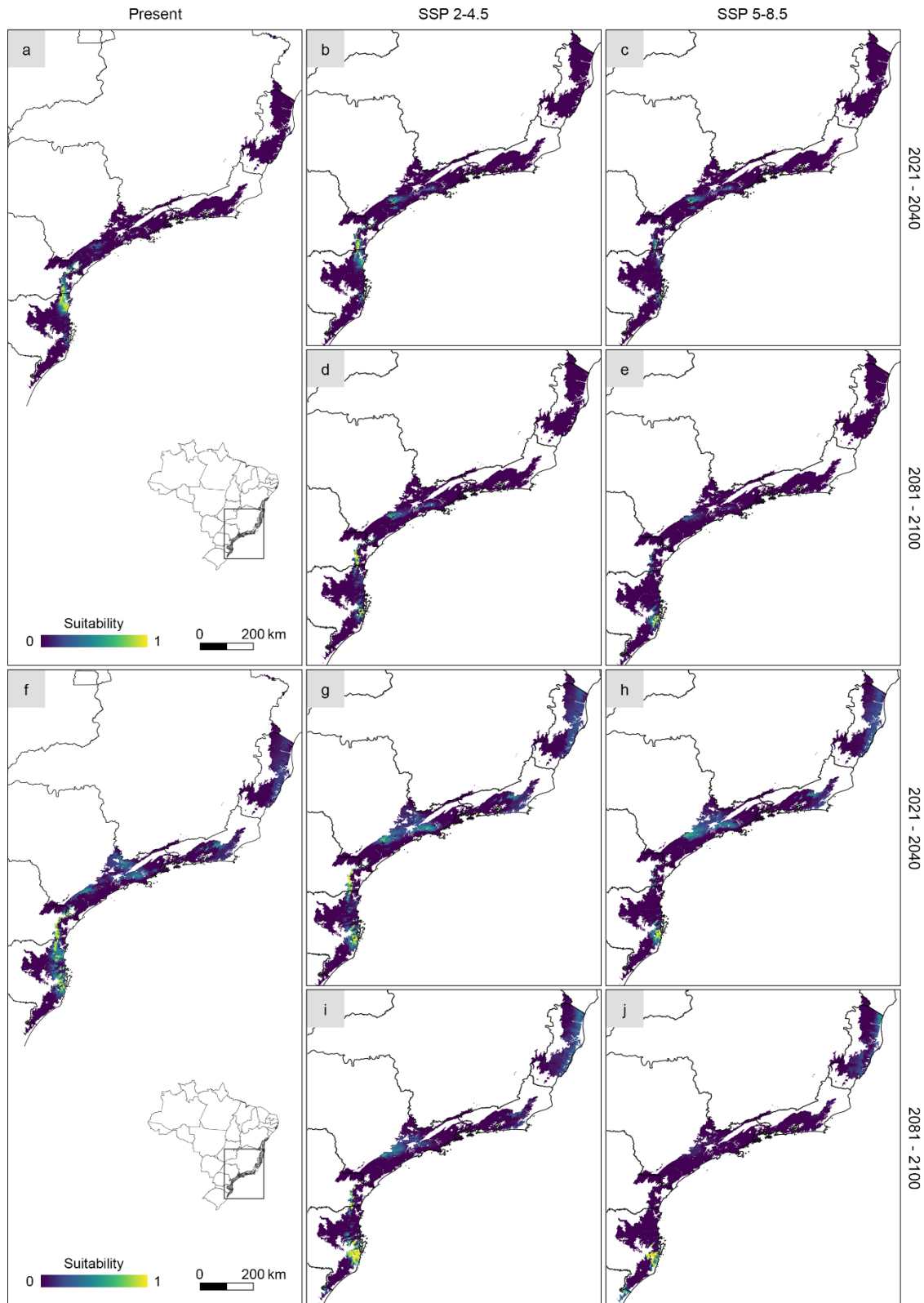


**Fig. 3.** Future projections of suitable areas of occurrence of *Myrceugenia basicordata* (b-e) and *M. joinvillensis* (g-j) based on intermediate (SSP 2–4.5) and pessimistic (SSP 5–8.5) scenarios in two different time slices (2021–2040; 2081–2100) compared to the present. Color bars indicate climatic suitability scores, with warmer and cooler colors indicating higher and lower suitability areas, respectively.

## Uncertainties and prospects

As expected, some uncertainties were encountered during the development of this study. The most significant limitation concerns the number of occurrence records. Given this, our results should be interpreted with caution due to potential biases associated with the limited number of records, as modeling approaches are known to be highly sensitive to sample size (van Proosdij et al. 2016; Trindade and Marques, 2024). We also applied a conservative threshold to binarize the models, specifically, the threshold at which sensitivity and specificity are equal, since the resulting maps appeared biologically consistent with the ecology of the species. This approach tends to overestimate the projected impacts of climate change and should be taken into account in future considerations (Nenzén and Araújo, 2011).

Additionally, projections under future climate conditions were based on a single GCM (MIROC6), as our primary objective was to inform current conservation efforts and provide only preliminary insights into future habitat suitability for both species. We acknowledge, however, that incorporating multiple GCMs would enhance the robustness of future projections, as it allows the assessment of the uncertainties associated with different projected future climate changes (e.g., Bernardinis et al. 2023; Navarro Mamani et al. 2023). Therefore, the findings presented here should be regarded as a working hypothesis and we strongly recommend further studies aimed at increasing the number of occurrence records. Moreover, the region where these species occur is generally under-sampled (e.g., Murray-Smith et al. 2009) and includes several montane areas that are difficult to access. Nonetheless, this region contains the largest remaining continuous tract of Atlantic Forest in Brazil (Grande Reserva Mata Atlântica, <https://grandereservamataatlantica.com.br/>) and harbors a high degree of endemism, underscoring the importance of improving data availability for this area (Murray-Smith et al. 2009; Ostroski et al. 2020; Werneck et al. 2011).

This is also the first study to apply species distribution modeling to *Myrceugenia* (Myrtaceae). Most studies of this kind involving the family focus on species of economic interest and/or biological invasions (Turchetto-Zolet et al. 2016; Mbobo et al. 2022; Nevill et al. 2014; but see Barrientos-Días et al. 2024 for a different approach). With this, we expect to contribute to the growing knowledge of “invisible species” (Trindade and Marques, 2024) and provide an initial framework for the conservation of rare *Myrceugenia* species in the Atlantic Forest.

## CONCLUSION

*Myrceugenia basicordata* and *M. joinvillensis* showed limited potential distribution areas, mainly restricted to the eastern portion of the study area, particularly in the states of Santa Catarina and Paraná, in southern Brazil. Preliminary future projections suggested that suitable habitat may shrink by at least 49% under pessimistic climate change scenarios. Although some of these suitable areas overlap with protected zones, the protection is often partial and may limit the effectiveness of conservation efforts, especially given their proximity to urban centers and ongoing land-use expansion. *Myrceugenia joinvillensis*, a species with a clear preference for higher elevations, exhibited larger areas of predicted suitability compared to *M. basicordata*. This study is the first to employ species distribution modeling focused on the *Myrceugenia* genus and provides new insights to guide future surveys and conservation planning for rare Myrtaceae species.

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## Authors' contribution

A.F. Augustin contributed to developing the idea and analyses, data interpretation, and writing the manuscript. D.F. Lima and M.K. Caddah contributed to developing the idea and data interpretation. F.C.S. Vieira contributed to the geographical data of the species. All authors reviewed the manuscript.

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## Conflict of interest

The authors declare having no conflict of interest.

## Data availability

All R scripts and raw data used for data processing are available in the companion GitHub repository: [https://github.com/Anaflavia28/myrceugenia\\_SDM](https://github.com/Anaflavia28/myrceugenia_SDM). Additional information can be obtained by contacting the corresponding author.

## Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used ChatGPT/OpenAI in order to correct grammatical and spelling errors, as well as idiomatic issues in English. After using this tool/service, the authors reviewed and edited the content as needed and takes full responsibility for the content of the publication.

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## CAPÍTULO III

### **Conservation genetics of two rare and endemic *Myrceugenia* species (myrtaceae) from the Brazilian Atlantic Forest**

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Autores: Ana Flávia Augustin, Duane Fernandes Lima, Fábio Cristiano Speck Vieira, Valdir M. Stefenon, Roberta Gargiulo e Mayara Krasinski Caddah

#### ABSTRACT

Genetic diversity is essential to the survival and resilience of all species, yet very few studies characterizing the intraspecific genetic diversity of rare species have been carried out. In this study, we assessed and described the genetic diversity and structure of two rare and endemic *Myrceugenia* species (Myrtaceae) from the Brazilian Atlantic Forest using microsatellite markers developed specifically for each species. We also followed the IUCN guidelines to assess their conservation status and discussed conservation strategies for these species. Our results suggested a moderate level of genetic diversity for both species. *Myrceugenia basicordata*, distributed at lower altitudes, is the species with the lowest genetic diversity, although with low differentiation among populations. *Myrceugenia joinvillensis* presented higher genetic diversity and a more distinct genetic structure, possibly because of its exclusive occurrence at higher altitudes. Both species require conservation efforts to avoid future declines in population size and distribution range. The main threat to these species is habitat loss or fragmentation due to urban expansion. Considering this, our practical recommendations for conserving these species include immediate actions, such as including the species in official red lists, and long-term actions, such as *ex situ* cultivation for future reintroduction. This study represents the first conservation effort focused on *Myrceugenia* species from the Atlantic Forest, marking an important initial step towards understanding these and other rare species from this biome.

**KEYWORDS:** Genetic diversity and structure, microsatellites, rare species, SSRs.

## INTRODUCTION

Conservation genetics provides tools for the conservation of biodiversity (Frankham 2010; Willi et al. 2021). The Group on Earth Observations - Biodiversity Observation Network (GEO BON), who is committed to improving and disseminating biodiversity information at different levels (GEO BON 2024), introduced the concept of Essential Biodiversity Variables (EBVs), a set of fundamental metrics designed to standardize and interpret complex biodiversity data (Jetz et al. 2019; Pereira et al. 2013). EBVs include genetic composition, species populations, species traits, community composition, ecosystem structure, and ecosystem function (Pereira et al. 2013). For the genetic composition category (genetic EBVs), four metrics are considered: (i) genetic diversity; (ii) genetic differentiation; (iii) inbreeding; and (iv) effective population size ( $N_e$ ) (Hoban et al. 2022).

The estimation of EBVs for threatened species remains a challenge due to lack of information. Rare species, including those with a narrow distribution, restricted habitat tolerance, in some cases with small populations, or any combination of these factors (Drury 1974; Harnik et al. 2012; Leitão et al. 2016), are usually considered threatened because they are more susceptible to habitat fragmentation and, consequently, to extinction, as they are unable to adapt to environmental changes (Brown et al. 2023; Davies et al. 2004). Notably, there is a high estimated occurrence of rare and threatened species in nature, suggesting that three out of every four undescribed species are already threatened to some degree (Brown et al. 2023). For this reason, improving our knowledge of rare species is essential to understanding their ecological niche and indirectly promoting the preservation of other species in the process (Dee et al. 2019).

The IUCN (International Union for Conservation of Nature) is one of the most important organizations for monitoring threatened biodiversity through the IUCN Red List assessments (IUCN Red List 2024). Based on systematic criteria, such as geographic range, demographic factors (e.g., number of mature individuals), and quantitative analyses, the IUCN Red List classifies threatened species into three main categories: critically endangered (CR), endangered (EN), and vulnerable (VU) (IUCN 2024). Additionally, the IUCN Red List recognizes genetic metrics as an important data source for assessing the conservation status of species. However, these metrics are not frequently used in species assessments, primarily due to practical challenges, including difficulties in data collection and interpretation, as well as the absence of

clear guidelines, such as specific criteria for incorporating genetic data (Garner et al. 2020; IUCN 2024).

In the Brazilian flora, Myrtaceae is one of the families with the largest number of species, mainly distributed in the Atlantic Forest and Cerrado domains, with great ecological importance. Myrtaceae species are frequently used in ecological corridors and in the restoration of degraded areas (Zamith and Scarano 2006), provide food for animals through the production of fruits throughout the year (Staggemeier et al. 2017), and are the main pollen source for native bees (Martins et al. 2023). *Myrceugenia* (Myrtaceae) includes 46 species (POWO 2024), most of which (34) are found in Brazil, especially in the Atlantic Forest (Vieira and Meirelles 2024). Recently, *Myrceugenia basicordata* and *M. joinvillensis* were described, both endemic to the Atlantic Forest and with a distribution restricted to the northeastern portion of the state of Santa Catarina, in southern Brazil. The aims of this study were to characterize the genetic diversity and structure in the two mentioned *Myrceugenia* species, considering their rarity and potential threats, and to discuss conservation strategies for these species.

## MATERIAL AND METHODS

### *Study species*

The two *Myrceugenia* species (Myrtaceae) included in our study are species with restricted distributions, endemic to Santa Catarina state, Brazil, and with few records of occurrence. They are both considered rare and threatened in the Brazilian Atlantic Forest. *Myrceugenia basicordata* F.C.S.Vieira, Molz & Sobral is a small tree, up to 2 m tall. It is currently restricted to a few forested areas, close to the urban area of Joinville, in northeastern Santa Catarina. It generally occurs on slopes at ca. 200 m above sea level (masl) of the submontane dense ombrophilous forest (Sobral et al. 2019), in the Serra do Mar Mountain range. The species' habitat is at the foothills/sedimentary area of the elevations, not found on slopes with a gradient of 45° or more (FCSV, field observations). *Myrceugenia joinvillensis* F.S.C.Vieira exhibits habits that range from shrub to arboreal, up to 3 m tall. The species is found at the edge of the Atlantic Forest mountains in northeastern Santa Catarina, as well as in the Serra do Mar, but primarily at higher altitudes between 400 and 700 masl (Vieira 2020), usually in mature forests. However, the species occupies relatively distinct areas of the forest characterized by the absence of a closed canopy and clearly defined strata (FCSV, field

observations). As recently described species, there is no specific information about the ecology of *M. basicordata* and *M. joinvillensis*.

#### *Data collection and field work*

We used online platforms to search for basic information about the species, such as distribution area and number of populations. The consulted sources were Specieslink (<http://www.splink.org.br/>), GBIF – Global Biodiversity Information Facility (<https://www.gbif.org/>) and REFLORA Virtual Herbarium (<http://reflora.jbrj.gov.br/>). We also searched the main herbarium collections from South and South-East Brazil for neglected specimens and no new records were found. We conducted field work in 2022 and 2023 and found all eight populations, four for *M. basicordata* and four for *M. joinvillensis* (Table 1). A total of 50 individuals of *M. basicordata* and 52 of *M. joinvillensis* were sampled. We collected young leaves from all the individuals (tree height: two to three meters) found at a minimum distance of 10 m apart. Leaf tissue was dried in silica gel. One individual from each population was herborized and deposited at the herbarium FLOR (acronym following Thiers 2024).

Table 1. Information about the populations collected for *Myrceugenia basicordata* and *M. joinvillensis* all localities are inserted in Santa Catarina State, Brazil

| Species                 | N of populations | Population ID | N of individuals sampled | Voucher     | Locality and municipality              |
|-------------------------|------------------|---------------|--------------------------|-------------|----------------------------------------|
| <i>M. basicordata</i>   | 4                | FIN           | 8                        | Augustin 36 | Morro do Finder, Joinville             |
|                         |                  | QUI           | 13                       | Augustin 38 | Picadão do Quiriri, Garuva             |
|                         |                  | CG            | 15                       | Augustin 47 | Morro Santa Galo, São Francisco do Sul |
|                         |                  | CUB           | 14                       | Vieira 3465 | Morro Cubatão, Joinville               |
| <i>M. joinvillensis</i> | 4                | BAR           | 18                       | Lima 565    | Barragem do 8º Salto, Schroeder        |
|                         |                  | JUR           | 14                       | Augustin 41 | Morro Jurapê, Joinville                |
|                         |                  | MC            | 10                       | Vieira 3473 | Monte Crista, Garuva                   |
|                         |                  | MUT           | 10                       | Vieira 3466 | Morro Mutucas, Joinville               |

Population identification: FIN = Finder, QUI= Quiriri, CG= Santa Galo, CUB= Cubatão, BAR= Barragem, JUR= Jurapê, MC= Monte Crista and MUT = Mutucas

#### *DNA extraction, high-throughput sequencing and quality control*

The extraction of genomic DNA was carried out using the CTAB protocol (Doyle and Doyle 1987). After extraction, DNA integrity was evaluated using gel electrophoresis;

quantification was carried out using Nanodrop and Qubit. One sample from each species (Augustin 47 and Lima 565) was selected for high-throughput sequencing (HTS). Genomic libraries from each sample were prepared separately using Illumina DNA preparation kit and sequenced on Illumina NextSeq platform ( $2 \times 100$  bp; with an average coverage of 10 million clusters per sample). The construction of genomic libraries and all the sequencing procedures were carried out by NGS Genomic Solutions (Piracicaba, Brazil).

The quality of the raw HTS data (reads) was evaluated using FastQC v. 0.12.1 (Andrews 2010). All the reads had high quality and trimming process was performed by NGS Genomic Solutions. The assembly of contigs (de novo assembly) was conducted using the online platform Galaxy (<https://usegalaxy.org/>), through the SPAdes v. 3.15.3 tool, suitable for short reads (Bankevich et al. 2012). Reads and contigs were visualized in Geneious v. 9.0.5 (Kearse et al. 2012). Due to the high number of contigs generated, and to optimize the computational processing, we used a custom Python script to filter and select only those with more than 10,000 bp for the subsequent steps.

#### *Development of SSRs markers and amplification*

Microsatellite markers were developed using GMATA software v. 2.3 (Wang and Wang 2016). We searched and selected sequences with di-, tri- and tetranucleotides motifs with at least five repetitions, and sequences with penta- and hexa-nucleotides with at least three repetitions. We only selected markers from different contigs and of nuclear origin (as inferred after a BLAST search against the NCBI (National Center for Biotechnology Information, <https://blast.ncbi.nlm.nih.gov/>, database). Markers whose sequences were in organellar regions or had inconclusive results in BLAST were excluded (Hagl et al. 2021).

The selected primers and markers were tested in two steps: first, we virtually validated the markers in GMATA (E-mapping function) and SPCR v. 3.0 (Cao et al. 2005). Twenty markers for each species showing good patterns of virtual amplification (reliable single fragment amplification) were selected for the second step, which consisted of laboratory tests and temperature optimizations. Twelve markers for each species showed good results in the second step and were selected for the genotyping process. The transferability of the final SSR markers (from *M. basicordata* to *M. joinvillensis* and vice-versa) was also virtually tested using SPCR software.

The primers were constructed using the M13 method, which consists in adding an oligonucleotide tail to the forward primer. This allows the annealing of a fluorochrome during the PCR reactions (Schuelke 2000), which facilitates fragment analysis after capillary electrophoresis. Amplifications were carried out in a final volume of 10  $\mu$ L, with 6  $\mu$ L of DreamTaq PCR Master Mix (2x) (Thermo Scientific), 0.5  $\mu$ L of reverse primer (10 $\mu$ M), 0.5  $\mu$ L of M13 tailed forward primer (10 $\mu$ M), 0.5  $\mu$ L of labelled-M13 fluorescent dye (FAM or HEX), 0.5  $\mu$ L of Bovine Serum Albumin (BSA) and 1  $\mu$ L of pure water. The PCR were performed as follows: 94°C for 5', followed by 30 cycles of 94°C for 30'', specific annealing temperature for 45'' (see Table 2), 72°C for 45'', 8 cycles of 94°C for 30'', 53 °C for 45'', 72°C for 45'', and a final extension of 72°C for 10' (Schuelke 2000).

#### *Fragment analysis and SSRs scoring*

Fragment analysis was conducted using ABI 3500xL Genetic Analyzer (Applied Biosystems). We used one  $\mu$ L of non-diluted PCR product in a solution containing 8.75  $\mu$ L of formamide and 0.25  $\mu$ L of GeneScan™ 500 LIZ™ Size Standard (Applied Biosystems), in a final volume of 10  $\mu$ L. Fragment sizing and scoring were performed in GeneMapper Software 6 (Applied Biosystems). We excluded five of the markers for each species during the genotyping and scoring processes because they either appeared as monomorphic, failed for most of the individuals, or their associated electropherograms were difficult to interpret and score. We used manual bin sets for SSR scoring. Finally, fourteen different polymorphic SSR markers were chosen to evaluate genetic diversity and differentiation in *M. basicordata* and *M. joinvillensis* (Table 2), seven for each species.

All the electropherograms were checked by two coauthors, to agree on the allele calling performed by the GeneMapper software. In some cases, allele sizes did not reflect the expectation based on the microsatellite motif. We handled this using two conservative approaches to avoid overestimating genetic diversity: when we observed such mutant allele sizes in more than one individual, we decided to keep it as a true allele; however, when we observed mutant allele sizes inconsistently, we attributed them to stuttering and therefore we approximated the size to the closest allele size.

In addition, we used the Micro-Checker software v. 2.2.3 (Van Oosterhout et al.2004) to search for scoring errors and null alleles and performed the analysis on the final set of markers for all populations.

Table 2. Information on the SSR markers used to assess genetic composition in *Myrceugenia basicordata* (MB) and *M. joinvillensis* (MJ)

| Locus    | Label | Primers sequence (5' - 3')                           | Allele size range (bp) | Motif    | Ta (°C) |
|----------|-------|------------------------------------------------------|------------------------|----------|---------|
| MB22     | FAM   | F: TGGTTCATGGGCAATACTCC<br>R: ACGCTGCATAACGGTCTCTT   | 390-396                | (CT)11   | 55      |
| MB45*    | HEX   | F: GGTTGGCAAACCTCGTGATCT<br>R: AGCTTCCTCAAGCACAAAGG  | 217-234                | (TTTA)5  | 60      |
| MB64     | HEX   | F: CGTAGCCTTCCGAGAAGATG<br>R: GAGCGAAACTTTGGTTGGAG   | 393-402                | (AGG)5   | 60      |
| MB92     | FAM   | F: AAAATCCCATGGTTCCACAA<br>R: CGTCCAACCTCCTTTCATGTTC | 387-394                | (TC)5    | 56.8    |
| MB116    | FAM   | F: AGTCGCCCAATGAAGAGAGA<br>R: CATCAAAAGCACAGGCAGAA   | 352-354                | (CT)5    | 56.8    |
| MB118    | FAM   | F: TTGTTTTCCCCTGGTGTAGC<br>R: TCGAGGCGAAGAAGAAATGT   | 341-344                | (TGA)5   | 55      |
| MB153    | FAM   | F: CGAGATCAATCCCGATCACT<br>R: GCTTCATCCCAAGTCCTGAA   | 405-407                | (CT)5    | 56.8    |
| MJ18     | FAM   | F: ATGTGTGGCGACCAACTGTA<br>R: TTCATGACGGTGAACCTCAA   | 323-338                | (ATT)5   | 60.6    |
| MJ31     | HEX   | F: AATGGACAGTGGCAATGGTT<br>R: TTGGTCGGAATTTTGCAATC   | 352-364                | (AGG)6   | 60.6    |
| MJ38     | FAM   | F: TGGGTTAATTTGGGTTTCGAC<br>R: ATGGGCATTTGGACGATTTA  | 269-274                | (ACCCA)3 | 63.2    |
| MJ56     | HEX   | F: TTGAACCCACCCAAATCTA<br>R: GCTGAATCCCGTACTTGGAA    | 206-220                | (TC)5    | 56.8    |
| MJ61**   | FAM   | F: TTGGTTCAGCAAATCGAGTG<br>R: CCTACATTCACCTCCCGGAAA  | 381-383                | (AG)6    | 56.8    |
| MJ71     | FAM   | F: TCCTTGTTGAGCTCCCATCT<br>R: TCCCACGACAATCTTCTTCC   | 415-421                | (CT)11   | 63.2    |
| MJ103*** | HEX   | F: TGCATTGATCTCTTGCCCTTG<br>R: CTTTCAAACGCATCGGTCTT  | 358-368                | (GA)8    | 60.6    |

\* For MB45 and MJ61, many individuals displayed doubtful heterozygous peaks and were considered as homozygous. \*\* MJ103 worked for two populations (MUT and MC), partially worked for one population (BAR) and did not work for the JUR population. Ta indicates the annealing temperature used during PCR.

#### *Population genetic analyses*

We estimated allele frequencies (Na), observed and expected heterozygosity (HO and uHE), and private alleles using the GenAlEx V6.51b2 plugin (Peakall and Smouse 2006). We evaluated whether populations were deviating from the Hardy-Weinberg proportions using the “HW exact tests”, checking specifically for heterozygote deficit and excess in the GenePop (v.

4.8.3 Rousset 2008) software. Additionally, we carried out tests for genotypic linkage disequilibrium (all default parameters for each locus pair across all populations), to test the null hypothesis of independence between loci. A significance level of  $\alpha = 0.05$  was considered and adjusted using the Holm-Bonferroni correction for multiple comparisons (Holm 1979). The inbreeding coefficient (FIS) was calculated using the Rho(is) approach, which takes into account allele sizes rather than allele identity (Weir and Cockerham 1984) in the GenePop software. Allelic richness (Ar) was calculated in FSTAT software v. 2.9.3.2, considering a minimum sample size of four diploid individuals (Goudet 2001).

Genetic structure was investigated in the Structure software v. 2.3.4 (Pritchard et al. 2000) which implements a Bayesian algorithm, using the Admixture model without sampling sites as a prior assumption. We tested K values (number of genetic clusters) ranging from 1 to 7, with 500,000 burn-in replicates, 500,000 MCMC replicates, and 25 iterations. To detect the optimal K value that best represented our dataset, we used the online tool Structure Selector (Li and Liu 2018) and summarized the results through CLUMPAK (Kopelman et al. 2015). For optimal K value detection in Structure Selector, we tested two different methods: Puechmaille method (Puechmaille 2016) with a threshold of 0.5, and Evanno method, including  $\Delta K$  and MeanLnP(K) (Evanno et al. 2005). Additionally, we performed a Discriminant Analysis of Principal ComponentsDAPC (Jombart et al. 2010) in R environment v. 4.4.1 (R Core Team 2024), using the adegenet package v. 2.1.10 (Jombart et al. 2008). As the Structure approach assumes panmictic populations (Pritchard et al. 2000), the DAPC analysis is an alternative method to assess the clustering of all individuals without the assumption of panmixia.

In Arlequin v. 3.5.2 (Excoffier and Lischer 2010), we performed a hierarchical Analyses of Molecular Variance (AMOVA) to evaluate genetic structure within and among populations (Excoffier et al. 1992). All the populations were combined into one group. Additionally, we performed population comparisons by computing pairwise FST for short genetic distances. For both analyses, we computed the distance matrix and set the sum of squared size difference (RST) as the distance method, with 1,000 permutations each analysis (Gargiulo et al. 2021). To construct the pairwise FST matrix, we used Arlequin xml outputs in R environment v. 4.4.1 (R Core Team 2024).

We estimated the effective population size (Ne) using NeEstimator, v. 2.1 (Do et al. 2014) with the linkage disequilibrium method (LD), assuming random mating (Hill 1981; Waples and Do 2008) and isolated populations. Runs were performed without frequency

restriction, excluding singletons. Jackknife confidence intervals were estimated (Jones et al. 2016). Although our small sample sizes might limit the accuracy of our  $N_e$  estimation, we proceeded with the analysis, as even approximate estimates can provide valuable insights for conservation decision-making (England et al. 2006; Garner et al. 2020).

To detect evidence of historical reductions in population size, we used Bottleneck v. 1.2.02 (Piry et al. 1999). We selected all three mutation models implemented in the software: Infinite Allele Model (IAM), Stepwise Mutation Model (SMM), and Two-Phase Model (TPM). The last two, especially TPM, are considered more appropriate for microsatellite data (Piry et al. 1999). For TPM, we used the default parameters defined by the software, which consists of a variance of 30, a proportion of SMM in TPM of 70%, and 1,000 iterations. We selected all tests available in the software, which assumes mutation-drift equilibrium (Piry et al. 1999): sign test, standardized differences test, and Wilcoxon sign-rank test. We also verified the occurrence of a shift in the allele frequencies with the qualitative test of mode-shift (Gargiulo et al. 2021).

#### *IUCN red list assessments*

We conducted an assessment for both species using the IUCN Red List guidelines (IUCN 2024), based on: (1) geographical information, through Extent of Occurrence (EOO) and Area of Occupancy (AOO) evaluations, performed using the online tool Geospatial Conservation Assessment Tool– GeoCAT (Bachman and Moat 2012); (2) the population analyses presented here; and (3) all current known information about the species, their ecology and projections in future scenarios (Augustin et al. in prep.). For EOO and AOO calculations, we included all points available on online platforms as described above, excluding points located in the centers of cities, and duplicates from the same collector number.

## RESULTS

Sequencing resulted in 11,026,738 reads for *M. basicordata* and 15,862,298 for *M. joinvillensis*, in a length average of 100 base pairs. The guanine and cytosine (GC) percentages were 42% and 43%, and the number of contigs generated was 234,722 and 249,015, respectively. To reduce computer processing, we only selected contigs with at least 10,000 base pairs, resulting in 80 and 87 contigs for each species, respectively.

In silico tests for marker transferability suggested that MJ61 and MJ71 (*M. joinvillensis* markers) could be further investigated for *M. basicordata*, as they showed amplification with

the expected fragment size. Other markers also showed amplification signals in the virtual tests (MB45 and MB118 for *M. joinvillensis*, and MJ31, MJ38, and MJ56 for *M. basicordata*), although with unexpected fragment sizes.

### *Genetic diversity and differentiation*

We found 24 alleles across all populations of *M. basicordata*. In the Micro-Checker analyses, we did not find evidence of scoring errors due to stuttering, large allele dropout, and null alleles. The number of different alleles per locus ranged from two to six. After Holm-Bonferroni corrections, the null hypothesis for genotypic linkage disequilibrium test was accepted, showing that all loci could be considered as independent. Three out of the seven loci showed significant values for heterozygote excess: MB118 (pop C:  $p = 0.0004$ , Q:  $p = 0.0057$  and CG:  $p = 0.0033$ ), MB116 (CG  $p = 0.0013$ ) and MB92 (CG  $p = 0.0096$ ). Santa Galo (CG) exhibited a heterozygote excess at all three loci (MB118, MB116, and MB91). Only for the FIN population there was no evidence of heterozygote excess. For the heterozygote deficit test, no deviations from Hardy-Weinberg proportions were found.

Observed heterozygosity (HO) ranged from 0.512 (QUI) to 0.661 (CG), while unbiased expected heterozygosity (uHE) ranged from 0.283 (FIN) to 0.498 (CUB). Allelic richness (AR) values followed the same pattern of uHE and  $N_a$ , where FIN had the lowest value (1.62) and CUB had the highest value (2.33). The inbreeding coefficient (FIS) was negative in three populations (FIN, CG, and QUI), and only CUB showed a positive value (0.10). In some cases, FIS values were based on a subset of loci, as the software reported “no information” for loci that were completely homozygous: FIS values in FIN were based on four loci, while in CUB, QUI, and CG values were based on six loci. Private alleles were detected in all populations, except in FIN, with CUB being the population with the highest number of private alleles ( $n = 3$ ) (Table3).

The most likely K value for *M. basicordata* changed depending on the method used. The Puechmaille method gave  $K = 3$  as the most likely value. However, results from the Evanno method were more ambiguous (Supplementary Information 1).  $\Delta K$  was associated with  $K = 2$ , while preplateau value in MeanLnP(K) was  $K = 3$ . In this case, we decided to keep  $K = 3$  as the finalK value (Fig. 1a), based on Puechmaille results, and the MeanLnP(K) results. The three clusters correspond to (1) FIN, (2) CG and (3) QUI + CUB (Fig. 1b), but some individuals showed some level of admixture.

The DAPC analysis showed low differentiation among the populations of *M. basicordata* (Fig. 2a). For the final results, 15 PCs were retained, and three clusters were considered after performing cross-validation procedures (Supplementary Information 2). Individuals from FIN and CG appeared as genetically very close. Individuals from CUB formed a different cluster and appeared in a sparse cloud. Likewise, individuals from QUI appeared as the most genetically differentiated when compared with those from other populations.

The AMOVA analysis suggested that most of the variation ( $\sim 80\%$ ) is distributed within populations, and only 20% among populations ( $F_{ST} = 0.206$ ,  $p = 0.000$ ). For this analysis, five loci were used by Arlequin and two were discarded because of missing data. The pairwise  $F_{ST}$  comparisons (Fig. 3a) indicated moderate differentiation, with the highest differentiation occurring between FIN and QUI (0.24), followed by CG and QUI (0.23).

The estimated effective population size ( $N_e$ ) in *Myrceugenia basicordata* ranged from 6.9 individuals in CUB (95% CI: 1.1 - infinite) to 11.6 (95% CI: 0.6 - infinite) in CG. The point estimate for the FIN population and the confidence intervals for all the populations had infinite upper value suggesting that the small sample sizes do not allow enough resolution to estimate  $N_e$  reliably.

The Bottleneck results suggested that, among all four populations of *Myrceugenia basicordata*, CUB showed evidence of historical reduction in population size. For all the statistical tests and mutation models performed, CUB showed  $p$ -value  $< 0.05$  (except for SMM model in sign test). CG and FIN also presented some evidence for a recent bottleneck, with  $p$ -values  $< 0.05$  in at least two of the three statistical tests, under at least two of the three mutation models tested. QUI presented  $p$ -values  $> 0.05$  for all statistical tests performed. All populations presented evidence of a shift in allele frequencies (Supplementary Information 3).

In *M. joinvillensis*, we found 31 alleles in total. As for *M. basicordata*, the Micro-Checker analysis did not reveal evidence of scoring errors due to stuttering, large allele dropout, and null alleles. The number of alleles per locus ranged from three to eight in all 52 samples. After Holm-Bonferroni corrections, the tests for genotypic linkage disequilibrium were not significant, confirming the independence between all pairs of loci. Hardy-Weinberg exact tests for heterozygote deficit suggested significant values for one locus in JUR, MJ56 ( $p = 0.0010$ ). MC population had  $p = 1$  for all loci, except for MJ56 ( $p = 0.0195$ ). Heterozygote excess test

suggested significant values for MJ38 ( $p = 0.0000$ ) and MJ71 ( $p = 0.0001$ ) in the BAR population.

Observed heterozygosity (HO) ranged from 0.335 (JUR) to 0.656 (BAR) and uHE ranged from 0.370 (JUR) to 0.478 (MUT). Allele richness ranged from 1.93 (BAR) to 2.73 (MUT). The estimated values of FIS were negative in all populations, except in JUR. In BAR and JUR, FIS values were based on six loci, as the software reported “no information” for completely homozygous loci. Additionally, private alleles were detected in all populations, except in JUR. MUT presented the highest number of private alleles ( $n = 6$ ), followed by MC (4) and BAR (2) (Table 3).

After the Structure analysis, the two best K-value in *M. joinvillensis* according to the Puechmaille and Evanno method were  $K = 4$  and  $K = 2$ , respectively (for both  $\Delta K$  and MeanLnP(K), see Supplementary Information 4). When considering  $K = 2$ , the groups were composed of (1) BAR + MC and (2) JUR + MUT. However, when considering  $K = 4$ , the groups corresponded to the four populations: (1) BAR, (2) JUR, (3) MC and (4) MUT (Fig. 4a and b). Based on the Puechmaille method, we considered  $K = 4$  as the most likely number of genetic clusters.

Retaining 20 PCs and four clusters (Supplementary Information 5), DAPC analysis suggested a clear differentiation among *M. joinvillensis* populations (Fig. 2b). Individuals from BAR, JUR and MUT were more closely related compared with MC, which formed an isolated cluster. Additionally, although BAR is the population in which we observed and sampled more individuals (18), it is also the population with the highest number of genetically similar individuals (Fig. 2b).

The hierarchical AMOVA for *M. joinvillensis* suggested that around 81% of the variation is within populations, and approximately 19% is among all four populations ( $F_{ST} = 0.193$ ,  $p = 0$ ). For this analysis, Arlequin used two loci over the seven, after excluding those with missing data. The pairwise  $F_{ST}$  comparisons (Fig. 3B) indicated that the highest differentiation occurs among BAR and MUT individuals (0.399), followed by MUT and JUR (0.212), corroborating the DAPC results.

Table 3. Genetic diversity indices for populations of *M. basicordata* and *M. joinvillensis*.

| Indices                   | <i>Myrceugenia basicordata</i> |                       |                      |                      | <i>Myrceugenia joinvillensis</i> |                       |                  |                   |
|---------------------------|--------------------------------|-----------------------|----------------------|----------------------|----------------------------------|-----------------------|------------------|-------------------|
|                           | FIN                            | CG                    | CUB                  | QUI                  | BAR                              | JUR                   | MC               | MUT               |
| A <sub>r</sub>            | 1.62                           | 1.84                  | 2.33                 | 2.32                 | 1.93                             | 2.23                  | 2.43             | 2.73              |
| Na (SE)                   | 1.714 (0.286)                  | 2.000 (0.218)         | 2.571 (0.369)        | 2.140 (0.286)        | 2.266 (0.360)                    | 2.143 (0.404)         | 2.714 (0.184)    | 3.143 (0.340)     |
| H <sub>o</sub> (SE)       | 0.625 (0.183)                  | 0.661 (0.158)         | 0.646 (0.135)        | 0.518 (0.120)        | 0.656 (0.161)                    | 0.335 (0.088)         | 0.439 (0.046)    | 0.457 (0.091)     |
| uHE (SE)                  | 0.283 (0.105)                  | 0.395 (0.087)         | 0.498 (0.090)        | 0.465 (0.088)        | 0.399 (0.089)                    | 0.370 (0.080)         | 0.424 (0.044)    | 0.478 (0.048)     |
| <i>F<sub>IS</sub></i>     | -0.929                         | -0.631                | 0.102                | -0.152               | -0.812                           | 0.186                 | -0.204           | -0.432            |
| Private alleles           | -                              | 1                     | 3                    | 1                    | 2                                | -                     | 4                | 6                 |
| <i>N<sub>e</sub></i> (CI) | Infinite (0.1 - Infinite)      | 11.6 (0.6 - Infinite) | 6.9 (1.1 - Infinite) | 8.2 (0.9 - Infinite) | Infinite (0.4 - Infinite)        | 21.8 (2.2 - Infinite) | 0.8 (0.2 - 87.1) | 2 (0. - Infinite) |

SE = Standard errors; Ar = Allelic richness (minimum sample size 4 diploid individuals); Na = Average number of different alleles per locus; HO = Observed heterozygosity; uHE = Unbiased expected heterozygosity; FIS = Inbreeding coefficient; NPA = Private alleles; Ne = Effective population size. CI = Confidence intervals.

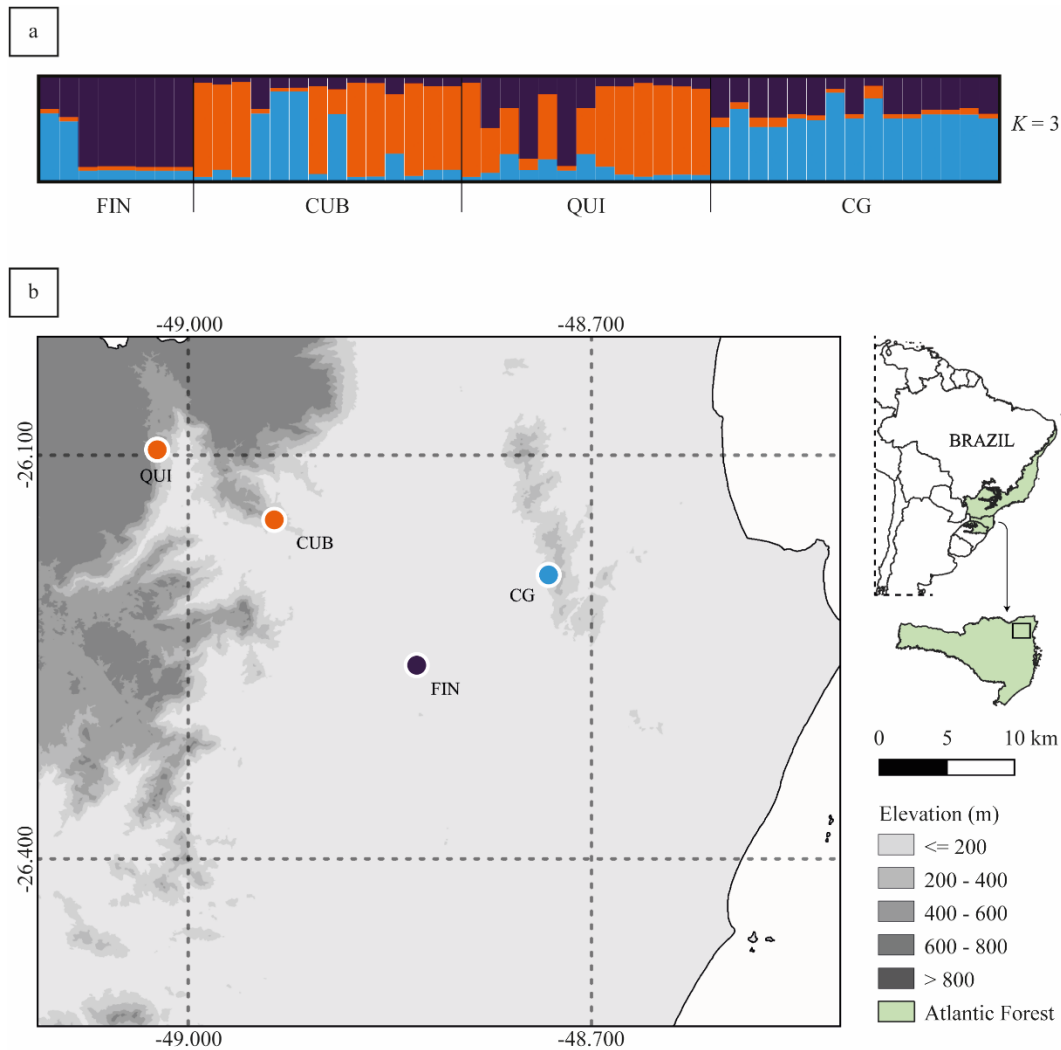


Fig. 1 (a) Bar plots from Structure, showing the best  $K$  value for *Myrceugenia basicordata* ( $K = 3$ ). (b) Geographic distribution of all populations of *M. basicordata*, Santa Catarina state, South Brazil. Colors refer to the main genetic clusters in the bar plots.

The estimated effective population size ( $N_e$ ) in *M. joinvillensis* ranged from 0.8 (CI 95% 0.2–87.1) in MC to 21.8 in JUR (CI 95% 2.2 - Infinite) and was infinite in BAR. All populations, except MC, presented an infinite upper confidence interval, indicating that our small sample sizes do not allow a reliable  $N_e$  estimation.

The Bottleneck tests, in general, did not indicate a clear recent reduction in populations of *M. joinvillensis* (Supplementary Information 6). Significant values were found in: BAR when considering the IAM model in both standardized differences test and Wilcoxon test; JUR, when considering the IAM mutation model for Wilcoxon test, and MUT, when considering the SMM in the Standardized differences test. MC did not exhibit significant p-values in any of the

performed tests. For the mode-shift analysis, BAR and MC showed shifts in allele frequencies, while JUR and MUT were associated with a normal L-shaped distribution.

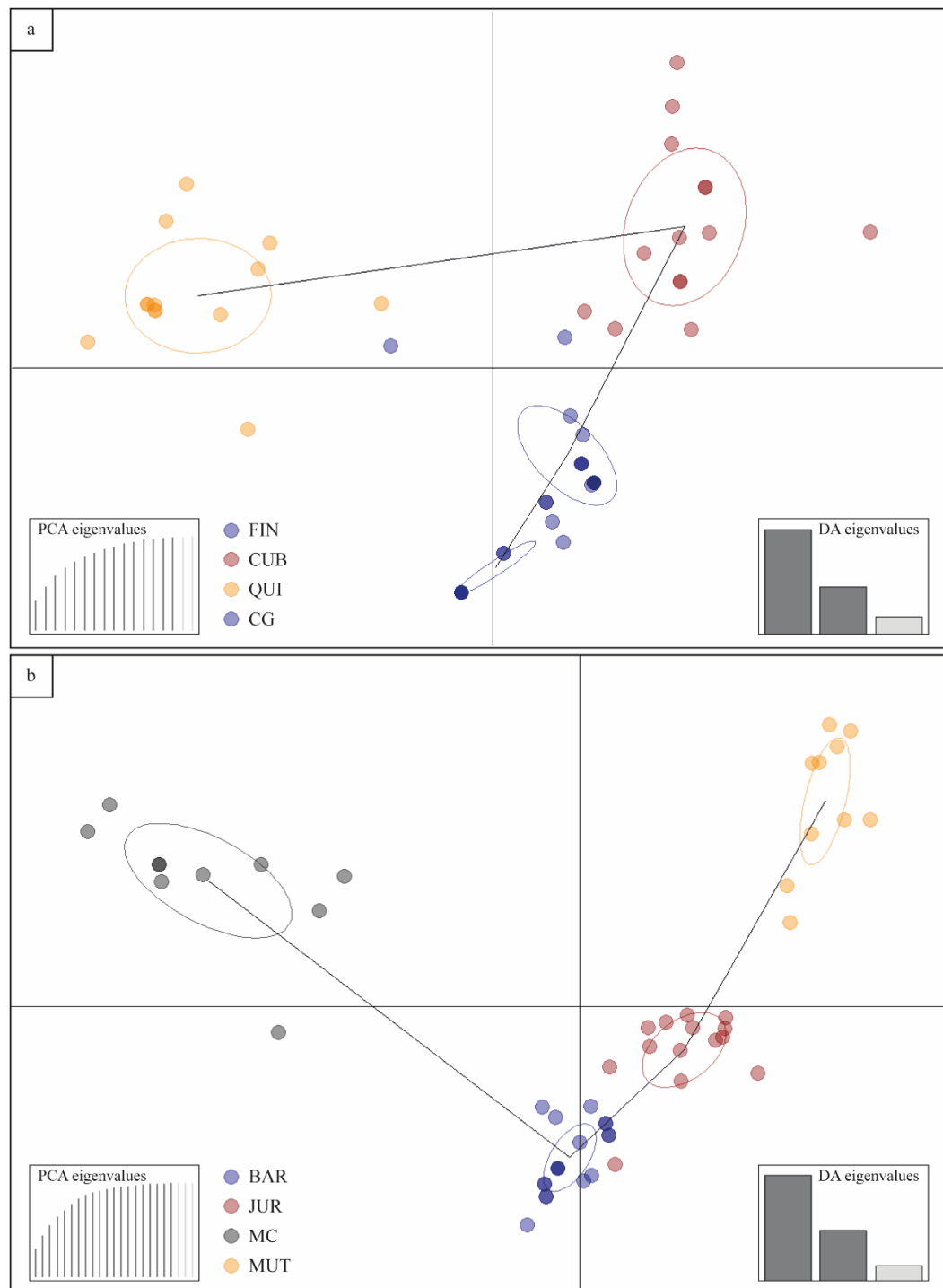


Fig. 2 Discriminant Analysis of Principal Components (DAPC). (a) *Myrceugenia basicordata* populations, considering three genetic clusters. Black line linking populations indicates a minimum spanning tree based on their squared distance within the entire space. (b) *Myrceugenia joinvillensis* populations, considering four genetic clusters. Black line linking the populations indicates a minimum spanning tree based on their squared distance within the entire space

### *IUCN red list assessments*

We compared the data on *M. basicordata* and *M. joinvillensis* with all categories and criteria from the IUCN Red List guidelines. For geographic range calculations, *M. basicordata* presented an EOO of 166.96 km<sup>2</sup> and an AOO of 20 km<sup>2</sup>. Similarly, *M. joinvillensis* presented an EOO of 72.95 km<sup>2</sup> and an AOO of 20 km<sup>2</sup>. We incorporated some of the genetic results presented here in the C criterion. As a result, both species fit in the threatened category of “endangered”, for criteria B (geographic range), C (small population size and decline— only for *M. basicordata*; based on the bottleneck analyses) and E (quantitative analysis, such as modeling approaches). The complete assessment report (SI – “*Apêndice C and D*” of this thesis) is in preparation to be submitted to the IUCN Red List (<https://www.iucnredlist.org/>).

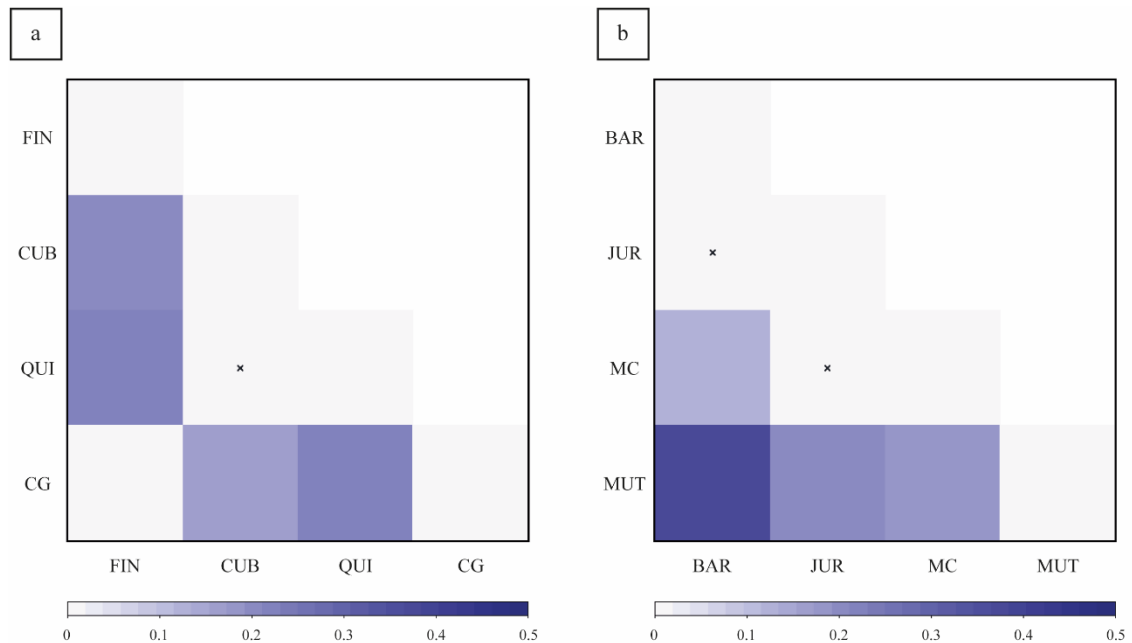


Fig. 3. Pairwise  $F_{ST}$  values in (a) *Myrceugenia basicordata* results, and (b) *Myrceugenia joinvillensis*. Population pairs marked with “x” indicate non-significant  $p$  values ( $p > 0.05$ ).

## DISCUSSION

### *Genetic diversity and differentiation*

We aimed to assess the Essential Biodiversity Variables (EBVs) for genetic composition for two rare and narrow endemic species of *Myrceugenia* (Myrtaceae) and to discuss these parameters in the context of conservation strategies. Our findings showed moderate levels of genetic diversity and differentiation for both species, especially considering the context of rare,

threatened, and endemic species (Gargiulo et al. 2019; López-Pujol et al. 2013; Martínez-León et al. 2022; Turchetto et al. 2016).

*Myrceugenia basicordata* showed the lowest genetic diversity between the two species. Among the four populations of *M. basicordata*, FIN showed the lowest values for allelic richness (Ar), number of different alleles per locus (Na), and expected heterozygosity (uHE). Additionally, FIN is the population with the smallest observed number of individuals, where only eight samples were collected from an urban park in Joinville (the largest city in the Santa Catarina state, according to IBGE 2024). Despite being a relatively protected green area, this urban park shows clear signs of human activity, such as ecotourism and leisure activities that might have led to the decline of the population.

Finder (FIN) also presented a strongly negative inbreeding coefficient (FIS), suggesting heterozygote excess (-0.93). We interpreted this result as artefactual, likely due to the reduced number of loci used in the analysis (4 out of 7 loci) and the extremely small sample size at this site (8 individuals). However, nearly all the populations of *M. basicordata* showed slightly negative FIS values, which we considered normal given the species' outcrossing system, although the opposite is typically expected for small population sizes (Allendorf et al. 2013; Ellstrand and Elam 1993). CUB was the only population to show a positive FIS value (0.10), and had the highest number of private alleles (NPA = 3), providing evidence of isolation and possibly high relatedness among individuals (Allendorf et al. 2013).

Our genetic diversity results for *Myrceugenia basicordata* can be more closely compared to another rare *Myrceugenia* species (*M. correifolia*) in Chile, where the genus is also diversified (Pérez et al. 2017). Using eight SSR markers and 124 sampled individuals from 16 sites, the authors found a higher mean number of alleles/locus (Na) and similar levels of uHE for *M. correifolia*. *Myrceugenia basicordata*, in contrast, presented higher HO and negative FIS values, suggesting a stronger tendency toward outbreeding than *M. correifolia*. Contrary to *M. basicordata*, whose distribution is more fragmented in the Atlantic Forest, *M. correifolia* occupies deep canyons in Mediterranean regions, forming large populations, which likely contributes to its higher allelic richness.

In terms of genetic structure, *M. basicordata* populations did not show clear differentiation according to the Structure and DAPC results. Both analyses indicated three clusters, with a slight difference in the groups: DAPC indicated one group formed by the FIN

and CG populations, another group only including CUB, and the last group only including QUI. The Structure analysis clustered FIN and CG in a separate group, but both analyses suggested admixture within clusters, which is also supported by the pairwise  $F_{ST}$  results. FIN and CG appeared to be more closely related to each other compared to the other populations. Additionally, QUI and CUB also appeared closely related, particularly according to the Structure analysis. It is important to note that QUI population is the most geographically distant, and its samples were collected over a wider area.

We observed that genetic diversity increases as *M. basicordata* populations move further away from the central urban region. FIN and CG (lower genetic diversity) are located near Joinville, whereas CUB and QUI (higher genetic diversity) are located in a wider area. We attribute this pattern to two main dependent factors: first, a possible reduction in pollinators (mainly bees in the case of Myrtaceae, as noted by Fidalgo and Kleinert 2009) within large urban centers, potentially caused by pollution, pesticides, and/or urban intensification, which has already been demonstrated in empirical studies (e.g., Baldock 2020). Second, populations with higher genetic diversity are located in protected habitats, in green areas at a certain distance from cities with lower human interference.

Although population declines have not been documented in previous studies, our bottleneck simulations suggested a historical reduction in population size in nearly all *M. basicordata* populations (except QUI), and particularly in CUB. Therefore, we strongly recommend continuous monitoring of these populations to detect any disturbance factors and prevent further declines. For *M. joinvillensis*, we did not find strong evidence of a bottleneck effect, which suggests that populations might be naturally small.

*Myrceugenia joinvillensis* presented higher values of genetic diversity, except for the BAR and JUR populations, which showed lower values for allelic richness ( $A_r$ ), number of different alleles per locus ( $N_a$ ), and expected heterozygosity ( $u_{HE}$ ), despite larger observed population size. Jurapê is located within a protected area, while BAR is situated in a dam area, on a private property owned by an electricity company, likely subjected to frequent disturbance. In BAR, we observed that individuals were relatively closer to each other compared to other sites, all of them seemed to be mature as presented reproductive structures, and were found next to a flooded area.

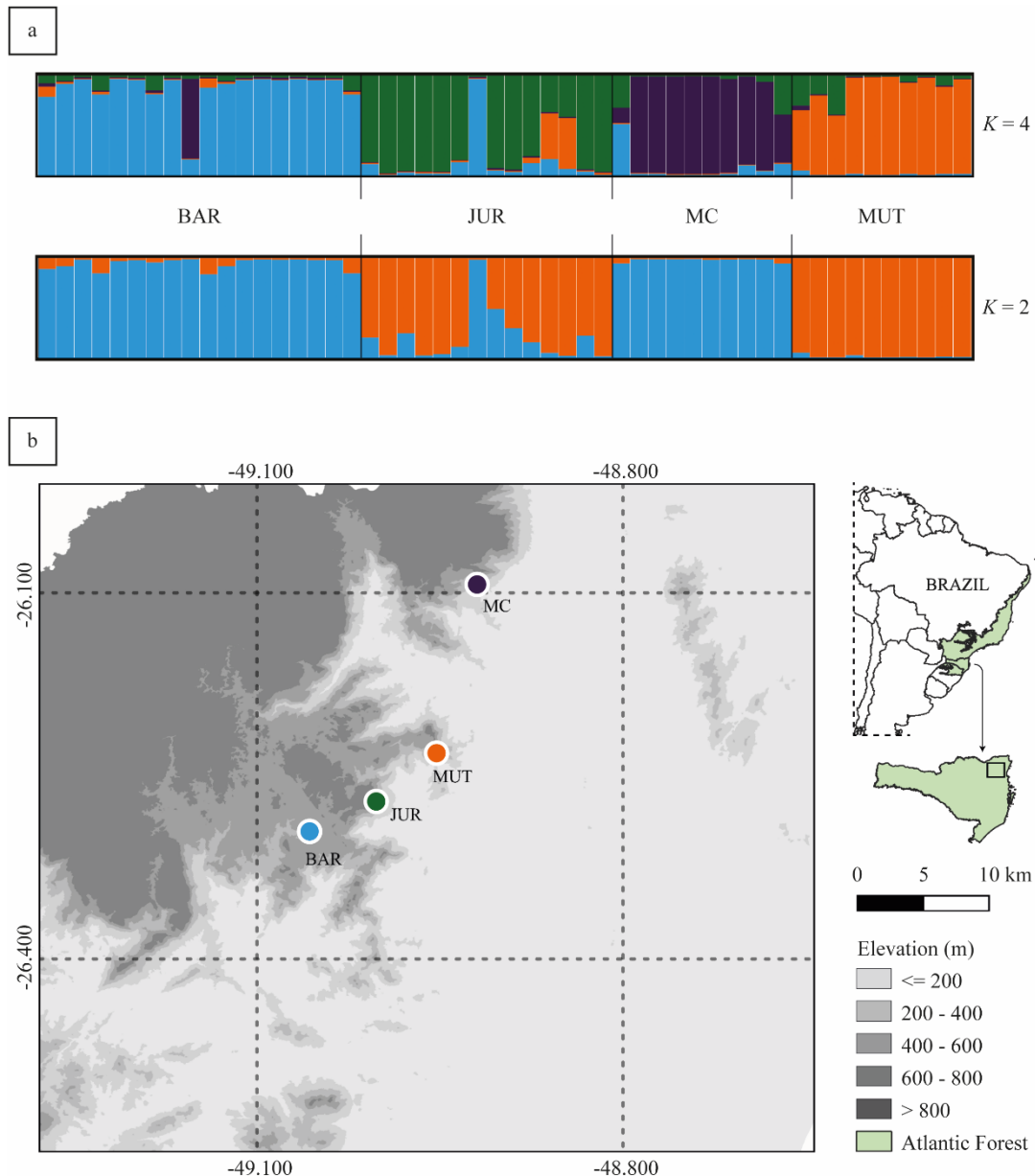


**Fig. 4.** (a) Bar plots from the Structure, showing the best  $K$  values for *M. joinvillensis* with  $K = 4$  and  $K = 2$ , for comparison. (b) Geographic distribution of all populations of *M. joinvillensis*, Santa Catarina state, South Brazil. Colors refer to the main genetic clusters in the bar plots, considering  $K = 4$ .

Jurapê was the only population with a positive  $F_{IS}$  value (0.186), indicating some level of inbreeding among its individuals. All other *M. joinvillensis* populations showed slightly negative  $F_{IS}$  values, consistent with the outcrossing reproductive strategy (Allendorf et al. 2013). However, BAR presented a relatively strong negative value (-0.812), which could be explained by reproductive dynamics, such as mating between different genotypes due to recent gene flow from neighboring populations (Allendorf et al. 2013). However, an artefactual excess

of heterozygotes cannot be excluded, as only two of the seven loci (MJ38 and MJ71) showed significant heterozygote excess after the HardyWeinberg exact tests.

The analysis of genetic differentiation in *M. joinvillensis* indicated four discrete and distinguishable clusters, according to both the Structure and DAPC results, with minor levels of admixture. BAR and JUR are more closely related, as further supported by the pairwise  $F_{ST}$  results. Although MC is the most geographically distant population, MUT is the most genetically different according to the  $F_{ST}$  and DAPC results, and also showed some degree of isolation, with the highest number of private alleles (NPA = 6).

Considering the geographical distribution of the populations and the results obtained, genetic diversity in *M. joinvillensis* increases alongside the linear distribution range of the species (BAR to MC populations, especially in MUT), with populations at higher altitudes (around 600 m) with higher genetic diversity. The observed genetic differentiation could be explained by the lower abundance of biotic pollinators at higher altitudes (Brito et al. 2016). In contrast, populations of *M. basicordata* located far from urban centers present higher genetic diversity values (FIN and CG to CUB and QUI, Fig. 1b), although genetic differentiation is less evident.

During the development of this study, we identified several caveats. First, we recognize the relatively small number of loci used as SSR markers, which may have led to limited resolution in our results. Second, some loci exhibited a significant percentage of missing data, preventing their inclusion in all the proposed analyses. Despite the challenges, our results have important implications for the conservation of *M. basicordata* and *M. joinvillensis* and allow us to discuss potential conservation strategies for the two species and for species with similar life-history traits and distribution.

Our results point out the need for clarifying genetic diversity in other rare Myrtaceae species occurring in the Brazilian Atlantic Forest with narrow distributions. Numerous studies focused on common Myrtaceae species, often linked to economic interests, such as *Eugenia* and *Campomanesia* spp. (e.g., Moreira et al. 2022; Telles et al. 2013; Turchetto-Zolet et al. 2016), or on important widespread species for habitat management, such as *Myrcia* and *Psidium* spp. (e.g., De Oliveira Bernardes et al. 2022; Brandão et al. 2015; Franceschinelli et al. 2007). However, we found only one study concerning narrow endemic or threatened Myrtaceae species in the Atlantic Forest, focusing on *Curitiba prismatica* (D.Legrand) Salywon &

Landrum, a vulnerable species from South Brazil (Flora e Funga do Brasil 2025; Silva et al. 2022). There are no studies on *Myrceugenia* for comparison, and this highlights a significant gap in the knowledge regarding threatened biodiversity, especially in contrast to other biodiversity centers of Myrtaceae distribution (see examples in Simmons et al. 2023; Rutherford et al. 2019; Rutherford et al. 2022 for Australia and Pérez et al. 2017 for Chile)

### *Implications for the conservation of endangered species*

This study represents the first conservation genetic effort focused on species of *Myrceugenia* from the Atlantic Forest, marking an important initial step towards understanding these and other rare species from this hotspot of biodiversity. Both *M. basicordata* and *M. joinvillensis* require conservation efforts to avoid future declines in population size and species ranges. These species are threatened by habitat loss or fragmentation caused by urban expansion, as they are not currently protected for their economic interest, or cultivated as ornamental plants. The state of Santa Catarina experienced an estimated population growth of 5.89% in 2023, making it the eighth state with the highest population increase in Brazil (IBGE 2024). Additionally, climate change may also negatively impact the species' survival, as it has been shown that rare and/or endemic species are more vulnerable than widespread species when their habitats are altered (Manes et al. 2021; Vincent et al. 2020). Furthermore, species distribution modeling approaches suggest a significant reduction in suitable habitats for these *Myrceugenia* species by 2100 (Augustin et al. in prep).

The species studied here are certainly not isolated cases within the Atlantic Forest domain. In fact, comprehensive conservation assessments for Atlantic Forest endemic trees revealed that 82% of them are already threatened to some degree (De Lima et al. 2024). Considering the gaps in knowledge about threatened Brazilian Myrtaceae, we strongly recommend future studies focused on the conservation of *Myrceugenia*. Based on the reduced number of records in online databases (such as Specieslink), we suggest that species such as *M. decussata* Mattos, *M. foveolata* (O.Berg) Sobral, *M. hatschbachii* Landrum and *M. mesomischa* (Burret) D.Legrand & Kausel should also be investigated for genetic composition.

Our findings also considered other biological and environmental aspects to evaluate the conservation status of *M. basicordata* and *M. joinvillensis*. The IUCN Red List assessments we carried out qualified both species as endangered (EN) according to the IUCN Red List criteria B, C and E. For *M. joinvillensis*, we also observed an extensive mining area nearby MUT, even

if this population is located in a protected area (FCSV observation; Google 2024). The IUCN Red List is extremely important for raising awareness of threatened species worldwide, due to its accessibility (e.g., Omar and Elgamar 2021; Harfoot et al. 2021). For *Myrceugenia*, 22 species (47%) have already been evaluated and are currently included on IUCN Red List, most of them are classified as least concern (9), but some of them are classified as endangered (2), vulnerable (8) or as near threatened (3).

Local lists of threatened species with federal and regional scope are equally important and essential for immediate conservation policies. Ideally, global and regional red lists should be interconnected and constantly updated which, unfortunately, is not the case for many Brazilian species (Moraes et al. 2014; Morais et al. 2012). For the state of Santa Catarina, for example, an official list of threatened species was made available in 2014 (CONSEMA 2014), but it has not been updated since then. For Myrtaceae, for which four species are mentioned, there are also many inconsistencies, such as taxonomic problems and an evident underestimation of the number of threatened species (Caddah and Lima 2022; Drischel and Caddah, in prep.).

We used the above considerations to recommend some practical conservation actions for *Myrceugenia basicordata* and *M. joinvillensis*, to guide future conservation plans for these species and possibly other species in the Atlantic Forest:

#### *Practical recommendations for M. basicordata and M. joinvillensis*

Our practical recommendations are divided into immediate actions, which should be considered for the next 1–2 years, and future actions, which should be considered for the next 3–10 years, and dependent on future studies clarifying the biology and the ecology of the two species. Immediate actions Continue monitoring populations and conduct further studies on the biology and ecology of the species.

##### Immediate actions

Continue monitoring populations and conduct further studies on the biology and ecology of the species

Monitoring populations of *M. basicordata* and *M. joinvillensis* is extremely important to evaluate whether or not a reduction in the number of individuals *in situ* is occurring. Although our analyses suggested a recent decrease in population sizes in *M. basicordata*, there are no

available studies or historical documentation that can confirm population decline. Additionally, *Myrceugenia joinvillensis* populations are particularly difficult to access, at high altitudes on mountain peaks (Fig. 4b), often covered by dense montane rainforest vegetation. Therefore, future monitoring efforts could leverage modern technologies based on drones, sensors IoT (Internet of Things) and Radio Frequency Identification tags (RFID) for example (Kocer et al. 2021; Sujanani et al. 2016; Tavilla et al. 2024).

Involving local communities might also be a powerful strategy for monitoring populations. Some citizen science projects have already been conducted for other endangered species in Brazil (e.g., “Faveiro-de-Wilson case, Fernandes et al. 2022). The involvement of local communities might help increase the number of discovered individuals and, consequently, provide better estimates of population sizes to incorporate into effective conservation action plans for the species (Fernandes et al. 2022). This approach could also be a cheaper option for future monitoring after *in situ* conservation actions have been implemented.

Finally, we strongly recommend further investigations into basic biological processes in *Myrceugenia*, including seed germination (e.g., viability, storage behavior, and overall development), reproductive systems, types of pollinators, and phenology (e.g., Nadarajan et al. 2021; Van der Walt et al. 2021). Although the ecology of Myrtaceae species is well-studied, their physiology exhibits significant variability, with germination periods ranging from 10 days to over a year (Lughadha and Proença 1996). Experiments focusing on the genus *Myrceugenia* are extremely important. Understanding their reproductive systems might enable the ex-situ growth of seedlings for future restoration strategies.

#### Include the species in official red lists

We recommend the inclusion of *M. basicordata* and *M. joinvillensis* in official red lists for the Atlantic Forest, such as the regional list (CONSEMA 2014) for the state of Santa Catarina, and the Brazilian national list (Lista Oficial de Espécies da Flora Brasileira Ameaçadas de Extinção, MMA 2022). In addition to disseminating knowledge about threatened flora and standardizing monitoring protocols, this will allow companies specialized in environmental restoration to encourage and prioritize the planting of seedlings of these species for restoration projects in suitable areas.

#### Future actions

### Introduce new individuals in areas of high-suitability

The introduction of new individuals into suitable habitats has already been tested as a successful conservation strategy (e.g., Pavlik et al. 1993; Soorae 2021). Therefore, we recommend the introduction of new populations of *M. basicordata* and *M. joinvillensis* in highly suitable areas (for example, those suggested in Augustin et al. in prep), preferably protected areas of the Atlantic Forest. Seedlings should originate from *ex situ* efforts (e.g., after germination experiments) targeted at generating genetically diverse and resilient material for reintroduction (Di Sacco et al. 2021), possibly excluding germplasm from populations that have reduced genetic diversity and small populations (FIN and JUR, for example). Analogous strategies should be used to reinforce populations at known sites, by facilitating crosspollination or introducing seedlings that have been generated using local genetic diversity.

### Deposit in seed banks

Most species within Myrtaceae from the Atlantic Forest have recalcitrant seeds, which are not tolerant to desiccation (Mayrink et al. 2019), posing challenges to the standard seed preservation; however, we are not aware of studies focused on *Myrceugenia*. If further studies clarified the best strategies to preserve seed *ex-situ*, depositing viable seeds from *M. basicordata* and *M. joinvillensis* might also serve as an important strategy to safeguard the genetic material necessary for species recovery, habitat restoration, and biodiversity conservation in the face of climate change and habitat loss.

We recommend depositing viable seeds from all known populations but prioritizing those with higher genetic diversity and, when possible, larger populations. For example, for *M. basicordata*, QUI and CUB populations should be considered as priority targets since they likely occupy a larger area and they display higher genetic diversity. For similar reasons, the populations MUT and MC of *M. joinvillensis* should be considered for seed collections. If new individuals/populations were to be discovered, further studies clarifying their population genetics would be advisable.

### *Ex situ* cultivation

When feasible, cultivation in botanical gardens, public plant nurseries, degraded areas that are targets of restoration projects, and private orchards (which also may involve local

communities) might serve as a supplementary strategy for *ex situ* conservation efforts, but also as a tool to observe the ecology of the species more closely.

## CONCLUSION

Despite its rarity, *M. basicordata* and *M. joinvillensis* presented moderate levels of genetic diversity. *Myrceugenia basicordata* showed the lowest indices of genetic diversity, suggesting a historical reduction in population size, despite more evidence of gene flow among populations. *Myrceugenia joinvillensis*, by contrast, presented higher indices of genetic diversity, but more discrete genetic groups, suggesting more limited gene flow among populations. Habitat loss and fragmentation are the most pressing threats to these species, which need to be safeguarded through increased knowledge and monitoring and long-term conservation measures. Our study represents the first conservation effort focused on *Myrceugenia* species from the Atlantic Forest, marking an important initial step toward understanding these and other rare species from this biome.

**Supplementary Information** The online version contains supplementary material available at <https://link.springer.com/article/10.1007/s10592-025-01703-4>

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## CONSIDERAÇÕES FINAIS

Este trabalho surgiu da necessidade de compreender o estado atual, e expandir o conhecimento a respeito das espécies ameaçadas da flora brasileira, focando em espécies pertencentes ao domínio Mata Atlântica e endêmicas de Santa Catarina. Como contribuição científica, é proposta uma atualização no status de conservação de espécies de Myrtales do estado (Capítulo I), o primeiro estudo abordando modelagem de distribuição de espécies para *Myrceugenia* sob diferentes cenários (Capítulo II), e o primeiro estudo abordando genética da conservação para o gênero no Brasil (Capítulo III). Aqui, ainda são apresentados 14 novos marcadores microsatélites para *M. basicordata* e *M. joinvillensis*, os quais poderão ser usados em futuras análises.

Considerando um panorama geral, foi possível verificar que o número e o grau de ameaça das espécies catarinenses estão subestimados há pelo menos 10 anos. Essas espécies ocupam habitats em áreas severamente afetadas pela expansão urbana e por outras atividades, como agropecuária e a mineração. Apesar de algumas espécies, como verificado nas espécies-alvo dos capítulos II e III, ainda apresentarem variabilidade genética relativamente favorável, com níveis moderados de diversidade e diferenciação, indícios de endogamia e de redução histórica populacional (testes bottleneck) sugerem que algumas de suas populações não são naturalmente pequenas, como se apresentam na atualidade, e que esse patrimônio genético pode ser perdido caso não existam políticas públicas suficientemente eficazes para garanti-lo a longo prazo, particularmente em cenários de mudanças climáticas.

Em termos de perspectivas futuras, algumas abordagens merecem ser mencionadas: Primeiro, ampliar esforços de coleta com o intuito de aumentar o número de registros, buscar novas populações e atualizar os dados de distribuição para as espécies ameaçadas são de extrema relevância. Sugere-se focar estes novos esforços nas regiões a oeste de Santa Catarina, onde a flora ameaçada se apresentou menos conhecida, mas também nas regiões entre os limites de Santa Catarina e Paraná, onde as espécies ameaçadas estão mais presentes. Áreas protegidas como Parque Estadual da Serra do Tabuleiro (ao sul de SC) e APA de Guaratuba (PR) também se mostraram promissoras para novos registros de *Myrceugenia basicordata* e *M. joinvillensis*. Tais atualizações poderiam fortalecer as análises de modelagem e enriquecer as descobertas aqui encontradas. Segundo, estudos com germinação de sementes são essenciais para compreender quais os limites da conservação *ex situ* das espécies ameaçadas. Terceiro, a avaliação de outros grupos de plantas também é essencial para atualizar as listas da flora

ameaçada do Brasil. Diante disto, este trabalho pode servir como um fluxo a ser seguido em esforços futuros.

## APÊNDICES

### APÊNDICE A – ESPÉCIES EXCLUÍDAS (CAPÍTULO I)

| Species excluded                                                                      | Justification                                                             | Reference or source        |
|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------|----------------------------|
| <b>Lythraceae</b>                                                                     |                                                                           |                            |
| <i>Cuphea iguazuensis</i> Lourteig.                                                   | Only occurs in Paraná                                                     | Flora e Funga do Brasil    |
| <b>Melastomataceae</b>                                                                |                                                                           |                            |
| <i>Chaetogastra longipilosa</i> (Cogn.) P.J.F.Guim. & Michelang.                      | Not endemic to Brazil (also in Argentina and Paraguay)                    | Plants of the World Online |
| <i>Chaetogastra versicolor</i> (Lindl.) P.J.F.Guim. & Michelang.                      | Not endemic to Atlantic Rainforest                                        | Plants of the World Online |
| <i>Chaetogastra crassifolia</i> F.S.Mey. & R.Goldenb.                                 | Only occurs in Paraná                                                     | Flora e Funga do Brasil    |
| <i>Chaetogastra riograndensis</i> F.S.Mey.                                            | Only occurs in Rio Grande do Sul                                          | Flora e Funga do Brasil    |
| <i>Miconia hatschbachii</i> (Brade) R.Goldenb.                                        | Only occurs in Paraná                                                     | Flora e Funga do Brasil    |
| <i>Miconia opaca</i> (Brade) R.Goldenb.                                               | Only occurs in Rio Grande do Sul (possible occurrences in Santa Catarina) | Flora e Funga do Brasil    |
| <i>Miconia sabiaensis</i> (Brade) R.Goldenb.                                          | Distribution includes Southeast, with only one sample in Santa Catarina   | Specieslink                |
| <i>Miconia reitzii</i> (Wurdack) R.Goldenb.                                           | Not endemic to Brazil (also in Paraguay)                                  | Plants of the World Online |
| <i>Ossaea flaccida</i> Brade                                                          | Only occurs in Rio Grande do Sul                                          | Flora e Funga do Brasil    |
| <i>Pleroma goldenbergii</i> (F.S.Mey., P.J.F.Guim. & Kozera) P.J.F.Guim. & Michelang. | Only occurs in Paraná                                                     | Flora e Funga do Brasil    |
| <i>Pleroma marumbiense</i> (Wurdack) P.J.F.Guim. & Michelang                          | Only occurs in Paraná                                                     | Flora e Funga do Brasil    |
| <b>Myrtaceae</b>                                                                      |                                                                           |                            |
| <i>Eugenia coaetanea</i> O.Berg                                                       | Only occurs in Rio Grande do Sul                                          | Flora e Funga do Brasil    |
| <i>Eugenia dimorpha</i> O.Berg                                                        | Only occurs in Rio Grande do Sul                                          | Flora e Funga do Brasil    |
| <i>Eugenia myrciariifolia</i> Soares-Silva & Sobral                                   | Only occurs in Paraná                                                     | Flora e Funga do Brasil    |
| <i>Myrceugenia bocaiuvensis</i> Mattos                                                | Only occurs in Paraná                                                     | Flora e Funga do Brasil    |
| <i>Myrceugenia hatschbachii</i> Landrum                                               | Only occurs in Paraná                                                     | Flora e Funga do Brasil    |
| <i>Plinia hatschbachii</i> (Mattos) Sobral                                            | Only occurs in Paraná                                                     | Flora e Funga do Brasil    |
| <i>Psidium reptans</i> (D.Legrand) Soares-Silva & Proença                             | Only occurs in Paraná                                                     | Flora e Funga do Brasil    |
| <b>Onagraceae</b>                                                                     |                                                                           |                            |

|                                              |                                               |                         |
|----------------------------------------------|-----------------------------------------------|-------------------------|
| <i>Fuchsia hatschbachii</i> P.E.Berry        | Only occurs in Paraná                         | Flora e Funga do Brasil |
| <i>Ludwigia hookeri</i> (Micheli) H.Hara     | Not endemic to Brazil (Argentina and Uruguay) | Farias et al. 2025      |
| <b>Vochysiaceae</b>                          |                                               |                         |
| <i>Callisthene inundata</i> O.L.Bueno et al. | Only occurs in Rio Grande do Sul              | Flora e Funga do Brasil |

## APÊNDICE B – REGISTROS VERIFICADOS QUANTO À SUA IDENTIFICAÇÃO (CAPÍTULO I)

Note: Unconfirmed specimens refer to material that we were either unable to verify (e.g., due to the absence of available images, missing database records) or that we checked and determined not to belong to the species. In both cases, these specimens were excluded from the EOO and AOO calculations.

| Species                                                    | Catalog number        | Voucher              | Confirmed? |
|------------------------------------------------------------|-----------------------|----------------------|------------|
| <b>Melastomataceae</b>                                     |                       |                      |            |
| Chaetogastra cisplatensis (Cogn.) P.J.F.Guim. & Michelang. | US 2340640            | Smith 8483           | No         |
| Chaetogastra cisplatensis (Cogn.) P.J.F.Guim. & Michelang. | FURB 23393            | Verdi, M. 3099       | Yes        |
| Chaetogastra cisplatensis (Cogn.) P.J.F.Guim. & Michelang. | ICN 51608             | -                    | Yes        |
| Chaetogastra cisplatensis (Cogn.) P.J.F.Guim. & Michelang. | HBR 49529; FLOR 24825 | Klein 10955          | Yes        |
| Chaetogastra cordeiroi F.S.Mey. & R.Goldenb.               | MBM 356213            | Cordeiro, J. 3028    | Yes        |
| Chaetogastra cordeiroi F.S.Mey. & R.Goldenb.               | UPCB 87153            | Meyer, F.S. 1023     | Yes        |
| Chaetogastra cordeiroi F.S.Mey. & R.Goldenb.               | UPCB 87152            | Meyer, F.S. 1024     | Yes        |
| Chaetogastra cordeiroi F.S.Mey. & R.Goldenb.               | UPCB 87151            | Meyer, F.S. 1025     | Yes        |
| Chaetogastra cordeiroi F.S.Mey. & R.Goldenb.               | UPCB 87141            | Meyer, F.S. 1026     | Yes        |
| Chaetogastra cordeiroi F.S.Mey. & R.Goldenb.               | UPCB 87148            | Meyer, F.S. 1028     | Yes        |
| Chaetogastra cordeiroi F.S.Mey. & R.Goldenb.               | UPCB 87150            | Meyer, F.S. 1030     | Yes        |
| Chaetogastra cordeiroi F.S.Mey. & R.Goldenb.               | UPCB 87149            | Meyer, F.S. 1031     | Yes        |
| Chaetogastra cordeiroi F.S.Mey. & R.Goldenb.               | UPCB 87147            | Meyer, F.S. 1032     | Yes        |
| Chaetogastra cordeiroi F.S.Mey. & R.Goldenb.               | UPCB 87146            | Meyer, F.S. 1033     | Yes        |
| Chaetogastra cordeiroi F.S.Mey. & R.Goldenb.               | UPCB 87145            | Meyer, F.S. 1036     | Yes        |
| Chaetogastra cordeiroi F.S.Mey. & R.Goldenb.               | HBR 27811             | Reitz, R. 10657      | Yes        |
| Chaetogastra cordeiroi F.S.Mey. & R.Goldenb.               | MBM 406636            | Schwirkowski, P. 946 | Yes        |
| Chaetogastra cordeiroi F.S.Mey. & R.Goldenb.               | MBM 406637            | Schwirkowski, P. 950 | Yes        |
| Chaetogastra cristaensis F.S.Mey & R.Goldenb.              | UPCB 60179            | Brotto, M.L. 90      | Yes        |
| Chaetogastra cristaensis F.S.Mey & R.Goldenb.              | MBM 406245            | Ferreira, P.C. 119   | Yes        |
| Chaetogastra cristaensis F.S.Mey & R.Goldenb.              | UPCB 87166            | Meyer, F.S. 1037     | Yes        |
| Chaetogastra cristaensis F.S.Mey & R.Goldenb.              | MBM 406640            | Meyer, F.S. 1038     | Yes        |

|                                                         |                            |                       |     |
|---------------------------------------------------------|----------------------------|-----------------------|-----|
| Chaetogastra cristaensis F.S.Mey & R.Goldenb.           | UPCB 87167                 | Meyer, F.S. 1039      | Yes |
| Chaetogastra cristaensis F.S.Mey & R.Goldenb.           | UPCB 87173                 | Meyer, F.S. 1040      | Yes |
| Chaetogastra cristaensis F.S.Mey & R.Goldenb.           | UPCB 87170                 | Meyer, F.S. 1041      | Yes |
| Chaetogastra cristaensis F.S.Mey & R.Goldenb.           | MBM 406641                 | Meyer, F.S. 1042      | Yes |
| Chaetogastra cristaensis F.S.Mey & R.Goldenb.           | UPCB 87169                 | Meyer, F.S. 1043      | Yes |
| Chaetogastra cristaensis F.S.Mey & R.Goldenb.           | UPCB 87168                 | Meyer, F.S. 1044      | Yes |
| Chaetogastra cristaensis F.S.Mey & R.Goldenb.           | UEC 187561                 | Meyer, F.S. 1677      | Yes |
| Chaetogastra cristaensis F.S.Mey & R.Goldenb.           | FURB 54386                 | Meyer, F.S. 1682      | Yes |
| Chaetogastra cristaensis F.S.Mey & R.Goldenb.           | UPCB 87171, UEC 187554     | Meyer, F.S. 1686      | Yes |
| Chaetogastra cristaensis F.S.Mey & R.Goldenb.           | UPCB 100703                | Meyer, F.S. 2731      | Yes |
| Chaetogastra cristaensis F.S.Mey & R.Goldenb.           | UPCB 100704                | Meyer, F.S. 2732      | Yes |
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. | LUSC 9645                  | Bortoluzzi, R.C. 4    | Yes |
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. | LUSC 9646                  | Bortoluzzi, R.C. 44   | Yes |
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. | UPCB 63719                 | Dreveck, S. 226       | Yes |
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. | FLOR 7083                  | Falkenberg, D.B. 2278 | Yes |
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. | US 2450646, HBR 29783      | Klein, R.M. 3329      | Yes |
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. | HBR 29759                  | Klein, R.M. 3401      | Yes |
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. |                            | Mattos, J. 3351       | Yes |
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. |                            | Mattos, J. 4489       | Yes |
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. | UPCB 92113                 | Meyer, F.S. 2151      | Yes |
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. | UPCB 92115                 | Meyer, F.S. 2165      | Yes |
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. | HBR 27782, US 2404840      | Reitz, R. 11307       | Yes |
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. | US 2404547, PACA-AGP 66219 | Reitz, R. 11900       | Yes |
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. | FLOR 819                   | Reitz, R. 14211       | Yes |
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. | HBR 29813                  | Reitz, R. 14268       | Yes |
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. | US 2646620, HBR 49442      | Reitz, R. 16658       | Yes |
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. | P05287281                  | Smith, L.B. 8120      | Yes |
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. | HBR 25178                  | Smith, L.B. 8935      | Yes |
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. | NY 558392, HBR 25199       | Smith, L.B. 9314      | Yes |
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. | US 2577517, HBR 34141      | Smith, L.B. 14061     | Yes |

|                                                         |                          |                                                               |     |
|---------------------------------------------------------|--------------------------|---------------------------------------------------------------|-----|
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. | US 2782802               | Smith, L.B. 16140                                             | Yes |
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. | FURB 11009               | Stival-Santos, A. 270                                         | Yes |
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. | R-TIPOS 168428, MO-      |                                                               |     |
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. | DUPLICATES 103149844     | Ule, E. 1447                                                  | Yes |
| Chaetogastra rupestris (Cogn.) P.J.F.Guim. & Michelang. | FURB 11263               | Verdi, M. 1407                                                | Yes |
| Miconia catharinensis (Cogn.) R.Goldenb.                | NY 478287, US 2340607    | Reitz R; Klein RM 5476                                        | Yes |
| Miconia catharinensis (Cogn.) R.Goldenb.                | HBR 29787, US 2450671    | Reitz R; Klein RM 16336                                       | Yes |
| Miconia catharinensis (Cogn.) R.Goldenb.                | US 2450661, HBR 29802    | Reitz R; Klein RM 13361                                       | Yes |
| Miconia catharinensis (Cogn.) R.Goldenb.                | MO-DUPLICATES 103105983, |                                                               |     |
| Miconia catharinensis (Cogn.) R.Goldenb.                | US 2340559               | E. H. G. Ule 1450                                             | Yes |
| Miconia catharinensis (Cogn.) R.Goldenb.                | FLOR 24677               | Falkenberg, D.B. 6754                                         | Yes |
| Miconia catharinensis (Cogn.) R.Goldenb.                | FLOR 16508               | Falkenberg, D.B.; Souza, M.L. 4024                            | Yes |
| Miconia catharinensis (Cogn.) R.Goldenb.                | CTBS 850                 | Fontoura, Simone Bernardes da 4                               | Yes |
| Miconia catharinensis (Cogn.) R.Goldenb.                | MBM 299686               | Hatschbach, G; Cervi, AC; Barboza, E 78096                    | Yes |
| Miconia catharinensis (Cogn.) R.Goldenb.                | UPCB 67057               | M. Reginato 1050                                              | Yes |
| Miconia catharinensis (Cogn.) R.Goldenb.                | UPCB 67073               | M. Reginato 1058                                              | Yes |
| Miconia catharinensis (Cogn.) R.Goldenb.                | UPCB 85981               | M. Reginato 1509                                              | Yes |
| Miconia catharinensis (Cogn.) R.Goldenb.                | MBM 418503               | Meyer, F.S.; Zampier, M.A. 2553                               | Yes |
| Miconia catharinensis (Cogn.) R.Goldenb.                | FLOR 34168               | Souza, M.L. 1279                                              | Yes |
| Miconia catharinensis (Cogn.) R.Goldenb.                | FLOR 33972               | Souza, M.L.; Lopes, I.L. 1314                                 | Yes |
| Miconia catharinensis (Cogn.) R.Goldenb.                | FLOR 34752               | Souza, M.L.; Zanin, A.; Longhi-Wagner, H.M. & Rieper, M. 1560 | Yes |
| Miconia catharinensis (Cogn.) R.Goldenb.                | FLOR 34768               | Souza, M.L.; Zanin, A.; Longhi-Wagner, H.M. & Rieper, M. 1577 | Yes |
| Miconia catharinensis (Cogn.) R.Goldenb.                | ICN 204072               | Reginato, M 1739                                              | Yes |
| Miconia catharinensis (Cogn.) R.Goldenb.                | ICN 204073               | Reginato, M 1740                                              | Yes |
| Miconia catharinensis (Cogn.) R.Goldenb.                | ICN 204084               | Reginato, M 1751                                              | Yes |
| Miconia catharinensis (Cogn.) R.Goldenb.                | JOI 18401                | Vieira, F.C.S. 2593                                           | Yes |
| Miconia catharinensis (Cogn.) R.Goldenb.                | JOI 18404                | Vieira, F.C.S. 2596                                           | Yes |
| Miconia catharinensis (Cogn.) R.Goldenb.                | SPF 186674               | Verdi, M 352                                                  | Yes |
| Miconia catharinensis (Cogn.) R.Goldenb.                | US 2646629               | R. M. Klein 4369                                              | Yes |

|                                                    |                |                                                        |     |
|----------------------------------------------------|----------------|--------------------------------------------------------|-----|
| <i>Miconia catharinensis</i> (Cogn.) R.Goldenb.    | ICN 211974     | R. Goldenberg; P.H. Labiak, F.A. Michelangeli 2707     | Yes |
| <i>Miconia catharinensis</i> (Cogn.) R.Goldenb.    | US 2577503     | L.B.Smith e R.M.Klein 13780                            | Yes |
| <i>Miconia luctatoris</i> (Wurdack) R.Goldenb.     | US 2340647     | L. Smith & R. Reitz 10237                              | No  |
| <i>Miconia luctatoris</i> (Wurdack) R.Goldenb.     | FLOR 21813     | Falkenberg, D.B. 5496                                  | Yes |
| <i>Miconia luctatoris</i> (Wurdack) R.Goldenb.     | FLOR 22294     | Falkenberg, D.B. 5673                                  | Yes |
| <i>Miconia luctatoris</i> (Wurdack) R.Goldenb.     | FLOR 24944     | Falkenberg, D.B.; Souza, M.L. 6844                     | Yes |
| <i>Miconia luctatoris</i> (Wurdack) R.Goldenb.     | US 2340335     | R. Reitz & R. M. Klein 7992                            | Yes |
| <i>Miconia luctatoris</i> (Wurdack) R.Goldenb.     | FLOR 25235     | Falkenberg, D.B. 7331                                  | Yes |
| <i>Miconia luctatoris</i> (Wurdack) R.Goldenb.     | FLOR 25358     | Falkenberg, D.B. 7495                                  | Yes |
| <i>Miconia luctatoris</i> (Wurdack) R.Goldenb.     | FLOR 25577     | Falkenberg, D.B. 7572                                  | Yes |
| <i>Miconia luctatoris</i> (Wurdack) R.Goldenb.     | US 2340638     | L. Smith & Klein, R. 7748                              | Yes |
| <i>Miconia dusenii</i> (Cogn.) R.Goldenb.          | FLOR 76874     | Ribas, O.S. 2238                                       | No  |
| <i>Miconia dusenii</i> (Cogn.) R.Goldenb.          | HB 10708       | P.R. Reitz; R.M. Klein 5902                            | Yes |
| <i>Miconia dusenii</i> (Cogn.) R.Goldenb.          | MBM 221115     | Ribas, O.S.; Cordeiro, J.; Barboza, E. 2238            | No  |
| <i>Miconia dusenii</i> (Cogn.) R.Goldenb.          | US 2340609     | R. Reitz & R. M. Klein 5902                            | Yes |
| <i>Miconia planifilamentosa</i> (Brade) R.Goldenb. | UPCB 85984     | M. Reginato 1502                                       | Yes |
| <i>Miconia planifilamentosa</i> (Brade) R.Goldenb. | FURB 40232     | L.A. Funez; K. Kemmelmeier; A.E. Zermiani 1587         | Yes |
| <i>Miconia planifilamentosa</i> (Brade) R.Goldenb. | FURB 23457     | A. Korte; A. Kniess 1784                               | Yes |
| <i>Miconia planifilamentosa</i> (Brade) R.Goldenb. | FURB 48661     | A.A. de Oliveira 2680                                  | Yes |
| <i>Miconia planifilamentosa</i> (Brade) R.Goldenb. | FURB 77551     | Goldenberg, R.; Michelangeli, F.A.   Labiak, P.H. 2689 | Yes |
| <i>Miconia planifilamentosa</i> (Brade) R.Goldenb. | FLOR 797       | Klein, R.M. 3172                                       | Yes |
| <i>Miconia planifilamentosa</i> (Brade) R.Goldenb. | FLOR 16649     | Falkenberg, D.B. 3837                                  | Yes |
| <i>Miconia planifilamentosa</i> (Brade) R.Goldenb. | FLOR 790       | Reitz, R.; Klein, R.M. 563                             | Yes |
| <i>Miconia planifilamentosa</i> (Brade) R.Goldenb. | HUFU 26421     | Hatschbach, G.; Cervi, A.C. & Barbosa, E. 71765        | Yes |
| <i>Miconia planifilamentosa</i> (Brade) R.Goldenb. | US 2340576     | R. M. Klein 2249                                       | Yes |
| <i>Miconia planifilamentosa</i> (Brade) R.Goldenb. | NY 478435      | L. Smith & Klein, R. 7511                              | Yes |
| <i>Miconia planifilamentosa</i> (Brade) R.Goldenb. | PACA-AGP 65114 | R. Klein 1103                                          | Yes |

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| Miconia planifilamentosa (Brade) R.Goldenb. | US 2404814     | R. Reitz & D. Klein 10414                                     | Yes |
| Miconia planifilamentosa (Brade) R.Goldenb. | NY 478433      | R. Reitz & D. Klein 10551                                     | Yes |
| Miconia planifilamentosa (Brade) R.Goldenb. | MBM 253608     | Hatschbach, G; Cervi, AC; Barboza, E 71692                    | Yes |
| Miconia planifilamentosa (Brade) R.Goldenb. | MBM 42139      | Reitz, R; Klein, RM 2470                                      | Yes |
| Miconia planifilamentosa (Brade) R.Goldenb. | US 2340588     | R. Reitz; R.M. Klein 2285                                     | Yes |
| Miconia planifilamentosa (Brade) R.Goldenb. | FLOR 25475     | Falkenberg, D.B. 7236                                         | Yes |
| Miconia planifilamentosa (Brade) R.Goldenb. | FLOR 24955     | Falkenberg, D.B.; Souza, M.L. 6930                            | Yes |
| Miconia riograndensis (Brade) R.Goldenb.    | FPS 1166       | Schwirkowski, P.                                              | Yes |
| Miconia riograndensis (Brade) R.Goldenb.    | PACA-AGP 60037 | Rambo, B.                                                     | Yes |
| Miconia riograndensis (Brade) R.Goldenb.    | PACA-AGP 60031 | Rambo, B.                                                     | Yes |
| Miconia riograndensis (Brade) R.Goldenb.    | FLOR 34623     | Zanin, A.; Longhi-Wagner, H.M.; Souza, M.L. & Rieper, M. 1009 | Yes |
| Miconia riograndensis (Brade) R.Goldenb.    | US 2340648     | L. Smith, R. Reitz & R. Klein 10295                           | Yes |
| Miconia riograndensis (Brade) R.Goldenb.    | FLOR 34644     | Zanin, A.; Longhi-Wagner, H.M.; Souza, M.L. & Rieper, M. 1030 | Yes |
| Miconia riograndensis (Brade) R.Goldenb.    | NY 02098768    | Reginato, M. 1051                                             | Yes |
| Miconia riograndensis (Brade) R.Goldenb.    | NY 02098759    | M. Reginato 1055                                              | Yes |
| Miconia riograndensis (Brade) R.Goldenb.    | US 2404843     | Reitz, R.; Klein, R.M. 11390                                  | Yes |
| Miconia riograndensis (Brade) R.Goldenb.    | NY 520694      | L. Smith & Klein, R. 11498                                    | Yes |
| Miconia riograndensis (Brade) R.Goldenb.    | US 2404843     | Reitz, R.; Klein 11390                                        | Yes |
| Miconia riograndensis (Brade) R.Goldenb.    | SP 114453      | Mattos, J 11961                                               | Yes |
| Miconia riograndensis (Brade) R.Goldenb.    | FLOR 34201     | Souza, M.L.; Lopes, I.L. 1303                                 | Yes |
| Miconia riograndensis (Brade) R.Goldenb.    | FLOR 23420     | M. L. Souza   I. Lopes 1325                                   | Yes |
| Miconia riograndensis (Brade) R.Goldenb.    | FLOR 34200     | Souza, M.L.; Lopes, I.L. 1388                                 | Yes |
| Miconia riograndensis (Brade) R.Goldenb.    | NY 01874767    | M. Reginato 1457                                              | Yes |
| Miconia riograndensis (Brade) R.Goldenb.    | UPCB 85986     | Reginato, M; Meyer, F.S. 1506                                 | Yes |
| Miconia riograndensis (Brade) R.Goldenb.    | NY 03287809    | Reginato, M; Meyer, F.S. 1510                                 | Yes |
| Miconia riograndensis (Brade) R.Goldenb.    | FLOR 34803     | Souza, M.L.; Zanin, A.; Longhi-Wagner, H.M. & Rieper, M. 1612 | Yes |
| Miconia riograndensis (Brade) R.Goldenb.    |                | Reginato, M 1749                                              | Yes |
| Miconia riograndensis (Brade) R.Goldenb.    | UPCB 89389     | Coelho, R.L.G. et al. 200                                     | Yes |

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| Miconia riograndensis (Brade) R.Goldenb. | MBM 202888  | Souza, ML; et al. 2325                                   | Yes |
| Miconia riograndensis (Brade) R.Goldenb. | UPCB 106687 | Meyer, FS; Zampier, MA 2552                              | Yes |
| Miconia riograndensis (Brade) R.Goldenb. | JOI 18402   | Vieira, F.C.S. 2594                                      | Yes |
| Miconia riograndensis (Brade) R.Goldenb. | ICN 211978  | Goldenberg, R.; Michelangeli, F.A.   Labiak, P.H. 2682   | Yes |
| Miconia riograndensis (Brade) R.Goldenb. | FURB 8491   | M. Verdi; S. Dreveck 387                                 | Yes |
| Miconia riograndensis (Brade) R.Goldenb. | FLOR 58959  | Fiaschi, P.; Trevisan, R. & Alcantara, S. 4462           | Yes |
| Miconia riograndensis (Brade) R.Goldenb. | MO 3228613  | B. Rambo S. J. 49577                                     | Yes |
| Miconia riograndensis (Brade) R.Goldenb. | US 2340601  | R. Reitz & D. Klein 5263                                 | Yes |
| Miconia riograndensis (Brade) R.Goldenb. | US 2340602  | R. Reitz & D. Klein 5285                                 | Yes |
| Miconia riograndensis (Brade) R.Goldenb. | FURB 34334  | A. Korte 6038                                            | Yes |
| Miconia riograndensis (Brade) R.Goldenb. | FLOR 24685  | Falkenberg, DB. 6746                                     | Yes |
| Miconia riograndensis (Brade) R.Goldenb. | FLOR 25021  | Falkenberg, D.B.; Souza, M.L. 6895                       | Yes |
| Miconia riograndensis (Brade) R.Goldenb. | FLOR 25433  | Falkenberg, D.B. 7533                                    | Yes |
| Miconia ulei (Cogn.) R.Goldenb.          | US 3286165  | A. Krapovickas & C. L. Cristóbal 44808                   | Yes |
| Miconia ulei (Cogn.) R.Goldenb.          | FLOR 54817  | Lehmkul, X. s.n.                                         | Yes |
| Miconia ulei (Cogn.) R.Goldenb.          | FURB 28578  | A. Stival-Santos; E. Legal; S. Silveira 3291             | Yes |
| Miconia ulei (Cogn.) R.Goldenb.          | FURB 28577  | A. Stival-Santos; E. Legal; S. Silveira 3290             | Yes |
| Miconia ulei (Cogn.) R.Goldenb.          | CRI 6287    | R. dos Santos; C. A. Correa & Z. P. Topanotti 303        | Yes |
| Miconia ulei (Cogn.) R.Goldenb.          | NY 00520793 | Lourteig 2367                                            | Yes |
| Miconia ulei (Cogn.) R.Goldenb.          | UPCB 87982  | M. Reginato 1454                                         | Yes |
| Miconia ulei (Cogn.) R.Goldenb.          | ICN 203992  | Reginato, M 1659                                         | Yes |
| Miconia ulei (Cogn.) R.Goldenb.          | NY 00520793 | A. Lourteig 2367                                         | Yes |
| Miconia ulei (Cogn.) R.Goldenb.          | FLOR 41868  | Muniz, L.V. 3                                            | Yes |
| Miconia ulei (Cogn.) R.Goldenb.          | PEL 15785   | Falkenberg, D.B.; Souza, M.L. 5845                       | Yes |
| Miconia ulei (Cogn.) R.Goldenb.          | FLOR 34183  | Souza, M.L.; Lopes, I.L. 1298                            | Yes |
| Miconia ulei (Cogn.) R.Goldenb.          | FURB 54362  | A. Kassner-Filho; D. Santos; G. Bollmann; D.A. Silva 683 | Yes |

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| Miconia ulei (Cogn.) R.Goldenb. | FURB 49119 | A.A. de Oliveira 2852                                                     | Yes |
| Miconia ulei (Cogn.) R.Goldenb. | ICN 193679 | Rabuske, CS; Santos-Jr.; R. 162                                           | Yes |
|                                 |            | Vanilde Citadini-Zanette; Jairo José Zocche & Aurélio José de Aguiar 1047 | Yes |
| Miconia ulei (Cogn.) R.Goldenb. | CRI 697    | Vanilde Citadini-Zanette; Aurélio José de Aguiar 1319                     | Yes |
| Miconia ulei (Cogn.) R.Goldenb. | CRI 1041   | R. Reitz & D. Klein 5728                                                  | Yes |
| Miconia ulei (Cogn.) R.Goldenb. | US 2338815 | Queiroz, M.H. de s.n.                                                     | Yes |
| Miconia ulei (Cogn.) R.Goldenb. | FLOR 54820 | Cardoso, J.H.; Anjos, A. 129                                              | Yes |
| Miconia ulei (Cogn.) R.Goldenb. | FLOR 41539 | Daniel B. Falkenberg 6072                                                 | Yes |
| Miconia ulei (Cogn.) R.Goldenb. | MBM 164787 | V. Citadini-Zanette; V. Boff 2250                                         | Yes |
| Miconia ulei (Cogn.) R.Goldenb. | CRI 5097   | A. Korte; A. Kniess 3518                                                  | Yes |
| Miconia ulei (Cogn.) R.Goldenb. | FLOR 53303 |                                                                           |     |
| Miconia ramboi Brade            | EFC 11270  | Saueressig, D.; Henke, J.M. 1545                                          | Yes |
| Miconia ramboi Brade            | FLOR 70723 | Franke, R.A.M.; Trevisan, R. 330                                          | Yes |
|                                 |            | L.A. Funez; P. Fiaschi; R. Trevisan; M. Comin; F.S. Cabral; I. Conti 9650 | Yes |
| Miconia ramboi Brade            | FURB 67222 | Ronaldo                                                                   | Yes |
| Miconia ramboi Brade            | CRI 8796   | Reginato, M 1753                                                          | Yes |
| Miconia ramboi Brade            | -          | Falkenberg, D.B.; Berry, P.E. 2299                                        | Yes |
| Miconia ramboi Brade            | MBM 102139 | Falkenberg, D.B.; Souza, M.L. 3988                                        | No  |
| Miconia ramboi Brade            | FLOR 16413 | Falkenberg, D.B. 4556                                                     | Yes |
| Miconia ramboi Brade            | FLOR 17606 | Smith, L.B.; Reitz, R. 8986                                               | Yes |
| Miconia ramboi Brade            | HBR 25180  | L. Smith & R. Reitz s.n.                                                  | Yes |
| Miconia ramboi Brade            | US 2323079 | R. Reitz 13756                                                            | Yes |
| Miconia ramboi Brade            | HBR 29792  | Reitz, R.; Klein, R. 4783                                                 | Yes |
| Miconia ramboi Brade            | NY 522155  | Costa, E.F.; Barbosa, E.; Cordeiro, J.; Barbosa, E.; Cordeiro, J. 122     | Yes |
| Miconia ramboi Brade            | SPSF 47740 | Vieira, F.C.S. 1275                                                       | Yes |
| Miconia ramboi Brade            | JOI 3891   | F.C.S. Vieira 1277                                                        | Yes |
| Miconia ramboi Brade            | JOI 3890   | Romão, GO; Rodrigues, CDN; Dantas, APT 1735                               | Yes |
| Miconia ramboi Brade            | UPCB 81455 |                                                                           |     |

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| Miconia ramboi Brade | UEC 160847 | Romão, GO; Rodrigues, CDN;<br>Dantas, APT 1745               | Yes |
| Miconia ramboi Brade | -          | Vieira, F.C.S. 2401                                          | No  |
| Miconia ramboi Brade | MBM 234051 | Silva, J.M.; Ribas, O.S.; Cordeiro, J.<br>& Barbosa, E. 2790 | No  |
| Miconia ramboi Brade | -          | R. Reitz & D. Klein s.n.                                     | Yes |
| Miconia ramboi Brade | -          | L. Smith & R. M. Klein s.n.                                  | Yes |
| Miconia ramboi Brade | -          | L. Smith & R. M. Klein                                       | No  |
| Miconia ramboi Brade | -          | L. B. Smith 4783                                             | Yes |
| Miconia ramboi Brade | US 2450684 | R. Reitz & D. Klein s.n.                                     | Yes |
| Miconia ramboi Brade | -          | R. Reitz & D. Klein                                          | No  |
| Miconia ramboi Brade | FLOR 54918 | Barboza, E.; Cordeiro, J.; Silva, J.M.<br>& Motta, J.T. 4055 | Yes |
| Miconia ramboi Brade | FLOR 59616 | L.A. Funez; R. Trevisan; J.P.R.<br>Ferreira; S. Venturi 4070 | Yes |
| Miconia ramboi Brade | MBM 299770 | J.M. Silva 4123                                              | Yes |
| Miconia ramboi Brade | UB 201965  | Barboza, E; et al. 4455                                      | No  |
| Miconia ramboi Brade | -          | Silva, JM; Sampaio, D; Coutinho,<br>APS 5176                 | Yes |
| Miconia ramboi Brade | FLOR 74072 | Silva, J.M.; Brotto, M.L. 9156                               | Yes |
| Miconia ramboi Brade | LUSC 2492  | Cardoso, R.                                                  | Yes |
| Miconia ramboi Brade | LUSC 5578  | Menegatti, R.D.                                              | Yes |
| Miconia ramboi Brade | LUSC 5580  | Menegatti, R.D.                                              | Yes |
| Miconia ramboi Brade | -          | Menegatti, R.D.                                              | Yes |
| Miconia ramboi Brade | -          | Mattos, J. 11980                                             | No  |
| Miconia ramboi Brade | -          | L. Smith & R. M. Klein s.n.                                  | Yes |
| Miconia ramboi Brade | -          | Dalmaso, CA s.n.                                             | Yes |
| Miconia ramboi Brade | -          | Dalmaso, CA                                                  | No  |
| Miconia ramboi Brade | -          | B. Rambo 49677                                               | Yes |
| Miconia ramboi Brade | FLOR 29279 | V. P. Boff 130                                               | No  |
| Miconia ramboi Brade | FLOR 2771  | Smith, L.B. Klein, R.M. 15516                                | Yes |
| Miconia ramboi Brade | -          | L. Smith & R. M. Klein s.n.                                  | Yes |

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| Miconia ramboi Brade                             |                                   | Reitz, R.                                                   | Yes |
| Miconia ramboi Brade                             | FLOR 796                          | Reitz, R.; Klein, R.M. 13709                                | Yes |
| Miconia ramboi Brade                             | MBM 23973                         | Hatschbach, G 30698                                         | Yes |
| Miconia ramboi Brade                             | -                                 | R. Reitz & D. Klein s.n.                                    | Yes |
| Miconia ramboi Brade                             | -                                 | G. Hatschbach s.n.                                          | Yes |
| Miconia ramboi Brade                             | -                                 | G. Hatschbach                                               | No  |
| Miconia ramboi Brade                             | CRI 6239                          | Átila Portal                                                | Yes |
| Miconia ramboi Brade                             | HPL 5316                          | H. Lorenzi 5710                                             | Yes |
| Miconia ramboi Brade                             | -                                 | Dreveck, S; Verdi, M; Godoy, MB 269                         | Yes |
| Miconia ramboi Brade                             | FURB 70766                        | R. Reitz & D. Klein                                         | Yes |
| Miconia ramboi Brade                             | US 2323071                        | L. Smith & R. Reitz s.n.                                    | Yes |
| Miconia ramboi Brade                             | HBR 25239                         | L. B. Smith 10158                                           | Yes |
| Miconia ramboi Brade                             | SP 57507                          | Reitz, R; Klein, RM 5392                                    | Yes |
| Miconia ramboi Brade                             | -                                 | R. Reitz & D. Klein s.n.                                    | Yes |
| Miconia ramboi Brade                             | -                                 | Rosina, A. 4                                                | No  |
| Miconia ramboi Brade                             | EVB 573                           | Rosina, A. 5                                                | No  |
| Miconia ramboi Brade                             | MBM 393521                        | Cordeiro, J.; Barboza, E.; Daniel, V.; Ariati, V. 5312      | Yes |
| Miconia ramboi Brade                             | ICN 211973                        | Goldenberg, R.; Michelangeli, F.A.   Labiak, P.H. 2705      | Yes |
| Miconia ramboi Brade                             | FLOR 25290                        | Falkenberg, D.B. 7381                                       | Yes |
| Miconia ramboi Brade                             | -                                 | Cordeiro, J.; Silva, J. M.; Barbosa, E. & Ribas, O. S. 1713 | No  |
| Miconia ramboi Brade                             | -                                 | O.S. Ribas; J.M. Silva; E. Barbosa; E.F. Costa 3651         | No  |
| Miconia ramboi Brade                             | -                                 | Smith, L.B. 7406                                            | No  |
| Miconia ramboi Brade                             | -                                 | Mattos, J. 11962                                            | No  |
| Pleroma dusenii (Cogn.) P.J.F.Guim. & Michelang. | FLOR 24831, US 2732998, HBR 49527 | Bresolin, A. 699                                            | Yes |
| Pleroma dusenii (Cogn.) P.J.F.Guim. & Michelang. | UEC 176045, IBGE 76733            | Funez, L.A. 1636                                            | Yes |
| Pleroma dusenii (Cogn.) P.J.F.Guim. & Michelang. | FURB 10510                        | Grippa, C.R. 591                                            | Yes |

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| Pleroma dusenii (Cogn.) P.J.F.Guim. & Michelang.    | HB 10706, HBR 27671, NY 658698, US 2324807                  | Klein, R.M. 2205       | Yes |
| Pleroma dusenii (Cogn.) P.J.F.Guim. & Michelang.    | US 2325439                                                  | Klein, R.M. 2320       | Yes |
| Pleroma dusenii (Cogn.) P.J.F.Guim. & Michelang.    | FURB 45215                                                  | Mayer, M. 623          | Yes |
| Pleroma dusenii (Cogn.) P.J.F.Guim. & Michelang.    | FURB 45697                                                  | Oliveira, A.A. de 1101 | Yes |
| Pleroma dusenii (Cogn.) P.J.F.Guim. & Michelang.    | MO 3217574                                                  | Pedersen, T.M. 13772   | No  |
| Pleroma dusenii (Cogn.) P.J.F.Guim. & Michelang.    | US 2325460, FURB 71006                                      | Reitz, R. 9549         | Yes |
| Pleroma dusenii (Cogn.) P.J.F.Guim. & Michelang.    | FURB 46495                                                  | Seubert, R.C. 66       | No  |
| Pleroma dusenii (Cogn.) P.J.F.Guim. & Michelang.    | FURB 2526                                                   | Sobral, M. s.n.        | Yes |
| Pleroma dusenii (Cogn.) P.J.F.Guim. & Michelang.    | UPCB 45124                                                  | Sobral, M. 8629        | Yes |
| Pleroma dusenii (Cogn.) P.J.F.Guim. & Michelang.    | FLOR 6114                                                   | Souza, M.L. 642        | Yes |
| Pleroma dusenii (Cogn.) P.J.F.Guim. & Michelang.    | FURB 20047                                                  | Verdi, M. 3774         | Yes |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. | NY 01164738, UEC 169584, CAS-BOT 409240                     | Almeda, F. 9868        | Yes |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. | FLOR 25108                                                  | Falkenberg, D.B. 7100  | Yes |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. | FLOR 25107                                                  | Falkenberg, D.B. 7102  | Yes |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. | FLOR 25106                                                  | Falkenberg, D.B. 7103  | Yes |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. | FLOR 25105                                                  | Falkenberg, D.B. 7104  | Yes |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. | FLOR 25104                                                  | Falkenberg, D.B. 7105  | Yes |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. | FLOR 25422                                                  | Falkenberg, D.B. 7223  | Yes |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. | FLOR 25313                                                  | Falkenberg, D.B. 7358  | Yes |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. | FLOR 25461                                                  | Falkenberg, D.B. 7505  | Yes |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. | UPCB 43063, MBM 173963, INPA 205552, SPF 143729, NY 1016785 | Hatschbach, G. 61702   | No  |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. |                                                             | Hatschbach, G. 79929   | Yes |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. | FURB 35402                                                  | Korte, A. 6013         | Yes |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. | FURB 35374                                                  | Korte, A. 6045         | Yes |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. | UPCB 90759                                                  | Meyer, F.S. 2143       | Yes |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. | UPCB 90760                                                  | Meyer, F.S. 2148       | Yes |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. | FLOR 74056                                                  | Meyer, F.S. 2575       | Yes |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. |                                                             | Rambo, S.J.B. 60242    | Yes |

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| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. | US 2340578, NY 778185                          | Reitz, R. 5267         | Yes |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. | US 2340579, HBR 7762                           | Reitz, R. 5304         | Yes |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. | US 3342764, SPF 141464, MBM 189067, FLOR 30190 | Ribas, O.S. 1148       | Yes |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. | FURB 57533                                     | Schwirkowski, P. 2641  | No  |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. | R-TIPOS 115666, US 2340656, P05315849          | Smith, L.B. 10591      | Yes |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. | US 2340332, NY 245774, R-TIPOS 136934          | Smith, L.B. 11249      | Yes |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. | US 2340660, NY 778184, R-TIPOS 112497          | Smith, L.B. 12039      | Yes |
| Pleroma kleinii (Wurdack) P.J.F. Guim. & Michelang. | FURB 34117                                     | Verdi, M. 5896         | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang.    | FURB 56598                                     | Kassner-Filho, A. 1635 | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang.    | -                                              | Souza, N.L. de 138     | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang.    | -                                              | Stival-Santos, A. 1823 | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang.    | FURB 30064                                     | Stival-Santos, A. 3099 | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang.    | FURB 21817                                     | Stival-Santos, A. 1567 | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang.    | -                                              | Stival-Santos, A. 2474 | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang.    | FURB 10913                                     | Grippa, C.R. 695       | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang.    | -                                              | Korte, A. 2159         | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang.    | -                                              | Oliveira, A.A. de 1138 | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang.    | -                                              | Funez, L.A. 4256       | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang.    | -                                              | Falkenberg, D.B. 3877  | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang.    | -                                              | Funez, L.A. 1550       | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang.    | -                                              | Gaspar, A.L. de 3488   | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang.    | -                                              | Gebien, W. 74          | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang.    | US 2325440                                     | Klein, R.M. 2416       | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang.    | -                                              | Schwache, C.A.W. s.n.  | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang.    | -                                              | Ule, E.H. 669          | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang.    | UPCB 66691                                     | Vieira, F.C.S. 1262    | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang.    | -                                              | Vieira, F.C.S. 2543    | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang.    | FLOR 30191                                     | Ribas, O.S. 1224       | Yes |

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| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | FURB 34228 | Korte, A. 6139         | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | MBM 410329 | Dreveck, S. 2178       | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Kassner-Filho, A. 6433 | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Elias, G.A. s.n.       | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Guislon, A.V. s.n.     | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Smekatz, R.C. s.n.     | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Kummrow, R. 1491       | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Souza, M.L. 618        | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | US 2321006 | Gevieski, A. 51        | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Klein, R.M. 1933       | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Korte, A. 2558         | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Orozco, L.I.           | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Reitz, R. 3128         | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Falkenberg, D.B. 4403  | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Hoeltgebaum, M.P. 4D   | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | NY 778195  | Pereira, E. 8771       | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Reginato, M. 1656      | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Souza, M.L. 667        | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Klein, R.M. 10950      | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | FURB 25721 | Korte, A. 3249         | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Luz, D.R. da s.n.      | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Seubert, R.C. 67       | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Uller, H.F. 150        | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | US 2321007 | Klein, R.M. 1052       | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Kassner-Filho, A. 1810 | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Souza, M.L. s.n.       | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Souza, M.L. 1177       | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | FLOR 23443 | Souza, M.L. 1207       | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | HBR 64928  | Souza, M.L. 1208       | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | FURB 24395 | Dreveck, S. 1858       | Yes |

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| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Lopes, C.P. s.n.          | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Reitz, R. 6285            | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Vieira, F.C.S. 389        | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Vieira, F.C.S. 826        | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | FURB 29931 | Korte, A. 3818            | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Stival-Santos, A. 763     | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | PEL 11302  | Jarenkow, J.A. 1235       | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Reitz, R. s.n.            | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Reitz, R. 3251            | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Reitz, R. 8251            | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | FLOR 41218 | Korte, A. 4535            | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | FURB 34306 | Korte, A. 4875            | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Korte, A. 5892            | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Citadini-Zanette, V. 863  | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Citadini-Zanette, V. 1053 | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | CRI 704    | Citadini-Zanette, V. 1054 | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Citadini-Zanette, V. 1069 | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Citadini-Zanette, V. 1544 | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Elias, G.A. s.n.          | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Verdi, M. 3930            | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | FURB 18394 | Cadorin, T.J. 125         | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | FURB 7523  | Verdi, M. 849             | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | FURB 10652 | Grippa, C.R. 649          | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Medeiros, J.D. s.n.       | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | FLOR 34285 | Schweitzer 1              | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | FURB 23434 | Korte, A. 1976            | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Korte, A. 3057            | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Dalmaso, C.A. s.n.        | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | FURB 18531 | Korte, A. 1483            | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -          | Reitz, R. 6124            | No  |

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| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -                       | Sevegnani, L. s.n.        | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -                       | Sohn, S. 10               | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -                       | Funez, L.A. 330           | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -                       | Uller, H.F. 130           | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -                       | Berger, J.Z. 25           | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -                       | Berger, J.Z. 4052725      | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -                       | Gasper, A.L. de 11        | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -                       | Guimarães, P.J.F. 445     | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | FURB 34073              | Korte, A. 5945            | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -                       | Meyer, F.S. 37            | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | UEC 187968              | Meyer, F.S. 1551          | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -                       | Schwirkowski, P. 61       | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -                       | Schwirkowski, P. 4036     | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | MBM 2103                | Reitz, R. 10801           | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -                       | Queiroz, M.H. de 173      | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -                       | Citadini-Zanette, V. 2244 | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | ICN 189497              | Gasper, A.L. de 1509      | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -                       | Gasper, A.L. de 1540      | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -                       | Kniess, A. 1792           | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -                       | Korte, A. 1792            | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -                       | Siqueira, E.L. 1567       | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | FLOR 6180               | Falkenberg, D.B. 2237     | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | HCF 23811               | Hatschbach, G. 78913      | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -                       | Souza, M.L. 1567          | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | US 2321012              | Reitz, R. 6573            | Yes |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -                       | Fox 48                    | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -                       | Hagelund, K. 6150         | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -                       | Mueller, F. 212           | No  |
| Pleroma pilosum (Cogn.) P.J.F.Guim. & Michelang. | -                       | Ule, E. 1444              | No  |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang.  | UEC 170673, NY 01164714 | Almeda, F. 9849           | yes |

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| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | NY 01164736, UEC 170393 | Almeda, F. 9889           | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | EFC 17119               | Brotto, M.L. 1590         | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | CRI 5213                | Citadini-Zanette, V. s.n. | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | CRI 218                 | Citadini-Zanette, V. 626  | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | CRI 5084                | Citadini-Zanette, V. 2237 | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | CRI 5090                | Citadini-Zanette, V. 2243 | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | CRI 5210                | Citadini-Zanette, V. 2361 | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | CRI 6053                | Citadini-Zanette, V. 2447 | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | FLOR 21408              | Falkenberg, D.B. 1851     | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | FLOR 17735              | Falkenberg, D.B. 4720     | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | FLOR 21635              | Falkenberg, D.B. 5521     | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | FLOR 24965              | Falkenberg, D.B. 6945     | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | FLOR 25546              | Falkenberg, D.B. 7446     | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | UPCB 108416             | Guimarães, P.J.F. 441     | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | MBM 155321              | Hatschbach, G. 57881      | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | MBM 161433              | Hatschbach, G. 59134      | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | HCF 23700               | Hatschbach, G. 78976      | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | ICN 172066              | Iganci, J.R.V. 399        | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | FURB 58591              | Kassner-Filho, A. 2661    | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | CRI 11687               | Kruger, A.Z. s.n.         | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | UEC 188206, UPGB 89607  | Meyer, F.S. 1459          | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | UPCB 90761              | Meyer, F.S. 2145          | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | CRI 14645               | Pasetto, M.R. s.n.        | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | HAS 96037               | Piovesani, W.S. 77        | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | HBR 27744, US 2321002   | Reitz, R. 8444            | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | HBR 27757, FLOR 792     | Reitz, R. 8449            | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | CRI 6246                | Santos, R. dos s.n.       | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | FLOR 34257              | Santos, R. dos 290        | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | LUSC 8750               | Smekatz, R.C. s.n.        | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang. | PEL 12345, FLOR 22001   | Sobral, M. 6490           | yes |

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| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang.       | FLOR 34779             | Souza, M.L. 1588        | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang.       | FLOR 34780             | Souza, M.L. 1589        | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang.       | P05287287              | Ule, E. 1750            | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang.       | FURB 13344, HUCS 48600 | Verdi, M. 1904          | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang.       | FURB 13343             | Verdi, M. 2110          | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang.       | FLOR 43114             | Verdi, M. 2316          | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang.       | FLOR 43113             | Verdi, M. 2354          | yes |
| Pleroma ramboi (Brade) P.J.F.Guim. & Michelang.       | CRI 17001              | J. G. Sandrini 50       | No  |
| Pleroma setosociliatum (Cogn.) F.S. Mey. & F.B. Matos | UPCB 60191             | Brotto, M.L. 104        | Yes |
| Pleroma setosociliatum (Cogn.) F.S. Mey. & F.B. Matos | US 3241124             | Cordeiro, J. 911        | Yes |
| Pleroma setosociliatum (Cogn.) F.S. Mey. & F.B. Matos | MBM 245466             | Cordeiro, J. 1716       | Yes |
| Pleroma setosociliatum (Cogn.) F.S. Mey. & F.B. Matos | UPCB 88345             | Meyer, F.S. 1796        | Yes |
| Pleroma setosociliatum (Cogn.) F.S. Mey. & F.B. Matos | UPCB 88339             | Meyer, F.S. 1797        | Yes |
| Pleroma setosociliatum (Cogn.) F.S. Mey. & F.B. Matos | UPCB 88347             | Meyer, F.S. 1798        | Yes |
| Pleroma setosociliatum (Cogn.) F.S. Mey. & F.B. Matos | UPCB 88346             | Meyer, F.S. 1800        | Yes |
| Pleroma setosociliatum (Cogn.) F.S. Mey. & F.B. Matos | UPCB 88341             | Meyer, F.S. 1801        | Yes |
| Pleroma setosociliatum (Cogn.) F.S. Mey. & F.B. Matos | UPCB 88344             | Meyer, F.S. 1803        | Yes |
| Pleroma setosociliatum (Cogn.) F.S. Mey. & F.B. Matos | EFC 11569              | Vieira, R.S. 184        | No  |
| Pleroma setosociliatum (Cogn.) F.S. Mey. & F.B. Matos | FURB 14813             | Vieira, F.C.S. 1509     | Yes |
| Pleroma setosociliatum (Cogn.) F.S. Mey. & F.B. Matos | JOI 19559              | Vieira, F.C.S. 3088     | No  |
| Pleroma setosociliatum (Cogn.) F.S. Mey. & F.B. Matos | PACA-AGP 110843        | Sehnem, A. 5486         | No  |
| Pleroma setosociliatum (Cogn.) F.S. Mey. & F.B. Matos | MBM 322227             | Silva, J.M. 5191        | Yes |
| <b>Myrtaceae</b>                                      |                        |                         |     |
| Campomanesia littoralis D.Legrand                     | CRI 3394               | Maria Costa Rebelo s.n. | Yes |
| Campomanesia littoralis D.Legrand                     | PACA-AGP 31725         | Rambo, B. s.n.          | No  |
| Campomanesia littoralis D.Legrand                     | PACA-AGP 73976         | A. O. Rosa s.n.         | Yes |
| Campomanesia littoralis D.Legrand                     | PACA-AGP 85135         | Mauhs, J. s.n.          | No  |
| Campomanesia littoralis D.Legrand                     | PACA-AGP 73977         | A. O. Rosa s.n.         | Yes |
| Campomanesia littoralis D.Legrand                     | EAFM 12062             | Gandolfo, ES 1035       | No  |
| Campomanesia littoralis D.Legrand                     | FLOR 67257             | Caddah, M. K. 1052      | Yes |

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|-----------------------------------|----------------|-------------------------------------------------------------|-----|
| Campomanesia littoralis D.Legrand | EAFM 12075     | Gandolfo, ES 1063                                           | No  |
| Campomanesia littoralis D.Legrand | EFC 21556      | Souza, I. 1226                                              | Yes |
| Campomanesia littoralis D.Legrand | HBR 19512      | L.B. Smith; R. Reitz 12267                                  | Yes |
| Campomanesia littoralis D.Legrand | EFC 21558      | Souza, I. 1228                                              | Yes |
| Campomanesia littoralis D.Legrand | HBR 9284       | R. Reitz; R.M. Klein 1231                                   | Yes |
| Campomanesia littoralis D.Legrand | HBR 4830       | R. Reitz; R.M. Klein 130                                    | Yes |
| Campomanesia littoralis D.Legrand | FURB 58766     | A. Kassner-Filho; D. Santos; G. Bollmann; D.A. Silva 1302   | Yes |
| Campomanesia littoralis D.Legrand | PACA-AGP 73042 | Sehnem, A. 13888                                            | Yes |
| Campomanesia littoralis D.Legrand | EAFM 13476     | Leal, ML; Silva, MS 17                                      | No  |
| Campomanesia littoralis D.Legrand | FLOR 2096      | Bresolin, A. 185                                            | Yes |
| Campomanesia littoralis D.Legrand | FLOR 22450     | Silva Filho, F.A. da; Souza, M.L. & Zanin, A. 217           | Yes |
| Campomanesia littoralis D.Legrand | CRI 6171       | Vanilde Citadini Zanette; Valdemar P. Boff 2505             | Yes |
| Campomanesia littoralis D.Legrand | US US 2141546  | R. Reitz & R. M. Klein 273                                  | Yes |
| Campomanesia littoralis D.Legrand | CRI 3490       | Robson dos Santos; Sebastião Aleques Macedo Waltrick 28     | Yes |
| Campomanesia littoralis D.Legrand | FLOR 22449     | Silva Filho, F.A. da; Leite, C.L. 281                       | Yes |
| Campomanesia littoralis D.Legrand | SORO 7842      | Garcia, R.J.F.; Amaral, P.; Fornari, M. 2863                | Yes |
| Campomanesia littoralis D.Legrand | FURB 60057     | A. Kassner-Filho; D. Santos; G. Bollmann; L.F. Althoff 3087 | Yes |
| Campomanesia littoralis D.Legrand | FLOR 31182     | Mattos, J. 31694                                            | Yes |
| Campomanesia littoralis D.Legrand | FLOR 31183     | Mattos, J. 31723                                            | Yes |
| Campomanesia littoralis D.Legrand | FLOR 39864     | Mattos, J. 32756                                            | Yes |
| Campomanesia littoralis D.Legrand | EAFM 11696     | Melo, S 364                                                 | No  |
| Campomanesia littoralis D.Legrand | EFC 17747      | Souza, I. 371                                               | No  |
| Campomanesia littoralis D.Legrand | FURB 47064     | L.A. Funez 4132                                             | Yes |
| Campomanesia littoralis D.Legrand | FLOR 50301     | Nuernberg, A.; Mello, A.S. 417                              | Yes |
| Campomanesia littoralis D.Legrand | FLOR 50332     | Nuernberg, A.; Mello, A.S. 420                              | Yes |
| Campomanesia littoralis D.Legrand | HUEFS 173075   | Souza, M.L 429                                              | Yes |

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| Campomanesia littoralis D.Legrand | CRI 3483     | Robson dos Santos; Clair Maria Martinello 43       | Yes |
| Campomanesia littoralis D.Legrand | HBR 4807     | R. Reitz 4351                                      | Yes |
| Campomanesia littoralis D.Legrand | FLOR 35216   | Guimarães, T.B.; Falkenberg, D.B. 456              | Yes |
| Campomanesia littoralis D.Legrand | FLOR 17619   | Falkenberg, D.B. 4576                              | Yes |
| Campomanesia littoralis D.Legrand | HBR 6805     | R. Reitz 4852                                      | Yes |
| Campomanesia littoralis D.Legrand | MBM 423728   | Korte, A 5293                                      | Yes |
| Campomanesia littoralis D.Legrand | ICN 096066   | Occhioni, P 5310                                   | No  |
| Campomanesia littoralis D.Legrand | FURB 33130   | A. Korte 5409                                      | Yes |
| Campomanesia littoralis D.Legrand | HBR 6825     | R. Reitz 5585                                      | Yes |
| Campomanesia littoralis D.Legrand | FURB 66551   | A. Kassner-Filho 5766                              | Yes |
| Campomanesia littoralis D.Legrand | FLOR 5484    | Klein, R.M.; Bresolin, A. 6365                     | Yes |
| Campomanesia littoralis D.Legrand | HBR 40939    | R.M. Klein; A. Bresolin 6387                       | Yes |
| Campomanesia littoralis D.Legrand | EAFM 13466   | Leal, ML; Silva, MS 7                              | No  |
| Campomanesia littoralis D.Legrand | CRI 7722     | T. B. Guimarães; Daniel de Barcelos Falkenberg 721 | No  |
| Campomanesia littoralis D.Legrand | HBR 17301    | L.B. Smith; R. Reitz; R.M. Klein 7262              | Yes |
| Campomanesia littoralis D.Legrand | MBM 265302   | Hatschbach, G; Cervi, AC; Barboza, E 72713         | Yes |
| Campomanesia littoralis D.Legrand | HUFSJ 2261   | Hatschbach, G; Barbosa, E; Costa, EF 79177         | Yes |
| Campomanesia littoralis D.Legrand | HUEFS 173074 | Klein, R. 8053                                     | Yes |
| Campomanesia littoralis D.Legrand | FLOR 2090    | Klein, R.M. 8461                                   | Yes |
| Campomanesia littoralis D.Legrand | HBR 6807     | R. Reitz; R.M. Klein 869                           | Yes |
| Campomanesia littoralis D.Legrand | HBR 4831     | R. Reitz; R.M. Klein 87                            | Yes |
| Campomanesia littoralis D.Legrand | SPF 151902   | Fiaschi, P 936                                     | Yes |
| Campomanesia littoralis D.Legrand | FURB 67198   | L.A. Funez; E. Zuchiuschi 9680                     | Yes |
| Campomanesia littoralis D.Legrand | HBR 1845     | R. Reitz c1287                                     | Yes |
| Campomanesia reitziana D.Legrand  | M-0146807    | Klein s.n.                                         | Yes |
| Campomanesia reitziana D.Legrand  | CRI 5110     | Vanilde Citadini Zanette; V. P. Boff s.n.          | Yes |

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| Campomanesia reitzianaD.Legrand | CRI 15321      | Aline V. Guislon; João Gava Just s.n.                                                       | Yes |
| Campomanesia reitzianaD.Legrand | CRI 12642      | Alexandre Medeiros s.n.                                                                     | Yes |
| Campomanesia reitzianaD.Legrand | CRI 12641      | Alexandre Medeiros s.n.                                                                     | Yes |
|                                 |                | Guilherme Alves Elias; Guilherme Lodetti; Robson dos Santos & Peterson Teodoro Padilha s.n. | Yes |
| Campomanesia reitzianaD.Legrand | CRI 12042      |                                                                                             |     |
| Campomanesia reitzianaD.Legrand | LUSC 6343      | Gomes, J.P. s.n.                                                                            | Yes |
| Campomanesia reitzianaD.Legrand | HDCF 4187      | Oliveira, O. S. s.n.                                                                        | No  |
| Campomanesia reitzianaD.Legrand |                | s.n.                                                                                        | No  |
| Campomanesia reitzianaD.Legrand |                | s.n.                                                                                        | No  |
| Campomanesia reitzianaD.Legrand | FURB 68317     | A.V. Guislon; J.O.G. Just s.n.                                                              | Yes |
| Campomanesia reitzianaD.Legrand | MBM 317010     | s.n.                                                                                        | Yes |
| Campomanesia reitzianaD.Legrand | HBR 52578      | C. Melim 2                                                                                  | No  |
| Campomanesia reitzianaD.Legrand | JOI 325        | C. Hering Rinnert 523                                                                       | Yes |
|                                 |                | Stival-Santos, A; Legal, E; Silveira, S 1012                                                | No  |
| Campomanesia reitzianaD.Legrand | FURB 15089     |                                                                                             |     |
| Campomanesia reitzianaD.Legrand | FURB 51716     | J.P. Maçaneiro 102                                                                          | Yes |
| Campomanesia reitzianaD.Legrand | MBM 47638      | Mattos, JR 10419                                                                            | No  |
| Campomanesia reitzianaD.Legrand | HBR 40936      | R.M. Klein; A. Bresolin 10608                                                               | Yes |
| Campomanesia reitzianaD.Legrand | HBR 15066      | R. Reitz; R.M. Klein 1071                                                                   | Yes |
| Campomanesia reitzianaD.Legrand | FURB 73042     | D.J. Parma; A. Kassner-Filho 113                                                            | No  |
| Campomanesia reitzianaD.Legrand | FURB 19303     | A. Korte; A. Kniess 1198                                                                    | Yes |
| Campomanesia reitzianaD.Legrand | SP 111892      | Mattos, J 12043                                                                             | Yes |
| Campomanesia reitzianaD.Legrand | PACA-AGP 86191 | Sehnem, A. 12324                                                                            | No  |
| Campomanesia reitzianaD.Legrand | HBR 10188      | R.M. Klein 1265                                                                             | No  |
| Campomanesia reitzianaD.Legrand | FLOR 68533     | Külkamp, J. 1306                                                                            | No  |
|                                 |                | A. Stival-Santos; E. Legal & S. Silveira 1308                                               | Yes |
| Campomanesia reitzianaD.Legrand | CRI 9385       |                                                                                             |     |
| Campomanesia reitzianaD.Legrand | ESA 146505     | A.S. Medeiros 1468                                                                          | Yes |
| Campomanesia reitzianaD.Legrand | US US 2248602  | R. M. Klein 1480                                                                            | Yes |
| Campomanesia reitzianaD.Legrand | HBR 10189      | R.M. Klein 1483                                                                             | Yes |

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| Campomanesia reitzianaD.Legrand | US US 2248609 | R. M. Klein 1514                                                 | Yes |
| Campomanesia reitzianaD.Legrand | UPCB 7888     | Stellfeld, C. 1720                                               | Yes |
| Campomanesia reitzianaD.Legrand | CRI 3135      | Vanilde Citadini-Zanette 1771                                    | Yes |
| Campomanesia reitzianaD.Legrand | HBR 3578      | R. Reitz 1848                                                    | No  |
| Campomanesia reitzianaD.Legrand | FURB 13954    | J.L. Schmitt 2                                                   | Yes |
| Campomanesia reitzianaD.Legrand | US US 2248668 | R. Reitz & R. Klein 2109                                         | Yes |
| Campomanesia reitzianaD.Legrand | CRI 14379     | Kassner-Filho, A.; Santos, D.;<br>Bollmann, G.; Silva, D.A. 2132 | No  |
| Campomanesia reitzianaD.Legrand | US 2321110    | R. Reitz & R. Klein 2133                                         | Yes |
| Campomanesia reitzianaD.Legrand | ESA 146970    | A.S. Medeiros 2161                                               | Yes |
| Campomanesia reitzianaD.Legrand | UPCB 6380     | Klein, R.M. 222                                                  | Yes |
| Campomanesia reitzianaD.Legrand | HUEFS 169642  | Ibrahim, M. 231                                                  | No  |
| Campomanesia reitzianaD.Legrand | HBR 3580      | R. Reitz 2318                                                    | Yes |
| Campomanesia reitzianaD.Legrand | FURB 13955    | M. Verdi; G. Klemz; J.F. Torres<br>2572                          | Yes |
| Campomanesia reitzianaD.Legrand | FURB 39731    | B. Tribess 26                                                    | Yes |
| Campomanesia reitzianaD.Legrand | FLOR 42210    | Nuernberg, A.; Mello, A.S. 274                                   | No  |
| Campomanesia reitzianaD.Legrand | HBR 6688      | R. Reitz 2827                                                    | Yes |
| Campomanesia reitzianaD.Legrand | FURB 60178    | A. Kassner-Filho; D. Santos; G.<br>Bollmann; L.F. Althoff 3175   | Yes |
| Campomanesia reitzianaD.Legrand | FLOR 38317    | Mattos, J. 32609                                                 | No  |
| Campomanesia reitzianaD.Legrand | FURB 60623    | A. Kassner-Filho; D. Santos; G.<br>Bollmann; L.F. Althoff 3399   | Yes |
| Campomanesia reitzianaD.Legrand | EAFM 13319    | Avila, JVC; Valadares, K; Zank, S<br>342                         | No  |
| Campomanesia reitzianaD.Legrand | JOI 226       | Hering-Rinnert, C. 347                                           | Yes |
| Campomanesia reitzianaD.Legrand | EAFM 13329    | Avila, JVC; Valadares, K; Zank, S<br>352                         | No  |
| Campomanesia reitzianaD.Legrand | US US 2141684 | R. Reitz 3578                                                    | No  |
| Campomanesia reitzianaD.Legrand | MICH 1231631  | R. Reitz 3581                                                    | No  |
| Campomanesia reitzianaD.Legrand | FLOR 16395    | Falkenberg, D.B. 3589                                            | No  |
| Campomanesia reitzianaD.Legrand | MBM 95991     | Bresolin, A 366                                                  | Yes |

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| Campomanesia reitzianaD.Legrand | FURB 22097   | M. Verdi; D.H. Klettenberg; G. Klemz 3703           | Yes |
| Campomanesia reitzianaD.Legrand | HBR 36936    | R.M. Klein 3902                                     | Yes |
| Campomanesia reitzianaD.Legrand | MICH 1231628 | Leslie R. Landrum 3971                              | No  |
| Campomanesia reitzianaD.Legrand | MBM 81862    | Landrum, LR 3978                                    | No  |
| Campomanesia reitzianaD.Legrand | MBM 81864    | Landrum, LR 3979                                    | No  |
| Campomanesia reitzianaD.Legrand | MBM 81863    | Landrum, LR 3980                                    | No  |
| Campomanesia reitzianaD.Legrand | MBM 81865    | Landrum, LR 3981                                    | No  |
| Campomanesia reitzianaD.Legrand | SORO 3252    | L.C. Bernacci & E.F. Souto 4024                     | No  |
| Campomanesia reitzianaD.Legrand | FURB 12853   | T.A. Beckhauser 43                                  | Yes |
| Campomanesia reitzianaD.Legrand | FLOR 17271   | Falkenberg, D.B. 4354                               | No  |
| Campomanesia reitzianaD.Legrand | FLOR 17406   | Falkenberg, D.B. 4414                               | No  |
| Campomanesia reitzianaD.Legrand | EFC 22892    | Dall Agnol, R.T.; Matos, N.B. 4660                  | No  |
| Campomanesia reitzianaD.Legrand | FLOR 17717   | Falkenberg, D.B. 4736                               | No  |
| Campomanesia reitzianaD.Legrand | CRI 14460    | Korte, A.; Kniess, A. 4838                          | No  |
| Campomanesia reitzianaD.Legrand | FURB 26653   | Verdi, M; Souza, NL; Klemz, G; klettenberg, DH 4849 | No  |
| Campomanesia reitzianaD.Legrand | MICH 1231629 | A. Rohr 486                                         | No  |
| Campomanesia reitzianaD.Legrand | JOI 583      | Hering-Rinnert, C. 522                              | No  |
| Campomanesia reitzianaD.Legrand | JOI 352      | Hering-Rinnert, C. 523                              | No  |
| Campomanesia reitzianaD.Legrand | FLOR 2086    | Klein, R.M. 5432                                    | No  |
| Campomanesia reitzianaD.Legrand | FURB 51474   | L.A. Funez 5527                                     | No  |
| Campomanesia reitzianaD.Legrand | FLOR 2077    | Bresolin, A. 591                                    | Yes |
| Campomanesia reitzianaD.Legrand | MACK 1279    | A. Korte; A. Kniess 602                             | No  |
| Campomanesia reitzianaD.Legrand | FURB 38449   | L.A. Funez 606                                      | No  |
| Campomanesia reitzianaD.Legrand | HUCS 46606   | Uller, HF; Klitzke, AR; Bollmann, GO 655            | No  |
| Campomanesia reitzianaD.Legrand | HBR 16325    | R. Reitz; R.M. Klein 6759                           | No  |
| Campomanesia reitzianaD.Legrand | HBR 16319    | R. Reitz; R.M. Klein 6843                           | Yes |
| Campomanesia reitzianaD.Legrand | FURB 69102   | A. Kassner-Filho; N.M. Rocha 6911                   | Yes |
| Campomanesia reitzianaD.Legrand | FLOR 39424   | Queiroz, M.H. de 70                                 | No  |

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| Campomanesia reitzianaD.Legrand | HBR 21852           | R. Reitz 7046                                               | No  |
| Campomanesia reitzianaD.Legrand | FURB 69021          | A. Kassner-Filho 7051                                       | No  |
| Campomanesia reitzianaD.Legrand | FURB 15683          | Korte, A; Kniess, A 715                                     | Yes |
| Campomanesia reitzianaD.Legrand | JOI 453             | F.C.S. Vieira 72                                            | Yes |
| Campomanesia reitzianaD.Legrand | HBR 21899           | R. Reitz; R.M. Klein 7240                                   | No  |
| Campomanesia reitzianaD.Legrand | FURB 69523          | A. Kassner-Filho; D. Santos 7516                            | No  |
| Campomanesia reitzianaD.Legrand | FLOR 1252           | Klein, R.M. 7557                                            | No  |
| Campomanesia reitzianaD.Legrand | FLOR 2089           | Klein, R.M.; Bresolin, A. 7628                              | No  |
| Campomanesia reitzianaD.Legrand | MBM 416805          | Marinero, F; Ariati, V 779                                  | No  |
| Campomanesia reitzianaD.Legrand | FURB 13910          | A. Stival-Santos; S. Silveira 782                           | Yes |
| Campomanesia reitzianaD.Legrand | MBM 139767          | Klein, RM 7851                                              | No  |
| Campomanesia reitzianaD.Legrand | FURB 13906          | A. Stival-Santos; S. Silveira 811                           | Yes |
| Campomanesia reitzianaD.Legrand | HBR 40229           | A. Bresolin 857                                             | Yes |
| Campomanesia reitzianaD.Legrand | HBR 30432           | R. Reitz; R.M. Klein 8604                                   | No  |
| Campomanesia reitzianaD.Legrand | EFC 12997           | Ribeiro, C.L. 87                                            | No  |
| Campomanesia reitzianaD.Legrand | MBM 95990           | Klein, RM; Souza Sobrinho 8744                              | No  |
| Campomanesia reitzianaD.Legrand | CRI 13893           | Alexandre Medeiros 898                                      | No  |
| Campomanesia reitzianaD.Legrand | MBM 130750          | Klein, RM 9608                                              | No  |
| Campomanesia reitzianaD.Legrand | NL-BOTANY U.1441022 | Lindeman JC; Haas JH de 1861                                | No  |
| Campomanesia reitzianaD.Legrand | MBM 317011          | Sobral, M s.n.                                              | No  |
| Campomanesia reitzianaD.Legrand | MBM 317010          | s.c. s.n.                                                   | No  |
| Campomanesia reitzianaD.Legrand | LUSC 11423          | Elias, G. A.; Lodetti, G.; Santos, R. & Padilha, P. T. s.n. | No  |
| Campomanesia reitzianaD.Legrand | SPF 82275           | Mattos, J s.n.                                              | No  |
| Campomanesia reitzianaD.Legrand | FLOR 40009          | Mattos, J. s.n.                                             | No  |
| Campomanesia reitzianaD.Legrand | SMDB 2230           | Klein, R M s.n.                                             | No  |
| Campomanesia reitzianaD.Legrand | HUCS 2816           | Sehnem, A s.n.                                              | No  |
| Campomanesia reitzianaD.Legrand | FURB 1784           | F. Bosio s.n.                                               | No  |
| Campomanesia reitzianaD.Legrand | FURB 1867           | L. Sevegnani s.n.                                           | No  |
| Campomanesia reitzianaD.Legrand | FURB 24             | L. Cristofolini s.n.                                        | No  |

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| Campomanesia reitziana D. Legrand                  | FURB 3259                | M. Sobral s.n.                                              | No  |
| Campomanesia reitziana D. Legrand                  | FURB 5732                | G.K. Piaz s.n.                                              | No  |
| Campomanesia reitziana D. Legrand                  | FURB 13895               | L. Sevegnani s.n.                                           | No  |
| Curitiba prismatica (D. Legrand) Salywon & Landrum | MO-DUPPLICATES 102131001 | Pe. Raulino Reitz Roberto M. Klein 11528                    | Yes |
| Curitiba prismatica (D. Legrand) Salywon & Landrum | FURB 46748               | A.A. de Oliveira 1375                                       | Yes |
| Curitiba prismatica (D. Legrand) Salywon & Landrum | FURB 36890               | A.L. de Gasper; E. Brogni 3004                              | Yes |
| Curitiba prismatica (D. Legrand) Salywon & Landrum | FURB 64667               | A. Kassner-Filho; D. Santos; H.F. Uller; A. Schneiders 5300 | Yes |
| Eugenia angelyana Mattos                           | MO-DUPPLICATES 2482568   | Roberto M. Klein A. Bresolin 9861                           | Yes |
| Eugenia joenssonii Kausel                          | FURB 54019               | Funez 6380                                                  | Yes |
| Eugenia joenssonii Kausel                          | FURB 54535               | Funez 6433                                                  | Yes |
| Eugenia joenssonii Kausel                          | FURB 683                 | Freygang s.n.                                               | Yes |
| Eugenia joenssonii Kausel                          | FURB 5836                | Kalk s.n.                                                   | Yes |
| Eugenia joenssonii Kausel                          | FURB 1878                | Sevegnani s.n.                                              | Yes |
| Eugenia joenssonii Kausel                          | ICN 120729               | Sobral 7997                                                 | Yes |
| Eugenia joenssonii Kausel                          | FURB 67405               | Kassner-Filho 5830                                          | Yes |
| Eugenia joenssonii Kausel                          | FURB 4001                | Pozzobon s.n.                                               | Yes |
| Eugenia joenssonii Kausel                          | HBR 40848                | Klein 7837                                                  | Yes |
| Eugenia joenssonii Kausel                          | FURB 77491               | Parma 292                                                   | Yes |
| Eugenia joenssonii Kausel                          | FURB 64033               | Kassner-Filho 1070                                          | Yes |
| Eugenia joenssonii Kausel                          | FURB 65127               | Bones 209                                                   | Yes |
| Eugenia joenssonii Kausel                          | FURB 64032               | Bones 204                                                   | Yes |
| Eugenia joenssonii Kausel                          | FLOR 67600               | Klein 7773                                                  | No  |
| Eugenia joenssonii Kausel                          | FURB 27641               | L.A. Funez 5365                                             | Yes |
| Eugenia joenssonii Kausel                          | JOI 20364                | F.C.S. Vieira 3305                                          | Yes |
| Eugenia mattosii D. Legrand                        | FURB 60760               | Funez 7745                                                  | Yes |
| Eugenia mattosii D. Legrand                        | JOI 1982                 | Uhlmann s.n.                                                | Yes |
| Eugenia mattosii D. Legrand                        | FURB 51570               | Funez 5608                                                  | Yes |
| Eugenia mattosii D. Legrand                        | MBM 47424                | Mattos 4400                                                 | Yes |
| Eugenia mattosii D. Legrand                        | HBR 37793                | Klein 2880                                                  | No  |

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| Eugenia mattosii D.Legrand | FLOR 52510             | Nuernberg 1398                                | Yes |
| Eugenia mattosii D.Legrand | HBR 58300              | Pansera s.n.                                  | Yes |
| Eugenia mattosii D.Legrand | HAS 74105              | Winge s.n.                                    | No  |
| Eugenia mattosii D.Legrand | FURB 65128             | Bones 210                                     | Yes |
| Eugenia mattosii D.Legrand | MO-DUPPLICATES 2483205 | Klein 2732                                    | No  |
| Eugenia mattosii D.Legrand | FURB 54565             | Funez 6468                                    | Yes |
| Eugenia mattosii D.Legrand | FURB 2648              | Uhlmann s. n.                                 | Yes |
| Eugenia mattosii D.Legrand | HBR 40849              | Reitz 7362                                    | Yes |
| Eugenia mattosii D.Legrand | FURB 67402             | Kassner-Filho 5825                            | Yes |
| Eugenia mattosii D.Legrand | FURB 3681              | Pozzobon s.n                                  | Yes |
| Eugenia mattosii D.Legrand | FURB 51617             | Funez 5651                                    | Yes |
| Eugenia mattosii D.Legrand | FURB 30984             | Funez 5394                                    | Yes |
| Eugenia mattosii D.Legrand | FURB 2406              | Pozzobon s.n                                  | Yes |
| Eugenia mattosii D.Legrand | HAS 87586              | Mattos 4399                                   | Yes |
| Eugenia mattosii D.Legrand | FLOR 76463             | Boell, M.E.C. 88                              | Yes |
| Eugenia mattosii D.Legrand | HBR 58300              | E. G. Pansera 22                              | No  |
| Eugenia neotristis Sobral  | US 2535463             | Klein 1447                                    | Yes |
| Eugenia neotristis Sobral  | HAS 87567              | Reitz 1704                                    | Yes |
| Eugenia neotristis Sobral  | HBR 15099              | Reitz 6500                                    | Yes |
| Eugenia neotristis Sobral  | JOI 7350               | F.C.S. Vieira 2051                            | Yes |
| Eugenia neotristis Sobral  | JOI 13787              | F.C.S. Vieira 2132                            | Yes |
| Eugenia neotristis Sobral  | ICN 206148             | Grings, M; Mello, AS 2310                     | Yes |
| Eugenia neotristis Sobral  | FURB 17770             | A.L. de Gasper; T.J. Cadarin; J. Schmitt 2425 | Yes |
| Eugenia neotristis Sobral  | JOI 18428              | Vieira, F.C.S. 2622                           | Yes |
| Eugenia neotristis Sobral  | FURB 48761             | A.A. de Oliveira 2705                         | Yes |
| Eugenia neotristis Sobral  | FLOR 55856             | Mello, A.S.; Nuernberg, A. 705                | Yes |
| Eugenia neotristis Sobral  | UPCB 21803             | Negrelle, R.R.B. A171                         | Yes |
| Eugenia neotristis Sobral  | MO-DUPPLICATES 2483452 | Anonymous s.n.11                              | No  |
| Eugenia neotristis Sobral  | FLOR 55873             | Mello, A.S. s.n.                              | Yes |

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| Eugenia neotristis Sobral             | JOI 20369                            | F. C. S. Vieira 3250                                      | No  |
| Eugenia neotristis Sobral             | FURB 78850                           | A. Kassner-Filho 10723                                    | Yes |
| Eugenia neotristis Sobral             | FURB 78094                           | A. Kassner-Filho                                          | Yes |
| Eugenia neotristis Sobral             | FURB 78087                           | A. Kassner-Filho 10332                                    | Yes |
| Eugenia pachyclada D.Legrand          | FURB 48041                           | A.A. de Oliveira 2824                                     | No  |
| Eugenia pachyclada D.Legrand          | US 2403014, HBR 24760                | Reitz & Klein 3190                                        | Yes |
| Eugenia pachyclada D.Legrand          | HBR 28617                            | Reitz, R.; Klein, R.M. 3747                               | Yes |
| Eugenia pachyclada D.Legrand          | NY 580011                            | R. Reitz; R.M. Klein 3797                                 | No  |
| Eugenia pachyclada D.Legrand          | CRI 16069, FURB 68502                | A. Kassner-Filho; N.M. Rocha 6625                         | Yes |
| Eugenia pachyclada D.Legrand          | FURB 4002                            | M. Pozzobon s.n.                                          | Yes |
| Eugenia pseudomalacantha D.Legrand    | JOI 12642                            | Schmoeller, F 211                                         | Yes |
| Eugenia pseudomalacantha D.Legrand    | SORO 8148, JOI 18524                 | Vieira, FCS 2890                                          | Yes |
| Eugenia pseudomalacantha D.Legrand    | ICN 061097                           | Klein, RM; Bresolin, A 7468                               | Yes |
| Eugenia pseudomalacantha D.Legrand    | MBM 51403                            | Klein, RM; Krapovickas, A 7727                            | Yes |
| Eugenia quiriri Sobral & F.C.S.Vieira | RB01446696                           | O.S.Ribas 3243                                            | Yes |
| Eugenia quiriri Sobral & F.C.S.Vieira | JOI 13790                            | Vieira 2115                                               | Yes |
| Eugenia reitziana D.Legrand           | HBR 6676, MO-DUPPLICATES<br>2475399  | Reitz 4326                                                | Yes |
| Eugenia reitziana D.Legrand           | US 2249320                           | Smith 9350                                                | Yes |
| Eugenia rostrifolia D.Legrand         | HPBR 11480                           | MAURIQUE CONSULTORIA<br>Aline V. Guislon; Renato Colares; | No  |
| Eugenia rostrifolia D.Legrand         | CRI 15171                            | Felipe Seron & Iara Z. Zanoni                             | No  |
| Eugenia rostrifolia D.Legrand         | PACA-AGP 96274                       | Zanoto, M                                                 | No  |
| Eugenia rostrifolia D.Legrand         | FLOR 37151                           | Falkenberg, D.B.; Oliveira, C.P.L.<br>de 11003            | No  |
| Eugenia rostrifolia D.Legrand         | FURB 46676                           | A.A. de Oliveira 1339                                     | No  |
| Eugenia rostrifolia D.Legrand         | JOI 14027                            | F.C.S. Vieira 2137                                        | No  |
| Eugenia rostrifolia D.Legrand         | UPCB 993                             | R.M. Klein 361                                            | Yes |
| Eugenia rostrifolia D.Legrand         | ICN 002731, NY 557613, US<br>2403098 | R. Reitz & Klein 4154                                     | Yes |
| Eugenia rostrifolia D.Legrand         | US 2403652                           | R. Reitz 6086                                             | Yes |

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| <i>Eugenia rostrifolia</i> D.Legrand  | FURB 34800            | A. Korte 6258                                     | Yes |
| <i>Eugenia rostrifolia</i> D.Legrand  | MBM 102108            | Klein & Bresolin 7522                             | Yes |
| <i>Eugenia rostrifolia</i> D.Legrand  | MBM 95929             | Klein, R.M.; Bresolin, A. 8539                    | Yes |
| <i>Eugenia rostrifolia</i> D.Legrand  | ICN 061527            | Klein; Bresolin, A 8678                           | Yes |
| <i>Eugenia rostrifolia</i> D.Legrand  | HBR 21862, US 2403530 | R. Reitz; R.M. Klein 8984                         | Yes |
| <i>Eugenia rostrifolia</i> D.Legrand  | HBR 23143, US 2403596 | R. Reitz; R.M. Klein 9282                         | Yes |
| <i>Eugenia rostrifolia</i> D.Legrand  | ICN 061091, FLOR 3804 | Klein, RM 9624                                    | Yes |
| <i>Eugenia rostrifolia</i> D.Legrand  | MBM 95921, FLOR 3531  | Klein, R.M. 9823                                  | Yes |
| <i>Eugenia rostrifolia</i> D.Legrand  | -                     | R. M. Klein 213                                   | Yes |
| <i>Eugenia rotundicosta</i> D.Legrand | FURB 46478            | A.A. de Oliveira 1258                             | No  |
| <i>Eugenia rotundicosta</i> D.Legrand | NY 1015857            | Smith, L.B.; Reitz, R. 12968                      | Yes |
| <i>Eugenia rotundicosta</i> D.Legrand | FURB 37269            | A.L. de Gasper; E. Brogni 3009                    | Yes |
| <i>Eugenia rotundicosta</i> D.Legrand | FURB 73333            | A. Kassner-Filho 8213                             | Yes |
| <i>Eugenia rotundicosta</i> D.Legrand | FURB 73386            | A. Kassner-Filho; D. Santos 8266                  | Yes |
| <i>Eugenia rotundicosta</i> D.Legrand | HAS 106439            | Molz, M s.n.                                      | Yes |
| <i>Eugenia rotundicosta</i> D.Legrand | HAS 106436            | Molz, M s.n.                                      | Yes |
| <i>Eugenia sclerocalyx</i> D.Legrand  | JOI 3385              | F.C.S. Vieira 1284                                | Yes |
| <i>Eugenia sclerocalyx</i> D.Legrand  | JOI 5002              | F.C.S. Vieira 1811                                | Yes |
| <i>Eugenia sclerocalyx</i> D.Legrand  | FURB 26896            | F.C.S. Vieira; R.V. Carvalho; H. Tomporowski 2158 | Yes |
| <i>Eugenia sclerocalyx</i> D.Legrand  | FURB 13645            | M. Verdi; R.P. Hasckel; G. Klemz 2447             | Yes |
| <i>Eugenia sclerocalyx</i> D.Legrand  | JOI 6456              | Mancinelli, W.S. 254                              | Yes |
| <i>Eugenia sclerocalyx</i> D.Legrand  | JOI 18425             | Vieira, F.C.S. 2618                               | Yes |
| <i>Eugenia sclerocalyx</i> D.Legrand  | HBR 4873              | R. Reitz 3488                                     | Yes |
| <i>Eugenia sclerocalyx</i> D.Legrand  | FURB 69536            | A. Kassner-Filho; D. Santos 7482                  | Yes |
| <i>Eugenia sclerocalyx</i> D.Legrand  | NY 405011             | Reitz ;Klein 8993                                 | Yes |
| <i>Eugenia sclerocalyx</i> D.Legrand  | FURB 13458            | S. Dreveck; F.E. Carneiro 923                     | Yes |
| <i>Eugenia sclerocalyx</i> D.Legrand  | ICN 124692            | Sobral, M; Sevegnani, L 9522                      | Yes |
| <i>Eugenia sclerocalyx</i> D.Legrand  | HAS 74517             | Mattos, J. s.n.                                   | No  |
| <i>Eugenia sclerocalyx</i> D.Legrand  | FURB 3130             | O. Jeremias s.n.                                  | Yes |

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| <i>Eugenia sclerocalyx</i> D.Legrand                       | FURB 76053 | A. Kassner-Filho 9409                                                                                        | Yes |
| <i>Myrceugenia basicordata</i> F.C.S.Vieira, Molz & Sobral | JOI 17415  | F.C.S. Vieira 2813                                                                                           | Yes |
| <i>Myrceugenia basicordata</i> F.C.S.Vieira, Molz & Sobral | JOI 8269   | F.C.S. Vieira 2094                                                                                           | Yes |
| <i>Myrceugenia basicordata</i> F.C.S.Vieira, Molz & Sobral | JOI 6614   | F.C.S. Vieira 1953                                                                                           | Yes |
| <i>Myrceugenia basicordata</i> F.C.S.Vieira, Molz & Sobral | UB -       | Vieira, F.C.S. 2575                                                                                          | Yes |
| <i>Myrceugenia basicordata</i> F.C.S.Vieira, Molz & Sobral | FLOR 75457 | F.C.S. Vieira 3465                                                                                           | Yes |
| <i>Myrceugenia basicordata</i> F.C.S.Vieira, Molz & Sobral | JOI 19864  | F.C.S. Vieira 2841                                                                                           | Yes |
| <i>Myrceugenia basicordata</i> F.C.S.Vieira, Molz & Sobral | JOIW 1109  | F.C.S. Vieira 2858                                                                                           | Yes |
| <i>Myrceugenia basicordata</i> F.C.S.Vieira, Molz & Sobral | FLOR 72398 | Augustin, A.F.; Caddah, M.K.;<br>Lima, D.F.; Vieira, F.S. 39                                                 | Yes |
| <i>Myrceugenia basicordata</i> F.C.S.Vieira, Molz & Sobral | FLOR 75456 | Augustin, A.F.; Caddah, M.K.;<br>Vieira, F.S. 47                                                             | Yes |
| <i>Myrceugenia basicordata</i> F.C.S.Vieira, Molz & Sobral | FLOR 72399 | Augustin, A.F.; Caddah, M.K.;<br>Lima, D.F.; Vieira, F.S. 40                                                 | Yes |
| <i>Myrceugenia basicordata</i> F.C.S.Vieira, Molz & Sobral | FLOR 72395 | Augustin, A.F.; Caddah, M.K.;<br>Lima, D.F.; Vieira, F.S. 36                                                 | Yes |
| <i>Myrceugenia basicordata</i> F.C.S.Vieira, Molz & Sobral | FLOR 72396 | Augustin, A.F.; Caddah, M.K.;<br>Lima, D.F.; Vieira, F.S. 37                                                 | Yes |
| <i>Myrceugenia basicordata</i> F.C.S.Vieira, Molz & Sobral | FLOR 72397 | Augustin, A.F.; Caddah, M.K.;<br>Lima, D.F.; Vieira, F.S. 38                                                 | Yes |
| <i>Myrceugenia basicordata</i> F.C.S.Vieira, Molz & Sobral | JOI 19922  | F.C.S. Vieira 2932                                                                                           | Yes |
| <i>Myrceugenia basicordata</i> F.C.S.Vieira, Molz & Sobral | JOI 19741  | F.C.S. Vieira 2551                                                                                           | No  |
| <i>Myrceugenia basicordata</i> F.C.S.Vieira, Molz & Sobral | JOI 20480  | F.C.S. Vieira 3267                                                                                           | Yes |
| <i>Myrceugenia basicordata</i> F.C.S.Vieira, Molz & Sobral | SORO 8495  | Vieira, F.C.S. 2579                                                                                          | Yes |
| <i>Myrceugenia basicordata</i> F.C.S.Vieira, Molz & Sobral | FLOR 75457 | Vieira, F.C.S.; Carvalho, R.J. 3465                                                                          | Yes |
| <i>Myrceugenia foveolata</i> (O.Berg) Sobral               | FURB 34958 | M. Verdi; A.L. Tomazi; G. Klemz<br>5923                                                                      | No  |
| <i>Myrceugenia foveolata</i> (O.Berg) Sobral               | FLOR 45880 | Bortoluzzi, R.L.C.; Silva, R.A. 728                                                                          | Yes |
| <i>Myrceugenia foveolata</i> (O.Berg) Sobral               | FURB 64343 | L.A. Funez; W.C. Ribeiro-Nardes<br>8260                                                                      | Yes |
| <i>Myrceugenia foveolata</i> (O.Berg) Sobral               | FURB 64378 | L.A. Funez; D.H. Costa-Rezende;<br>W. Ribeiro-Nardes; T. Kossmann;<br>A. Kassner-Filho; F.L.V. Bones<br>8645 | Yes |

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|----------------------------------------------------|--------------------------------------------------|--------------------------------------------------------------------------------------------------------------|------------|
| Myrceugenia foveolata (O.Berg) Sobral              | FURB 64369                                       | L.A. Funez; D.H. Costa-Rezende;<br>W. Ribeiro-Nardes; T. Kossmann;<br>A. Kassner-Filho; F.L.V. Bones<br>8657 | Yes        |
| Myrceugenia foveolata (O.Berg) Sobral              | FURB 67376                                       | L.A. Funez; W. Ribeiro-Nardes;<br>K.M. Cunha 9548                                                            | Yes        |
| Myrceugenia joinvillensis F.C.S.Vieira             | JOI 15004<br>HUCS 41871, ASE 35501, JOI<br>14041 | Mancinelli, W.S. 1208<br>Vieira, FCS 2129                                                                    | Yes<br>Yes |
| Myrceugenia joinvillensis F.C.S.Vieira             | JOI 17412                                        | F.C.S. Vieira 2783                                                                                           | Yes        |
| Myrceugenia joinvillensis F.C.S.Vieira             | HUFSJ 11115, JOI 17413                           | Vieira, FCS 2784                                                                                             | Yes        |
| Myrceugenia joinvillensis F.C.S.Vieira             | FLOR 75459                                       | F.C.S. Vieira 3473                                                                                           | Yes        |
| Myrceugenia joinvillensis F.C.S.Vieira             | FLOR 75458                                       | Vieira, F.C.S.; Carvalho, R.J. 3466                                                                          | Yes        |
| Myrceugenia joinvillensis F.C.S.Vieira             | JOIW 1111, JOI 19564                             | F.C.S. Vieira 3092                                                                                           | Yes        |
| Myrceugenia joinvillensis F.C.S.Vieira             | JOI 17414                                        | F.C.S. Vieira 2785                                                                                           | Yes        |
| Myrceugenia joinvillensis F.C.S.Vieira             | FLOR 74594                                       | Lima, D.F.; Caddah, M.K.; Pscheidt,<br>F.; Lange, V. 565                                                     | Yes        |
| Myrceugenia joinvillensis F.C.S.Vieira             | FLOR 74595                                       | Lima, D.F.; Caddah, M.K.; Pscheidt,<br>F.; Lange, V. 566                                                     | Yes        |
| Myrceugenia joinvillensis F.C.S.Vieira             | FLOR 74596                                       | Lima, D.F.; Caddah, M.K.; Pscheidt,<br>F.; Lange, V. 567                                                     | Yes        |
| Myrceugenia joinvillensis F.C.S.Vieira             | FURB 62298                                       | A. Kassner-Filho 2909                                                                                        | Yes        |
| Myrceugenia joinvillensis F.C.S.Vieira             | FLOR 72400                                       | Augustin, A.F.; Caddah, M.K.;<br>Lima, D.F.; Vieira, F.S. 41                                                 | Yes        |
| Myrceugenia joinvillensis F.C.S.Vieira             | FLOR 75460                                       | Vieira, F.C.S. 3474                                                                                          | Yes        |
| Myrceugenia mesomischa (Burret) D.Legrand & Kausel | LUSC 8716                                        | Mendes, A. s.n.                                                                                              | Yes        |
| Myrceugenia mesomischa (Burret) D.Legrand & Kausel | LUSC 8712                                        | Mendes, A. s.n.                                                                                              | Yes        |
| Myrceugenia mesomischa (Burret) D.Legrand & Kausel | LUSC 8791                                        | Dallabrida, J. P. s.n.                                                                                       | No         |
| Myrceugenia mesomischa (Burret) D.Legrand & Kausel | LUSC 9040                                        | Duarte, E. s.n.                                                                                              | No         |
| Myrceugenia mesomischa (Burret) D.Legrand & Kausel | EFC 18294                                        | Liebsch, D. 1113                                                                                             | Yes        |
| Myrceugenia mesomischa (Burret) D.Legrand & Kausel | EFC 15566                                        | Liebsch, D. 1268                                                                                             | Yes        |
| Myrceugenia mesomischa (Burret) D.Legrand & Kausel | EFC 1506                                         | Seitz, R. 14                                                                                                 | Yes        |
| Myrceugenia mesomischa (Burret) D.Legrand & Kausel | JOI 17916, SORO 8423                             | Vieira, F.C.S. 2329                                                                                          | Yes        |

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| Myrceugenia mesomischa (Burret) D.Legrand & Kausel | JOI 17952            | Vieira, F.C.S. 2368                                         | Yes |
| Myrceugenia mesomischa (Burret) D.Legrand & Kausel | FURB 20107           | A.L. de Gasper; F.E. Carneiro 2523                          | No  |
| Myrceugenia mesomischa (Burret) D.Legrand & Kausel | FURB 48741           | A.A. de Oliveira 2609                                       | No  |
| Myrceugenia mesomischa (Burret) D.Legrand & Kausel | FURB 64507           | A. Kassner-Filho; D. Santos; G. Bollmann; L.F. Althoff 4368 | Yes |
| Myrceugenia mesomischa (Burret) D.Legrand & Kausel | FURB 62097           | A. Kassner-Filho; D. Santos; G. Bollmann; L.F. Althoff 4404 | Yes |
| Myrceugenia mesomischa (Burret) D.Legrand & Kausel | FURB 63982           | A. Kassner-Filho; D. Santos; G. Bollmann; L.F. Althoff 4847 | Yes |
| Myrceugenia mesomischa (Burret) D.Legrand & Kausel | BHCB 111911          | Grupo de estudos Reófitas UHBG 52                           | Yes |
| Myrceugenia mesomischa (Burret) D.Legrand & Kausel | HAS 75921            | Mattos, J. 5347                                             | No  |
| Myrceugenia mesomischa (Burret) D.Legrand & Kausel | LAG 1734, FURB 73881 | A. Kassner-Filho; D. Santos 8598                            | Yes |
| Myrceugenia mesomischa (Burret) D.Legrand & Kausel | JOI 20368            | F. C. S. Vieira 3313                                        | No  |
| Myrcia garuvana F.C.S.Vieira & Sobral              | JOI 15432            | F.C.S. Vieira 1180                                          | Yes |
| Myrcia garuvana F.C.S.Vieira & Sobral              | JOI 5591             | F.C.S. Vieira 1437                                          | No  |
| Myrcia garuvana F.C.S.Vieira & Sobral              | JOI 8223             | F.C.S. Vieira 1774                                          | Yes |
| Myrcia garuvana F.C.S.Vieira & Sobral              | JOI 8228             | F.C.S. Vieira 1804                                          | Yes |
| Myrcia garuvana F.C.S.Vieira & Sobral              | -                    | F. Longen 4                                                 | Yes |
| Myrcia garuvana F.C.S.Vieira & Sobral              | JOI 8225             | F.C.S. Vieira 680                                           | Yes |
| Myrcia garuvana F.C.S.Vieira & Sobral              | -                    | F.C.S. Vieira 959                                           | Yes |
| Myrcia hatschbachii D.Legrand                      | LUSC 10259           | Gomes, J.P.                                                 | Yes |
| Myrcia hatschbachii D.Legrand                      | LUSC 2332            | Aguiar, M.D.                                                | Yes |
| Myrcia hatschbachii D.Legrand                      | LUSC 7718            | Larsen, J.G.                                                | Yes |
| Myrcia hatschbachii D.Legrand                      | LUSC 9135            | Amaral, M.; Büttner, B.; Moraes, G.                         | Yes |
| Myrcia hatschbachii D.Legrand                      | LUSC 6254            | Marcon, A.                                                  | Yes |
| Myrcia hatschbachii D.Legrand                      | LUSC 6253            | Mariot, A.                                                  | Yes |
| Myrcia hatschbachii D.Legrand                      | LUSC 6252            | Steiner, F.                                                 | Yes |
| Myrcia hatschbachii D.Legrand                      | HUFSJ 8362           | Scipioni, Marcelo Calegari                                  | No  |
| Myrcia hatschbachii D.Legrand                      | PACA-AGP 49564       | Rambo, B.                                                   | No  |
| Myrcia hatschbachii D.Legrand                      | CRI 8063             | A. Stival Santos; H. F. Uller e Simone Silvera              | Yes |

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| Myrcia hatschbachii D.Legrand | R-TIPOS 114576 | L. Smith & R. Reitz 10089                                   | Yes |
| Myrcia hatschbachii D.Legrand | MBM 130773     | Klein, R.M.; Bresolin, A. 10595                             | Yes |
| Myrcia hatschbachii D.Legrand | FLOR 2379      | Klein, R.M.; Bresolin, A. 10613                             | Yes |
| Myrcia hatschbachii D.Legrand | FURB 45654     | A.A. de Oliveira 1074                                       | No  |
| Myrcia hatschbachii D.Legrand | US 2859753     | L. B. Smith 10878                                           | Yes |
| Myrcia hatschbachii D.Legrand | MBM 51580      | Klein, RM; Klein, MM 11001                                  | Yes |
| Myrcia hatschbachii D.Legrand | FURB 19573     | A. Korte; A. Kniess 1106                                    | Yes |
| Myrcia hatschbachii D.Legrand | FLOR 37267     | Falkenberg, D.B.; Oliveira, C.P.L. de 11118                 | No  |
| Myrcia hatschbachii D.Legrand | US 2580288     | Reitz, R; Klein, RM 11393                                   | Yes |
| Myrcia hatschbachii D.Legrand | FLOR 27119     | Ribas, O.S. 1198                                            | Yes |
| Myrcia hatschbachii D.Legrand | FLOR 68900     | Külkamp, J.; Lino, V. 1350                                  | Yes |
| Myrcia hatschbachii D.Legrand | FLOR 6757      | Bresolin, A. 1387                                           | Yes |
| Myrcia hatschbachii D.Legrand | CRI 14758      | Scipioni, M.C. 139                                          | Yes |
| Myrcia hatschbachii D.Legrand | FURB 20957     | A. Stival-Santos 1474                                       | Yes |
| Myrcia hatschbachii D.Legrand | AFR 5660       | J.S.Silva 17                                                | No  |
| Myrcia hatschbachii D.Legrand | FURB 29980     | T.J. Cadorin; B. Grosch; R. Zimmermann 1739                 | Yes |
| Myrcia hatschbachii D.Legrand | CTBS 1026      | França, Ana Rosa da Silva 2                                 | Yes |
| Myrcia hatschbachii D.Legrand | FURB 64579     | A. Kassner-Filho; D. Santos; G. Bollmann; L.F. Althoff 2099 | No  |
| Myrcia hatschbachii D.Legrand | US 2561275     | A. Lourteig 2272                                            | Yes |
| Myrcia hatschbachii D.Legrand | FURB 10829     | Stival-Santos, A 232                                        | Yes |
| Myrcia hatschbachii D.Legrand | SORO 8422      | Vieira, F.C.S. 2332                                         | Yes |
| Myrcia hatschbachii D.Legrand | SORO 8507      | Vieira, F.C.S. 2391                                         | Yes |
| Myrcia hatschbachii D.Legrand | JOI 18006      | Vieira, F.C.S. 2423                                         | Yes |
| Myrcia hatschbachii D.Legrand | FURB 58507     | A. Kassner-Filho; D. Santos; G. Bollmann; L.F. Althoff 2581 | Yes |
| Myrcia hatschbachii D.Legrand | FPS 1117       | Schwirkowski, P; Bianconcini 25B                            | Yes |
| Myrcia hatschbachii D.Legrand | MBM 61413      | Landrum, LR 2630                                            | Yes |
| Myrcia hatschbachii D.Legrand | CTBS 1071      | Kulkamp, Josimar 39                                         | Yes |
| Myrcia hatschbachii D.Legrand | FLOR 1828      | Bresolin, A. 44                                             | Yes |

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|-----------------------------------|-----------------------|-------------------------------------------------------------|-----|
| Myrcia hatschbachii D.Legrand     | FURB 36482            | R.C. Avi 466                                                | Yes |
| Myrcia hatschbachii D.Legrand     | FURB 64548            | A. Kassner-Filho; D. Santos; G. Bollmann; L.F. Althoff 5067 | Yes |
| Myrcia hatschbachii D.Legrand     | US 2268656            | R. Reitz & R. Klein 6006                                    | Yes |
| Myrcia hatschbachii D.Legrand     | ICN 062049            | R. M. Klein 6950                                            | Yes |
| Myrcia hatschbachii D.Legrand     | HCF 35905             | Schwirkowski, P. 748                                        | Yes |
| Myrcia hatschbachii D.Legrand     | MBM 102097            | Klein, R.M.; Bresolin, A. 7684                              | Yes |
| Myrcia hatschbachii D.Legrand     | CEN 121760            | A. Kassner-Filho; D. Santos 7756                            | Yes |
| Myrcia hatschbachii D.Legrand     | CTBS 1029             | Ludwig, Raquel Lúcia 9                                      | Yes |
| Myrcia hatschbachii D.Legrand     | NY 616179             | L. Smith & R. Reitz 9090                                    | Yes |
| Myrcia hatschbachii D.Legrand     | ICN 174412            | Molz, M; Mauhs, J s.n.                                      | No  |
| Myrcia hatschbachii D.Legrand     | FURB 612              | L. Sevegnani s.n.                                           | Yes |
| Myrcia hatschbachii D.Legrand     | FURB 76731            | Kassner-Filho 9859                                          | Yes |
| Myrcianthes riparia Sobral et al. | CEN 66383             | Amaral-Santos 2892                                          | Yes |
| Myrcianthes riparia Sobral et al. | HUFSJ 5489            | Grippa; Guimarães 151                                       | Yes |
| Myrcianthes riparia Sobral et al. | -                     | Grupo de estudos Reófitas 1609                              | Yes |
| Myrcianthes riparia Sobral et al. | HUFSJ 5489            | Grippa, CR; Guimarães, TB 151                               | Yes |
| Myrciaria plinioides D.Legrand    | FURB 19583, CRI 9641  | M.Verdi A.L.Tomazi; G.klemz 2956                            | Yes |
| Myrciaria plinioides D.Legrand    | FURB 18697            | M. Verdi, DHKlettenb; G. Klemz 3184                         | Yes |
| Myrciaria plinioides D.Legrand    | HBR 28608             | Reitz R; Klein RM 7398                                      | Yes |
| Myrciaria plinioides D.Legrand    | MO-DUPLICATES 2477690 | Pe. Raulino Reitz Roberto M. Klein 9487                     | Yes |
| Myrciaria plinioides D.Legrand    | L.2528111             | Reitz R; Klein RM 24785                                     | No  |
| Myrciaria plinioides D.Legrand    | FURB 64033            | A. Kassner-Filho; F.L.V. Bones 1070                         | Yes |
| Myrciaria plinioides D.Legrand    | FURB 46543            | A.A. de Oliveira 1295                                       | No  |
| Myrciaria plinioides D.Legrand    | FLOR 7076             | Bresolin, A 1379                                            | Yes |
| Myrciaria plinioides D.Legrand    | FURB 64032            | F.L.V. Bones; A. Kassner Filho 204                          | Yes |
| Myrciaria plinioides D.Legrand    | FURB 65127            | F.L.V. Bones 209                                            | Yes |
| Myrciaria plinioides D.Legrand    | FURB 12472            | M. Verdi; A.L. de Gasper 2169                               | Yes |

|                                                |                        |                                               |     |
|------------------------------------------------|------------------------|-----------------------------------------------|-----|
| Myrciaria plinioides D.Legrand                 | FURB 20103             | A.L. de Gasper; S. Dreveck; E. Brogni 2521    | No  |
| Myrciaria plinioides D.Legrand                 | FURB 19583             | M. Verdi; et al. 2956                         | Yes |
| Myrciaria plinioides D.Legrand                 | PACA-AGP 109973        | M. Verdi 3031                                 | Yes |
| Myrciaria plinioides D.Legrand                 | FURB 18697             | Verdi, M; Klettenberg, DH; Klemz, G 3184      | Yes |
| Myrciaria plinioides D.Legrand                 | LUSC 9173              | C. Mondin 3740                                | Yes |
| Myrciaria plinioides D.Legrand                 | FURB 16800             | A. Korte; A. Kniess 522                       | Yes |
| Myrciaria plinioides D.Legrand                 | US 2841230             | R. M. Klein 5433                              | Yes |
| Myrciaria plinioides D.Legrand                 | FURB 51554             | L.A. Funez 5592                               | Yes |
| Myrciaria plinioides D.Legrand                 | FURB 67480             | A. Kassner-Filho 5907                         | Yes |
| Myrciaria plinioides D.Legrand                 | ESA 154103, FLOR 2079  | Bresolin, A. 593                              | Yes |
| Myrciaria plinioides D.Legrand                 | ESA 154100, FLOR 2395  | Bresolin, A. 653                              | Yes |
| Myrciaria plinioides D.Legrand                 | FLOR 1651              | Klein, R.M. 7062                              | Yes |
| Myrciaria plinioides D.Legrand                 | FLOR 974, US 2580301   | Reitz, R.; Klein, R.M. 7398                   | Yes |
| Myrciaria plinioides D.Legrand                 | FURB 69529             | A. Kassner-Filho; D. Santos 7540              | Yes |
| Myrciaria plinioides D.Legrand                 | FLOR 5500              | Klein, R.M.; Bresolin, A. 8791                | Yes |
| Myrciaria plinioides D.Legrand                 | FLOR 1688              | Klein, R.M. 9183                              | Yes |
| Myrciaria plinioides D.Legrand                 | HBR 24786              | R. Reitz; R.M. Klein 9301                     | Yes |
| Myrciaria plinioides D.Legrand                 | US 2403613             | R. Reitz & D. Klein 9406                      | Yes |
| Myrciaria plinioides D.Legrand                 | MO-DUPPLICATES 2477690 | R. Reitz; R.M. Klein 9487                     | Yes |
| Myrciaria plinioides D.Legrand                 | FURB 45309             | M. Mayer s.n.                                 | No  |
| Myrciaria plinioides D.Legrand                 | HAS 75777              | Mattos, J. s.n.                               | No  |
| Myrciaria plinioides D.Legrand                 | HAS 75816              | Mattos, J. s.n.                               | No  |
| Neomitranthes cordifolia (D.Legrand) D.Legrand | FURB 72993             | A. Kassner-Filho 8109                         | Yes |
| Neomitranthes cordifolia (D.Legrand) D.Legrand | FURB 73012             | A. Kassner-Filho 8128                         | No  |
| Neomitranthes cordifolia (D.Legrand) D.Legrand | FURB 48802             | A.A. de Oliveira 2750                         | No  |
| Neomitranthes cordifolia (D.Legrand) D.Legrand | FLOR 4640              | Bresolin, A. 299                              | Yes |
| Neomitranthes cordifolia (D.Legrand) D.Legrand | MO 3210094             | Hatschbach, G; Hatschbach, M; Silva, JM 57863 | Yes |
| Neomitranthes cordifolia (D.Legrand) D.Legrand | CRI 15962              | Julia Gava Sandrini; João Gava Just 12        | No  |

|                                                |                                      |                                            |     |
|------------------------------------------------|--------------------------------------|--------------------------------------------|-----|
| Neomitranthes cordifolia (D.Legrand) D.Legrand | CRI 8923                             | M. Verdi; D.H. Klettenberg & G. Klemz 2890 | Yes |
| Neomitranthes cordifolia (D.Legrand) D.Legrand | NY 1019454                           | M.C. Souza 550                             | Yes |
| Neomitranthes cordifolia (D.Legrand) D.Legrand | CRI 8436                             | Mainara F. Cascaes s/n                     | Yes |
| Neomitranthes cordifolia (D.Legrand) D.Legrand | FLOR 62296                           | Mello, A.S.; Nuernberg, A. 706             | Yes |
| Neomitranthes cordifolia (D.Legrand) D.Legrand | UB 168157                            | Negrelle, R s/n                            | Yes |
| Neomitranthes cordifolia (D.Legrand) D.Legrand | UPCB 21455                           | Negrelle, R.R.B. s/n                       | Yes |
| Neomitranthes cordifolia (D.Legrand) D.Legrand | UPCB 21454                           | Negrelle, R.R.B. A568                      | Yes |
| Neomitranthes cordifolia (D.Legrand) D.Legrand | UPCB 21453                           | Negrelle, R; et al. A323                   | Yes |
| Neomitranthes cordifolia (D.Legrand) D.Legrand | SJRP 08575                           | R. Negrelle s/n                            | Yes |
| Neomitranthes cordifolia (D.Legrand) D.Legrand | CRI 1601                             | R. Negrelle; C. Londero 568                | Yes |
| Neomitranthes cordifolia (D.Legrand) D.Legrand | NY 616853                            | R. R. B. Negrelle; et al. 323              | Yes |
| Neomitranthes cordifolia (D.Legrand) D.Legrand | HBR 23151                            | R. Reitz & D. Klein 9327                   | Yes |
| Neomitranthes cordifolia (D.Legrand) D.Legrand | MO-DUPLICATES 2477810                | R. Reitz; R.M. Klein 1045                  | Yes |
| Neomitranthes cordifolia (D.Legrand) D.Legrand | HBR0009301                           | R. Reitz; R.M. Klein 1345                  | Yes |
| Neomitranthes cordifolia (D.Legrand) D.Legrand | NY 616855                            | R. Reitz; R.M. Klein 844                   | Yes |
| Neomitranthes cordifolia (D.Legrand) D.Legrand | NY 616854                            | Reitz ;Klein 9055                          | Yes |
| Neomitranthes cordifolia (D.Legrand) D.Legrand | CRI 15889                            | Renato Colares; Bruna & Vanessa s/n        | No  |
| Neomitranthes cordifolia (D.Legrand) D.Legrand | CRI 15894                            | Renato Colares; Bruna & Vanessa s/n        | No  |
| Neomitranthes gemballae (D.Legrand) D.Legrand  | FURB 69127                           | A. Kassner-Filho 7000                      | Yes |
| Neomitranthes gemballae (D.Legrand) D.Legrand  | FURB 49125                           | A.A. de Oliveira 2757                      | No  |
| Neomitranthes gemballae (D.Legrand) D.Legrand  | PACA-AGP 66910                       | G. Gemballa s/n                            | No  |
| Neomitranthes gemballae (D.Legrand) D.Legrand  | FLOR 4765                            | Gemballa, G. s/n                           | Yes |
| Neomitranthes gemballae (D.Legrand) D.Legrand  | ICN 204172, HUEFS 259053, FLOR 69830 | Külkamp, J 1469                            | Yes |
| Neomitranthes gemballae (D.Legrand) D.Legrand  | FURB 34837                           | M. Verdi; D.H. Klettenberg; G. Klemz 5935  | Yes |
| Neomitranthes gemballae (D.Legrand) D.Legrand  | HBR0024787                           | R. Reitz; R.M. Klein 8883                  | Yes |
| Neomitranthes gemballae (D.Legrand) D.Legrand  | HBR 37195                            | Reitz & Klein 17045                        | Yes |
| Neomitranthes gemballae (D.Legrand) D.Legrand  | FURB 20668                           | S. Dreveck; F.E. Carneiro 1994             | No  |

|                                               |                        |                                                                              |     |
|-----------------------------------------------|------------------------|------------------------------------------------------------------------------|-----|
| Neomitranthes gemballae (D.Legrand) D.Legrand | EFC 11246              | Saueressig, D.; Henke, J.M. 1428                                             | No  |
| Neomitranthes gemballae (D.Legrand) D.Legrand | FURB 30900             | T.J. Cadorin; B. Grosch; R. Zimmermann 2170                                  | Yes |
| Neomitranthes gemballae (D.Legrand) D.Legrand | CRI 805                | Vanilde Citadini-Zanette; Aurélio José de Aguiar & Valdemar Piazza Boff 1168 | Yes |
| Neomitranthes gemballae (D.Legrand) D.Legrand | IBGE 86758, FURB 76182 | Kassner-Filho, A 9538                                                        | No  |
| Neomitranthes gemballae (D.Legrand) D.Legrand | FURB 75961             | A. Kassner-Filho 9317                                                        | Yes |
| Neomitranthes gemballae (D.Legrand) D.Legrand | FURB 78948             | A. Kassner-Filho; L.A. Bini; D.J. Parma 10745                                | Yes |
| Neomitranthes gemballae (D.Legrand) D.Legrand | FURB 78803             | A. Kassner-Filho; L.A. Bini; D.J. Parma; A.C. Fortes 10678                   | No  |
| Neomitranthes gemballae (D.Legrand) D.Legrand | JOI 20457              | Vieira, F.C.S. s/n                                                           | Yes |
| Neomitranthes gemballae (D.Legrand) D.Legrand | HBR 37198              | R. M. Klein 5431                                                             | Yes |
| Neomitranthes gemballae (D.Legrand) D.Legrand | FURB 79046             | A. Kassner-Filho; L.A. Bini; D.J. Parma; M.A. Yamamoto 10843                 | Yes |
| Neomitranthes gemballae (D.Legrand) D.Legrand | HBR 37199, FURB 79330  | R. Reitz & R. M.Klein 17057                                                  | Yes |
| Neomitranthes gemballae (D.Legrand) D.Legrand | HUCS 60281, FURB 78827 | Kassner-Filho, A 10702                                                       | Yes |
| Plinia cordifolia (D.Legrand) Sobral          | FURB 56386             | A. Kassner-Filho; D. Santos; G. Bollmann; D.A. Silva 1931                    | Yes |
| Plinia cordifolia (D.Legrand) Sobral          | FURB 19549             | A. Stival-Santos; E. Legal; S. Silveira 1329                                 | Yes |
| Plinia cordifolia (D.Legrand) Sobral          | FURB 45719             | A.A. de Oliveira 1114                                                        | Yes |
| Plinia cordifolia (D.Legrand) Sobral          | JOI 923                | F.C.S. Vieira 124                                                            | Yes |
| Plinia cordifolia (D.Legrand) Sobral          | JOI 3017               | F.C.S. Vieira 477                                                            | Yes |
| Plinia cordifolia (D.Legrand) Sobral          | JOI 3018               | F.C.S. Vieira 540                                                            | Yes |
| Plinia cordifolia (D.Legrand) Sobral          | JOI 1656               | F.C.S. Vieira 596                                                            | Yes |
| Plinia cordifolia (D.Legrand) Sobral          | JOI 3019               | F.C.S. Vieira 634                                                            | Yes |
| Plinia cordifolia (D.Legrand) Sobral          | FLOR 22593             | Falkenberg, D.B.; Zanin, A. 5808                                             | Yes |
| Plinia cordifolia (D.Legrand) Sobral          | FURB 37202             | J.L. Schmitt 3231                                                            | Yes |
| Plinia cordifolia (D.Legrand) Sobral          | FURB 30805             | Korte, A; Kniess, A 4071                                                     | Yes |
| Plinia cordifolia (D.Legrand) Sobral          | FURB 20650             | M. Verdi; R.P. Hasckel; G. Klemz 3883                                        | Yes |
| Plinia cordifolia (D.Legrand) Sobral          | CRI 14585              | Peterson T. Padilha; Martin Molz s/n                                         | No  |

|                                             |                        |                                                                                     |     |
|---------------------------------------------|------------------------|-------------------------------------------------------------------------------------|-----|
| <i>Plinia cordifolia</i> (D.Legrand) Sobral | HBR 28605              | R. M. Klein 2128                                                                    | Yes |
| <i>Plinia cordifolia</i> (D.Legrand) Sobral | HBR 6677               | R. Reitz 4104                                                                       | Yes |
| <i>Plinia cordifolia</i> (D.Legrand) Sobral | NY 616916              | R. Reitz & Klein 3589                                                               | Yes |
| <i>Plinia cordifolia</i> (D.Legrand) Sobral | HBR 28733              | R. Reitz; R.M. Klein 10355                                                          | Yes |
| <i>Plinia cordifolia</i> (D.Legrand) Sobral | HBR 28604              | R. Reitz; R.M. Klein 5878                                                           | Yes |
| <i>Plinia cordifolia</i> (D.Legrand) Sobral | PACA-AGP 50383         | Rambo, B. s/n                                                                       | Yes |
| <i>Plinia cordifolia</i> (D.Legrand) Sobral | MBM 47541              | Reitz, R; Klein, RM 4152                                                            | No  |
| <i>Plinia cordifolia</i> (D.Legrand) Sobral | JOI 17368              | Schmitt, J. L. 3223                                                                 | Yes |
| <i>Plinia cordifolia</i> (D.Legrand) Sobral | FURB 48537             | Schwirkowski, P. 1165                                                               | Yes |
| <i>Plinia cordifolia</i> (D.Legrand) Sobral | FPS 1007               | Schwirkowski, P. 1273                                                               | Yes |
| <i>Plinia cordifolia</i> (D.Legrand) Sobral | FURB 55730             | Schwirkowski, P. 2299                                                               | Yes |
| <i>Plinia cordifolia</i> (D.Legrand) Sobral | FPS 3550               | Schwirkowski, P. 2977                                                               | Yes |
| <i>Plinia cordifolia</i> (D.Legrand) Sobral |                        | Seubert, R.C.; Sampaio, D.K.;<br>Hofschneider, E.; Rezini, J.A. &<br>Gebien, W. 117 | Yes |
| <i>Plinia cordifolia</i> (D.Legrand) Sobral | FURB 46598             | T.J. Cadorin; B. Grosch; R.<br>Zimmermann 2609                                      | Yes |
| <i>Plinia cordifolia</i> (D.Legrand) Sobral | FURB 32002             | A. Stival-Santos; E. Legal; S.<br>Silveira 2337                                     | Yes |
| <i>Psidium longipetiolatum</i> D.Legrand    | FURB 29754             | Aécio Amaral-Santos 2754                                                            | Yes |
| <i>Psidium longipetiolatum</i> D.Legrand    | CEN 66274              | Ariati, V; Detzel, L 808                                                            | Yes |
| <i>Psidium longipetiolatum</i> D.Legrand    | MBM 397403             | Campos, J.M.; Leite, P.F. s/n                                                       | Yes |
| <i>Psidium longipetiolatum</i> D.Legrand    | FLOR 8242              | J.M. Campo; P.F. Leite s/n                                                          | Yes |
| <i>Psidium longipetiolatum</i> D.Legrand    | HBR 47186              | Klein 6322                                                                          | Yes |
| <i>Psidium longipetiolatum</i> D.Legrand    | HUCS 6672              | Klein & Bresolin 10607                                                              | Yes |
| <i>Psidium longipetiolatum</i> D.Legrand    | HBR 37643              | Klein & Bresolin 10946                                                              | Yes |
| <i>Psidium longipetiolatum</i> D.Legrand    | US 2743297, NY 1015853 | L. Smith & R. M. Klein 15750                                                        | No  |
| <i>Psidium longipetiolatum</i> D.Legrand    | EAFM 13469             | Leal, ML; Silva, MS 10                                                              | No  |
| <i>Psidium longipetiolatum</i> D.Legrand    | FLOR 31223             | Mattos, J. 31704                                                                    | No  |
| <i>Psidium longipetiolatum</i> D.Legrand    | FPS 3157               | P. Schwirkowski 2583                                                                | Yes |
| <i>Psidium longipetiolatum</i> D.Legrand    | FURB 63649             | P. Schwirkowski 3259                                                                | Yes |

|                                                                   |            |                                                 |     |
|-------------------------------------------------------------------|------------|-------------------------------------------------|-----|
| <i>Psidium longipetiolatum</i> D.Legrand                          | US 2403004 | P.R. Reitz; R.M. Klein, 2255                    | Yes |
| <i>Psidium longipetiolatum</i> D.Legrand                          | LUSC 3951  | Pozzan, M. s/n                                  | Yes |
| <i>Psidium longipetiolatum</i> D.Legrand                          | HBR 37018  | R.M. Klein 4570                                 | Yes |
| <i>Psidium longipetiolatum</i> D.Legrand                          | JOI 18451  | Vieira, F.C.S. 2796                             | Yes |
| <i>Psidium longipetiolatum</i> D.Legrand                          | FLOR 81209 | J. Kulkamp 1623                                 | Yes |
| <i>Psidium longipetiolatum</i> D.Legrand                          | JOI 19548  | F. C. S. Vieira 3077                            | Yes |
| <b>Onagraceae</b>                                                 |            |                                                 |     |
| <i>Ludwigia humboldtiana</i> Funez, D.M.Farias, Hassemer & Gasper | HUCS 53735 | Funez, LA; Zermiani, AE 9375                    | Yes |
| <i>Ludwigia humboldtiana</i> Funez, D.M.Farias, Hassemer & Gasper | FURB 67158 | L.A. Funez; A.E. Zermiani 9375                  | Yes |
| <i>Ludwigia humboldtiana</i> Funez, D.M.Farias, Hassemer & Gasper | FURB 45937 | L.A. Funez 3315                                 | Yes |
| <i>Ludwigia litoranea</i> Cocc. & Boldrini                        | HUCS 46883 | Grings, M 1909                                  | Yes |
| <i>Ludwigia litoranea</i> Cocc. & Boldrini                        | ICN 180886 | Hagelund, K 14425                               | Yes |
| <i>Ludwigia litoranea</i> Cocc. & Boldrini                        | ICN 009149 | Lindeman, JC                                    | Yes |
| <i>Ludwigia litoranea</i> Cocc. & Boldrini                        | UFG 70983  | Grings, M. 1909                                 | Yes |
| <i>Ludwigia irregularis</i> Funez, Hassemer, D.M. Farias & Gasper | FURB 77903 | L.A. Funez 9617                                 | Yes |
| <i>Oenothera catharinensis</i> Cambess.                           | P05180371  | Gaudichaud 252                                  | Yes |
| <i>Oenothera catharinensis</i> Cambess.                           | HBR 4690   | R. Reitz; R.M. Klein 137                        | Yes |
| <i>Oenothera catharinensis</i> Cambess.                           | MO 3327665 | Jim Conrad Werner Dietrich 14                   | Yes |
| <i>Oenothera catharinensis</i> Cambess.                           | HBR 4691   | R. Reitz; R.M. Klein 185                        | Yes |
| <i>Oenothera catharinensis</i> Cambess.                           | MO 3327612 | Jim Conrad Werner Dietrich 2143                 | Yes |
| <i>Oenothera catharinensis</i> Cambess.                           | MO 3327279 | Gert G. Hatschbach 40988                        | Yes |
| <i>Oenothera catharinensis</i> Cambess.                           | MO 3327434 | Gert G. Hatschbach 42226                        | Yes |
| <i>Oenothera catharinensis</i> Cambess.                           | ICN 206739 | Massing, AA 534                                 | Yes |
| <i>Oenothera catharinensis</i> Cambess.                           | ICN 206739 | R.M. Klein; R. Souza Sobrinho; A. Bresolin 5801 | Yes |
| <i>Oenothera catharinensis</i> Cambess.                           | HBR 36634  | R.M. Klein; R. Souza Sobrinho; A. Bresolin 5824 | Yes |
| <i>Oenothera catharinensis</i> Cambess.                           | ICN 206736 | Massing, AA 611                                 | Yes |
| <i>Oenothera catharinensis</i> Cambess.                           | MO 3327486 | Gert G. Hatschbach 72/1345                      | Yes |
| <i>Oenothera catharinensis</i> Cambess.                           | ICN 206747 | Massing, AA 776                                 | Yes |
| <i>Oenothera catharinensis</i> Cambess.                           | HBR 26340  | R. Reitz; R.M. Klein 980                        | Yes |

**Vochysiaceae**

|                                    |            |                                                                   |     |
|------------------------------------|------------|-------------------------------------------------------------------|-----|
| Callisthene kuhlmannii H.F.Martins | MBM 42888  | Reitz, R; Klein, RM 5610                                          | Yes |
| Callisthene kuhlmannii H.F.Martins | FURB 60397 | A. Kassner-Filho; D. Santos; G. Bollmann; L.F. Althoff 3260       | Yes |
| Callisthene kuhlmannii H.F.Martins | UPCB 14862 | Negrelle, R.R.B.; Hatschbach, G.   Fontella, H.   Cervi, A.C. 148 | Yes |
| Callisthene kuhlmannii H.F.Martins | FURB 34964 | M. Verdi; D.H. Klettenberg; G. Klemz 5921                         | Yes |

# APÊNDICE C – AVALIAÇÃO A SER SUBMETIDA A IUCN (CAPÍTULO III)

## *Myrceugenia basicordata* F.C.S.Vieira, Molz & Sobral

Assessors: Ana Flávia Augustin, Duane Fernandes Lima, Fábio C.S. Vieira, Roberta Gargiulo, Mayara Krasinski Caddah

### **Taxonomy**

| Kingdom | Phylum       | Class         | Order    | Family    |
|---------|--------------|---------------|----------|-----------|
| Plantae | Tracheophyta | Magnoliopsida | Myrtales | Myrtaceae |

**Scientific name:** *Myrceugenia basicordata* F.S.C.Vieira, Molz & Sobral

**Synonym(s):** None

### **Taxonomic Source(s):**

Flora e Funga do Brasil. Available at: <https://floradobrasil.jbrj.gov.br/consulta/> (Accessed: 2024).

POWO. 2024. Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. Available at: <http://powo.science.kew.org/>. (Accessed: 2024).

**Taxonomic Notes:** The species was described and published in 2019, in the journal Phytotaxa (425 (2): 096–104) by Marcos Sobral, Martin Molz and Fábio C. S. Vieira. Type: BRAZIL. Santa Catarina: Joinville, Morro do Finder, March 14, 2018, *F.C.S. Vieira 2813*. *Myrceugenia basicordata* can be described as having arboreal habits, leaves with a base rounded or cordiform, long and wide pedicels and bilocular ovary (Sobral *et al.* 2019). It is morphologically similar to *Myrceugenia miersiana* (Gardner) D.Legrand and Kausel, a widespread species from the Atlantic Forest.

### **Assessment Information**

**Red List Category & Criteria:** EN B1ab(iii,iv); C2a(i)

### **Justification:**

*Myrceugenia basicordata* is a small tree endemic to the southern portion of the Atlantic Forest, with only a few occurrences in the state of Santa Catarina (southern Brazil). It is estimated that the extent of occurrence (EOO) for this species is 166.967 km<sup>2</sup>, and the area of occupancy (AOO) is 20 km<sup>2</sup>. Therefore, it is classified in the Endangered category under criteria B1 (geographic range). A reduced number of locations (<4) and a continuing decline in its habitat has been observed, mainly because the subpopulations are located near large urban centers, such as the Joinville municipality. Furthermore, the Atlantic Forest is one of the most threatened biomes in the Brazilian territory, characterized by highly fragmented vegetation that is continuously shrinking (Carlucci *et al.* 2021; Vancine *et al.* 2024).

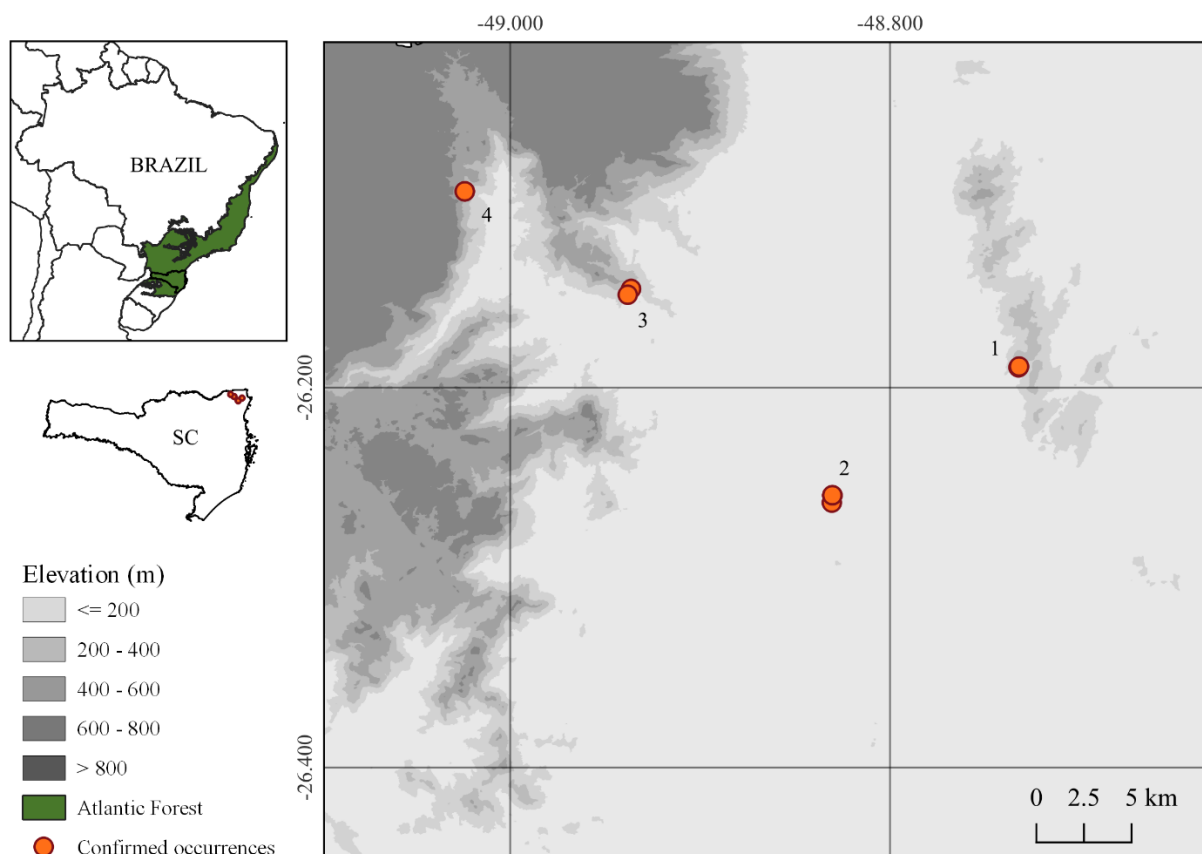
During 2022 and 2023, fieldwork to assess all known subpopulations of *M. basicordata* was conducted (Augustin *et al.* 2025). Four sites were visited near three different cities in the state of Santa Catarina: Joinville, São Francisco do Sul, and Garuva. These sites were used as reference points for sampling and field observations. A total of 50 individuals were sampled for population genetic analyses. The subpopulation with the highest number of sampled individuals was Canta Galo, in São Francisco do Sul, with 15 individuals, while the smallest was Finder, in Joinville, with eight individuals. Field observations suggest that each subpopulation harbors fewer than 30 mature individuals, with Canta Galo appearing to be the largest and Finder the smallest. Based on these estimates, the species also meets IUCN criterion C, with fewer than 250 mature individuals in total. Population decline was also detected by Bottleneck tests (Augustin *et al.* 2025). However, it is important to note that some of the subpopulations are within partially protected areas. Despite this, it is not estimated a total population number exceeding 250 mature individuals.

### Geographic range

**Description:** Native and endemic of the Brazilian Atlantic Forest domain, with confirmed occurrences in the northeastern portion of Santa Catarina state (South Brazil).

**Occurrences:** Brazil, Santa Catarina state, with confirmed occurrences in Joinville, São Francisco do Sul and Garuva.

**Distribution map:** *Myrceugenia basicordata* distribution in the state of Santa Catarina (South of Brazil). Four locations were found and considered for genetic population purposes (1 = Canta Galo; 2 = Finder; 3 = Cubatão; 4 = Quiriri). All occurrences included here corresponds to all points available on online platforms (e.g., Specieslink <https://specieslink.net/search/>). Points located in the cities centres, and duplicates from the same collector number were excluded.



## Population trend

*Myrceugenia basicordata* has a total of 50 sampled individuals, all within a specific altitude range of 200–400 meters. Population genetic analyses indicated moderate levels of genetic diversity and unclear differentiation among the four subpopulations, suggesting high levels of gene flow between them (Augustin *et al.* 2025). The subpopulations with the highest genetic diversity were located in green areas at a certain distance from urban centers (Cubatão and Quiriri subpopulations). These results were based on seven nuclear microsatellite markers, which produced 22 different alleles, ranging between 2 and 4 across all loci (Augustin *et al.* 2025).

Although there is no record of a decrease in population size, bottleneck analysis suggested a concerning situation, with strong evidence of a historical reduction in population size for three of the four subpopulations (except Quiriri). The results were particularly worrying for the Cubatão subpopulation (Augustin *et al.* 2025). Based on these indicators, the current population trend for *M. basicordata* is likely decreasing, although further monitoring efforts are necessary to confirm this trend.

**Current population trend:** decreasing

## Habitat and Ecology

*Myrceugenia basicordata* is a small tree, reaching up to 2 meters in height, that occupies the mountain slopes of dense ombrophilous forests in the Atlantic Forest. The species

preferably occurs within a specific altitude range, between 200 and 400 meters (Sobral *et al.* 2019), in areas with minimal habitat disturbance. Individuals were collected bearing fruit in July, and specimens with flowers were found in January-February, while those with flower buds were recorded in September-October. Differences in the maturation stages of flowers and fruits among individuals from the same region have been previously noted in the literature (Fidalgo and Kleinert 2009) and were also observed in the field for this species.

**Habitat:** Terrestrial.

## Use and Trade

There is no information on the use of this plant for any activities, its effects when consumed or its economic potential.

## Threats

Based on the topics mentioned above, two main factors threaten *Myrceugenia basicordata* natural management: (1) habitat loss and fragmentation due to expansion of urban centers in its geographical range, and (2) climate changes. The city of Joinville, the largest city of Santa Catarina state and where most of the records of *M. basicordata* are concentrated, currently has an estimated population of 654,888 habitants and a total area of 1,127,947 km<sup>2</sup>. Additionally, the state of Santa Catarina experienced an estimated population growth of 5.89% in 2023, making it the eighth state in population increase in the country (IBGE 2024). Despite some subpopulations are inserted in protected areas, these are categorized as “Conservation Units for Sustainable Use” (Unidades de Conservação de Uso Sustentável, in Portuguese) and allow human use and activity (SNUC 2000). The Serra Dona Francisca Environmental Protection Area, which embraces two over four subpopulations, is a tourist attraction and houses an important highway (SC418) with constant flow of vehicles and anthropic actions.

In fact, habitat fragmentation is an important threat to be considered for *Myrceugenia basicordata*, not only for Joinville area. There is only 23% of its forest coverage remaining for the Atlantic Forest. It is also mentioned that intensely deforestation of the Atlantic Forest occasioned an increase of small vegetation fragments (< 50 ha), composing 97% of the coverage. Additionally, 50-60% of the vegetation is less than 90 meters from its edges. Roads and railways are also responsible for the subdivision of the largest fragments (>500,000 ha) (Vancine *et al.* 2024).

Additionally, climate changes are a concerning reality that intensely affects biodiversity. According to the data collected in 2023 by NASA (National Aeronautics and Space Administration) and NOAA (National Oceanic and Atmospheric Administration) the Earth's surface temperature has risen by about 1.4 °C above the average since the end of the nineteenth century and the last decade was the warmest on record (NASA 2024). Yet, empirical efforts in species distribution modeling suggest a significant loss of suitable habitat for *M. basicordata* by the end of the century (Augustin *et al.* subm.).

## Conservation actions

There are no current conservation measures focused on *Myrceugenia basicordata*, as it was recently described and included in empirical studies. However, it is important to mention that some of its subpopulations (Finder, Quiriri and Cubatão) are inserted within protected areas, such as Dona Francisca Environmental Protection Area (Área de Proteção Ambiental Dona Francisca – APA Dona Francisca, in Portuguese) and Morro do Finder Municipal Park (Parque Municipal Morro do Finder, in Portuguese). A few practical recommendations for *M. basicordata* conservation are cited in Augustin et al. (2025), which, mostly, highlight the importance of basic biology studies, such as seed collection for germination investigation, inclusion in local red lists for management and continuing monitoring the subpopulations.

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## APÊNDICE D – AVALIAÇÃO A SER SUBMETIDA A IUCN (CAPÍTULO III)

### *Myrceugenia joinvillensis* F.C.S.Vieira

Assessors: Ana Flávia Augustin, Duane Fernandes Lima, Fábio C.S. Vieira, Roberta Gargiulo, Mayara Krasinski Caddah

#### Taxonomy

| Kingdom | Phylum       | Class         | Order    | Family    |
|---------|--------------|---------------|----------|-----------|
| Plantae | Tracheophyta | Magnoliopsida | Myrtales | Myrtaceae |

**Scientific name:** *Myrceugenia joinvillensis* F.S.C.Vieira

**Synonym(s):** None

**Taxonomic Source(s):** Flora e Funga do Brasil. Reflora. Available in: <https://floradobrasil.jbrj.gov.br/consulta/>

**Taxonomic Notes:** *Myrceugenia joinvillensis* was published in 2020, by F.C.S. Vieira, in the journal Phytotaxa 435 (2): 208–212. Type: BRAZIL. Santa Catarina: Joinville, Morro Mutucas, 16th November 2017, *F.C.S. Vieira* 2784. It is morphologically similar to *Myrceugenia reitzii* D.Legrand and can be identified by the axillary flowers, linear to narrowly ovate calyx lobes, in addition to the broad leaves, with a rounded to cordate base, and simple trichomes. Its epithet refers to the city of Joinville, where it was found for the first time (Vieira, 2020).

#### Assessment Information

**Red List Category & Criteria:** EN B1b(iii,iv)

#### Justification:

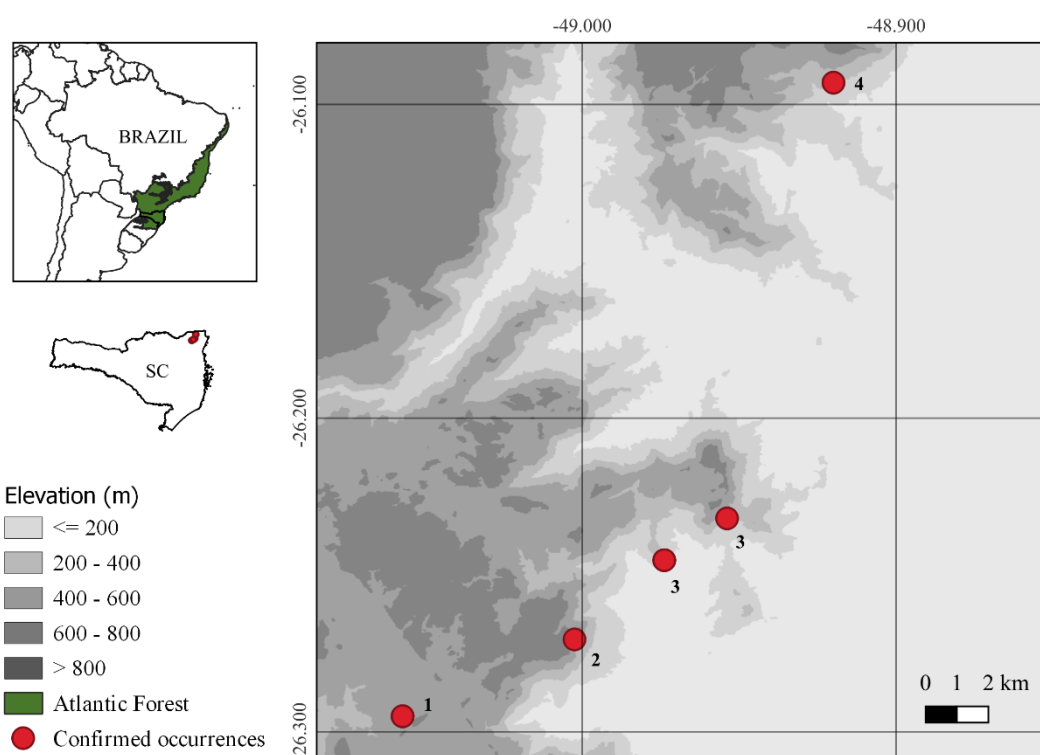
*Myrceugenia joinvillensis* is a small tree, up to 3m tall, which occupies the interior of undisturbed vegetation in the south portion of Atlantic Forest. It has only a few records for the state of Santa Catarina, at altitudes ranging between 400 – 700 meters (Vieira 2020). It presented an extent of occurrence (EOO) of 72.950 km<sup>2</sup> and an area of occupancy (AOO) of 20 km<sup>2</sup>, being classified, therefore, in the Endangered category by the criterium B (geographic range). There are only four locations mentioned for *M. joinvillensis*, two of them within protected areas that allow human activity in some degree – named as Conservation Units for Sustainable Use (*Unidades de Conservação de Uso Sustentável* in Portuguese, SNUC 2000), but one of them are allocated in a private area. These observations and the continuing fragmentation of the Atlantic Forest, one of the most threatened domains in the Brazilian territory (Vancine *et al.* 2024), make *M. joinvillensis* fits in the mentioning conditions for criterion B. It is also mentioned that an extensive mining area exists nearby one of the subpopulations (Mutucas), even if this population is located in a protected area (Augustin *et al.* 2025).

#### Geographic range

**Description:** Native and endemic of the Brazilian Atlantic Forest domain, with confirmed occurrences in the northeastern portion of Santa Catarina state (South Brazil).

**Occurrences:** Confirmed occurrences for *Myrceugenia joinvillensis* is documented for three municipalities of the state of Santa Catarina: Schroeder, Joinville and Garuva.

**Distribution map:** *Myrceugenia joinvillensis* distribution in the state of Santa Catarina (South of Brazil). Four locations were found and considered for genetic population purposes (1 = Barragem; 2 = Jurapê; 3 = Mutucas (two sites); 4 = Monte Crista). All occurrences included here corresponds to all points available on online platforms (for example Specieslink <https://specieslink.net/search/>). Points located in the cities centres, and duplicates from the same collector number were excluded.



## Population trend

Fieldworks for genetic populations purposes were conducted during the years 2022 and 2023, which resulted in four subpopulations found for *M. joinvillensis*: Barragem, Jurapê, Mutucas and Monte Crista, named according to the localities where they were found, in three different municipalities of the state of Santa Catarina - Schroeder, Joinville and Garuva (Augustin *et al.* 2025). Fifty-two individuals were sampled for all the four subpopulations. The number of individuals sampled ranged from 10 (Mutucas and Monte Crista) to 18 (Barragem) (Augustin *et al.* 2025). In some cases, most of the observed individuals presented some reproductive structures (fruits or flowers in some stage of development), indicating maturity. The results of this investigations used seven loci of microsatellite markers and indicated a moderate level of genetic diversity, with 29 different alleles, ranging from 3 to 8 in all subpopulations. Barragem and Jurapê (very close to each other) demonstrated lower genetic

diversity indices (allelic richness, heterozygosity, among others), while Monte Crista and Mutucas, demonstrated higher levels of genetic diversity, specially Mutucas (Augustin *et al.* 2025). Genetic differentiation tests suggested a clear differentiation among the subpopulations, with individuals from Barragem, Jurapê and Mutucas populations are more closely related, while Monte Crista formed an isolated cluster (Augustin *et al.* 2025).

There are no others studies in the literature that mention *Myrceugenia joinvillensis* population size, or a possible decrease. Additionally, bottlenecks tests were conducted and did not find strong evidence of a recent reduction in population size (Augustin *et al.* 2025). Based on this information and the genetic trend mentioned above, *Myrceugenia joinvillensis* population is considered stable, although further monitoring efforts are recommended, especially because of its small population size.

**Current population trend:** Stable

## Habitat and Ecology

*Myrceugenia joinvillensis* is a small tree, reaching up to 3 meters in height. This species occupies specific altitudes (between 400 – 700 meters) in the interior of undisturbed forests within Atlantic Forests domain (Vieira 2020). Apparently, the species presents a long period of reproductive phase as individuals were collected bearing fruit in July, and specimens with flowers were preserved in January-February, while those with flower buds were recorded in September-October (Augustin *et al.* 2025). Differences in the maturation stages of flowers and fruits among individuals from the same site have been previously noted in the literature (Fidalgo and Kleinert 2009) and were also observed in the field for this species.

## Use and Trade

There is no information on the use of this plant for any activities, its effects when consumed or its economic potential.

## Threats

*Myrceugenia joinvillensis* management is threatened in response to current habitat loss and fragmentation in the Atlantic Forest domain. The Atlantic Forest in Brazilian territory is one of the most diverse hotspots of biodiversity and is seriously threatened by human activity (SOS Mata Atlântica, Vancine *et al.* 2024). It is estimated that since 1986, there was a decrease of its extent of 3.8%, around 97% of the remaining fragments are small units (<50 ha) and most part of the vegetation are close to its edge, less than 90 meters of distance (Vancine *et al.* 2024). Although some of *Myrceugenia joinvillensis* known subpopulations are within protected areas (Jurapê and Mutucas), these areas may be not sufficient to guarantee the permanence of the species in such domain, especially because only 10% of the Atlantic Forest are protected areas, with vegetation region covering less than 10 km in those areas (Vancine *et al.* 2024). Additionally, those areas are frequently criticized by its efficiency, especially those who allows human activity in some degree (Fonseca and Venticinque 2018).

Additionally, climate changes are also considered an important threat to the species. Species distribution modeling approaches suggested that the most important bioclimatic

variable for *M. joinvillensis* is temperature (Augustin *et al.* 2024), and efforts from the National Oceanic and Atmospheric Administration (NASA) have determined that the Earth's surface temperature has increased by about 1.4 °C since the end of the nineteenth century, being the last decade the warmest on record (NASA 2024). Yet, species distribution modeling approaches suggest a significant loss of suitable habitat for *M. joinvillensis* by the end of the century (Augustin *et al.* *subm.*).

## Conservation actions

There are no current conservation measures focused on *Myrceugenia joinvillensis*, as it was recently described and included in empirical studies (Augustin *et al.* *subm.*; Augustin *et al.* 2025; Vieira 2020). However, as previously mentioned, some of the species subpopulations are inserted within protected areas. Jurapê and Mutucas are allocated in mountain peaks of the Dona Francisca Environmental Protection Area (Área de Proteção Ambiental Dona Francisca – APA Dona Francisca, in Portuguese). Bragem, however, is inserted in a private area, a dam of an electricity company. Monte Crista is close to APA Dona Francisca, but is not included in its limits.

Some practical recommendations for *M. joinvillensis* conservation are cited in Augustin and collaborators (2025), highlighting the importance of basic biological studies for the species, which includes seed collection for germination investigation, inclusion in local red lists for management and continuing monitoring the subpopulations.

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