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Checklist and geographic distribution of Myrtaceae species occurring in campinaranas of the Brazilian Amazon

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ABSTRACT

White-sand vegetation (campinarana) is a type of vegetation restricted to oligotrophic and highly leached white sand soils in the Amazon phytogeographic domain that includes grassland to forest phytophysiognomies. Campinaranas cover about 5% of this phytogeographic domain and are impacted by various anthropic activities that put plant species, especially endemic ones, at risk. Myrtaceae has significant representativeness in oligotrophic edaphic environments, but floristic and taxonomic studies on the family in campinaranas are still few and geographically limited. We present a checklist of Myrtaceae species known from campinaranas of the Brazilian Amazon based on the survey of herbarium specimens and literature data in order to assess the level of endemism of these species for this vegetation type. We compiled occurrence records of 72 species and six genera. *Myrcia* and *Eugenia* were the genera with the highest number of species. Overall, 38 species (53%) occurred only in the Amazon and two were endemic to campinaranas (*Eugenia campina* and *Myrcia psammophila*). Four species are new records for the Brazilian Amazon: *Blepharocalyx salicifolius*, *Eugenia hatschbachii*, *Myrcia anceps* and *Myrcia racemosa*. The specific richness of Myrtaceae in Brazilian campinaranas is likely to be underestimated since extensive areas, especially those farther from the riverbanks, in the states of Amazonas and Roraima, have not yet been intensively surveyed.

KEYWORDS: white sand vegetation; floristics; oligotrophic soils; endemisms; *Myrcia; Eugenia*

Checklist e distribuição geográfica das espécies de Myrtaceae que ocorrem em campinaranas da Amazônia brasileira

RESUMO

Campinarana é um tipo de vegetação restrita a solos de areia branca oligotróficos e altamente lixiviados no domínio fitogeográfico amazônico, que inclui fitofisionomias campestres a florestais. Campinaranas cobrem aproximadamente 5% deste domínio fitogeográfico e estão sujeitas ao impacto de várias atividades antrópicas que colocam em risco as espécies vegetais, especialmente as endêmicas. Myrtaceae possui uma representatividade significativa em ambientes edáficos oligotróficos, mas estudos florísticos e taxonômicos sobre a família em campinaranas ainda são escassos e geograficamente limitados. Nós apresentamos um checklist de espécies de Myrtaceae em campinaranas da Amazônia Brasileira, com base no levantamento de espécimes de herbários e dados de literatura, com o objetivo de verificar o nível de endemismo dessas espécies para este tipo de vegetação. Nós compilamos registros de ocorrência de 72 espécies e seis gêneros. *Myrcia* e *Eugenia* foram os gêneros com maior riqueza específica. Do total de espécies, 38 (53%) ocorreram somente na Amazônia e duas foram endêmicas das campinaranas (*Eugenia campina* e *Myrcia psammophila*). Quatro espécies constituem novos registros para a Amazônia brasileira: *Blepharocalyx salicifolius*, *Eugenia hatschbachii*, *Myrcia anceps* e *Myrcia racemosa*. A riqueza específica de Myrtaceae nas campinaranas brasileiras provavelmente está subestimada, pois extensas áreas, especialmente aquelas mais distantes dos rios nos estados de Amazonas e Roraima, ainda não foram intensamente amostradas.

PALAVRAS-CHAVE: vegetação de areia branca; florística; solos oligotróficos; endemismos; *Myrcia; Eugenia*

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INTRODUCTION

Campinarana is the term used in Brazil to define a type of vegetation restricted to oligotrophic and highly leached white-sand soils in the Amazon phytogeographic domain that is formed by open vegetation, from grassland to forest phytophysiognomies, usually forming islands embedded in other types of vegetation (Fine and Bruna 2016; Guimarães and Bueno 2016). Campinaranas currently cover about 5% (335.000 km²) of the area of the Amazon phytogeographic domain and 2.8% (217.039 km²) of the Brazilian Amazon domain (Adeney et al. 2016; García-Villacorta et al. 2016). They are impacted by anthropic activities such as sand extraction, deforestation and vegetation burning for cattle ranching and charcoal production, resulting in fragmentation and severe area reduction that lead to species extinction, especially endemic ones (Ferreira et al. 2013; Adeney et al. 2016; Oliveira-Filho et al. 2021).

In recent decades, an increasing number of studies have focused on campinaranas and their importance for species diversity patterns, evolutionary processes and ecosystem services in the Brazilian Amazon, but they are still few and limited in scope (e.g., Ferreira et al. 2014; Adeney et al. 2016; Daly et al. 2016; Demarchi et al. 2022). Floristic and taxonomic studies have shown that Myrtaceae is one of the most well-represented botanical families in campinaranas (e.g., Ferreira 2009; Demarchi et al. 2022). Myrtaceae is also frequently represented in other Amazonian oligotrophic environments (e.g., Amazonian savannas and sandy coastal vegetation known in Brazil as restinga), where *Eugenia* L. and *Myrcia* DC. are the genera with the highest species richness (Silva et al. 2010; Da Rocha and Da Costa Neto 2019; Da Silva e Silva et al. 2021). The occurrence of these genera in limiting environments such as campinaranas has been associated with adaptations in anatomical traits and morphological plasticity, such as reduction in leaf area and parenchyma tissue, and a well-developed cuticle, which enhance resistance to high light incidence, and clustering and diameter change of stem vessels, which indicate an investment in hydraulic efficiency (Amorim and Júnior 2016; Lemos et al. 2019, 2020).

Considering the scarcity of published information on the identification and distribution of Myrtaceae in Brazilian campinaranas, and its importance for the biogeography, conservation and ecological restoration policies of these environments, the objective of the present study was to provide a checklist of Myrtaceae species that occur in campinaranas in the Brazilian Amazon with emphasis on endemic species.

MATERIAL AND METHODS

Study area

The campinarana areas considered in this study are distributed in the states of Acre, Amapá, Amazonas, Pará, Rondônia and Roraima, corresponding to 27 localities in the Brazilian Amazon (Figure 1; Supplementary Material, Table S1). The climate in Brazilian campinaranas is predominantly of the Af type (humid tropical, without a pronounced dry season) according to the Köppen classification (Alvares et al. 2013). Annual precipitation ranges from 1,800 to 3,000 mm and average annual temperature ranges from 24 to 28 °C (INMET 2024). The types of soil found in campinaranas are commonly sandy, classified as sposols or neosols, which undergo high leaching, resulting in a low nutrient content, which characterizes them as oligotrophic (Mendonça et al. 2015; Atwell et al. 2023).

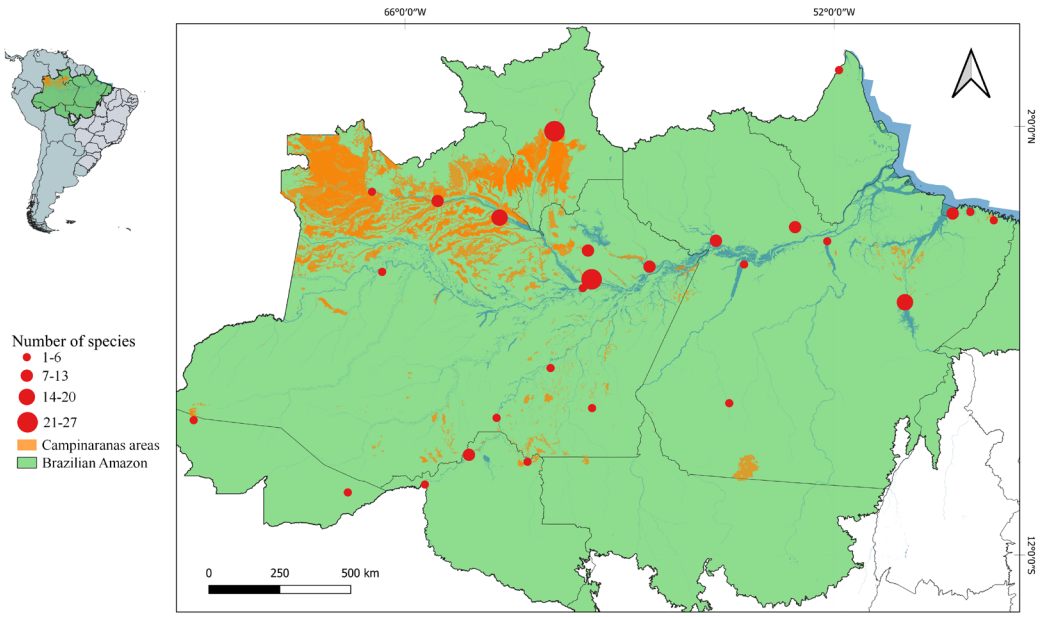

Figure 1. Locality records of specimens of Myrtaceae collected in campinaranas in the Brazilian Amazon phytogeographic domain and number of species per locality.

Data collection and treatment

Specimens of Myrtaceae species from campinaranas were compiled through consultation in person to the herbaria HBRA, HCP, HIFPA, HF, IAN and MG (acronyms according to Thiers 2023). Online herbarium records were also obtained from SpeciesLink (https://specieslink.net, accessed on 29 Feb 2023) using "campina" (an obsolete term for campinarana), "campinarana" and/or "white sand" as search terms. We considered published floristic surveys conducted in Brazilian Amazonian campinaranas by Anderson et al. (1975), Ferreira et al. (2013), Ferreira et al. (2014), Daly et al. (2016) and Demarchi et al. (2022), and also the technical report by Silveira (2003) and the doctoral thesis by Ferreira (2009). The species names used in these sources were revised and are cited here according to Flora e Funga do Brasil (https://floradobrasil.jbrj.gov.br/, accessed on 26 Feb 2023). Only herborized specimens were analyzed for this study. The identity of species that constitute new occurrences for Brazilian Amazonian campinaranas were confirmed by Myrtaceae taxonomists (see Acknowledgments). Geographic distribution data, including distribution in phytogeographic domains, were obtained from Flora e Funga do Brasil (https://floradobrasil.jbrj.gov.br/, accessed on 26 Feb 2023) and Global Biodiversity Information Facility (https://gbif.org, accessed on 09 Feb 2023). We adopted the classification of vegetation types by Flora e Funga do Brasil. The resulting list of Myrtaceae is presented in alphabetical order of genera and species and testimonial material is provided for each record. We also elaborated a Venn diagram showing the number of Myrtaceae species shared among the sampled Brazilian Amazonian campinaranas and other phytogeographic domains in Brazil, as well as a diagram showing the occurrence of Myrtaceae species found in Brazilian Amazonian campinaranas in other Brazilian vegetation types. For this, we used PowerPoint software version 2016 of the Office package (https://www.microsoft.com/pt-br/microsoft-365/previous -versions/microsoft-office-2016) and the Illustration software (https://www.adobe.com/br/products/illustrator.html).

RESULTS

We recorded 72 Myrtaceae species distributed in six genera in the 27 campinarana localities (Table 1). The genera with the greatest number of species were *Myrcia* (38 species) and *Eugenia* (21), both representing 82% of all recorded species, followed by *Psidium* L. and *Calycolpus* O.Berg (4 each), *Blepharocalyx* O.Berg and *Myrciaria* O.Berg (2 each) and *Siphoneugena* O.Berg (1).

The number of recorded species ranged from one to 27 species per locality (Figure 1), with highest numbers in the municipalities of Caracaraí (Roraima) and Manaus (Amazonas) with 22 and 27 species, respectively (Supplementary Material, Table S1). Overall, 38 (53%) species were endemic to the Amazon, although most were not restricted to campinaranas. The remaining species had a wide geographic distribution in Brazil, 19 species (26%) occurring in three or more phytogeographic domains. Cerrado (Brazilian savanna) and Atlantic Forest were the domains with the highest number of species shared with campinaranas (27 and 25, respectively). Species occurring in campinaranas rarely occurred in the Pantanal (3) or Pampa (southern Brazilian grasslands) (2) (Figure 2).

Almost all species that occurred in campinaranas also occurred in other types of vegetation in Brazil (Figure 3), mostly in terra firme forest (65% of the 72 species), followed by seasonally flooded forests, including várzea (forests periodically flooded by white water rivers), igapó (forests flooded by black water rivers) and gallery forests (48%), and ombrophilous forest (rainforest) (31%). Two species occurred exclusively in campinaranas: *Eugenia campina* Sobral & M.A.D. Souza and *Myrcia psammophila* Gaem & Farroñay. However, both species have a punctual distribution: *E. campina* was recorded in two localities, one in the state of Pará and another in the state of Amazonas, and *M. psammophila* was found only in a single site in Amazonas. In addition to the latter two species, *Eugenia hatschbachii* Mazine, *Myrcia cuprea* (O.Berg) Kiaersk. and *Myrcia saxatilis* (Amshoff) McVaugh were recorded only in campinarana and in vegetation types that develop in oligotrophic soils (restingas, cerrado (lato sensu) or Amazonian savanna). We report four species as new records for the Brazilian Amazon: *Blepharocalyx salicifolius* (Kunth) O.Berg, *E. hatschbachii, Myrcia anceps* (Spreng.) O.Berg and *Myrcia racemosa* (O.Berg) Kiaersk.

Table 1. Species of Myrtaceae recorded in 27 campinarana sites throughout the Brazilian Amazon and their occurrence in Brazilian phytogeographic domains and vegetation types. New occurrences for the Brazilian Amazon are marked with an asterisk (*).

Species	Herbarium voucher	Phytogeographic domain	Vegetation type
Blepharocalyx eggersii (Kiaersk.) Landrum	Ferreira, CAC 12970 (INPA)	Amazon, Atlantic Forest	Campinarana, terra firme forest, ombrophilous forest (rainforest), restinga
* *Blepharocalyx salicifolius* (Kunth) O.Berg	Dácio, IMS 1309 (INPA)	Amazon, Caatinga, Cerrado, Atlantic Forest, Pampa	Anthropic area, grassland, campinarana, rupestrian fields, cerrado (lato sensu), seasonally deciduous forest, seasonally semideciduous forest, ombrophilous forest (rainforest), mixed ombrophilous forest, restinga
Calycolpus calophyllus (Kunth) O.Berg	Lima, DF 304 (INPA)	Amazon	Campinarana, várzea forest, amazonian savanna
Calycolpus goetheanus (Mart. ex DC.) O.Berg	Souza, MAD 482 (IAN)	Amazon, Cerrado	Campinarana, terra firme forest, várzea forest, amazonian savanna

Table 1. Continued.

Species	Herbarium voucher	Phytogeographic domain	Vegetation type
Calycolpus revolutus (Schauer) O.Berg	Souza, MAD 482 (IAN)	Amazon	Campinarana, terra firme forest, amazonian savanna
Calycolpus roraimensis Steyerm.	Perigolo, NA 218 (INPA)	Amazon	Campinarana, amazonian savanna, rock outcrop vegetation
Eugenia biflora (L.) DC.	Black, GA 8695 (IAN)	Amazon, Caatinga, Cerrado	Campinarana, cerrado (lato sensu), terra firme forest, várzea forest
Eugenia caducipetala M.A.D.Souza & Scudeller	Carvalho-Sobrinho, JG 960 (INPA)	Amazon	Campinarana, terra firme forest
Eugenia calva McVaugh	Souza, MAD de 190 (INPA)	Amazon	Campinarana, várzea forest
Eugenia citrifolia Poir.	Labiak, P.H. 5616 (UFPR)	Amazon	Campinarana, terra firme forest
Eugenia egensis DC.	Cabral, FN 1258 (INPA)	Amazon, Cerrado, Atlantic Forest	campinarana, cerrado (lato sensu), igapó forest, terra firme forest, várzea forest, seasonally deciduous forest
Eugenia florida DC.	Pereira-Silva, G 16514 (IAN)	Amazon, Caatinga, Cerrado, Atlantic Forest	Campinarana, caatinga (stricto sensu), cerrado (lato sensu), terra firme forest, várzea forest, Seasonal semideciduous forest, ombrophilous forest (rainforest)
Eugenia gomesiana O.Berg	Cabral, FN 377 (INPA)	Amazon	Campinarana, riverine forest and/or gallery forest, igapó forest, terra firme forest, várzea forest
* *Eugenia hatschbachii* Mazine	Assunção, PACL 1135 (INPA)	Amazon, Cerrado	Campinarana, cerrado (lato sensu)
Eugenia inundata DC.	Nitta, A 17591 (IAN)	Amazon, Cerrado	Campinarana, igapó forest, várzea forest
Eugenia moschata (Aubl.) Nied. ex T.Durand & B.D.Jacks.	Roosmalen, MGMV 1319 (INPA)	Amazon, Cerrado	Campinarana, cerrado (lato sensu), terra firme forest, várzea forest
Eugenia omissa McVaugh	Prance, GT 3323 (INPA)	Amazon	Campinarana, terra firme forest
Eugenia patens Poir.	Medeiros, H 1081 (HUFSJ)	Amazon	Campinarana, terra firme forest, várzea forest
Eugenia patrisii Vahl	Daly, DC 944 (IAN)	Amazon	Campinarana, várzea forest
Eugenia protenta McVaugh	Thomas, WW 5342 (INPA)	Amazon	Campinarana, terra firme forest
Eugenia punicifolia (Kunth) DC.	Oliveira, E 4765 (IAN)	Amazon, Caatinga, Cerrado, Atlantic Forest, Pantanal	Campinarana, caatinga (stricto sensu), campinarana, rupestrian fields, cerrado (lato sensu), seasonal semideciduous forest, restinga, rock outcrop vegetation
Eugenia pusilliflora M.L.Kawasaki & B.Holst	Nelson, BW 637 (INPA)	Amazon	Campinarana, terra firme forest
Eugenia roseiflora McVaugh	L. Alencar 228 (US)	Amazon	Campinarana, várzea forest
Eugenia stictopetala Mart. ex DC.	Daly, DC 1007 (INPA)	Amazon, Caatinga, Cerrado, Atlantic Forest	Campinarana, rupestrian fields, cerrado (lato sensu), terra firme forest, ombrophilous forest (rainforest)
Eugenia stipitata McVaugh	Fróes, RL 32483 (IAN)	Amazon	Campinarana, terra firme forest, várzea forest
Eugenia subterminalis DC.	Souza, MAD de 109 (INPA)	Amazon, Caatinga, Cerrado, Atlantic Forest	Campinarana, seasonal evergreen forest, seasonal semideciduous forest, ombrophilous forest (rainforest), mixed ombrophilous forest
Eugenia campina Sobral & M.A.D.Souza	Anderson, AB 313 (INPA)	Amazon	Campinarana
Myrcia aliena McVaugh	Daly, DC 10612 (UFACPZ)	Amazon	Campinarana, terra firme forest, várzea forest
Myrcia amapensis McVaugh	Pires, MJ 592 (INPA)	Amazon	Campinarana, terra firme forest, restinga, amazonian savanna
Myrcia amazonica DC.	Souza, MAD 327 (IAN)	Amazon, Cerrado, Atlantic Forest	Campinarana, cerrado (lato sensu), riverine forest and/or gallery forest, terra firme forest, seasonal semideciduous forest, ombrophilous forest (rainforest)
* *Myrcia anceps* (Spreng.) O.Berg	Rocha, GPE 191 (UB)	Amazon, Atlantic Forest	Campinarana, seasonal semideciduous forest, ombrophilous forest (rainforest)
Myrcia bracteata (Rich.) DC.	Assunção, PACL 1657 (INPA)	Amazon, Cerrado	Campinarana, terra firme forest
Myrcia caudata (McVaugh) E.Lucas & C.E.Wilson	Sakagawa, S 439 (INPA)	Amazon	Campinarana, riverine forest and/or gallery forest, terra firme forest
Myrcia clusiifolia (Kunth) DC.	Holanda, ASS 372 (INPA)	Amazon	Campinarana, cerrado (lato sensu), terra firme forest
Myrcia crebra (McVaugh) A.R.Lourenço & E.Lucas	Lourenço, AR 339 (BHCB)	Amazon	Campinarana, terra firme forest, várzea forest
Myrcia cuprea (O.Berg) Kiaersk.	Conceição, LA 9 (IAN)	Amazon	Campinarana, restinga, amazonian savanna
Myrcia cuspidata (Mart. ex DC.) A.R.Lourenço & E.Lucas	Farroñay, FJ 1305 (INPA)	Amazon	Campinarana, igapó forest, terra firme forest, várzea forest
Myrcia decorticans DC.	Black, GA 18944 (IAN)	Amazon, Atlantic Forest	Campinarana, ombrophilous forest (rainforest), restinga
Myrcia deflexa (Poir.) DC.	Damasceno, B 18 (IAN)	Amazon, Cerrado	Campinarana, riverine forest and/or gallery forest, terra firme forest, seasonal evergreen forest
Myrcia eximia DC.	Coelho, C.A. 417 (INPA)	Amazon, Cerrado, Atlantic Forest	Campinarana, cerrado (lato sensu), ombrophilous forest (rainforest)
Myrcia florifera (McVaugh) Gaem & E.Lucas	Melo, A 885 (INPA)	Amazon	Campinarana, riverine forest and/or gallery forest, terra firme forest

Table 1. Continued.

Species	Herbarium voucher	Phytogeographic domain	Vegetation type
Myrcia gigas McVaugh	Junqueira, AB 881 (INPA)	Amazon	Campinarana, igapó forest, terra firme forest, várzea forest
Myrcia glabra (O.Berg) D.Legrand	Demarchi, LO 1330 (INPA)	Amazon, Atlantic Forest	Campinarana, ombrophilous forest (rainforest), restinga
Myrcia grandis McVaugh	Damasco, G 591 (INPA)	Amazon	Campinarana, terra firme forest
Myrcia guianensis (Aubl.) DC.	Souza, MAD 1640 (IAN)	Amazon, Caatinga, Cerrado, Atlantic Forest, Pantanal	Caatinga (stricto sensu), campinarana, rupestrian fields, cerrado (lato sensu), terra firme forest, seasonally deciduous forest, seasonal semideciduous forest, ombrophilous forest (rainforest), mixed ombrophilous forest, restinga
Myrcia hylobates (Standl. ex Amshoff) E.Lucas & K.Samra	Ferreira, CAC 10067 (CEN)	Amazon, Atlantic Forest	Campinarana, terra firme forest, ombrophilous forest (rainforest)
Myrcia inaequiloba (DC.) Lemée	Lima, DF 305 (INPA)	Amazon, Atlantic Forest	Campinarana, riverine forest and/or gallery forest, terra firme forest, várzea forest
Myrcia intonsa (McVaugh) B.Holst	Carvalho-Sobrinho, JG 1503 (INPA)	Amazon	Campinarana, terra firme forest
Myrcia megapaniculata A.R.Lourenço & Parraos.	Perigolo, NA 206 (IAN)	Amazon	Campinarana, terra firme forest, várzea forest
Myrcia multiflora (Lam.) DC.	Pires, MJ 662 (INPA)	Amazon, Caatinga, Cerrado, Atlantic Forest, Pampa	Anthropic area, rupestrian fields, campinarana, cerrado (lato sensu), terra firme forest, seasonal semideciduous forest, ombrophilous forest (rainforest), mixed ombrophilous forest
Myrcia neoforsteri A.R.Lourenço & E.Lucas	Lourenço, AR 339 (INPA)	Amazon	Campinarana, terra firme forest, várzea forest
Myrcia ovata Cambess.	Carvalho, FA de 1747 (INPA)	Amazon, Atlantic Forest	Campinarana, ombrophilous forest (rainforest), restinga
Myrcia paivae O.Berg	Gaem, PH 135 (UFSCar)	Amazon	Campinarana, terra firme forest, várzea forest
Myrcia platyclada DC.	Vicentini, A 1398 (SP)	Amazon	Campinarana, terra firme forest
Myrcia psammophila Gaem & Farroñay	Farroñay, FJ 1305 (INPA)	Amazon	Campinarana
Myrcia pyrifolia (Desv. ex Ham.) Nied.	Black, GA 18952 (IAN)	Amazon	Campinarana, terra firme forest, várzea forest
* *Myrcia racemosa* (O.Berg) Kiaersk.	Carvalho, FA de 1837 (INPA)	Amazon, Cerrado, Atlantic Forest	Anthropic area, campinarana, ombrophilous forest (rainforest), restinga
Myrcia rufipila McVaugh	Lisboa, P.L.B. 1403 (MG)	Amazon	Campinarana, terra firme forest
Myrcia saxatilis (Amshoff) McVaugh	Demarchi, LO 1377 (INPA)	Amazon	Campinarana, amazonian savanna
Myrcia servata McVaugh	Souza, MAD 506 (IAN)	Amazon	Campinarana, terra firme forest, várzea forest, amazonian savanna
Myrcia splendens (Sw.) DC.	Simon, MF 1005 (IAN)	Amazon, Caatinga, Cerrado, Atlantic Forest, Pantanal	Campinarana, rupestrian fields, cerrado (lato sensu), riverine forest and/or gallery forest, terra firme forest, seasonal evergreen forest, Seasonal semideciduous forest,ombrophilous forest (rainforest)
Myrcia sylvatica (G.Mey.) DC.	Mansano, VF 869 (IAN)	Amazon, Caatinga, Cerrado, Atlantic Forest	Campinarana, terra firme forest, várzea forest, ombrophilous forest (rainforest)
Myrcia tomentosa (Aubl.) DC.	UB 217225	Amazon, Caatinga, Cerrado, Atlantic Forest	Campinarana, caatinga (stricto sensu), high altitude grassland, rupestrian fields, cerrado (lato sensu), riverine forest and/or gallery forest, terra firme forest, várzea forest, seasonal semideciduous forest, ombrophilous forest (rainforest), restinga
Myrcia uaupensis (O.Berg) Gaem & E.Lucas	Krukoff, BA 7232 (SP)	Amazon	Campinarana, igapó forest, terra firme forest, ombrophilous forest (rainforest)
Myrcia umbraticola (Kunth) E.Lucas & C.E.Wilson	Campos, P 1230 (INPA)	Amazon	Campinarana, igapó forest, ombrophilous forest (rainforest)
Myrciaria dubia (Kunth) McVaugh	Pires, JM 6742 (IAN)	Amazon, Cerrado	Campinarana, várzea forest
Myrciaria floribunda (H.West ex Willd.) O.Berg	HBRA6158	Amazon, Caatinga, Cerrado, Atlantic Forest	Campinarana, rupestrian fields, cerrado (lato sensu), riverine forest and/or gallery forest, terra firme forest, várzea forest, seasonally deciduous forest, seasonal evergreen forest, Seasonal semideciduous forest, ombrophilous forest (rainforest), mixed ombrophilous forest, restinga
Psidium acutangulum DC.	Souza, MAD 1769 (IAN)	Amazon	Campinarana, várzea forest
Psidium guineense Sw.	Lourenço, AR 334 (INPA)	Amazon, Caatinga, Cerrado, Atlantic Forest	Campinarana, anthropic area, caatinga, high altitude grassland, rupestrian fields, cerrado, seasonal semideciduous forest, ombrophilous forest (rainforest)
Psidium guyanense Pers.	Coradin, L 120 (IAN)	Amazon, Cerrado	Campinarana, cerrado (lato sensu), terra firme forest, amazonian savanna
Psidium salutare (Kunth) O.Berg	Coradin, L 141 (IAN)	Amazon, Cerrado, Atlantic Forest	Campinarana,caatinga (stricto sensu), grassland, rupestrian fields, cerrado (lato sensu), seasonal semideciduous forest, mixed ombrophilous forest
Siphoneugena dussii (Krug & Urb.) Proença	Prance, GT 25051 (MO)	Amazon, Caatinga, Cerrado, Atlantic Forest	Campinarana, caatinga (stricto sensu), cerrado (lato sensu), terra firme forest, seasonal semideciduous forest

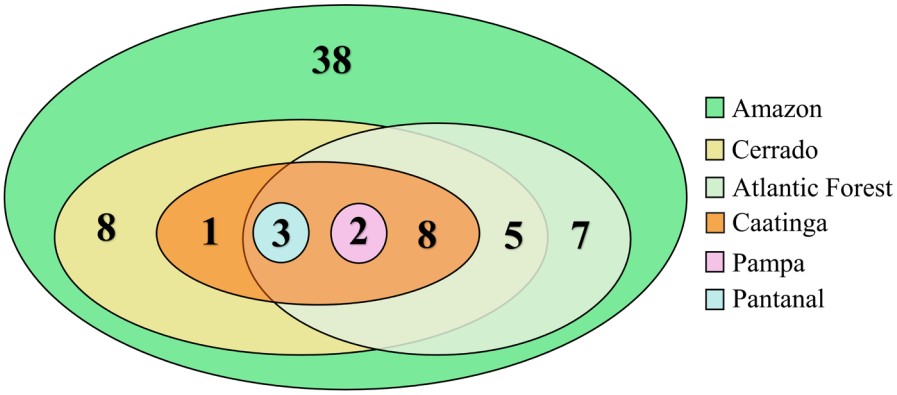

Figure 2. Venn diagram showing the number of Myrtaceae species shared among campinaranas of the Brazilian Amazon and other phytogeographic domains in Brazil.

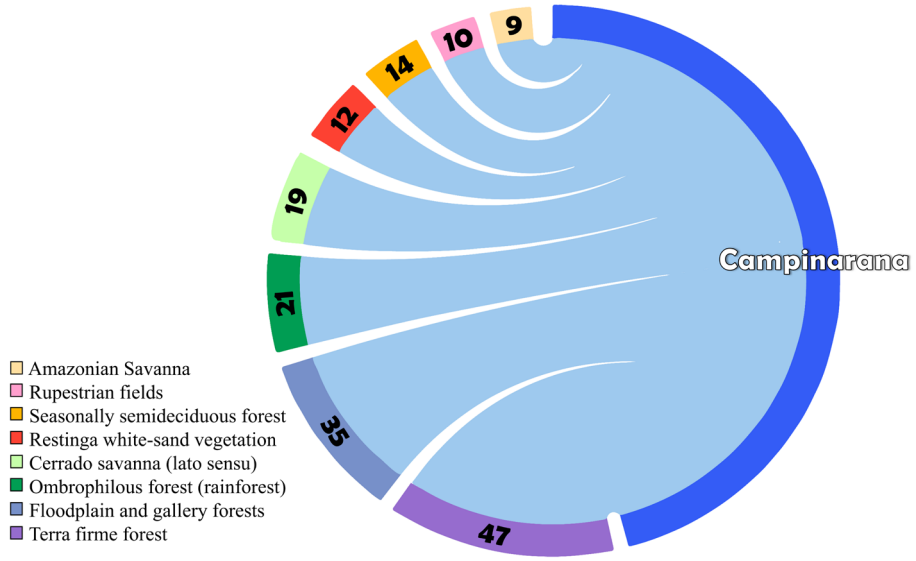

Figure 3. Diagram showing the occurrence of 72 Myrtaceae species found in campinaranas of the Brazilian Amazon and other Brazilian vegetation types. Each species occurred in one to eleven other vegetation types besides campinaranas.

DISCUSSION

Myrtaceae frequently occur in environments of the Amazonian phytogeographic domain with limiting conditions, such as savannas and restingas (Silva et al. 2010; Da Rocha and Da Costa Neto 2019; Da Silva e Silva et al. 2021). *Myrcia* and *Eugenia* were the genera with the highest richness of species recorded both in campinaranas (Ferreira 2009; Demarchi et al. 2022; this study) and restingas (Amaral et al. 2008; Silva et al. 2010; Lourenço and Barbosa 2012) in Brazil. However, our results indicate a higher number of Myrtaceae species in campinaranas than in Amazonian restingas (Amaral et al. 2008; Silva et al. 2010; Da Silva e Silva et al. 2021; Flora e Funga do Brasil (https://is.gd/VtfAvj) and Amazonian savannas (Magnusson et al. 2008; Da Rocha and Da Costa Neto 2019; Campos et al. 2021; Flora e Funga do Brasil (https://is.gd/07yG7L). This is likely related to the less hostile conditions of campinaranas compared to Amazonian savannas, which undergo seasonal fire regimes, and restingas, influenced by saline and windy coastal conditions.

The high number of species of Myrtaceae in campinaranas can also be associated with anatomical adaptations in this family that enable different mechanisms of colonization, establishment and development, conferring phenotypic plasticity to successfully resist limiting environmental conditions (Arruda et al. 2009; Melo Júnior and Torres Boeger 2015; Amorim and Melo Júnior 2017; Lemos et al. 2018; Gavilanes et al. 2020; Radersma et al. 2020; Amboni et al. 2022). For example, changes in leaf anatomy are decisive in the acclimatization capacity of species exposed to different environmental conditions (Donato and De Morretes 2009; Amorim and Melo Júnior 2017; Lemos et al. 2018). The

leaves of *Eugenia glazioviana* Kiaersk developed xeromorphic anatomical features in response to water stress (Esposito-Polesi et al. 2011) and similar results have been observed in *Eugenia luschnathiana* (O.Berg) Klotzsch ex B.D.Jacks. Also, morphological data of *Myrcia splendens* (Sw.) DC. (Amorim and Júnior 2016) and *Myrcia guianenses* (Aubl.) DC. (Lemos et al. 2020) showed that plasticity is an advantageous feature in response to certain abiotic factors, such as increased temperature and water deficit. The presence in campinaranas of species with a preference for oligotrophic soils, such as *E. hatschbachii*, *M. cuprea* and *M. saxatilis,* reinforces the existence of specialist species in these environments, as previously reported (Fine et al. 2010; Silva et al. 2010; Ferreira et al. 2013; Adeney et al. 2016; Daly et al. 2016; Fine and Baraloto 2016; García-Villacorta et al. 2016; Demarchi et al. 2022). Anatomical and physiological plasticity in plant species confers the ability to adjust and achieve high fitness under different environmental conditions (Sultan 2000) and provide insights into how species can deal with possible natural or anthropogenic climatic and environmental changes (Valladares et al. 2014).

The highest number of species recorded in the campinaranas of Amazonas and Roraima is likely related to the larger size of the campinarana areas and the greater number of floristic studies conducted in these states (Adeney et al. 2016). It is also notable that collections are concentrated in areas near the riverbanks (Figure 1), which helps to understand why these species are well distributed among the wetlands (Figure 3). However, this sampling concentration may mask the true richness of campinarana flora, since vegetation islands farther from the riverbank will have less influence from flooded areas, and other species may compose these landscapes (García-Villacorta et al. 2016; Demarchi et al. 2022).

Most species in our checklist are restricted to the Amazon phytogeographic domain (53%), corroborating that most woody species in the Amazon are endemic or rare (ter Steege et al. 2013). On the order hand, the greatest diversity of the family is concentrated in the Atlantic Forest (Santos et al. 2017), and plant species originating from Cerrado are often found in campinaranas (Guimarães and Bueno 2016). This scenario, combined with the high dispersal capacity of Myrtaceae (Gressler et al. 2006), justifies Cerrado and Atlantic Forest as the domains with the highest number of species shared with campinaranas. Campinaranas are embedded mainly in terra firme forests (Adeney et al. 2016), which probably explains why terra firme forest was the type of vegetation with the highest number of species shared with campinaranas. However, campinaranas are also expected to be strongly influenced by other vegetation types due to factors such as geographic proximity (Vicentini 2004; Adeney et al. 2016), variation in abiotic conditions within campinarana islands, such as the increase in temperature and decrease in humidity in more open physiognomies and variation in water table position (García Villacorda et al. 2016; Demarchi et al. 2018).

Little is known about the conservation status of Myrtaceae. For the two endemic species recorded in our study, only *E.campina* was evaluated for its preliminary conservation status, being classified as of Least Concern (LC) (De Souza and Sobral 2018). Species endemic to campinaranas were also recorded for Clusiaceae (Demarchi et al. 2021), Fabaceae (Rando and De Lima 2020) and Malvaceae (Guevara Andino and Fernández-Alonso 2018), highlighting the need for further floristic and taxonomic surveys to assess the species diversity and composition in this vegetation type.

CONCLUSIONS

We conclude that Myrtaceae species in Brazilian Amazonian campinaranas are mostly endemic to the Amazonian phytogeographical domain. Four species of Myrtaceae were recorded for the first time in the Brazilian Amazon. Some species are specialists in soils with limiting conditions and a significant portion has plastic anatomical and morphological characteristics, in addition to long-distance dispersal mechanisms, that favor occupation and survival in campinaranas. The specific richness of Myrtaceae (72 species) recoredd for Brazilian campinaranas is relatively high, but is probably underestimated, since extensive areas of campinaranas, especially those further away from riverbanks in the states of Amazonas and Roraima, have not yet been intensively surveyed. Therefore, we emphasize the need to know the floristic diversity of campinaranas (not only Myrtaceae) to identify areas of special interest for conservation.

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REFERENCES

Adeney, J.M.; Christensen, N.L.; Vicentini, A.; Cohn-Haft, M. 2016. White-sand ecosystems in Amazonia: What and where are white-sands. *Biotropica* 48: 7–23.

Amaral, D.D. do; Prost, M.T.; Bastos, M. de N. do C.; Neto, S.V.C.; Santos, J.U.M. dos. 2008. Restingas do litoral amazônico, estados do Pará e Amapá, Brasil. *Boletim do Museu Paraense Emílio Goeldi, Ciências Naturais* 3: 35–67.

Alvares, C.A.; Stap, J.L.; Sentalhes, P.C; Gonçalves, J.L.M; Sparovek, G. 2013 Koppen's climate classification map for Brazil. *Meteorologische Zeitschrift* 22: 711-728. doi:10.1127/0941-2948/2013/0507.

Amboni, A.; Soffiatti, P.; Melo Júnior, J.C.F. de. 2022. Structural adjustment of *Schwartzia brasiliensis* (Marcgraviaceae) in two restinga formations. *Rodriguésia* 73: e00342022.

Amorim, M.W.; Júnior, J.C.F. de M. 2016. Plasticidade morfológica de *Myrcia splendens* (S.w.) CD. (Myrtaceae) ocorrente em Mata Atlântica e Cerrado. *Iheringia* 71: 261–268.

Amorim, M.W.; Melo Júnior, J.C.F. de. 2017. Plasticidade morfoanatômica foliar de *Tibouchina clavata* (Melastomataceae) ocorrente em duas formações de restinga. *Rodriguésia* 68: 545–555.

Anderson, A. B.; Prance, G.T.; Albuquerque, B.W.P. 1975. Estudos sobre a vegetação das campinas amazônicas. *Acta Amazonica* 6: 193–211.

Arruda, R. do C. de O.; Viglio, N.S.F.; Barros, A.A.M. de. 2009. Anatomia foliar de halófitas e psamófilas reptantes ocorrentes na Restinga de Ipitangas, Saquarema, Rio de Janeiro, Brasil. *Rodriguésia* 60: 333–352.

Atwell, M.A.; Wuddivira, M.N.; Fiedler, S.; Oatham, M.; Herrmann L.; Glasner, B.; et al. 2023. Influence of soil geomorphic factors on vegetation patterns in a model white sands ecosystem complex. *Catena* 225: 107044. doi: 10.1016/j.catena.2023.107044

Campos, A.C. de Souza; Costa-Neto, S.V. da; Jardim, M.A.G. 2021. Floristica, estrutura e formas de vida da regeneração de uma savana amazônica, Pará, Brasil. *Revista Brasileira de Geografia* 2: 758–769.

Da Rocha, A.E.S.; Da Costa Neto, S.V. 2019. Florística e fitossociologia do estrato herbáceo/arbustivo em 19 áreas de savanas amazônicas, Brasil. *Boletim do Museu Paraense Emílio Goeldi - Ciências Naturais* 14: 159–181.

Da Silva e Silva, W.L.; da Silva, M.F.; do Amaral, D.D.; de Nazaré Lima do Carmo, M.; Gurgel, E.S.C.; dos Santos, J.U.M. 2021. Checklist of angiosperms in the restingas of Pará state, Brazil, with comments on floristic affinities and phytophysiognomies. *Rodriguesia* 72: e01532019.2021

Da Silva, R.M.; Reis, Â.C.A.; Mehlig, U. 2018. Diversity and dominance patterns in Amazon coast dune forest island tree communities. *Plant Ecology* 219: 343–357.

Daly, D.C.; Silveira, M.; Medeiros, H.; Castro, W.; Obermüller, F.A. 2016. The white-sand vegetation of Acre, Brazil. *Biotropica* 48: 81–89.

De Souza, M.A.D.; Sobral, M. 2018. Six new *Eugenia* (Myrtaceae) from Amazonas, Brazil. *Phytotaxa* 349: 18-30.

Demarchi, L.O.; Klein, V.P.; Aguiar, D.P.P.; Marinho, L.C.; Ferreira, M.J.; Lopes, A.; et al. 2022. The specialized white-sand flora of the Uatumã Sustainable Development Reserve, central Amazon, Brazil. *Check List* 18: 187–217.

Demarchi, L.O.; Piedade, M.T.F.; Marinho, L.C. 2021. *Tovomita cornuta* (Clusiaceae): a new and threatened species from the Amazonian campinaranas revealed by ecological field research. *Acta Botanica Brasilica* 35: 554–561.

Demarchi, L.O.; Scudeller, V.V.; Moura, L.C.; Dias-Terceiro, R.G.; Lopes, A.; Wittmann, F.K.; et al. 2018. Floristic composition, structure and soil-vegetation relations in three white-sand soil patches in central Amazonia. *Acta Amazonica* 48: 46-56.

Donato, A.M.; De Morretes, B.L. 2009. Foliar anatomy of *Eugenia florida* DC. (Myrtaceae). *Revista Brasileira de Farmacognosia* 19: 759–770.

Esposito-Polesi, N.P.; Rodrigues, R.R.; Almeida, M. de. 2011. Anatomia ecológica da folha de *Eugenia glazioviana* Kiaersk (MYRTACEAE). *Revista Árvore* 35: 255–263.

Ferreira, C.A.C. 2009. *Análise comparativa de vegetação lenhosa do ecossistema campina na Amazônia brasileira*. Doctoral thesis, Universidade Federal do Amazonas, Brazil, 277p. (https://repositorio.inpa.gov.br/handle/1/12804).

Ferreira, L. V; Chaves, P.P.; Cunha, D.A.; Rosário, A.S.; Parolin, P. 2013. A extração ilegal de areia como causa do desaparecimento de campinas e campinaranas no estado do Pará, Brasil. *Pesquisas, Botânica* 64: 157–173.

Ferreira, L.V.; Chaves, P.P.; Cunha, D. A.; Parolin, P. 2014. Florística e estrutura das campinaranas do Baixo Rio Tocantins como subsídio para a criação de novas unidades de conservação no Estado do Pará. *Pesquisas* 65: 169–182.

Fine, P.V.A.; Baraloto, C. 2016. Habitat endemism in white-sand forests: Insights into the mechanisms of lineage diversification and community assembly of the Neotropical flora. *Biotropica* 48: 24–33.

Fine, P.V.A.; Garca-Villacorta, R.; Pitman, N.C.A.; Mesones, I.; Kembel, S.W. 2010. A floristic study of the white-sand forests of Peru. *Annals of the Missouri Botanical Garden* 97: 283–305. Gaem, P.H.; Farroñay, F.; Mazine, F.F.; Vicentini, A. 2019. *Myrcia psammophila* (Myrtaceae), a new species from the Amazonian white-sand vegetation. *Phytotaxa* 414: 253–261.

García-Villacorta, R.; Dexter, K.G.; Pennington, T. 2016. Amazonian white-sand forests show strong floristic links with surrounding oligotrophic habitats and the Guiana Shield. *Biotropica* 48: 47–57.

Gavilanes, M.L.; Silva, A.M. da; Dias, M.V. de F.; Oliveira, J.A. de; Corrêa, F.F.; Rodrigues, L.C. de A.; et al. 2020. Leaf structure of *Byrsonima coccolobifolia* Kunth. (Malpighiaceae) in a savannah and rupestrian field environment. *Research, Society and Development* 9: e14991210077.

Gressler, E.; Pizo, M.A.; Morellato, L.P.C. 2006. Polinização e dispersão de sementes em Myrtaceae do Brasil. *Revista Brasileira de Botânica* 29: 509–530.

Guevara Andino, J.E.; Fernández-Alonso, J.L. 2018. A remarkable new species of *Pachira* (Malvaceae: Bombacoideae) from an Amazonian hotspot of endemism. *Systematic Botany* 43: 993–999.

Guimarães, F.S.; Bueno, G.T. 2016. As campinas e campinaranas amazônicas/The amazonian campinas and campinaranas. *Caderno de Geografia* 26: 113-133.

INMET. 2024. Instituto Nacional de Meteorologia. Dados de estações convencionais do Banco de Dados Meterologicos do INMET. (https://bdmep.inmet.gov.br/). Accessed on 15 Jan 2024.

Lemos, V. de O.T.; de Lucena, E.M.P.; Bonilla, O.H.; Edson-Chaves, B. 2019. Ecological anatomy of *Eugenia punicifolia* (Kunth) dc. (Myrtaceae) in the restinga region, state of Ceará. *Revista Brasileira de Fruticultura* 41: 1–11. doi: 10.1590/0100-29452019503

Lemos, V. de O.T.; de Lucena, E.M.P.; Bonilla, O.H.; Edson-Chaves, B.; Freitas, M.A. 2020. Ecological anatomy of *Myrcia*

guianensis (Aubl.) DC. leaf in restinga in Ceará state. *Ciencia Florestal* 30: 307–322.

Lemos, V. de O.T.; Lucena, E.M.P. de; Bonilla, O.H.; Edson-Chaves, B.; Castro, M.A. de; Sampaio, V. da S. 2018. Ecological anatomy of *Eugenia luschnathiana* (O.Berg) Klotzsch ex B.D.Jacks. (Myrtaceae) leaves in the Restinga region, state of Ceara. *Revista Brasileira de Fruticultura* 40: e-696.

Lourenço, A.R. de L.; Barbosa, M.R. de V. 2012. Myrtaceae em restingas no limite norte de distribuição da Mata Atlântica, Brasil. *Rodriguésia* 63: 373–393.

Magnusson, W.E.; Lima, A.P.; Albernaz, A.L.K.M.; Sanaiotti, T.M.; Guillaumet, J.-L. 2008. Composição florística e cobertura vegetal das savanas na região de Alter do Chão, Santarém - PA. *Revista Brasileira de Botânica* 31: 165-177.

Melo Júnior, J.C.F.; Torres Boeger, M.R. 2015. Leaf traits and plastic potential of plant species in a light-edaphic gradient from restinga in Southern Brazil. *Acta Biológica Colombiana* 21: 51-62.

Mendonça, B.A.F. de; Fernandes Filho, E.I.; Schaefer, C.E.G.R.; Simas, F.N.B.; Paula, M.D. de. 2015. Os solos das campinaranas na Amazônia brasileira: ecossistemas arenícolas oligotróficos. *Ciência Florestal* 25: 827–839.

Oliveira-Filho, A.T.; Dexter, K.G.; Pennington, R.T.; Simon, M.F.; Bueno, M.L.; Neves, D.M. 2021. On the floristic identity of Amazonian vegetation types. *Biotropica* 53: 767–777.

Radersma, R.; Noble, D.W.A.; Uller, T. 2020. Plasticity leaves a phenotypic signature during local adaptation. *Evolution Letters* 4: 360–370.

Rando, J.G.; De Lima, H.C. 2020. A new arborescent *Chamaecrista* (Leguminosae) from Amazon, Brazil. *Phytotaxa* 433: 161–166.

Silva, R.M. da; Mehlig, U.; Santos, J.U.M. dos; Menezes, M.P.M. de. 2010. The coastal restinga vegetation of Pará, Brazilian Amazon: a synthesis. *Brazilian Journal of Botany* 33: 563–573.

Silveira, M. 2003. V*egetação e Flora das Campinaranas do Sudoeste Amazônico.* Unpublished technical scientific report to SOS Amazônia, New York Botanical Garden, New York, 26p. (https://www.nybg.org/bsci/acre/pdfs/VegetacaoeFloraCampinaranas.pdf).

Sultan, S.E. 2000. Phenotypic plasticity for plant development, function and life history. *Trends in Plant Science* 5: 537–542.

Santos, M.F.; Lucas, E.; Sano, P.T; Buerki, S.; Staggemeier, V.G; Forest, F. 2017. Biogeographical patterns of *Myrcia* s.l. (Myrtaceae) and their correlation with geological and climatic history in the Neotropics. *Molecular Phylogenetics and Evolution* 108: 34-48

ter Steege, H.; Pitman, N.C.A.; Sabatier, D.; Baraloto, C.; Salomão, R.P.; Guevara, J.E.; et al. 2013. Hyperdominance in the Amazonian tree flora. *Science* 342: 1243092

Thiers, B. 2023. [continuously updated]. 2023. Index Herbariorum: A global directory of public her baria and associated staff. New York Botanical Garden's Virtual Herbarium. (http://sweetgum.nybg.org/scence/ih/). Accessed on 09 Feb 2023.

Vicentini, A. 2004. A vegetação ao longo de um gradiente edáfico no Parque Nacional do Jaú. In: Borges, S.H.; Iwanaga, S.; Durigan, C.C.; Pinheiro, M.R. (Eds.). *Janelas Para a Biodiversidade no Parque Nacional do Jaú: Uma Estratégia Para o Estudo da Biodiversidade na Amazônia.* Fundação Vitória Amazônica (FVA), WWF, IBAMA, Manaus, p.117-143.

Valladares, F.; Matesanz, S.; Guilhaumon, F.; Araújo, M.B.; Balaguer, L.; Benito-Garzón, M.; et al. 2014. The effects of phenotypic plasticity and local adaptation on forecasts of species range shifts under climate change. *Ecology Letters* 17: 1351–1364.

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DATA AVAILABILITY: All data supporting the results of this study have been published in this article. All species records mentioned have a voucher number listed in Table 1 and can be accessed at https://specieslink.net/ or in the respective herbaria. The coordinates of each locality and species per locality are in the supplementary material

SUPPLEMENTARY MATERIAL

Natividade et al. Checklist and geographic distribution of Myrtaceae species occurring in campinaranas of the Brazilian Amazon

Table S1. Species of Myrtaceae recorded in each of 27 localities of campinarana in six states of the Brazilian Amazon.

State	Municipality	Coordinates	Species
Acre	Mâncio Lima	7°35'36.0"S, 72°56'08.4"W	*Eugenia patens*
			Myrcia aliena
			Myrcia bracteata
			Myrcia hylobates
	Rio Branco	9°51'25.2"S, 67°35'11.7"W	*Eugenia pusilliflora*
			Myrcia guianensis
			Myrciaria floribunda
Amapá	Oiapoque	3°49'55.3"N, 51°47'27.3"W	*Psidium acutangulum*
Amazonas	Apuí	7°12'00.6"S, 59°54'00.8"W	*Eugenia hatschbachii*
			Eugenia moschata
	Barcelos	0°27'53.5"N, 63°28'31.1"W	*Calycolpus calophyllus*
			Eugenia citrifolia
			Eugenia egensis
			Eugenia gomesiana
			Eugenia punicifolia
			Myrcia bracteata
			Myrcia clusiifolia
			Myrcia gigas
			Myrcia grandis
			Myrcia intonsa
			Myrcia racemosa
			Myrcia saxatilis
			Myrcia servata
			Myrcia splendens
			Myrcia sylvatica
			Myrcia umbraticola
	Humaitá	7°31'11.5"S, 63°01'00.5"W	*Eugenia calva*
			Eugenia florida
			Eugenia omissa
			Myrcia splendens
			Myrcia uaupensis
	Iranduba	3°15'40.8"S, 60°11'01.1"W	*Eugenia biflora*
			Eugenia punicifolia
			Myrcia amazonica
			Myrcia psammophila
			Myrcia umbraticola
	Jutaí	2°49'15.2"S, 66°41'40.3"W	*Myrcia bracteata*
	Machadinho	8°53'55.9"S, 61°58'32.6"W	*Myrcia splendens*
			Psidium acutangulum
	Manaus	2°48'46.7"S, 59°52'34.6"W	*Calycolpus goetheanus*
			Calycolpus revolutus
			Eugenia biflora
			Eugenia calva
			Eugenia campina
			Eugenia inundata
			Eugenia moschata
			Eugenia patrisii
			Eugenia protenta
			Eugenia punicifolia
			Eugenia subterminalis
			Eugenia stictopetala
			Myrcia amazonica
			Myrcia bracteata
			Myrcia caudata
			Myrcia clusiifolia
			Myrcia cuspidata
			Myrcia eximia
			Myrcia guianensis
			Myrcia multiflora
			Myrcia paivae
			Myrcia platyclada
			Myrcia saxatilis
			Myrcia servata
			Myrcia splendens
			Myrcia sylvatica
			Myrcia umbraticola
	Manicoré	5°52'58.9"S, 61°14'31.5"W	*Myrcia umbraticola*
	Presidente Figueiredo	2°01'32.7"S, 60°02'39.4"W	*Eugenia biflora*
			Eugenia caducipetala
			Eugenia moschata
			Eugenia protenta
			Eugenia stictopetala
			Myrcia caudata
			Myrcia clusiifolia
			Myrcia grandis
			Myrcia guianensis
			Myrcia intonsa
			Myrcia saxatilis
			Myrcia splendens
			Myrcia umbraticola
	Santa Isabel do Rio Negro	0°12'12"S, 65°07'34"W	*Eugenia egensis*
			Eugenia gomesiana
			Eugenia moschata
			Eugenia punicifolia
			Myrcia grandis
			Myrcia inaequiloba
			Myrcia saxatilis
			Myrcia sylvatica
			Myrcia uaupensis
			Myrcia umbraticola
	São Gabriel da Cachoeira	0°12'00.2"N, 67°33'08.5"W	*Eugenia roseiflora*
			Myrcia ovata
			Myrcia racemosa
			Myrcia splendens
	São Sebastião do Uatumã	2°35'18.9"S, 58°01'06.2"W	*Eugenia biflora*
			Myrcia clusiifolia
			Myrcia glabra
			Myrcia grandis
			Myrcia guianensis
			Myrcia saxatilis
			Myrcia splendens
Pará	Almeirim	0°43'12.6"S, 52°31'11.7"W	*Eugenia punicifolia*
			Myrcia amapensis
			Myrcia cuprea
			Myrcia multiflora
			Myrcia splendens
	Alter do Chão	2°25'26.7"S, 54°48'37.3"W	*Eugenia biflora*
			Eugenia punicifolia

Table S1. Continued.

State	Municipality	Coordinates	Species
			Myrcia guianensis
			Myrcia multiflora
			Siphoneugena dussii
	Bragança	1°04'03.0"S, 46°43'34.0"W	*Myrcia cuprea*
			Myrcia guianensis
	Martins Pinheiro	0°46'51.8"S, 47°33'26.2"W	*Eugenia punicifolia*
			Myrcia bracteata
			Psidium guineense
			Psidium guyanense
			Psidium salutare
	Novo Progresso	7°08'52.0"S, 55°22'52.0"W	*Myrcia guianensis*
			Myrcia tomentosa
	Oriximiná	1°39'25.6"S, 56°00'42.6"W	*Eugenia biflora*
			Eugenia campina
			Eugenia punicifolia
			Myrcia amazonica
			Myrcia bracteata
			Myrcia guianensis
			Myrcia pyrifolia
			Myrcia servata
			Myrcia splendens
			Myrcia sylvatica
	Porto de Moz	1°45'01.5"S, 52°13'31.8"W	*Eugenia stipitata*
			Myrcia multiflora
	Tucuruí	3°44'09.2"S, 49°44'07.3"W	*Calycolpus goetheanus*
			Eugenia biflora
			Eugenia gomesiana
			Eugenia moschata
			Eugenia patens
			Eugenia patrisii
			Eugenia protenta
			Eugenia punicifolia
			Eugenia stictopetala
			Myrcia amazonica
			Myrcia guianensis
			Myrcia inaequiloba
			Myrcia multiflora
			Myrcia rufipila
			Myrcia splendens
			Myrcia sylvatica
			Myrcia tomentosa
	Vigia de Nazaré	0°49'32.2"S, 48°06'25.2"W	*Calycolpus goetheanus*
			Eugenia biflora
			Eugenia punicifolia
			Myrcia amazonica
			Myrcia bracteata
			Myrcia cuprea
			Myrcia decorticans
			Myrcia deflexa
			Myrcia pyrifolia
			Myrcia splendens
			Myrcia sylvatica
			Myrciaria dúbia
			Psidium guineense
Rondônia	Abunã	9°38'32.0"S, 65°02'42.0"W	*Myrcia megapaniculata*
			Psidium acutangulum
	Porto Velho	8°39'18.5"S, 63°56'51.8"W	*Calycolpus roraimensis*
			Eugenia florida
			Myrcia amazonica
			Myrcia anceps
			Myrcia caudata
			Myrcia cuspidata
			Myrcia megapaniculata
			Myrcia splendens
Roraima	Caracaraí	1°50'29.0"N, 61°07'40.0"W	*Blepharocalyx eggersii*
			Blepharocalyx salicifolius
			Calycolpus calophyllus
			Calycolpus goetheanus
			Eugenia egensis
			Eugenia florida
			Eugenia gomesiana
			Eugenia patrisii
			Myrcia clusiifolia
			Myrcia crebra
			Myrcia florifera
			Myrcia grandis
			Myrcia guianensis
			Myrcia inaequiloba
			Myrcia neoforsteri
			Myrcia pyrifolia
			Myrcia saxatilis
			Myrcia splendens
			Myrcia umbraticola
			Myrciaria floribunda
			Psidium guineense