

SOLANACEAE IN THE GRUMARI RESTINGA, RJ: FLORISTIC AND SIMILARITY

Eliza Christina do Nascimento Melo¹
Rosana Conrado Lopes²

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ABSTRACT

The Neotropical region has the major diversity of Solanaceae. In Brazil, most of them occur in the Atlantic Forest, especially in the southeast region. The Grumari restinga is one of the few well preserved areas in Rio de Janeiro city. This study aims for the floristic survey of Solanaceae species in Grumari restinga and the floristic similarity evaluation among other restingas of the Rio de Janeiro state, based on the family. All the collections were deposited in RFA herbarium. Descriptions, comments and a key to identification are presented. The family is represented by ten native species, *Athenaea fasciculata*, *Cestrum axillare*, *Solanum americanum*, *S. argenteum*, *S. caavurana*, *S. capsicoides*, *S. cordifolium*, *S. jussiaei*, *S. mauritianum* and *S. paniculatum*. A new occurrence is registered for *Solanum argenteum*. Twelve restingas, including Grumari, were compared by ordination and cluster analyses, using Sørensen coefficient and UPGMA. Mantel Test was performed to verify the influence between geographic distance and species distribution. The dendrogram grouped Grumari and Marambaia with 58% of similarity. All restingas of the Coastal Lowland region were aggregated in the cluster and ordination analyses. The Mantel test showed that the geographic distance affects species distribution. These results contribute to assist conservation and restoration works.

Keywords: Atlantic Forest domain, species distribution, taxonomy

RESUMO

A região Neotropical possui a maior diversidade de Solanaceae. No Brasil, a maioria ocorre na Mata Atlântica, principalmente na região sudeste. A restinga de Grumari é uma das poucas áreas ainda bem preservadas da cidade do Rio de Janeiro. Este estudo tem como objetivo o levantamento florístico das espécies de Solanaceae da restinga de Grumari, Rio de Janeiro, e a avaliação da similaridade florística entre outras restingas do estado, baseado na família. Todas as coletas foram depositadas no herbário RFA. Descrições, comentários e uma chave de identificação são apresentados. A família é representada por dez espécies nativas, *Athenaea fasciculata*, *Cestrum axillare*, *Solanum americanum*, *S. argenteum*, *S. caavurana*, *S. capsicoides*, *S. cordifolium*, *S. jussiaei*, *S. mauritianum* e *S. paniculatum*. Nova ocorrência é registrada para *Solanum argenteum*. Doze restingas, incluindo Grumari, foram comparadas pelas análises de ordenação e agrupamento, usando o coeficiente de Sørensen e UPGMA. Teste de Mantel foi realizado para verificar a correlação entre a distância geográfica e a distribuição de espécies. O dendrograma agrupou Grumari e Marambaia com 58% de similaridade. Todas as restingas da região da baixada litorânea agruparam-se nas análises de agrupamento e de ordenação. O teste

1 Bacharel em Ciências Biológicas – Biologia Vegetal, Mestranda no Programa de Pós-Graduação em Ciências Biológicas (Botânica), Museu Nacional, Universidade Federal do Rio de Janeiro, 20940-040, Rio de Janeiro, RJ, Brazil; elizacnmelo@gmail.com

2 Doutora em Botânica, Professora Associada no Laboratório Integrado de Sistemática Vegetal, Departamento de Botânica, Instituto de Biologia, Universidade Federal do Rio de Janeiro, 21941-490, Rio de Janeiro, RJ, Brazil; rclopespecial@gmail.com

de Mantel mostrou que a distância geográfica influencia na distribuição das espécies. Estes resultados contribuem para auxiliar trabalhos de conservação e restauração.

Palavras-chave: domínio Mata Atlântica, distribuição de espécies, taxonomia

INTRODUCTION

Solanaceae A.Juss. includes approximately 100 genera and 2500 species (Olmstead, 2013), divided in seven subfamilies (Olmstead *et al.*, 2008). The origin and diversification of the group occurred in South America, with the subsequent dispersion to other parts of the world (Olmstead, 2013). The Neotropical region is responsible for its major diversity and endemism (Hunziker, 2001; Olmstead, 2013).

The species have several habits, from annual herbs to small perennial trees, and even lianas and hemiepiphytes. Trichomes are an important character that can be used to separate some taxa (Metcalf & Chalk, 1957). Its leaves are simple, alternate, without stipules. The flowers are generally exuberant and its fruits, berry or capsule, frequently exhibit attractive colors in maturity (Hunziker, 2001).

In Brazil, the family has wide distribution, with 35 genera and about 499 species. Mostly occurs in the Atlantic Forest, in the southeast region. Only for Rio de Janeiro state, it is represented by 19 genera and 173 species (Flora do Brasil 2020, 2020), of which 38 are indicated to restinga vegetation (Bárbara & Carvalho, 1996).

Restingas are coastal sandy areas that comprise a diversified vegetation zone, represented mostly by pioneer species, adapted to a nutrient poor soil and high salinity (CONAMA, 1999). These regions exhibit great biodiversity and endemic species (Scarano, 2002). Some Solanaceae are endemic to the Brazilian restingas but, unfortunately, these localities have been suffering with the uncontrolled human interference and the real-estate speculation (Rocha *et al.*, 2007).

Many works about the restingas of Rio de Janeiro state are found in the literature (e.g.: Araujo, 2000; Assumpção & Nascimento, 2000; Costa & Dias, 2001; Menezes *et al.*, 2005). *Despite this, the localities of Jurubatiba and Maricá are the most studied (Rocha et al., 2007).* For Solanaceae, a preliminary list of species was published by Bárbara & Carvalho (1996).

The present study aims for the floristic survey of Solanaceae species in Grumari restinga, Rio de Janeiro, and the floristic similarity evaluation among other restingas of the state, based on the family.

MATERIAL AND METHODS

Study area

The Grumari restinga (23°02'46.5"S; 43°31'45.8"W), is located in the western zone of Rio de Janeiro city (Fig. 1). With an area about 140 ha (Rocha *et al.*, 2007), it belongs to the Grumari Municipal Natural Park, forming a continuum with the Pedra Branca State Park, a remnant area of dense rainforest. The site frequently receives human impacts, even in an area of environmental protection (PMRJ, 2012). However, it is one of the few areas well preserved in the city (Argôlo, 2001).

Unlike other restingas of the state, Grumari is characterized by a closed shrubby vegetation that increases in size until the forest. Six vegetation formations are found in the area: halophilous, psammophilous, post-beach, open shrub, closed shrub, and restinga forest (Moreira *et al.*, 2014), associated with a lagoon and a river, Lagoa Feia and Rio do Mundo, respectively. The mean temperature and total precipitation for the region are 23.6 °C and 1550 mm, respectively (PMRJ, 2012).

In an attempt to know the local flora, the project “Floristic diversity in Grumari restinga, Rio de Janeiro, Brazil” was created in 2006. Since then, all collected specimens are deposited in RFA herbarium (Thiers [continuously updated]).

Taxonomy and floristic

Collections were made once per month, from June/2016 to July/2017, in the study area, using a random walking method (Figueiras *et al.*, 1994). All the collected material was fertile, being processed according to Peixoto & Maia (2013), deposited in the RFA herbarium and identified at species level.

Species identification was made with specific literature for the family and the restingas of the Rio de Janeiro state. Material from the R, RB and RFA herbaria were also analyzed (herbarium acronyms follow Thiers [continuously updated]). Finally, descriptions, information, comments and a key to identification are presented here. The terminology adopted here is according to Radford *et al.* (1974).

Similarity analysis

Twelve restingas of Rio de Janeiro state (Fig. 1), including Grumari, were compared in the analysis (Tab. 1). To facilitate data understanding, the restingas were separated according to their region in the Rio de Janeiro state (Tab. 1). Data was acquired from floristic lists (Silva & Oliveira, 1989; Bárbara & Carvalho, 1996; Araujo, 2000; Assumpção & Nascimento, 2000; Costa & Carvalho, 2001; Braga, 2004; Conde *et al.*, 2005; Araujo *et al.*, 2009) and, to avoid overestimation, complemented with recent information available in the Reflora Virtual Herbarium (2020). A binary matrix of presence/absence species were compiled based on these information (Tab. 2). Taxa without identification at species level were not considered.

The localities were compared by cluster analysis using Sørensen coefficient and the Unweighted Pair Group Method with Arithmetic Averages (UPGMA) (Legendre & Legendre, 1998), in the software Fitopac 2.1 (Shepherd, 2010). The Factorial Correspondence Analysis (FCA) was also performed to verify data variation (Valentin, 2012). The species acronyms were made linking the three first letters of the genus and the specific epithet.

The Outliers analysis was made in the software PCOrd 4.1 (McCune & Mefford, 1999) with a cutoff level of 2.0.

The Mantel Test was performed to verify the correlation between geographic distance and species distribution (Legendre & Legendre, 1998). It was also performed in Fitopac 2.1, using matrices of geographical coordinates and species presence/absence, with 1000 permutations.

RESULTS AND DISCUSSION

Taxonomy and floristic

The Solanaceae family is represented by ten native species in the Grumari restinga (Tab. 3). Eight belong to the genus *Solanum* L. whereas *Athenaea* Sendtn. and *Cestrum* L. have one species each. New occurrence is registered for *Solanum argenteum* Dunal in the area. All collected species are shrubs, except for the herbaceous *Solanum americanum* Mill. *Solanum jussiaei* Dunal is extremely heliophyte and just occurs in the open shrub formation.

Key to identification of the species of Solanaceae in Grumari restinga

1. Glabrous or glabrescent leaves.

2. Oblanceolate leaves. Abaxial main vein pronounced, with a different color from the blade. Yellow or light-green tubular-hypocrateriform flowers.....2. *Cestrum axillare*
- 2'. Elliptical leaves. Abaxial main vein pronounced or not, with a similar color to the blade. White stellate flowers.
3. Fasciculiform inflorescence. White flowers with green marks. Calyx apex acuminate. Anthers with longitudinal dehiscence 1. *Athenaea fasciculata*
- 3'. Helicoid cyme inflorescence. White flowers without marks. Calyx apex ovate-apiculate. Anthers with poricidal dehiscence.....5. *Solanum caavurana*
- 1'. Pubescent leaves, in one or both faces.
4. Unarmed plants.
5. Alternate spiral leaves. Trichomes in both faces of the leaf. Stellate trichomes. Violet flowers.....9. *Solanum mauritianum*
- 5'. Alternate distichous leaves. Trichomes in one or both faces of the leaf. Simple or peltate trichomes. White flowers.
6. Herbs. Leaves with simple trichomes in both faces 3. *Solanum americanum*
- 6'. Shrubs. Silvery peltate trichomes only in the abaxial face, adaxial glabrous
.....4. *Solanum argenteum*
- 4'. Armed plants.
7. Simple craspedodromous venation.
8. Acicular prickles. Multicellular acicular trichomes on leaves, in abundance at the margin. Glabrous fruit with strong orange color6. *Solanum capsicoides*
- 8'. Curved prickles. Glandular trichomes on leaves. Pubescent fruit with green color 7. *Solanum cordifolium*
- 7'. Brochidodromous and/or mixed craspedodromous venation.
9. Alternate distichous leaves. Scorpioid cyme inflorescence, sometimes branched. Calyx 3-5 mm diam., apex short triangular..... 8. *Solanum jussiaei*
- 9'. Alternate spiral leaves. Dichasial inflorescence. Calyx 7-10 mm diam., apex acuminate10. *Solanum paniculatum*

1. *Athenaea fasciculata* (Vell.) I.M.C. Rodrigues & Stehmann, Taxon 68(4): 841. 2019.
Fig. 2C-D.

Shrubs or trees, unarmed; branches glabrous. Leaves green discolorous, isolate and geminate; petiole 0.7-1.2 cm long; blade subchartaceous, 4-7.7 x 1.5-2.3 cm, elliptic, base cuneate to slightly oblique, margin entire, apex acute to acuminate; abaxial main vein pronounced, green similar to the blade, venation brochidodromous; presence of simple trichomes in both faces, adaxial blade glabrous, trichomes just on the main vein, abaxial face glabrescent. Inflorescence fasciculiform, axillary, 1-1.5 cm long. Floral buttons light green. Flowers pedicelate; calyx green, campanulate, 4-8 mm diam., apex acuminate, persistent; corolla white with green marks, stellate, 1.4-2 cm diam.; stamens 5, 4-5 mm long; filaments white; anthers brownish, oblong, longitudinal dehiscence; ovary subglobose, axile placentation; style white; stigma dark-green, discoid; presence of nectary disk. Berry green, globose, ca. 1 cm diam., fruiting calyx not accrescent, glabrous. Seeds not observed.

Selected material: RIO DE JANEIRO: Rio de Janeiro, Restinga de Grumari, 27.VI.2005, fr., A.A.M. de Barros 2487 (RB); borda da restinga para rua Santa Beatriz, 07.III.2017, fl., E.C.N. Melo 18 (RFA).

Distribution: Brazil: AC, AL, BA, DF, ES, MG, PA, PE, PR, RJ, RS, SC, SP. Argentina, Bolivia, Paraguay and Peru (Rodrigues *et al.*, 2019).

Flowering & Fruiting: Flowering in February, March, May and November. Fruiting in May and June.

Comments: Until recently, this species was placed in the genus *Aureliana* Sendtn. (Rodrigues *et al.*, 2019). It can be easily identified through its stellate white flowers with green details and anthers with longitudinal dehiscence. When dry, *Athenaea fasciculata* can be mistaken with *Solanum caavurana*. The anthers dehiscence, calyx shape and inflorescence type differentiate both species. It can be found in the closed shrub vegetation and restinga forest.

2. *Cestrum axillare* Vell., Fl. Flumin. 101. 1829. Ic. 3, tab. 6. 1831. Fig. 2A-B.

Scandent shrubs, unarmed; branches glabrous. Leaves green discolorous, isolate, distichous; petiole 1.8-2.2 cm long; blade chartaceous, 12.5-8.8 x 3.7-3.2 cm, oblanceolate, base cuneate, margin entire, apex acuminate, persistent, not accrescent; abaxial main vein pronounced and yellow, different color from the blade, venation brochidodromous; adaxial and abaxial faces glabrous. Inflorescence cyme, axillary or terminal, 2-4 cm long. Floral buttons yellowish. Flowers subsessile; calyx light green, cupuliform, 5-10 mm diam., apex deltoid; corolla yellow or light green, tubular-hypocrateriform, apex lobate, tube 1.2-1.8 cm long, lobes 2-4 mm long; stamens 5, 3-6 mm long; filaments yellow; anthers brownish, short-oblong, longitudinal dehiscence; ovary ovoid, axile placentation; style greenish-yellow; stigma green, capitate. Berry black, ovoid, 0.6-1 cm long, 0.3-0.5 cm diam., fruiting calyx not accrescent, glabrous. Seeds not observed.

Selected material: RIO DE JANEIRO: Rio de Janeiro, Restinga de Grumari, 13.VII.1979, fl. and fr., A. Paschoal (RB 190865); borda da restinga para a Estrada do Grumari, 21.III.2017, fl., E.C.N. Melo 24 (RFA).

Distribution: Brazil: AC, AL, AM, BA, CE, DF, ES, GO, MA, MG, MS, MT, PB, PE, PR, RJ, RN, SC, SE, SP (Flora do Brasil 2020, 2020). Argentina and Paraguay, naturalized in some parts of Africa (Vignoli-Silva, 2009).

Flowering & Fruiting: Collected with flowers in March and May to September, with fruits in January and July.

Comments: The pronounced yellowish vein facilitates the species identification (Fig. 2A) (Vignoli-Silva, 2009). It is widely distributed in Brazil, occurs in almost all biomes (Flora do Brasil 2020, 2020), common in restingas and disturbed areas, known as cairana, coerana, João-mole, maria-branca, among others (Vignoli-Silva, 2009). In Grumari restinga, this species can be found in the closed shrub vegetation and restinga forest.

3. *Solanum americanum* Mill., Gard. Dict. ed. 8, n.5. 1768. Fig. 2E.

Herbs, unarmed; branches sparsely pilose, simple trichomes. Leaves not to slightly discolorous, isolates and geminate, distichous; petiole 0.7-0.9 cm long; blade membranaceous, 1.7-2.2 x 1.6-1.2 cm, ovoid, base cuneate, margin entire, apex acute; abaxial main vein not pronounced and green, similar color to the blade, venation brochidodromous; simple trichomes in both faces, more concentrated in the abaxial veins. Inflorescence cyme, axillary, 1-1.5 cm long. Floral buttons light yellow. Flowers pedicelate; calyx green, campanulate, 2-4 mm diam., apex deltoid, persistent; corolla white, stellate,

0.5-0.8 cm diam.; stamens 5, 2-3 mm long; filaments yellow; anthers yellow, oblong, poricidal dehiscence; ovary globose, axile placentation; style white; stigma green, rounded. Berry black, globose, 0.6-0.7 cm diam., fruiting calyx not accrescent, glabrous. Seeds not observed.

Selected material: RIO DE JANEIRO: Rio de Janeiro, Restinga de Grumari, 06.V.1992, fl. and fr., *J.M.A. Braga 11 & E.F. Amado* (RB); interior da mata, 01.XII.2016, fl., *R.A.A. Borges et al. 04* (RFA).

Distribution: Brazil: found in all states (Flora do Brasil 2020, 2020). Central and South America, and other continents (Mentz & Oliveira, 2004).

Flowering & Fruiting: Collected with flowers in May, July and December, with fruits in May and July.

Comments: *Solanum americanum* is the only species found in the study area with herbaceous habit. Besides that, it can be easily identified through the presence of its small, sometimes reflexed, white flowers with poricidal anthers (Fig. 2E) and black fruits in maturity. It is known in Brazil by various common names: aguaraguá, caraxixá, erva de bicho, erva mocó, erva moura, maria-pretinha, pimenta de cachorro, pimenta de galinha, pimenta de rato, among others (Moreira & Bragança, 2010). It was collected in an illuminated area in the closed shrub vegetation, near the lagoon.

4. *Solanum argenteum* Dunal, Encycl. Suppl. 3: 755. 1814. Fig. 2F-G.

Shrubs, unarmed; branches pubescent, lepidote indument. Leaves discolorous, adaxial dark green, abaxial silvery, isolate and geminate, distichous; petiole 0.5-0.8 cm long; blade subchartaceous, 6.8-8.7 x 3.4-3.6 cm, elliptic, base cuneate, margin entire, apex acuminate; abaxial main vein pronounced and silver, similar color to the blade, venation brochidodromous; adaxial face glabrous, abaxial pubescent, peltate trichomes. Inflorescence scorpioid cyme, axillary, 1-1.5 cm long. Floral buttons silvery. Flowers pedicelate; calyx green, campanulate, 6-8 mm diam., apex cuspidate, persistent; corolla white, stellate, 1.4-1.6 cm diam.; stamens 5, 3-5.5 mm long; filaments green; anthers yellow, oblong, poricidal dehiscence; ovary ovoid, axile placentation; style white; stigma green, flattened. Berry black, oblong, 1-1.5 cm long, 0.6-0.8 cm diam., fruiting calyx not accrescent, glabrescent, peltate trichomes. Seeds not observed.

Examined material: RIO DE JANEIRO: Rio de Janeiro, Restinga de Grumari, Borda da formação arbustiva fechada para a Estrada do Grumari, 06.IV.2017, fl., *E.C.N. Melo 25* (RFA).

Additional material: RIO DE JANEIRO: Rio de Janeiro, Restinga da Tijuca, 31.V.1946, fr., *O.X.B. Machado* (RB 75375).

Distribution: Brazil: DF, ES, GO, MG, PR, RJ, SP (Flora do Brasil 2020, 2020).

Flowering & Fruiting: Flowering in April and fruiting in May.

Comments: *Solanum argenteum* is an endemic species from Brazil. It can be easily identified by the presence of peltate trichomes in the abaxial side of the leaves (Fig. 2G). The collected material registers a new occurrence for the area. It was found in the restinga forest, at the trail edge.

The species occurs in a few other restingas in Rio de Janeiro state. Bárbara & Carvalho (1996) indicate the presence of *Solanum argenteum* in restinga areas near to Grumari, but, unfortunately, these areas were devastated by real-estate speculation. It is known as erva-prata or erva-de-iansã (Arjona *et al.*, 2007).

5. *Solanum caavurana* Vell., Fl. Flumin. 86. 1829.

Shrubs or trees, unarmed; branches glabrous. Leaves green discolorous, isolate and geminate; petiole 0.6-0.8 cm long; blade membranaceous, 9.5-10.6 x 5.3-4.8 cm, elliptic,

base cuneate to slightly oblique, margin entire, apex acute to obtuse, abaxial main vein pronounced and green, similar color to the blade, venation brochidodromous; adaxial lustrous, both faces glabrous. Inflorescence helicoid cyme, axillary, 2-4.5 cm long. Floral buttons white to greenish. Flowers pedicelate; calyx white to green, campanulate, 8-13 mm diam., apex ovate-apiculate, persistent; corolla white, stellate, 1.8-2.5 cm diam.; stamens 5, 4-5 mm long; anthers yellow, oblong, poricidal dehiscence; ovary subglobose. Fruit not seen. Seeds not seen.

Selected material: RIO DE JANEIRO: Rio de Janeiro, Restinga de Grumari, 17.XI.2000, fl., *M.G. Bovini et al.* 1915 (RB).

Distribution: Brazil: AL, BA, CE, ES, MA, MG, MS, MT, PB, PE, PI, PR, RJ, RN, SC, SE, SP (Flora do Brasil 2020, 2020). Argentina and Paraguay (Mentz & Oliveira, 2004).

Flowering & Fruiting: Flowering in January, March and November. Fruiting in June.

Comments: This species is commonly mistaken with *Athenaea fasciculata* when in vegetative state. The type of inflorescence and flowers are crucial for identification. The inflorescences are quite different, *Solanum caavurana* exhibits a helicoid cyme whereas *A. fasciculata*, a fasciculiform. While the first presents white flowers with yellow poricidal anthers, the second has white flowers with green details and longitudinal brownish anthers. Its common names are peloteira and caavurana (Carvalho & Bovini, 1997; Mentz & Oliveira, 2004).

6. *Solanum capsicoides* All., Auct. Syn. Meth. Stirp. Hort. Reg. Taurensis 12. 1773. Fig. 2H-J

Subshrub or shrubs, armed, acicular prickles; branches pilose, multicellular acicular trichomes. Leaves not discoloured, isolate, spiral; petiole 1.5-1.8 cm long; blade membranaceous 6.7-7.4 x 5.5-6.2 cm, ovoid, base obtuse, margin lobed, apex acute; abaxial main vein pronounced and green, similar color to the blade, venation simple craspedodromous; adaxial and abaxial faces pubescent, multicellular acicular trichomes, in abundance at the margin, acicular prickles on primary and secondary veins. Inflorescence cyme, axillary, 1.2-1.5 cm long. Floral buttons light green. Flowers pedicelate; calyx green, campanulate, 6-8 mm diam., apex deltoid, persistent; corolla white to purplish, stellate, 1-1.4 cm diam.; stamens 5, ca. 5 mm long; filaments yellow; anthers yellow, lanceolate, poricidal dehiscence; ovary subglobose; style white, reduced in staminate flowers. Berry strong orange, globose, 1.5-2.5 cm diam., fruiting calyx not accrescent, glabrous. Seeds flattened, reniform, ca. 2 mm long.

Selected material: RIO DE JANEIRO: Restinga de Grumari, 30.V.1972, fl. and fr., *J. Almeida 1592* (RB). Rio de Janeiro, Restinga de Grumari, Borda da restinga para a Estrada do Grumari, 21.III.2017, fr., *E.C.N. Melo 23* (RFA).

Distribution: Brazil: AL, BA, CE, ES, MG, PB, PE, PR, RJ, RN, RS, SC, SE, SP (Flora do Brasil 2020, 2020). United States of America and some countries of Central and South America (Agra *et al.*, 2009).

Flowering & Fruiting: Collected with flowers in January and May, with fruits in January, March and May.

Comments: A characteristic of *Solanum capsicoides* is the acicular multicellular trichomes (Fig. 2J). They can be found on both sides of the leaves, but the margin concentrates most of them. This is the only species found in the locality with acicular prickles. Furthermore, its fruits show an intense orange color (Fig. 2I). The species was found at the trail edge of the closed shrub formation. Its common names are arrebenta-

boi, arrebenta-cavalo, baga de espinho, gogoia, joá vermelho, juá vermelho, melancia da praia (Moreira & Bragança, 2010).

7. *Solanum cordifolium* Dunal, Encycl. suppl. 3 p.764. 1814. Fig. 2K-M

Scandent shrubs, armed, curved prickles; branches pilose, glandular trichomes. Leaves green discolorous, isolate, spiral; petiole 2.5-3.0 cm long; blade membranaceous, 6.8-8.1 x 3.5-5.0 cm, ovoid to elliptic, base obtuse, slightly oblique to subcordate, margin slightly lobed, apex acute to obtuse; abaxial main vein pronounced and green, similar color to the blade, venation simple craspedodromous; adaxial and abaxial pubescent, glandular trichomes in both faces, stellate trichomes on abaxial face, curved prickles on main veins. Inflorescence scorpioid cyme, axillary, 2.4-3.5 cm long. Floral buttons green. Flowers pedicelate; calyx green, campanulate, 12-15 mm diam., apex acute, persistent; corolla purple with white marks, stellate, 2.5-3.5 cm diam.; stamens 5, 7-10 mm long; filaments yellow; anthers yellow, lanceolate, poricidal dehiscence; ovary subglobose, axile placentation; style white; stigma green, rounded. Berry green, globose, ca. 1 cm diam., fruiting calyx not accrescent, pilose, glandular trichomes. Seeds flattened, reniform, ca. 4 mm long.

Selected material: RIO DE JANEIRO: Rio de Janeiro, Restinga de Grumari, entrada da trilha para a lagoa, 01.XII.2017, fl. and fr., *E.C.N. Melo 6* (RFA).

Distribution: Brazil: ES, MG, RJ, SP (Flora do Brasil 2020, 2020).

Flowering & Fruiting: Flowering and fruiting all the year.

Comments: Frequent in the restinga. Its purple flowers (Fig. 2K) are easily seen in the vegetation. It is found only in the closed shrub vegetation, in well illuminated areas. This species is endemic from Brazil, specifically the Southeast region (Flora do Brasil 2020, 2020).

8. *Solanum jussiaei* Dunal, Encycl. suppl. 3 p.767. 1814. Fig. 2N-O

Scandent shrubs, armed, curved prickles; branches glabrescent, lustrous, stellate trichomes. Leaves green discolorous, isolate, alternate distichous; petiole 1.8-3.2 cm long; blade membranaceous, 5.8-11 x 3.2-7.4 cm, elliptic, base cuneate to obtuse, margin slightly sinuate to lobed, apex acute; abaxial main vein pronounced and green, similar color to the blade, venation bochidodromous; adaxial and abaxial pubescent, stellate trichomes sparse on adaxial face, dense on abaxial, curved prickles on main veins. Inflorescence scorpioid cyme, sometimes branched, axillary or terminal, 3-7 cm long. Floral buttons light green. Flowers pedicelate; calyx green, campanulate, 3-5 mm diam., apex short triangular, persistent; corolla white or light lilac, stellate, 2-3 cm diam.; stamens 5, 5-8 mm long; filaments white; anthers yellow, lanceolate, poricidal dehiscence; ovary subglobose, intrusive axile placentation; style white; stigma light green, retuse. Berry orange, globose, 2-4 cm diam., fruiting calyx not accrescent, pilose, stellate trichomes. Seeds flattened, reniform, ca. 2 mm long.

Selected material: RIO DE JANEIRO: Rio de Janeiro, Restinga de Grumari, Beira da Estrada, 07.VI.2016, fr., *E.C.N. Melo 3* (RFA). Formação arbustiva aberta, 01.XII.2016, fl., *E.C.N. Melo 17* (RFA).

Distribution: Brazil: CE, ES, RJ, SP (Flora do Brasil 2020, 2020; Sampaio *et al.*, 2019).

Flowering & Fruiting: Collected with flowers in March, May, June and December. With fruits in March, May, June and November.

Comments: *Solanum jussiaei* is endemic to the Brazilian Atlantic Forest (Flora do Brasil 2020, 2020). Until recently, its occurrence was restricted to the southeast region,

but Sampaio *et al.* (2019) registered in the Ceará state (northeast region). Its common name is jurubeba-macho (Salim, 2017).

It is frequent in the locality and only found in open shrub formation. The presence of a great quantity of trichomes probably contributes to its extremely heliophyle behavior. A variability in the leaves morphology was observed, ranging from deeply lobed margin to almost entire. This may be the reason for being mistaken with other species and its many synonyms.

The sepals of *S. jussiaei* are remarkably short, giving a truncate aspect to the calyx. Besides that, the calyx also exhibits a bright color when dry, covered by stellate trichomes. The ovary appears to be tetralocular because of the intrusive axile placentation.

9. *Solanum mauritianum* Scop., Delic. Fl. Faun. Insubr. 3: 16, t. 8. 1788.

Shrubs, unarmed; branches pilose, stellate trichomes. Leaves isolate and geminate, spiral; petiole 2-2.6 cm long; blade membranaceous, 10.6-12.7 x 2.4-2.5 cm, lanceolate, base cuneate, margin entire, apex acute; abaxial main vein pronounced and green, similar color to the blade, venation brochidodromous; adaxial and abaxial pubescent, stellate trichomes. Inflorescence dichasial, terminal, ca. 7 cm long. Flowers pedicelate; calyx campanulate, 6-8 mm diam., apex acute, persistent; corolla violaceous, stellate, 1.4-1.8 cm diam.; stamens 5, 4-5 mm long.; anthers yellow, oblong, poricidal dehiscence; ovary globose. Berry greyish, globose, 1-1.5 cm diam., fruiting calyx not accrescent, pubescent. Seeds not observed.

Examined material: RIO DE JANEIRO: Rio de Janeiro, praia de Grumari, 15.VII.1984, fl. and fr., V.F. Ferreira 3455 (RB).

Additional material: RIO DE JANEIRO: Rio de Janeiro, Barra de Guaratiba, Margem da Via Rio Santos, 28.IX.1972, fl. and fr., J. Almeida de Jesus 1974 (RB).

Distribution: Brazil: ES, MG, PR, RJ, RS, SC, SP (Flora do Brasil 2020, 2020). Argentina, Paraguay, Uruguay and introduced in other continents (Ruschel & Nodari, 2011).

Flowering & Fruiting: Collected with flowers in July and with fruits in September.

Comments: Despite all the collection effort and analysis of herbarium material, *Solanum mauritianum* has not been collected in the area since 1984. It is considered a ruderal species, represents an important food source for animals and provides conditions to other species colonization (Ruschel & Nodari, 2011). In 1986, the locality became a protected area and the continued preservation may be the reason for its suppression. *Solanum mauritianum* has a high growth rate, however its senescence occurs approximately at 15 years old. In Brazil, it is known as fumo-bravo, cuvitinga, couvetinga, tabaqueira, fona-de-porco (Ruschel & Nodari, 2011).

10. *Solanum paniculatum* L., Sp. Pl. ed. 2: 1: 267. 1762.

Shrubs, armed, curved prickles; branches pubescent, stellate trichomes. Leaves strongly discoloured when dry, adaxial dark, abaxial whitish, isolate, spiral; petiole 1.7-3.6 cm long; blade membranaceous, 5.1-12.8 x 2.9-11.5 cm, ovoid, base obtuse, oblique to subcordate, margin slightly sinuate to lobed, apex acuminate; abaxial main vein pronounced and whitish when dry, similar color to the blade, venation brochidodromous to mixed craspedodromous; adaxial face pilose, abaxial pubescent, stellate trichomes, curved prickles on the veins. Inflorescence dichasial, axillary, 5.5-8 cm long. Flowers pedicelate; calyx green, campanulate, 7-10 mm diam., apex acuminate, persistent; corolla white to lilac with purple marks, stellate, 1.3-1.7 cm diam.; stamens 5, ca. 5 mm long;

anthers yellow, lanceolate, poricidal dehiscence; stigma white. Berry 0.6-0.8 cm diam., fruiting calyx not accrescent, glabrous. Seeds not observed.

Selected material: RIO DE JANEIRO: Rio de Janeiro, Restinga do Grumari, 28.III.1979, fl. and fr., *L.D'Á. Freire de Carvalho* (RB 189193).

Distribution: Brazil: AL, BA, CE, DF, ES, GO, MA, MG, MS, MT, PA, PB, PE, PI, PR, RJ, RN, RS, SC, SE, SP (Flora do Brasil 2020, 2020). Argentina and Paraguay (Nee, 1999 *apud* Sampaio *et al.*, 2019).

Flowering & Fruiting: Flowering and fruiting in March.

Comments: When dry, the leaves vary in their color notably. The adaxial face is dark while the abaxial face is whitish. Lobed leaves exhibit craspedodromous venation whereas the ones slightly sinuate, brochidodromous venation.

Solanum paniculatum is known as joá manso, jubeba, jupeba, jurubeba, jurubeba verdadeira, jurubebinha, juena, juuna, among others (Moreira & Bragança, 2010). The species has not been collected in the area since 1979. It is considered a ruderal species (Mentz & Oliveira, 2004). Probably, the restinga conservation, since the implementation of environmental protection measures, contributed to its suppression.

The preliminary list elaborated by Bárbara & Carvalho (1996) indicated the occurrence of seven species to Grumari restinga. Two other works (Araujo, 2000; Argôlo, 2001), registered only three. *Solanum leptostachys* Dun. was pointed to the locality, however, this specie was not collected and any specimen was found in the herbaria. As this species has no occurrence for restinga areas, it was not considered.

Some ruderal species have not been collected since the 1980s, which may indicate the area is being preserved and the environment protection measures implemented are effective. In the 19th century, some crops were cultivated in the region. In the 1960s, in an attempt to transform the area in a complex, some streets were opened. In 1986, the Grumari Environmental Protection Area was created and 2001 the Grumari Municipal Natural Park, to protect the Atlantic Forest remnants (PMRJ, 2012).

Three species are endemic to Brazil, *Solanum argenteum*, *S. cordifolium* and *S. jussiaei*. *Solanum cordifolium* and *S. jussiaei* are also endemic to the Atlantic Forest (Flora do Brasil 2020, 2020). The latter two occur frequently in the area although does not exist, until now, conservation data on them.

It was observed a great variety of indumenta, which helped in the species characterization. The venation types and the calyx morphology were also efficient in the identification.

Similarity analysis

Cabo Frio (14), Jurubatiba (14) and Marambaia (14) exhibit the greatest number of species followed by Grumari (10), Massambaba (10) and Angra dos Reis (8) (Tab. 2). Seven species are indicated to the other areas, except for São João da Barra that was represented by five.

The dendrogram was generated using the coefficient of Sørensen and the UPGMA cluster analysis (Fig. 3). The cophenetic correlation was 0.7838. In the Outliers analysis, none of the samples obtained standard deviation above 2.0.

The cluster analysis indicated six groups. Group 1, with 53% of similarity, formed by Angra dos Reis and Paraty, are the southern areas of the state. It was the first to separate and only where *Solanum carautae* occurs.

This region is the most different. All other studies consulted, exhibited a similar pattern (Gomes, 2008; Moura *et al.*, 2007; Moreira *et al.*, 2014; Calazans *et al.*, 2018),

including the floristic inventory of Grumari restinga (Argôlo, 2001). This is probably related to the strong influence received from the Serra do Mar hillside forests (Araujo, 2000). Besides that, the region has many islands, geographic isolation and other factors may have contributed to the dissimilarity (MacArthur & Wilson, 1967).

Group 2 only included Niterói. Niterói is a city that belongs to the metropolitan area of Rio de Janeiro state. The major part of the restingas areas were removed mainly because of urbanization and is still threatened by the same (Rocha *et al.*, 2007). Even not grouping in the cluster analysis, the Factorial Correspondence Analysis (FCA) arranged Niterói near the Coastal Lowland restingas (Fig. 4).

In other studies, Niterói grouped with Maricá or other Metropolitan restinga (Gomes, 2008; Calazans *et al.*, 2018). These results exhibit certain stability probably because of the proximity among the areas. The species *Acnistus arborescens* only occurs in this restinga (Tab. 2), and is responsible for departing Niterói from the Coastal Lowland restingas group (Fig. 5).

Group 3 is just formed by São João da Barra, near to Grumari and Marambaia. This area showed different results in other family studies. In Bromeliaceae (Moura *et al.*, 2007), the north coast, composed of São João da Barra and Macaé, was more similar to Marambaia. For Araceae it was similar to Búzios, a place that belongs to the Coastal Lowlands (Calazans *et al.*, 2018). In Rubiaceae, it grouped with all other restingas, with exception of the south coast (Gomes, 2008), the same pattern found in the floristic inventory of Grumari restinga (Argôlo, 2001).

Group 4 comprised Grumari and Marambaia, reaching about 58% of similarity, with seven shared species. Using only floristic lists, Grumari exhibits major similarity with Jurubatiba. The list of Jurubatiba was elaborated by Solanaceae specialists, which probably contributed for some distortion in the comparison. Thus, complementary information was included in the analyses, obtained through the Re flora virtual herbarium, dated after the 2000s, later period of the major consulted works. In other studies, Grumari presented certain pattern, grouping with Marambaia (Argôlo, 2001) or Maricá (Moura *et al.*, 2007; Gomes, 2008; Moreira *et al.*, 2014; Calazans *et al.*, 2018), nearby areas.

Group 5 included Jurubatiba. This is one of the best-studied restingas in the Brazilian southeast (Rocha *et al.*, 2007). Generally, this area appears together with São João da Barra (Moura *et al.*, 2007) or some Coastal Lowland restinga (Argôlo, 2001; Gomes, 2008; Calazans *et al.*, 2018), presumably by the proximity with these areas.

Group 6 agglomerated all the Coastal Lowland restingas. Two subgroups can be separated within it, one formed by Praia Virgem and Massambaba, with 59% of similarity, and other with Maricá, Barra de São João and Cabo Frio. The major percentage of the analysis was 67%, between Barra de São João and Cabo Frio.

In the Factorial Correspondence Analysis (FCA) diagram, axis 1 and 2 totalized 38.69% of variation (Fig. 4). The results clustered all Coastal Lowland restingas, similar to the dendrogram.

Many aspects, as the substrate characteristics, composition and drain conditions, can interfere in the restingas vegetation (Silva, 1999). As shown in Table 2, some species are widely distributed. *Athenaea fasciculata*, *Solanum caavurana*, *S. cordifolium* and *S. insidiosum* can be found in seven of the twelve areas. *Cestrum axillare* and *S. pseudoquina* in eight. The most widespread was *S. jussiaei*, in nine, characterizing the family in the Rio de Janeiro restingas. In spite of this, many species only occur in certain areas, which shows how important is the conservation of each locality. Furthermore, these plants have an important ecological role, serving as food for insects, birds, mammals and others (Knapp, 2002; Aximoff *et al.*, 2020).

The Mantel test results refuted the null hypothesis, showing that the geographic distance influences the species distribution. The rM value was -0.5001, demonstrating a strong correlation between the matrices, and the p value was significant, equal to 0.001 ($p < 0.05$).

The variation in the spatial distribution of species may be related with geomorphology, ecological differentiation and origin of propagules (Cerqueira, 2000). The Brazilian coast is divided in five coastal regions according to its characteristics. Rio de Janeiro belongs to the Southeast Coast, that begins in the south of the Espírito Santo state and goes until the south of Santa Catarina (Silva, 1999). An expanded survey for Solanaceae covering restingas of adjacent states of Rio de Janeiro, may explain if the observed areas are more similar to each other or to these nearby areas, being able to assist conservation and restoration works.

Of the 173 species of Solanaceae found in the Rio de Janeiro state, Grumari refuge about 6% of species richness. For the restingas, approximately 30%, based on the 33 species, surveyed by the floristic lists and the virtual herbarium. Although it can be considered a small area when compared to other protected localities, the restinga contributes to conservation in regional level (Couto *et al.*, 2017; Calazans *et al.*, 2018).

Two other protected restinga remnants of Rio de Janeiro city, Marapendi and Chico Mendes Park, are surrounded by buildings and active anthropic activity. Differently, Grumari forms a continuum with the Pedra Branca State Park, covering a gradient of distinct ecosystems. This shows, once again, the relevance of the area conservation. Besides, these areas provide important ecosystem services for the one of the largest cities in Brazil (Scarano & Ceotto, 2015).

CONCLUSION

The Solanaceae family is represented by ten native species in the Grumari restinga. For the first time, *Solanum argenteum* is registered in the area. Some ruderal species have not been collected since the 1980s, which may indicate the area is being conserved. Endemic plants from Brazil and the Atlantic forest can be found in the restinga.

The diversity of indumenta, the venation types and the calyx morphology helped in the species identification.

Grumari and Marambaia grouped in the similarity analysis, with 58% of similarity, probably due to the proximity. The South restingas were the most different in the comparison. All restingas of the Coastal Lowland region were aggregated in the cluster and ordination analyses, with the highest percentage of 67% between Barra de São João and Cabo Frio. The Mantel test showed the geographic distance affects species distribution.

The Grumari restinga plays an important role in the species conservation and maintenance of ecosystem services for the region.

REFERENCES

- AGRA, M.F.; NURIT-SILVA, K. & BERGER, L.R. 2009. Flora da Paraíba, Brasil: *Solanum* L. (Solanaceae). *Acta Botanica Brasilica* 23(3): 826-842.
- ARAUJO, D.S.D. 2000. Análise florística e fitogeográfica das restingas do Estado do Rio de Janeiro. PhD Thesis, UFRJ, Rio de Janeiro.
- ARAUJO, D.S.D.; SÁ, C.F.C.; FONTELLA-PEREIRA, J.; GARCIA, D.S.; FERREIRA, M.V.; PAIXÃO, R.J.; SCHNEIDER, S.M. & FONSECA-KRUEL, V.S. 2009. Área de Proteção Ambiental de Massambaba, Rio de Janeiro: caracterização fitofisionômica e florística. *Rodriguésia* 60: 67–96.

- ARGÔLO, A.M. 2001. Levantamento florístico, caracterização fisionômica e comparação da restinga de Grumari, RJ, com outras restingas do estado do Rio de Janeiro. MSc Thesis, Museu Nacional - UFRJ, Rio de Janeiro.
- ARJONA, F.B.S.; MONTEZUMA, R.C. M. & SILVA, I.M. 2007. Aspectos etnobotânicos e biogeografia de espécies medicinais e/ou rituais comercializadas no mercado de Madureira, RJ. *Caminhos de Geografia* 8(23): 41-50.
- ASSUMPÇÃO, J. & NASCIMENTO, M.T. 2000. Estrutura e composição florística de quatro formações vegetais de restinga no complexo lagunar Grussaí/Iquipari, São João da Barra, RJ, Brazil. *Acta Botanica Brasilica* 14(3): 301-315.
- AXIMOFF, I.A.; SOARES, H.M. & BERNADELLO, G. 2020. *Acnistus arborescens* (Solanaceae): an important food resource for birds in an Atlantic Forest site, Southeastern Brazil. *Rodriguésia* 71: e02232018.
- BÁRBARA, T. & CARVALHO, L.D'A.F. 1996. Solanáceas nas Restingas do Estado do Rio de Janeiro – Lista Preliminar. *Boletim do Museu de Biologia Mello Leitão (N. Ser.)* 4: 3-23.
- BRAGA, H.N. 2004. Levantamento das espécies fanerogâmicas da Praia Virgem, Município Rio das Ostras, RJ. MSc Thesis, Museu Nacional - UFRJ, Rio de Janeiro.
- CALAZANS, L.S.B.; VALADARES, R.T.; SAKURAGUI, C.M. & LOPES, R.C. 2018. Araceae of Grumari restinga: contribution to the conservation of the flora of Rio de Janeiro State, Brazil. *Acta Botanica Brasilica* 32(1): 55-62.
- CARVALHO, L.d'A.F. & BOVINI, M.G. 1997. SOLANACEAE Juss. In: MARQUES, M.C.M.; VAZ, A.S.F. & MARQUETE, R. (orgs.) *Flórua da APA Cairuçu, Parati, RJ: Espécies Vasculares*. Rio de Janeiro, Instituto de Pesquisas Jardim Botânico do Rio de Janeiro. p. 509-539.
- CERQUEIRA, R. 2000. Biogeografia das Restingas. In: ESTEVES, F.A. & LACERDA, L.D. (eds.) *Ecologia de Restingas e Lagoas Costeiras*. Macaé, NUPEM - UFRJ. p. 65-75.
- CONAMA – CONSELHO NACIONAL DO MEIO AMBIENTE. 1999. Resolução 261, de 30 de Junho de 1999.
- CONDE, M.M.S.; LIMA, H.R.P. & PEIXOTO, A.L. 2005. Aspectos florísticos e vegetacionais da Marambaia, Rio de Janeiro, Brazil. In: MENEZES, L.F.T.; PEIXOTO, A.L. & ARAUJO, D.S.D. (eds.) *História Natural da Marambaia*. Seropédica, EDUR. p. 135.
- COSTA, L.H.P. & CARVALHO, L.D'A.F. 2001. Solanaceae. In: COSTA, A.F. & DIAS, I.C.A. (orgs.) *Flora do Parque Nacional da Restinga de Jurubatiba e arredores, Rio de Janeiro, Brasil: listagem, florística e fitogeografia: angiospermas, pteridófitas, algas continentais*. Série Livros, n. 8. Rio de Janeiro, Museu Nacional - UFRJ. p. 132-134.
- COSTA, A.F. & DIAS, I.C.A. 2001. *Flora do Parque Nacional da Restinga de Jurubatiba e arredores, Rio de Janeiro, Brasil: listagem, florística e fitogeografia: angiospermas, pteridófitas, algas continentais*. Série Livros, n. 8. Rio de Janeiro, Museu Nacional - UFRJ.
- COUTO, D.R.; URIBBE, F.P.; JACQUES, S.S.A.; FRANCISCO, T.M. & LOPES, R.C. 2017. Vascular epiphytes in the Grumari restinga, RJ: floristic and similarities between restingas in Eastern Brazil. *Rodriguésia* 68(2): 337-346.
- FILGUEIRAS, T.S.; NOGUEIRA, P.E.; BROCHADO, A.L. & GUALA, G.F. 1994. Caminhamento: um método expedito para levantamentos florísticos qualitativos. *Cadernos de Geociências* 12: 39-43.
- FLORA DO BRASIL 2020. 2020. Solanaceae. Jardim Botânico do Rio de Janeiro. Disponível em: <<http://floradobrasil.jbrj.gov.br/reflora/floradobrasil/FB225>> Acesso em: 25 mai. 2020.
- GOMES, M. 2008. Rubiaceae das Restingas do Estado do Rio de Janeiro: Taxonomia e Florística. PhD Thesis, Museu Nacional - UFRJ, Rio de Janeiro.
- HERBÁRIO VIRTUAL REFLORA. 2020. *Consulta Pública do Herbário Virtual*. Disponível em <http://www.reflora.jbrj.gov.br/reflora/herbarioVirtual/> Acesso em 9 dez 2019.
- HUNZIKER, A.T. 2001. *Genera Solanacearum: the genera of Solanaceae illustrated, arranged according to a new system*. Ruggell, A.R.G. Gantner Verlag K.G.

- KNAPP, S. 2002. Tobacco to tomatoes: a phylogenetic perspective on fruit diversity in the Solanaceae. *Journal of Experimental Botany* 53(377): 2001-2022.
- LEGENDRE, P. & LEGENDRE, L. 1998. *Numerical Ecology*. 2ed. Amsterdam, Elsevier.
- MACARTHUR, R.H. & WILSON, E.O. 1967. *The Theory of Island Biogeography*. New Jersey, Princeton University Press.
- MCCUNE, B. & MEFFORD, M.J. 1999. *PC-ORD: multivariate analysis of ecological data*, version 4.10. Gleneden Beach: MjM Software Design.
- MENEZES, L.F.T.; PEIXOTO, A.L. & ARAUJO, D.S.D. 2005. *História Natural da Marambaia*. Seropédica, EDUR.
- MENTZ, L.A. & OLIVEIRA, P.L. 2004. *Solanum* (Solanaceae) na Região Sul do Brasil. *Pesquisas, Botânica* 54: 1-327.
- METCALFE, C.R. & CHALK, L. 1957. *Anatomy of the Dicotyledons: Leaves, stem, and wood in relation to taxonomy with notes on economic uses*, vol. II. London, Oxford University Press.
- MOREIRA, M.M.; BARBERENA, F.F.V.A. & LOPES, R.C. 2014. Orchidaceae of the Grumari restinga: floristic and similarity among restingas in Rio de Janeiro state, Brazil. *Acta Botanica Brasilica* 28(3): 321-326.
- MOREIRA, H.J.C. & BRAGANÇA, H.B.N. 2010. *Manual de Identificação de Plantas Infestantes: Cultivos de Verão*. São Paulo, FMC Agricultural Products.
- MOURA, R.L.; COSTA, A.F. & ARAUJO, D.S.D. 2007. Bromeliaceae das Restingas Fluminenses: Florística e Fitogeografia. *Arquivos do Museu Nacional* 65(2): 139-168.
- NEE, M. 1999. Synopsis of *Solanum* in the New world. In: NEE, M.; SYMON, D.E.; LESTER, R.N. & JESSOP, J.P. (eds.) *Solanaceae IV*. Kew, Royal Botanic Gardens. p. 285-333.
- OLMSTEAD, R.G. 2013. Phylogeny and biogeography in Solanaceae, Verbenaceae and Bignoniaceae: a comparison of continental and intercontinental diversification patterns. *Botanical Journal of the Linnean Society* 171: 80-102.
- OLMSTEAD, R.G.; BOHS, L.; MIGID, H.A.; SANTIAGO-VALENTIN, E.; GARCIA, V.F. & COLLIER, S.M. 2008. A molecular phylogeny of the Solanaceae. *Taxon* 57(4): 1159-1181.
- PEIXOTO, A.L. & MAIA, L.C. 2013. *Manual de procedimentos para herbário*. Recife, Editora Universitária UFPE.
- PMRJ - PREFEITURA DA CIDADE DO RIO DE JANEIRO. 2012. Parque Natural Municipal Da Prainha e Parque Natural Municipal De Grumari, Plano De Manejo. Rio de Janeiro.
- QGIS DEVELOPMENT TEAM. 2020. *QGIS Geographic Information System*. Open Source Geospatial Foundation Project. v. 3.8. <http://qgis.osgeo.org>.
- RADFORD, A.E.; DICKISON, W.C.; MASSEY, J.R. & BELL, C.R. 1974. *Vascular Plant Systematics*. New York, Harper & Row.
- ROCHA, C.F.D.; BERGALLO, H.G.; VAN SLUYS, M.; ALVES, M.A.S. & JAMEL, C.E. 2007. The remnants of restinga habitats in the Brazilian Atlantic Forest of Rio de Janeiro state, Brazil: Habitat loss and risk of disappearance. *Brazilian Journal of Biology* 67(2): 263-273.
- RODRIGUES, I.M.C.; KNAPP, S. & STEHMANN, J.R. 2019. The nomenclatural re-establishment of *Athenaea* Sendtn. (Solanaceae) with a nomenclatural synopsis of the genus. *Taxon* 68: 839-846.
- RUSCHEL, A.R. & NODARI, R.O. 2011. *Solanum mauritianum*. In: CORADIN, L.; SIMINSKI, A. & REIS, A. (eds.) *Espécies Nativas da Flora Brasileira de Valor Econômico Atual ou Potencial*. Ministério do Meio Ambiente, Brasília. p. 692-696.
- SALIM, D.R. 2017. Saberes e conhecimentos populares da flora do Rio de Janeiro: uma revisão bibliográfica de trabalhos de etnobotânica. Trabalho de conclusão de curso. UFRJ, Rio de Janeiro.
- SAMPAIO, V.S.; VIEIRA, I.M.F.; LIMA JÚNIOR, E.A. & LOIOLA, M.I.B. 2019. Flora do Ceará, Brazil: *Solanum* (Solanaceae). *Rodriguésia* 70: e02512017.
- SCARANO, F.R. 2002. Structure, Function and Floristic Relationships of Plant Communities in Stressful Habitats Marginal to the Brazilian Atlantic Rainforest. *Annals of Botany* 90: 517-524.

SCARANO, F.R & CEOTTO, P. 2015. Brazilian Atlantic forest: impact, vulnerability, and adaptation to climate change. *Biodiversity and Conservation* 24(9): 2319-2331.

SHEPHERD, G.J. 2010. *FITOPAC 2.1*. Departamento de Botânica, UNICAMP.

SILVA, S.M. 1999. Diagnósticos das restingas do Brasil. In: *Workshop de avaliação e ações prioritárias para conservação da biodiversidade da zona costeira e marinha*, Porto Seguro.

SILVA, J.G. & OLIVEIRA, A.S. 1989. A Vegetação de Restinga no Município de Maricá – RJ. *Acta Botanica Brasilica* 3(2): 1989 suppl. 253-272.

THIERS, B. [continuously updated]. *Index herbariorum: a global directory of public herbaria and associated staff*. New York Botanical Garden's Virtual Herbarium. Disponível em <http://sweetgum.nybg.org/science/ih/> Acesso em 16 April 2020.

VIGNOLI-SILVA, M. 2009. O gênero *Cestrum* L. (Solanaceae) no Brasil extra-amazônico. PhD Thesis, UFRGS, Porto Alegre.

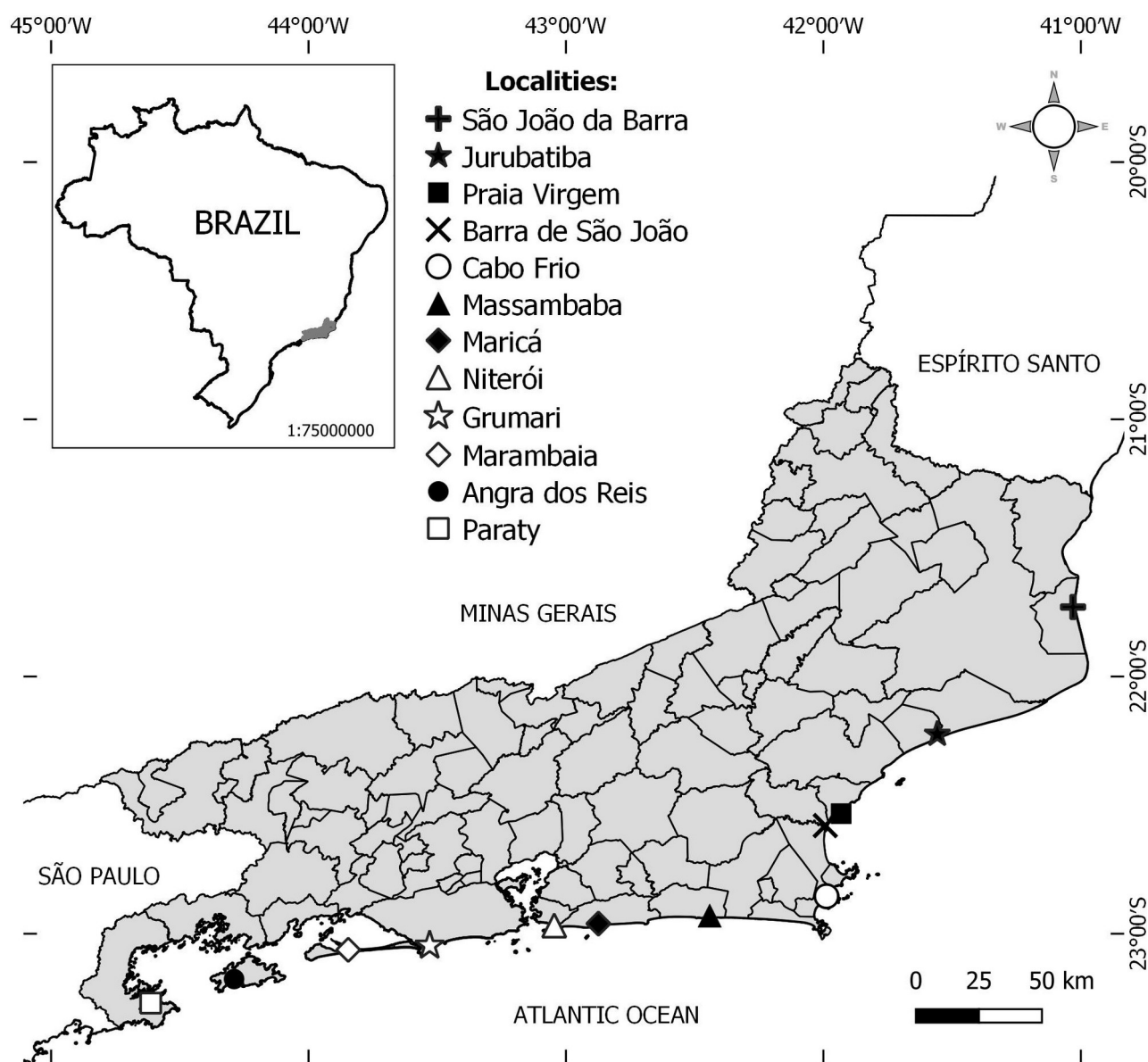


Figure 1. Location of the twelve restinga areas in Rio de Janeiro state compared in the similarity analysis. Map elaborated on QGIS (2020).

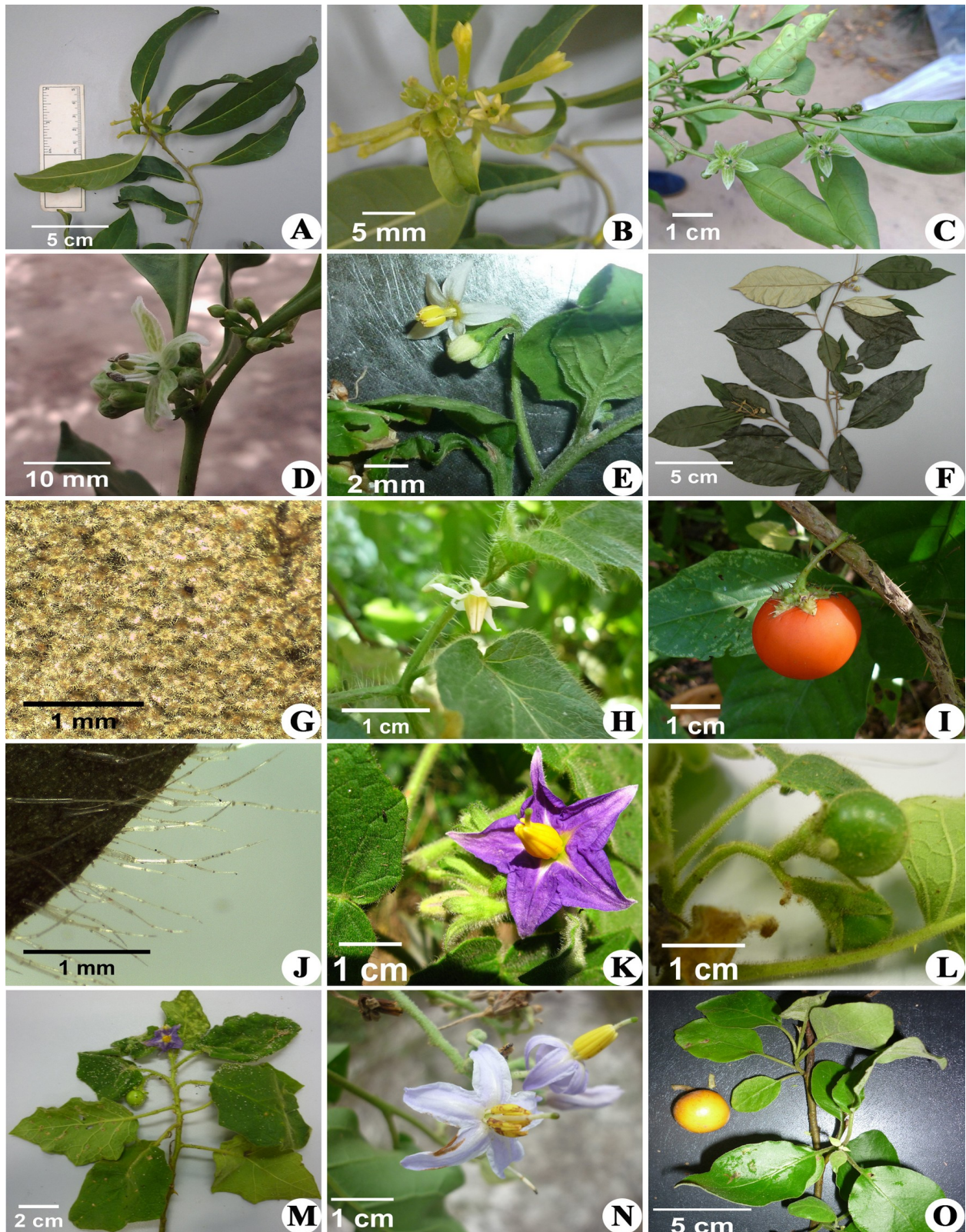


Figure 2. Species of Solanaceae in Grumari restinga. *Cestrum axillare* Vell.: A. Fertile branch. B. Flower. *Athenaea fasciculata* (Vell.) I.M.C. Rodrigues & Stehmann.: C. Fertile branch. D. Flower. *Solanum americanum* Mill.: E. Flower. *Solanum argenteum* Dunal: F. Dry branch. G. Peltate trichomes on the abaxial surface of the leaf. *Solanum capsicoides* All.: H. Flower. I. Fruit. J. Acicular trichomes in the margin of the leaf. *Solanum cordifolium* Dunal: K. Flower. L. Fruit. M. Fertile branch. *Solanum jussiaei* Dunal: N. Flower O. Branch and fruit.

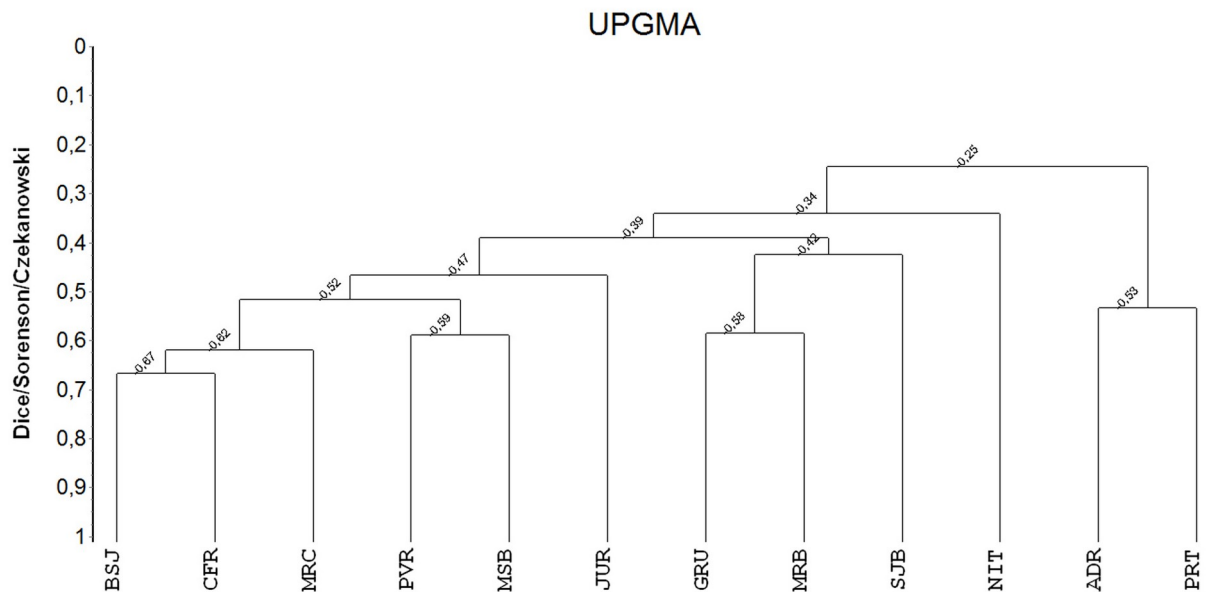


Figure 3. Sørensen similarity dendrogram obtained by UPGMA clustering method among twelve restinga areas of Rio de Janeiro state. GRU: Grumari; SJB: São João da Barra; JUR: Jurubatiba; PVR: Praia Virgem; BSJ: Barra de São João; CFR: Cabo Frio; MSB: Massambaba; MRC: Maricá; NIT: Niterói; MRB: Marambaia; ADR: Angra dos Reis; PRT: Paraty

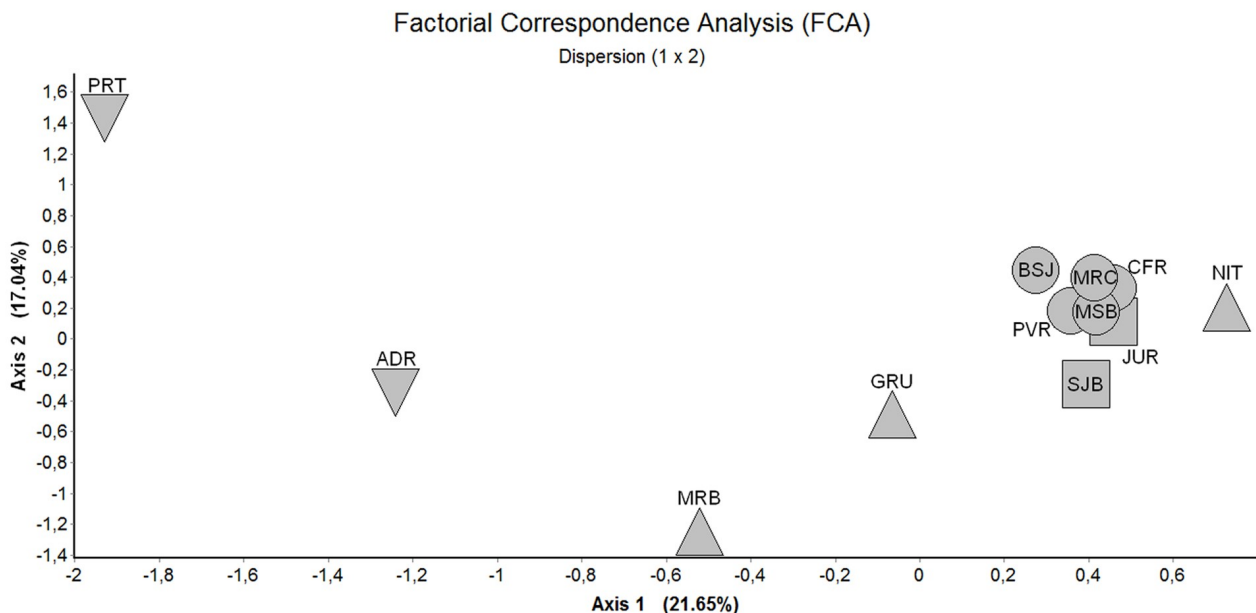


Figure 4. Factorial Correspondence Analysis (FCA) diagram, dispersion, axis 1 and 2. Both axis explain 38.69% of variation. The symbols represent different coastal regions of Rio de Janeiro state, squares: North; circles: Coastal Lowland; triangles: Metropolitan; inverted triangles: South. GRU: Grumari; SJB: São João da Barra; JUR: Jurubatiba; PVR: Praia Virgem; BSJ: Barra de São João; CFR: Cabo Frio; MSB: Massambaba; MRC: Maricá; NIT: Niterói; MRB: Marambaia; ADR: Angra dos Reis; PRT: Paraty.

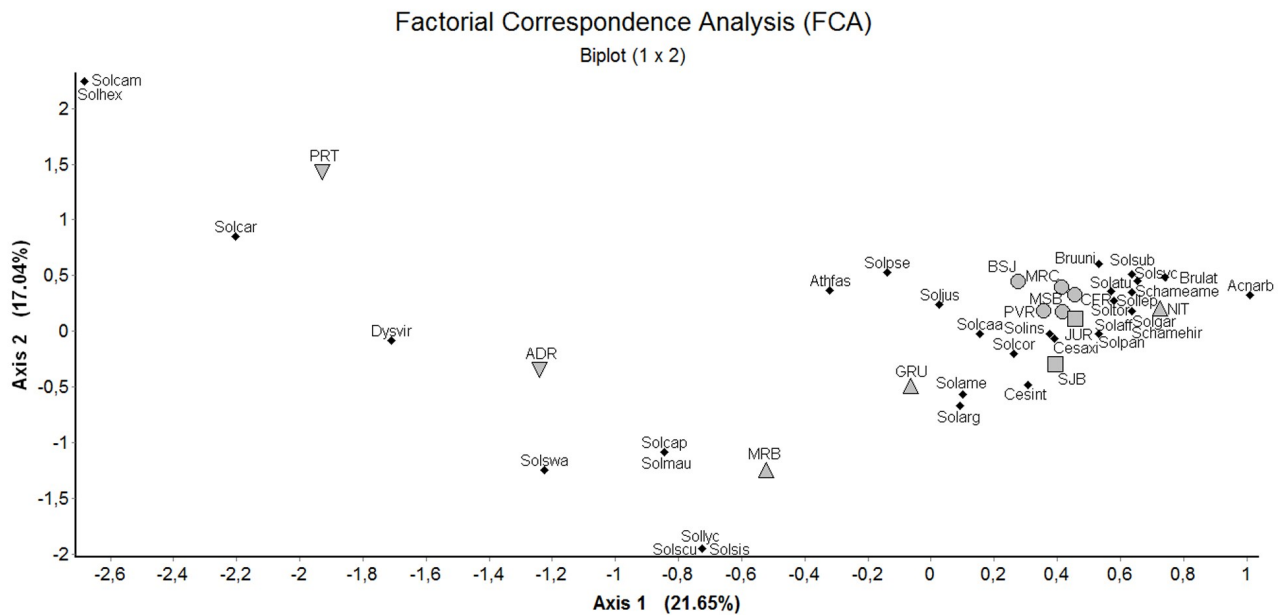


Figure 5. Factorial Correspondence Analysis (FCA) diagram, biplot, axis 1 and 2. Both axes explain 38.69% of variation. The gray symbols represent different coastal regions of Rio de Janeiro state, squares: North; circles: Coastal Lowland; triangles: Metropolitan; inverted triangles: South. Black diamonds represent the species, indicated by the link between the three first letters of the genus and the specific epithet. GRU: Grumari; SJB: São João da Barra; JUR: Jurubatiba; PVR: Praia Virgem; BSJ: Barra de São João; CFR: Cabo Frio; MSB: Massambaba; MRC: Maricá; NIT: Niterói; MRB: Marambaia; ADR: Angra dos Reis; PRT: Paraty.

Table 1. Localities compared in the similarity analysis, its geographic coordinates, acronyms used in this study and region of the state that they belong.

Restinga	Latitud	Longitud	Acronym	Region
São João da Barra	-21.729.907	-41.030.172	SJB	North
Parque Nacional de Jurubatiba	-22.224.379	-41.557.454	JUR	North
Praia Virgem, Rio das Ostras	-22.533.276	-41.930.802	PVR	Coastal lowland
Barra de São João	-22.579.773	-41.992.500	BSJ	Coastal lowland
Cabo Frio	-22.854.384	-41.987.722	CFR	Coastal lowland
Massambaba, Saquarema	-22.929.381	-42.441.609	MSB	Coastal lowland
Maricá	-22.960.922	-42.873.946	MRC	Coastal lowland
Niterói	-22.968.087	-43.045.533	NIT	Metropolitan
Grumari, Rio de Janeiro	-23.046.252	-43.529.385	GRU	Metropolitan
Marambaia, Rio de Janeiro	-23.062.891	-43.845.631	MRB	Metropolitan
Angra dos Reis	-23.176.439	-44.289.125	ADR	South
Paraty	-23.270.053	-44.613.098	PRT	South

Table 2. Binary matrix (presence/absence) of Solanaceae species found in the twelve restinga areas of Rio de Janeiro state. GRU: Grumari; SJB: São João da Barra; JUR: Jurubatiba; PVR: Praia Virgem; BSJ: Barra de São João; CFR: Cabo Frio; MSB: Massambaba; MRC: Maricá; NIT: Niterói; MRB: Marambaia; ADR: Angra dos Reis; PRT: Paraty.

Species	GRU	SJB	JUR	PVR	BSJ	CFR	MSB	MRC	NIT	MRB	ADR	PRT
<i>Acnistus arborescens</i> (L.) Schlttdl.	0	0	0	0	0	0	0	0	1	0	0	0
<i>Athenaea fasciculata</i> (Vell.) I.M.C. Rodrigues & Stehmann	1	0	1	0	1	1	1	0	0	0	1	1
<i>Brunfelsia latifolia</i> (Pohl) Benth.	0	0	0	0	0	1	0	1	1	0	0	0
<i>Brunfelsia uniflora</i> (Pohl) D.Don	0	0	0	0	1	1	0	1	0	0	0	0
<i>Cestrum axillare</i> Vell.	1	0	1	1	0	1	1	1	1	1	0	0
<i>Cestrum intermedium</i> Sendtn.	0	0	1	0	0	0	0	0	1	1	0	0
<i>Dysochroma viridiflorum</i> (Sims) Miers	0	0	0	0	0	0	0	0	0	1	1	1
<i>Schwenckia americana</i> Rooyen ex L. var. <i>americana</i>	0	0	1	0	0	1	0	0	0	0	0	0
<i>Schwenckia americana</i> var. <i>hirta</i> (Klotzsch) Carv.	0	0	1	0	0	0	0	0	0	0	0	0
<i>Solanum affine</i> Sendtn.	0	0	1	0	0	0	0	0	0	0	0	0
<i>Solanum americanum</i> Mill.	1	0	1	0	0	0	1	0	0	1	0	0
<i>Solanum argenteum</i> Dun.	1	1	0	0	0	1	0	0	0	1	0	0
<i>Solanum aturense</i> Dun.	0	0	0	1	0	1	1	0	0	0	0	0
<i>Solanum caavurana</i> Vell.	1	1	1	1	0	1	0	1	0	0	1	0
<i>Solanum campaniforme</i> Roem. & Schult.	0	0	0	0	0	0	0	0	0	0	0	1
<i>Solanum capsicoides</i> All.	1	0	0	0	0	0	0	0	0	1	1	0
<i>Solanum carautae</i> Carv.	0	0	0	0	0	0	0	0	0	0	1	1
<i>Solanum cordifolium</i> Dun.	1	1	0	1	1	1	1	0	0	1	0	0
<i>Solanum gardneri</i> Sendtn.	0	0	1	0	0	0	0	0	0	0	0	0
<i>Solanum hexandrum</i> Vell.	0	0	0	0	0	0	0	0	0	0	0	1
<i>Solanum insidiosum</i> Mart.	0	1	1	0	1	1	1	1	0	1	0	0
<i>Solanum jussiaei</i> Dun.	1	0	1	1	1	1	0	1	1	1	0	1
<i>Solanum leptostachys</i> Dun.	0	0	1	0	0	0	0	0	0	0	0	0
<i>Solanum lycocarpum</i> A.St.-Hil.	0	0	0	0	0	0	0	0	0	1	0	0
<i>Solanum mauritanum</i> Scop.	1	0	0	0	0	0	0	0	0	1	1	0
<i>Solanum paniculatum</i> L.	1	1	1	1	0	0	1	0	1	0	0	0
<i>Solanum pseudoquina</i> A.St.-Hil.	0	0	1	1	1	1	1	1	0	0	1	1
<i>Solanum scuticum</i> M.Nee	0	0	0	0	0	0	0	0	0	1	0	0
<i>Solanum sisymbriifolium</i> Lam.	0	0	0	0	0	0	0	0	0	1	0	0
<i>Solanum sublentum</i> Hiern	0	0	0	0	0	1	0	0	0	0	0	0
<i>Solanum swartzianum</i> Roem. & Schult.	0	0	0	0	0	0	0	0	0	1	1	0
<i>Solanum sycocarpum</i> Mart. & Sendtn.	0	0	0	0	1	1	1	0	1	0	0	0
<i>Solanum torvum</i> Sw.	0	0	0	0	0	0	1	0	0	0	0	0
Total	10	5	14	7	7	14	10	7	7	14	8	7

Table 3. Information about Solanaceae species present in Grumari restinga. N/d=no data.

Species	Life-form	Behavior	Last Record
<i>Athenaea fasciculata</i> (Vell.) I.M.C. Rodrigues & Stehmann	Shrub or treelet	Heliophyte to semiheliophyte	2017
<i>Cestrum axillare</i> Vell.	Shrub	Heliophyte	2017
<i>Solanum americanum</i> Mill.	Herb	Heliophyte to sciophyte	2016
<i>Solanum argenteum</i> Dun.	Shrub	Semiheliophyte	2017
<i>Solanum caavurana</i> Vell.	Shrub or tree	Heliophyte	2000
<i>Solanum capsicoides</i> All.	Shrub	Heliophyte	2017
<i>Solanum cordifolium</i> Dun.	Shrub	Heliophyte	2017
<i>Solanum jussiaei</i> Dun.	Shrub	Heliophyte	2017
<i>Solanum mauritianum</i> Scop.	Shrub	N/d	1984
<i>Solanum paniculatum</i> L.	Shrub	Heliophyte	1979