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The vascular flora and vegetation of Queimada Grande Island, São Paulo State, southeastern Brazil

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Abstract: Studies of the vegetation on islands off the coast of southeastern Brazil are still very scarce, despite their importance for assessing, managing, and conserving insular biodiversity. We present here a list of the vascular flora of Queimada Grande Island (QGI; 24°29′10″ S, 46°40′30″ W, 57 ha, 33.2 km from the coast) in southeastern Brazil and describe its phytophysiognomies. The island is covered mainly by Atlantic Forest (Dense Ombrophilous Forest), as well as with rock outcrop and anthropogenic vegetation with herbaceous-shrub phytophysiognomies. QGI showed relatively low species richness (S = 125) when compared to other Brazilian coastal islands. Herbaceous (52) and climbing species (31) predominated on QGI. The richest families were Fabaceae (11 species), Poaceae (9), and Apocynaceae, Asteraceae and Orchidaceae (8 species each). Most species (S = 112) are autochthonous from different phytophysiognomies of the southeastern Brazilian Atlantic Forest complex. Many species associated with anthropically disturbed areas (S = 26) can be found on QGI, including the invasive grass *Melinis minutiflora*. There was a slight predominance of zoochory (S = 50). We did not identify any species endemic to QGI. One of its species (*Cattleya intermedia*, Orchidaceae) is vulnerable at both national and regional levels, and another (*Barrosoa apiculata*, Asteraceae) is presumably extinct on the mainland in São Paulo State. The vascular flora of QGI originated from the mainland Atlantic Forest complex, following the pattern of other coastal islands in southeastern Brazil. The flora and vegetation of QGI reflect the combination of insular conditions, the small size of the island, habitat restriction, steep topography, incipient soils, and the past use of the area with the introduction of several foreign species. We recommend permanent monitoring of the vegetation cover of QGI and its management, in order to ensure the conservation of the local native biota.

Keywords: *Atlantic Forest; biodiversity conservation; coastal islands; dispersal syndromes; invasive species; protected areas.*

Flora vascular e vegetação da Ilha Queimada Grande, São Paulo, sudeste do Brasil

Resumo: Estudos sobre a vegetação de ilhas costeiras no sudeste do Brasil ainda são muito escassos, apesar de sua importância para a avaliação, manejo e conservação da biodiversidade insular. Nós apresentamos aqui uma lista da flora vascular da Ilha Queimada Grande (IQG; 24°29′10″ S, 46°40′30″ W, 57 ha, 33,2 km da costa), sudeste do Brasil, e descrevemos suas fitofisionomias. A ilha é recoberta principalmente por Floresta Atlântica (Floresta Ombrófila Densa), bem como por vegetação sobre afloramento rochoso e vegetação antrópica com fisionomias herbáceo-arbustivas. A IQG apresentou riqueza relativamente baixa (S = 125) comparada a de outras ilhas costeiras do Brasil. Espécies herbáceas (52) e trepadeiras (31) predominaram na IQG. As famílias mais ricas foram Fabaceae (11 espécies), Poaceae (9), Apocynaceae, Asteraceae e Orchidaceae (8 espécies cada). A maioria das espécies (S = 112) é autóctone de diferentes fitofisionomias do complexo da Floresta Atlântica do sudeste do Brasil. Muitas espécies associadas a áreas antropicamente alteradas (S = 26) são encontradas na IQG, incluindo a gramínea invasora *Melinis minutiflora*. Houve ligeira predominância de zoocoria (S = 50). Nós não identificamos espécies endêmicas para a IQG. Uma espécie (*Cattleya intermedia*, Orchidaceae)

encontra-se vulnerável em nível nacional e estadual, e outra (*Barrosoa apiculata*, Asteraceae) está presumivelmente extinta no estado de São Paulo. A flora vascular da IQG originou-se no complexo da Floresta Atlântica continental, seguindo o padrão de outras ilhas costeiras do sudeste do Brasil. A flora e a vegetação da IQG refletem a combinação da condição insular, tamanho reduzido da ilha, restrição de habitat, topografia acidentada, solos incipientes e o uso pretérito da área com a introdução de várias espécies alóctones. Nós recomendamos o monitoramento permanente da vegetação da IQG e seu manejo, visando garantir a conservação da biota nativa local.

Palavras-chave*: Floresta Atlântica; conservação da biodiversidade; ilhas costeiras; síndromes de dispersão; espécies invasoras; áreas protegidas.*

Introduction

Islands have long attracted the attention of scientists and naturalists, and studies of their biota have produced important insights into the interactions of processes and patterns in biogeography (Lomolino 2000). The Equilibrium Theory of Island Biogeography (MacArthur & Wilson 1967), for example, has strongly influenced studies of ecology and conservation biology through its proposal that the number of species on a given island is the result of both immigration and extinction rates, and that these two opposing forces are closely related to the size and isolation of the island. According to Kreft et al. (2008), the richness of the vascular flora of an island is mainly determined by the island's size, followed by its degree of geographic isolation, current climatic conditions, and its topography and geology. Island biotas are seriously threatened by climate change, habitat loss and, especially, the introduction of invasive alien species (Kreft et al. 2008, Serafini et al. 2010).

Queimada Grande Island (QGI), located off the southern coast of São Paulo State in southeastern Brazil, has stimulated the interests of various researchers in recent decades. The golden lancehead pit viper, *Bothrops insularis* (Amaral, 1921), is endemic to the island and is critically endangered both nationally (Brasil 2014) and globally (Marques et al. 2004). Although several studies have been carried out on QGI focusing on the biology of this snake (e.g., Wüster et al. 2005, Martins et al. 2008, Marques et al. 2012, Guimarães et al. 2014), information about the island's vegetation cover is still extremely incipient (Martins et al. 2008, Bataus & Reis 2011). Data on its flora are quite rare in the literature, except for Campos & Mello-Filho (1966), who presented a study of the flora that referred to approximately twenty (mostly ruderal) species.

Studies of the vegetation on coastal islands in southeastern Brazil have been very scarce (e.g., Barros et al. 1991, Salino et al. 2005, Silva & Britez 2005, Ferreira et al. 2007, Callado et al. 2009, Bovini et al. 2013, 2014) in spite of their importance for assessing, managing, and conserving biodiversity. Small island plant inventories are even more scarce (Kemenes 2003, Ferreira et al. 2007, Bovini et al. 2014). These studies have frequently indicated that the floras of coastal islands are basically composed of mainland Atlantic Forest complex species (*sensu* Oliveira-Filho & Fontes 2000, Scarano 2002), and are related to their recent histories of isolation from the mainland.

We present here and analyze the terrestrial vascular flora of QGI, describe the phytophysiognomies and biodiversity present on the island, and present data useful for managing that area. This contribution was part of a research project conducted jointly by the Instituto de Pesquisas Jardim Botânico do Rio de Janeiro and the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio) to map and characterize the vegetation cover of QGI and promote the conservation of that island.

Material and Methods

1. Study site

QGI (center point: 24°29′10″ S, 46°40′30″ W) is located 33.2 km from the southern coast of São Paulo State in southeastern Brazil (Figure 1). The island has no beaches or plateaus, with very steep slopes and cliffs in its southern

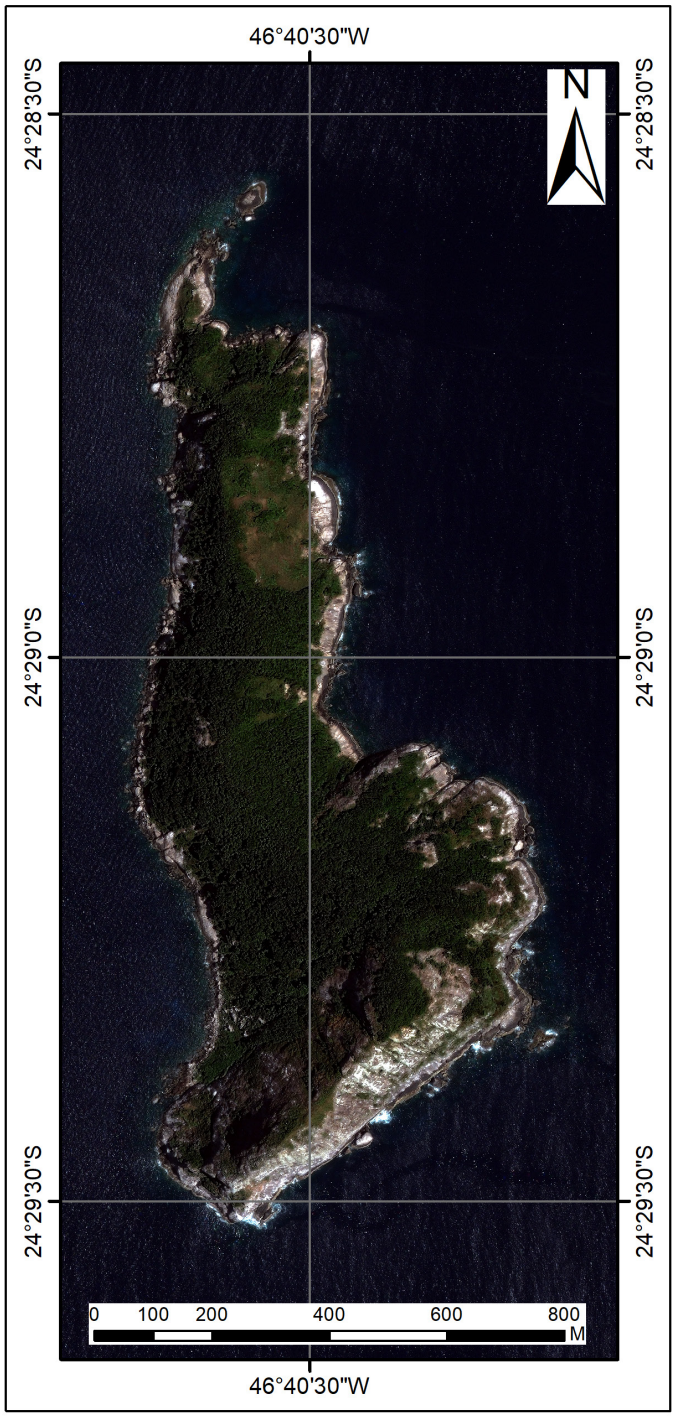

Figure 1. Location of Queimada Grande Island, São Paulo, southeastern Brazil. QuickBird image, December 31, 2013, Datum SIRGAS 2000.

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portion (Figure 2) at elevations from 0–210 m above sea level (Bataus & Reis 2011). Its projected surface area is 57 ha (B.C. Kurtz et al., unpubl. data) and its soils are shallow, with many boulders and rocky outcrops (pers. obs.). Climate data specific for QGI are extremely scarce. According to Guimarães et al. (2014), the local climate is subtropical with two distinct seasons: rainy and warm (October–March) and dry and cold (April–September). Average monthly temperatures ranged from 18.3°C (August) to 27.2°C (March) in 2007–2008, and rainfall from 0.2 mm (July) to 135.2 mm (December) (Marques et al. 2012). The general climate for the coast where QGI is located is classified as Af (Tropical, rainforest), following the Köppen's system (Rolim et al. 2007). Itanhaém, for example, the closest city to QGI, has an average annual rainfall of 2030 mm (Cepagri 2017). The island is relatively distant from the Serra do Mar Range along the mainland coast, however, and should be less affected by orographic rains.

This small coastal island was connected by a land bridge to the mainland during the last glaciation (Wisconsin) maximum about 17,000 years BP, when sea levels were approximately 110 m lower than today (Tessler & Goya 2005). The last contact of QGI with the mainland occurred about 11,000 years ago (Marques et al. 2002) when rising sea levels during the Holocene isolated many coastal areas of different sizes and at varying distances from the coastline in southeastern Brazil.

QGI is covered mainly by Dense Ombrophilous Forest (IBGE 2012), with shorter trees than found on the mainland due to local environmental conditions. Additional phytophysiognomies include rock outcrop vegetation (see Meirelles et al. 1999), areas covered by anthropogenic vegetation (characterized by an herbaceous-shrub physiognomy and corresponding to the initial phases of secondary growth as described by IBGE 2012), and a small banana (*Musa paradisiaca*) plantation (see description below). The latter two formations are the result of past human use of the area.

In 1909, the Brazilian Navy built a lighthouse on QGI, and lighthouse keepers lived there until 1925. The lighthouse has been automated since then and periodically maintained (Bataus & Reis 2011). QGI was declared part of the Area of Relevant Ecological Interest (AREI) of the Queimada Pequena and Queimada Grande Islands in 1985, a Federal Conservation Area for Sustainable Use managed by ICMBio.

2. Data collection

The current floristic list was compiled from collections made on QGI between May/2014 and March/2015 (SISBIO N. 44050-1) and between March/1996 and September/1997, covering all of the seasons of the year. Additionally, samples from the *Herbário Virtual da Flora e dos Fungos* (INCT 2016) were included, using 'São Paulo' as the search keyword for the state, and 'Ilha Queimada Grande' for the locality. We also included three species that were not collected (found only sterile, or in places of difficult access), but identified in the field. The list was also complemented with information from Wanderley et al. (2001, 2002, 2003, 2005, 2007, 2009, 2012, 2016). The botanical material was identified by the authors and/or specialists. The descriptions of the local phytophysiognomies are based on observations made during field excursions.

3. Data analysis

Names and botanical families of all species followed the Flora do Brasil 2020 website (2016) (under construction), which also provided information about life-forms, substrates, and distributions. Species indicated as 'liana/scandent/vine' were treated here simply as climbers (see Morellato & Leitão-Filho 1996). The conservation statuses of the species at global and national levels followed IUCN (2017) and CNCFlora (2017), respectively. Additionally, we used São Paulo (2016) to confirm the

Figure 2. Aerial photograph of Queimada Grande Island, São Paulo, Brazil, showing its rugged topography and its different vegetation physiognomies. Note the area covered by anthropogenic vegetation (in the center of the island near the lighthouse). Photo by J.M. Rosa.

conservation statuses in São Paulo State. Based on the information about the collection sites found on herbarium labels, species were assigned to one or more of the following habitat classes: forest interior, forest edges (interfaces between forests and open areas), rock outcrop vegetation, anthropogenic vegetation, and banana plantation. By consulting the literature (Ichaso 1980, Pennington et al. 1981, Pennington 1990, Lorenzi 1998, 2000, Barroso et al. 1999, Bovini et al. 2001, Wanderley et al. 2001, 2002, 2003, 2005, 2007, 2009, 2012, 2016, Mansano et al. 2004, Passos & Oliveira 2004, Rodrigues et al. 2005, Reis 2006, Souza & Morim 2008, Ferreira 2009, Gomes-Costa & Alves 2012, Silva-Luz et al. 2012, Ferreira & Miotto 2013, Soares Neto et al. 2014), specialists, and through examinations of material deposited at the RB Herbarium, the species of angiosperms were classified into four major groups according to the morphological criteria of Pijl (1982): 1) anemochoric, with diaspores adapted to wind dispersal; 2) zoochoric, with diaspores adapted to animal dispersal; 3) hydrochoric, with diaspores adapted to water dispersal; and 4) autochoric, with diaspores displaying no apparent specific adaptation to the above dispersal agents, including barochoric species (gravity dispersal) and those with explosive dispersal. By consulting the same aforementioned sources, we also determined which species are autochthonous to ombrophilous forests and/or pioneer formations (*sensu* IBGE 2012): beach ridge vegetation (*restinga*; Lacerda et al. 1993) and rock outcrop vegetation (Meirelles et al. 1999), of the Atlantic Forest complex in southeastern Brazil, and which species are associated with anthropically disturbed areas (ruderal species; *sensu* Moro et al. 2012). Finally, we identified the invasive alien species in the Atlantic Forest complex that could be competing or displacing populations of native species and hampering vegetation regeneration on QGI, based on *Base de Dados Nacional de Espécies Exóticas Invasoras I3N Brasil* (Instituto Hórus 2017).

We compared the species richness at QGI with that of other coastal islands in eastern and southeastern Brazil by selecting sites with comprehensive published surveys and physiographies comparable to that of QGI.

Results

We identified 125 species of vascular plants on QGI, distributed among 115 genera and 57 families, including four pteridophytes and 121 angiosperms (Table 1). The richest families were Fabaceae (11 species), Poaceae (nine species), and Apocynaceae, Asteraceae and Orchidaceae (eight species each). Considering the maximum life-form expression of each species, there was a predominance of herbs (S = 52; 41.6% of the total) and climbers (S = 31; 24.8%). Shrubs and subshrubs totaled 25 species (20%); only 17 species (13.6%) show arboreal habits. Our results indicated a very low richness of epiphytes on the island, with strictly epiphytic species accounting for only 2.4% of the local flora (S = 3: *Acianthera saundersiana*, *Epidendrum densiflorum* and *Peperomia glabella*), although this number rises to 8% if hemiepiphytes (*Monstera praetermissa*) and facultative epiphytes (i.e., those plants capable of living as rupiculous or terrestrial individuals) with six species (including *Rumohra adiantiformis*, *Aechmea caudata* and *Cattleya intermedia*) are included. QGI showed a relatively low number of species when compared to other coastal islands of eastern and southeastern Brazil (Table 2).

The vast majority of the species (S = 112; 89.6%) are autochthonous from ombrophilous forests and/or pioneer formations (*restinga* and rock outcrop vegetation) within the Atlantic Forest complex of southeastern Brazil; 13 (10.4%) species are allochthonous from those formations (e.g., *Tetragonia tetragonoides*, *Crotalaria laeta*, *Musa paradisiaca* and *Rivina humilis*). Additionally, several species (26) were indicated in the literature (or by specialists) as characteristic of anthropically disturbed areas (e.g., *Asclepias curassavica*, *Bidens pilosa*, *Ipomoea cairica*, *Merremia dissecta*, *Desmodium incanum*, *Sida rhombifolia*, *Digitaria insularis* and *Paspalum virgatum*), with two invasive alien species in the Atlantic Forest complex (*Oeceoclades maculata* and *Melinis minutiflora*). Forty species were identified in the local Dense Ombrophilous Forest, and 20 on rock outcrop vegetation. Forty-five species were found in anthropogenic vegetation (including banana plantations) and 37 along forest edges. Some species occurred in more than one habitat. Information concerning the habitats of 7 species was not available (Table 1).

Dense Ombrophilous Forest currently occupies about 50% of the island area, especially at higher altitude sites and those showing less human interference (Figure 2). Canopy height rarely exceeds 10 m, and species typical of mainland secondary forest formations occur there (such as *Guapira opposita*, *Myrsine guianensis* and *Gallesia integrifolia*). Some forest areas are dominated by the palm tree *Syagrus romanzoffiana*. The herbaceous layer is rich in Acanthaceae, Orchidaceae, and Araceae. Epiphytes are relatively rare, occurring only sporadically (*Lepismium cruciforme* and *Aechmea caudata*).

The rock outcrop vegetation type with an herbaceous or shrub phytophysiognomy occurs on steep slopes or on island peaks, associated with patches of incipient soil accumulation, forming vegetation clumps on the otherwise bare rocky matrix (Figure 3). Closer to the sea, under the influence of salt spray, the rock outcrop vegetation is composed mainly of small shrubs and fleshy herbs, especially *Begonia subvillosa*, *Cereus fernambucensis*, and the allochthonous species *Tetragonia tetragonoides*.

Anthropogenic vegetation, characterized by an herbaceous-shrub physiognomy, represents the early stages of ecological succession in areas originally covered by the Dense Ombrophilous Forest (Figure 2). These areas were formally occupied by rustic houses and small farms (see below), and grasses and other species associated with anthropically disturbed areas predominate there (including *Bidens pilosa*, *Solidago chilensis*, *Lepidium bonariense*, *Ipomoea cairica*, *Eleusine indica* and *Melinis minutiflora*). The anthropogenic vegetation type also includes a small abandoned banana plantation.

Considering only angiosperms, there was a slight predominance of zoochory (S = 50; 41.3%). Thirty-seven species (30.6%) are anemochoric and 33 (27.3%) autochoric, with four hydrochoric species (3.3%). These numbers include some species of Poaceae with more than one dispersal syndrome (Table 1). The predominant Dense Ombrophilous Forest showed a preponderance of zoochory (S = 21; 53.8% of the species surveyed in this vegetation), including species with fleshy fruits (e.g., *Eugenia* spp., *Guapira opposita*, *Myrsine guianensis*, *Rudgea minor* and *Sideroxylon obtusifolium*) or arilate seeds (e.g., *Trichilia casaretti* and *Cupania oblongifolia*) adapted to endozoochory. Zoochoric species, on the other hand, occurring in the anthropogenic vegetation and along forest edges showed different dispersal strategies, including structures that facilitate the adhesion of their diaspores to animals (or clothes) (e.g., *Cyathula prostrata*, *Bidens* spp., *Desmodium incanum* and *Sida* spp.).

This study did not detect any plant species endemic to QGI. Most of the species found on QGI have not yet been evaluated in terms of their conservation statuses at a national level, and only one species (*Cattleya intermedia*) is considered vulnerable (VU) at both national and regional levels. The only record of this orchid on the island is from 1922 (A. Gehrt s/n, SP 8146), and it may be presumed to be extinct on QGI, as it has not been found during recent expeditions. Additionally, *Barrosoa apiculata* is considered extinct (EX) in São Paulo State according to the official list of threatened species of São Paulo. The only known specimen of this species was collected on the island in 1920 (A. Gehrt s/n, SP 4535) and our collecting efforts failed to find any additional individuals. Although *Trichilia casaretti* has been classified as vulnerable (VU) at a global level, its status needs updating according to IUCN (2017).

Table 1. List of the vascular flora of Queimada Grande Island, São Paulo, Brazil. Species marked with an '*' are indicated in the literature as characteristic of anthropically disturbed areas, and species marked with a '†' are invasive in the Atlantic Forest complex in southeastern Brazil. Substrate: Epi (epiphytic); Hem (hemiepiphytes); Rup (rupiculous); Ter (terrestrial). Origin: Auto (autochthonous); Allo (allochthonous) from the Atlantic Forest complex in southeastern Brazil. Dispersal syndrome: Anemo (anemochoric); Auto (autochoric); Hydro (hydrochoric); Zoo (zoochoric). Conservation statuses at global [square brackets], national (no brackets), and regional {curly brackets} levels: NE (Not Evaluated); LC (Least Concern); VU (Vulnerable); EX (Presumably Extinct). Herbaria: ESA (Escola Superior de Agricultura Luiz de Queiroz); NY (The New York Botanical Garden); RB (Instituto de Pesquisas Jardim Botânico do Rio de Janeiro); SP (Herbário do Estado Maria Eneyda P. Kaufmann Fidalgo); SPF (Universidade de São Paulo); UEC (Universidade Estadual de Campinas).

Family	Species	Life-form	Substrate	Origin	Habitat	Syndrome	Status	Voucher
PTERIDOPHYTES								
Aspleniaceae	*Asplenium claussenii* Hieron.	Herb	Rup, Ter	Auto	Forest	—	NE	V.C. Souza 11067: RB 629051
Blechnaceae	*Blechnum polypodioides* Raddi	Herb	Ter	Auto	No information	—	NE	A. Gehrt 4545: NY 814169
Dryopteridaceae	*Rumohra adiantiformis* (G. Forst.) Ching	Herb	Epi, Rup, Ter	Auto	Rock outcrop vegetation	—	NE	V.C. Souza 11037: RB 611809
Polypodiaceae	*Serpocaulon triseriale* (Sw.) A.R. Sm.	Herb	Rup, Ter	Auto	Forest edge	—	NE	V.C. Souza 11054: RB 627263
ANGIOSPERMS								
Acanthaceae	*Dicliptera mucronifolia* Nees	Subshrub	Ter	Auto	Forest	Auto	NE	G.O. Joaquim Jr. 16: RB 627046
	Justicia kleinii Wassh. & L.B. Sm.	Herb	Ter	Auto	Forest	Auto	LC	A.M. Magalhães 65: RB 636590
	Pseuderanthemum heterophyllum (Nees) Radlk.	Herb	Ter	Auto	Forest	Auto	NE	G.O. Joaquim Jr. 39: ESA 33144
	Ruellia brevifolia (Pohl) C. Ezcurra	Subshrub	Ter	Auto	Forest edge	Auto	NE	G.O. Joaquim Jr. 123: RB 627016
Aizoaceae	*Sesuvium portulacastrum* (L.) L.	Herb	Rup, Ter	Auto	Rock outcrop vegetation	Auto	NE	V.C. Souza 11045: ESA 27428
	Tetragonia tetragonoides (Pall.) Kuntze	Herb	Ter	Allo	Rock outcrop vegetation	Hydro	NE	V.C. Souza 11032: ESA 31994
Amaranthaceae	*Alternanthera brasiliana* (L.) Kuntze	Subshrub	Ter	Auto	Anthropogenic vegetation	Auto	NE	A. Gehrt s/n: SP 4565
	Cyathula prostrata Blume*	Subshrub	Ter	Auto	Anthropogenic vegetation	Zoo	NE	A.M. Magalhães 38: RB 636575
	Dysphania ambrosioides (L.) Mosyakin & Clemants	Subshrub	Ter	Allo	Anthropogenic vegetation	Zoo	NE	A. Gehrt s/n: SP 4564
Amaryllidaceae	*Hippeastrum reticulatum* Herb.	Herb	Ter	Auto	Forest	Auto	NE	A.M. Magalhães 66: RB 636591
Apocynaceae	*Asclepias curassavica* L.*	Herb	Ter	Auto	Anthropogenic vegetation	Anemo	NE	A.M. Magalhães 51: RB 636582
	Aspidosperma australe Müll. Arg.	Tree	Ter	Auto	Forest	Anemo	LC	A.M. Magalhães 96: RB 636611
	Forsteronia thyrsoidea (Vell.) Müll. Arg.	Climber	Ter	Auto	Forest edge	Anemo	NE	A. Gehrt s/n: RB 119773
	Gonolobus rostratus (Vahl) R. Br. ex Shult.	Climber	Ter	Auto	Forest edge, Anthropogenic vegetation	Anemo	NE	A.M. Magalhães 99: RB 636613
	Jobinia connivens (Hook. & Arn.) Malme	Climber	Ter	Auto	Forest edge	Anemo	NE	G.O. Joaquim Jr. 127: ESA 34562
	Marsdenia macrophylla (Humb. & Bonpl. ex Schult.) E. Fourn.	Climber	Ter	Auto	Forest edge	Anemo	NE	A. Gehrt s/n: SP 28663
	Orthosia urceolata E. Fourn.	Climber	Ter	Auto	Forest edge	Anemo	NE	G.O. Joaquim Jr. 115: ESA 34577
	Temnadenia odorifera (Vell.) J.F. Morales	Climber	Ter	Auto	Anthropogenic vegetation	Anemo	NE	A.M. Magalhães 74: RB 637080
Araceae	*Anthurium parasiticum* (Vell.) Stellfeld	Herb	Ter	Auto	Forest	Zoo	LC	V.C. Souza 11091: RB 427676
	Monstera praetermissa E.G. Gonç. & Temponi	Herb	Hem	Auto	Forest	Zoo	NE	V.C. Souza 11041: ESA 27427
	Xanthosoma sp.	Herb		Auto	Rock outcrop vegetation, Anthropogenic vegetation	Zoo		Not collected

Table 1. Continued...

Family	Species	Life-form	Substrate	Origin	Habitat	Syndrome	Status	Voucher
Arecaceae	*Syagrus romanzoffiana* (Cham.) Glassman	Palm Tree	Ter	Auto	Forest	Zoo	LC	Not collected
Asteraceae	*Austroeupatorium inulaefolium* (Kunth) R.M. King & H. Rob.	Shrub, Subshrub	Rup, Ter	Auto	Forest edge, Anthropogenic vegetation	Anemo	NE	A.M. Magalhães 21: RB 637078
	Barrosoa apiculata (Gardner) R.M. King & H. Rob.	Herb	Ter	Auto	Rock outcrop vegetation	Anemo	LC {EX}	A. Gehrt s/n: SP 4535
	Bidens pilosa L.*	Herb	Ter	Allo	Anthropogenic vegetation	Zoo	NE	V.C. Souza 11015: ESA 26128
	Bidens segetum Mart. ex Colla	Climber, Subshrub	Ter	Auto	Anthropogenic vegetation	Zoo	NE	A.M. Magalhães 39: RB 636576
	Chromolaena odorata (L.) R.M. King & H. Rob.*	Shrub	Ter	Auto	Forest edge, Anthropogenic vegetation	Anemo	NE	A.M. Magalhães 24: RB 636569
	Cyrtocymura scorpioides (Lam.) H. Rob.	Subshrub	Ter	Auto	Anthropogenic vegetation	Anemo	NE	A.M. Magalhães 59: RB 636585
	Mikania micrantha Kunth*	Climber	Ter	Auto	Anthropogenic vegetation	Anemo	NE	A.M. Magalhães 44: RB 636579
	Solidago chilensis Meyen*	Subshrub	Ter	Auto	Anthropogenic vegetation	Anemo	NE	V.C. Souza 11069: ESA 26144
Basellaceae	*Anredera cordifolia* (Ten.) Steenis	Climber	Ter	Auto	Forest edge	Auto	NE	V.C. Souza 11021: ESA 26119
Begoniaceae	*Begonia fernandocostae* Irmsch.	Subshrub	Ter	Auto	No information	Anemo	NE	A. Amaral & J. Domingues 26a: SP 3946
	Begonia subvillosa Klotzsch	Herb	Rup, Ter	Auto	Forest, Rock outcrop vegetation	Anemo	NE	V.C. Souza 11011: ESA 26125
Bignoniaceae	*Dolichandra quadrivalvis* (Jacq.) L.G. Lohmann	Climber	Ter	Auto	Forest	Anemo	NE	A. Gehrt s/n: SP 4556
Boraginaceae	*Tournefortia membranacea* (Gardner) DC.	Shrub, Climber, Subshrub	Ter	Auto	Forest edge	Zoo	NE	V.C. Souza 11090: ESA 26155
	Varronia curassavica Jacq.	Shrub	Ter	Auto	Forest edge, Anthropogenic vegetation	Zoo	NE	D.F. Bertani s/n: RB 552595
Brassicaceae	*Lepidium bonariense* L.*	Herb	Ter	Auto	Anthropogenic vegetation	Zoo	NE	G.O. Joaquim Jr. 14: ESA 33163
Bromeliaceae	*Aechmea caudata* Lindm.	Herb	Epi, Rup, Ter	Auto	Forest	Zoo	LC	V.C. Souza 11022: RB 471967
Cactaceae	*Cereus fernambucensis* Lem.	Shrub, Subshrub	Rup, Ter	Auto	Rock outcrop vegetation	Zoo	NE [LC]	A. Gehrt s/n: SP 4574
	Coleocephalocereus fluminensis (Miq.) Backeb.	Shrub	Rup	Auto	Rock outcrop vegetation	Zoo	NE [LC]	A.M. Magalhães 94: RB 636609
	Lepismium cruciforme (Vell.) Miq.	Herb	Epi, Rup	Auto	Forest	Zoo	LC [LC]	V.C. Souza 11060: ESA 26136
	Pereskia aculeata Mill.	Climber	Rup, Ter	Auto	Forest, Forest edge	Zoo	LC [LC]	A.M. Magalhães 76: RB 636598
Campanulaceae	*Hippobroma longiflora* (L.) G. Don*	Herb, Shrub	Ter	Auto	Anthropogenic vegetation	Auto	NE	A.M. Magalhães 62: RB 636588
Cannabaceae	*Trema micrantha* (L.) Blume	Shrub, Tree	Ter	Auto	Forest	Zoo	NE	V.C. Souza 11058: ESA 26153
Cannaceae	*Canna indica* L.	Herb	Ter	Auto	Forest edge, Anthropogenic vegetation	Auto	NE	A.M. Magalhães 63: RB 636589
Capparaceae	*Cynophalla flexuosa* (L.) J. Presl	Shrub	Ter	Auto	Forest	Zoo	NE	V.C. Souza 11068: ESA 26143
Celastraceae	*Hippocratea volubilis* L.	Climber	Ter	Auto	Forest edge	Anemo	NE	V.C. Souza 11030: ESA 27433
Cleomaceae	*Cleome rosea* Vahl ex DC.	Herb, Subshrub	Rup, Ter	Auto	Rock outcrop vegetation	Zoo	NE	V.C. Souza 11012: ESA 26126

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Table 1. Continued...

Family	Species	Life-form	Substrate	Origin	Habitat	Syndrome	Status	Voucher
	Hemiscola aculeata (L.) Raf.*	Herb	Rup, Ter	Auto	Forest edge	Zoo	NE	A. Gehrt s/n: SPF 100854
Commelinaceae	*Commelina erecta* L.*	Herb	Rup, Ter	Auto	Forest edge, Rock outcrop vegetation	Auto	NE [LC]	A.M. Magalhães 95: RB 636610
	Gibasis geniculata (Jacq.) Rohweder	Herb	Rup, Ter	Auto	Forest edge	Auto	NE	V.C. Souza 11092: ESA 26157
	Tradescantia fluminensis Vell.	Herb	Epi, Rup, Ter	Auto	Forest	Auto	NE	V.C. Souza 11093: ESA 26158
Convolvulaceae	*Ipomoea cairica* (L.) Sweet*	Climber	Ter	Auto	Anthropogenic vegetation	Anemo	NE	G.O. Joaquim Jr. 113: ESA 34579
	Ipomoea tiliacea (Willd.) Choisy*	Climber	Ter	Auto	Forest edge	Anemo	NE	V.C. Souza 11066: ESA 70940
	Ipomoea triloba L.*	Climber	Ter	Allo	Anthropogenic vegetation	Auto	NE	G.O. Joaquim Jr. 129: ESA 87102
	Jacquemontia ferruginea Choisy	Climber	Ter	Auto	Forest edge, Anthropogenic vegetation	Auto	NE	A.M. Magalhães 68: RB 636593
	Merremia dissecta (Jacq.) Hallier f.*	Climber	Ter	Auto	Forest edge, Anthropogenic vegetation	Auto	NE	A.M. Magalhães 85: RB 636601
Cucurbitaceae	*Melothria pendula* L.*	Climber	Ter	Auto	Forest edge	Zoo	NE	A.M. Magalhães 64: RB 637079
Cyperaceae	*Cyperus ligularis* L.	Herb	Rup, Ter	Auto	Anthropogenic vegetation	Zoo	NE	A.M. Magalhães 78: RB 636599
Dioscoreaceae	*Dioscorea fodinarum* Kunth	Climber	Ter	Auto	Forest edge	Anemo	NE	V.C. Souza 11086: ESA 27114
Ebenaceae	*Diospyros inconstans* Jacq.	Tree	Ter	Auto	Forest, Forest edge	Zoo	LC	V.C. Souza 11010: ESA 26134
Erythroxylaceae	*Erythroxylum cuspidifolium* Mart.	Shrub, Tree	Ter	Auto	Forest	Zoo	NE	V.C. Souza 11078: ESA 27107
Euphorbiaceae	*Algernonia riedelii* (Müll. Arg.) G.L. Webster	Tree	Ter	Auto	Forest	Auto	NE	V.C. Souza 11087: ESA 27115
	Euphorbia insulana Vell.	Herb	Ter	Auto	Anthropogenic vegetation	Auto	NE	V.C. Souza 11061: ESA 26137
	Tragia volubilis L.	Climber	Epi, Ter	Auto	Forest edge	Auto	NE	A. Amaral & D. Lemos s/n: SP 3887
Fabaceae	*Canavalia rosea* (Sw.) DC.	Herb, Climber	Ter	Auto	Rock outcrop vegetation	Hydro	NE	V.C. Souza 11031: ESA 27434
	Centrosema virginianum (L.) Benth.	Climber	Ter	Auto	Anthropogenic vegetation	Auto	NE	G.O. Joaquim Jr. 122: RB 587987
	Chaetocalyx brasiliensis (Vogel) Benth.	Climber	Ter	Auto	Rock outcrop vegetation	Auto	NE	A. Gehrt s/n: UEC 84324
	Condylostylis candida (Vell.) A. Delgado	Climber	Ter	Auto	Forest edge	Auto	NE	V.C. Souza 11096: ESA 26161
	Crotalaria laeta Mart. ex Benth.	Subshrub	Ter	Allo	Anthropogenic vegetation	Auto	NE	A.M. Magalhães 75: RB 636597
	Crotalaria vitellina Ker Gawl.	Shrub, Subshrub	Ter	Auto	Forest edge, Rock outcrop vegetation	Auto	NE	F.T. Farah 30: RB 593080
	Desmodium incanum (Sw.) DC.*	Subshrub	Ter	Allo	Forest edge, Anthropogenic vegetation	Zoo	NE	A.M. Magalhães 46: RB 636580
	Senegalia tenuifolia (L.) Britton & Rose	Shrub, Climber	Ter	Auto	Forest, Forest edge, Anthropogenic vegetation	Auto	NE	A.M. Magalhães 69: RB 636594
	Senna neglecta (Vogel) H.S. Irwin & Barneby*	Shrub	Rup, Ter	Auto	Anthropogenic vegetation	Auto	NE	V.C. Souza 11085: RB 591824
	Sigmoidotropis speciosa (Kunth) A. Delgado	Climber	Ter	Auto	Rock outcrop vegetation	Auto	NE	A. Gehrt s/n: SP 4553
	Zollernia ilicifolia (Brongn.) Vogel	Shrub, Tree	Ter	Auto	Forest	Zoo	NE	A. Gehrt s/n: SP 4559
Iridaceae	*Neomarica imbricata* (Hand.-Mazz.) Sprague	Herb	Ter	Auto	Forest	Auto	NE	A. Gehrt s/n: SP 4659

Table 1. Continued...

Family	Species	Life-form	Substrate	Origin	Habitat	Syndrome	Status	Voucher
Lamiaceae	*Mesosphaerum sidifolium* (L'Hérit.) Harley & J.F.B. Pastore	Herb, Subshrub	Ter	Auto	Forest edge	Zoo	NE	V.C. Souza 11065: ESA 26141
Malvaceae	*Sida planicaulis* Cav.*	Shrub, Subshrub	Ter	Auto	Forest edge, Anthropogenic vegetation	Zoo	NE	A.M. Magalhães 40: RB 636577
	Sida rhombifolia L.*	Herb	Ter	Auto	Forest edge, Anthropogenic vegetation	Zoo	NE	A.M. Magalhães 52: RB 636583
Marantaceae	*Maranta divaricata* Roscoe	Herb	Ter	Auto	Forest	Auto	NE	A.M. Magalhães 97: RB 636612
Meliaceae	*Trichilia casaretti* C. DC.	Tree	Ter	Auto	Forest	Zoo	LC [VU]	D.F. Bertani QT-96: RB 552254
Musaceae	*Musa paradisiaca* L.	Herb	Ter	Allo	Banana plantation	Sterile	NE	Not collected
Myrtaceae	*Eugenia astringens* Cambess.	Tree	Ter	Auto	Forest	Zoo	NE	D.F. Bertani QP-80: RB 552194
	Eugenia sulcata Spring ex Mart.	Tree	Ter	Auto	Forest	Zoo	NE	A. Gehrt s/n: SP 4528
Nyctaginaceae	*Guapira opposita* (Vell.) Reitz	Shrub, Tree	Ter	Auto	Forest, Anthropogenic vegetation	Zoo	NE	A.M. Magalhães 60: RB 636586
Orchidaceae	*Acianthera saundersiana* (Rchb. f.) Pridgeon & M.W. Chase	Herb	Epi	Auto	No information	Anemo	NE [LC]	A. Gehrt s/n: SP 5452
	Cattleya intermedia Grah.	Herb	Epi, Rup	Auto	No information	Anemo	VU {VU}	A. Gehrt s/n: SP 8146
	Cyclopogon bicolor (Ker-Gaw.) Schltr.	Herb	Ter	Auto	Forest	Anemo	NE	G.O. Joaquim Jr. 23: ESA 33124
	Eltroplectris calcarata (Sw.) Garay & Sweet	Herb	Ter	Auto	Forest	Anemo	LC	G.O. Joaquim Jr. 24: ESA 33125
	Epidendrum densiflorum Hook.	Herb	Epi	Auto	Forest	Anemo	NE	A. Gehrt s/n: SP 4621
	Epidendrum fulgens Brongn.	Herb	Rup, Ter	Auto	Rock outcrop vegetation, Anthropogenic vegetation	Anemo	NE	A. Amaral s/n: SP 3967
	Mesadenella cuspidata (Lindl.) Garay	Herb	Ter	Auto	Forest	Anemo	NE	V.C. Souza 11042: ESA 27425
	Oeceoclades maculata (Lindl.) Lindl.†	Herb	Ter	Allo	Forest	Anemo	NE [LC]	V.C. Souza 11040: ESA 27423
Passifloraceae	*Passiflora suberosa* L.*	Climber	Ter	Auto	Forest edge	Zoo	NE	V.C. Souza 11025: RB 482678
Phytolaccaceae	*Gallesia integrifolia* (Spreng.) Harms	Tree	Ter	Auto	Forest	Anemo	NE	A.M. Magalhães 50: RB 636581
	Rivina humilis L.	Herb	Ter	Allo	Forest, Forest edge, Anthropogenic vegetation	Zoo	NE	A.M. Magalhães 67: RB 636592
Piperaceae	*Peperomia glabella* (Sw.) A. Dietr.	Herb	Epi	Auto	No information	Zoo	NE	L.E. Mello Filho 1979: NY 558881
Plantaginaceae	*Scoparia dulcis* L.	Herb, Subshrub	Ter	Auto	Rock outcrop vegetation	Anemo	NE	V.C. Souza 11084: ESA 27112
Plumbaginaceae	*Plumbago scandens* L.	Subshrub	Ter	Auto	Anthropogenic vegetation	Zoo	NE	A.M. Magalhães 36: RB 636574
Poaceae	*Digitaria ciliaris* (Retz.) Koeler*	Herb	Ter	Allo	Anthropogenic vegetation	Anemo, Zoo	NE	A.M. Magalhães 93: RB 636608
	Digitaria insularis (L.) Fedde*	Herb	Ter	Allo	Anthropogenic vegetation	Anemo, Zoo	NE	A.M. Magalhães 90: RB 636605
	Eleusine indica (L.) Gaertn.*	Herb	Ter	Allo	Anthropogenic vegetation	Zoo	NE [LC]	A.M. Magalhães 87: RB 636603
	Lasiacis ligulata Hitchc. & Chase	Herb	Ter	Auto	Forest	Zoo	NE	V.C. Souza 11062: ESA 26138
	Melinis minutiflora P. Beauv.*†	Herb	Ter	Allo	Anthropogenic vegetation	Anemo	NE	F.T. Farah 9: ESA 39563

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Table 1. Continued...

Family	Species	Life-form	Substrate	Origin	Habitat	Syndrome	Status	Voucher
	Paspalum distichum L.	Herb	Ter	Auto	Anthropogenic vegetation	Hydro, Zoo	NE [LC]	G.O. Joaquim Jr. 44: ESA 33136
	Paspalum virgatum L.*	Herb	Ter	Auto	Anthropogenic vegetation	Auto	NE	A.M. Magalhães 91: RB 636606
	Sporobolus virginicus (L.) Kunth	Herb	Ter	Auto	Rock outcrop vegetation	Anemo	NE	A.M. Magalhães 92: RB 636607
	Stenotaphrum secundatum (Walter) Kuntze	Herb	Ter	Auto	Rock outcrop vegetation, Anthropogenic vegetation	Hydro, Zoo	NE	A.M. Magalhães 86: RB 636602
Polygonaceae	*Ruprechtia laurifolia* (Cham. & Schltdl.) A.C. Meyer	Tree, Climber	Ter	Auto	No information	Anemo	NE	A. Gehrt s/n: UEC 80555
Portulacaceae	*Portulaca oleracea* L.	Herb	Ter	Auto	Rock outcrop vegetation	Auto	NE	A.M. Magalhães 73: RB 636596
	Talinum paniculatum (Jacq.) Gaertn.	Herb	Rup, Ter	Auto	Rock outcrop vegetation	Auto	NE	A.M. Magalhães 100: RB 636614
Primulaceae	*Myrsine guianensis* (Aubl.) Kuntze	Shrub, Tree	Ter	Auto	Forest	Zoo	NE	D.F. Bertani QT-2: RB 560747
Rubiaceae	*Chiococca alba* (L.) Hitchc.	Shrub	Ter	Auto	Forest edge, Anthropogenic vegetation	Zoo	NE [LC]	A.M. Magalhães 61: RB 636587
	Rudgea minor (Cham.) Standl.	Shrub, Tree	Ter	Auto	Forest	Zoo	LC	A.M. Magalhães 71: RB 636595
Sapindaceae	*Cardiospermum halicacabum* L.*	Herb, Climber	Ter	Auto	Anthropogenic vegetation	Zoo	NE	A.M. Magalhães 102: RB 636616
	Cupania oblongifolia Mart.	Tree	Ter	Auto	Forest	Zoo	NE	D.F. Bertani QT-23: RB 551934
	Urvillea triphylla (Vell.) Radlk.	Climber	Ter	Auto	Forest edge	Anemo	NE	V.C. Souza 11075: ESA 27104
Sapotaceae	*Sideroxylon obtusifolium* (Roem. & Schult.) T.D. Penn.	Shrub, Tree	Ter	Auto	Forest	Zoo	LC	A.M. Magalhães s/n: RB 637081
Urticaceae	*Pilea pubescens* Liebm.	Herb	Ter	Auto	No information	Auto	NE	A.R. Duarte 56: ESA 49651
Vitaceae	*Cissus verticillata* (L.) Nicolson & C.E. Jarvis	Climber	Ter	Auto	Forest edge	Zoo	NE	A.M. Magalhães 101: RB 636615

Figure 3. Rock outcrop vegetation on a steep cliff, with a large population of *Coleocephalocereus fluminensis*, Queimada Grande Island, São Paulo, southeastern Brazil. Photo by A.M. Magalhães.

Table 2. Number of plant species on islands off the coast of eastern and southeastern Brazil.

Site/Code	Coordinates	Phytophysiognomies	Approximate area (ha)/ Maximum altitude (m)	Distance to mainland (km)	Number of species	Reference
Queimada Grande Island, Peruíbe, São Paulo (QGI)	24°29′10″ S, 46°40′30″ W (center point)	Dense Ombrophilous Forest, rock outcrop vegetation, anthropogenic vegetation	57/210	33.2	125 (vascular plants)	This study
Abrolhos Marine National Park, Caravelas, Bahia (ABR)*	17°57′35″-17°58′56″ S, 38°41′27″- 38°42′56″ W	Rock outcrop vegetation, *restinga*	77/36	65	40 (angiosperms)	Kemenes (2003)
Franceses Island, Itapemirim, Espírito Santo (FRA)	20°55′36″ S, 40°45′15″ W (center point)	Dense Ombrophilous Forest, rock outcrop vegetation, *restinga*, mangrove swamps, anthropogenic vegetation	16/36	3.5	123 (angiosperms)	Ferreira et al. (2007)
Cagarras Islands Natural Monument, Rio de Janeiro, Rio de Janeiro (CAG)**	23°01′30″-23°04′32″ S, 43°11′23″-43°12′32″ W	Dense Ombrophilous Forest, rock outcrop vegetation, anthropogenic vegetation	79/240	3.8-8.6	169 (vascular plants)	Bovini et al. (2014)
Grande Island, Angra dos Reis, Rio de Janeiro (GRA)	23°04′30″-23°13′40″ S, 44°05′26″-44°22′43″ W	Dense Ombrophilous Forest, rock outcrop vegetation, *restinga*, mangrove swamps, anthropogenic vegetation	19,300/1,011	3.1	795 (vascular plants)	Callado et al. (2009)
Cardoso Island, Cananéia, São Paulo (CAR)	25°03′05″-25°18′18″ S, 47°53′48″-48°05′42″ W	Dense Ombrophilous Forest, rock outcrop vegetation, *restinga*, mangrove swamps, anthropogenic vegetation	22,500/840	<1	985 (angiosperms)	Barros et al. (1991)
Mel Island, Paranaguá, Paraná (MEL)	25°29′00″-25°34′32″ S, 48°17′15″-48°23′16″ W	Dense Ombrophilous Forest, rock outcrop vegetation, *restinga*, mangrove swamps, anthropogenic vegetation	2,894/148	2.8	~504 (vascular plants)	Kersten & Silva (2005); Kozera & Rodrigues (2005); Marques & Oliveira (2005); Salino et al. (2005)

* The survey included the five islands that make up ABR: Guarita, Redonda, Santa Barbara, Siriba and Sueste.

** The survey included the four largest islands at CAG: Cagarra, Comprida, Palmas and Redonda.

Discussion

The small islands (<100 ha) along the eastern and southeastern coast of Brazil have very non-diverse floras (Kemenes 2003, Ferreira et al. 2007, Bovini et al. 2014) related to their insular conditions, sizes, habitat restrictions, steep topographies, incipient soils, and use histories (see Lomolino 2000, Kreft et al. 2008). Species richness on QGI is lower than that on CAG (Bovini et al. 2014) and close to that on FRA (an island of only 16 ha; Ferreira et al. 2007) – which is apparently related to the distance of QGI from the coast, making the arrival and establishment of propagules more difficult. The very low richness on ABR (Kemenes 2003) can also be related to its greater distance from the coast.

Large islands generally have richer floras due to their great environmental heterogeneity (Barros et al. 1991, Kersten & Silva 2005, Kozera & Rodrigues 2005, Marques & Oliveira 2005, Salino et al. 2005, Callado et al. 2009). These islands can be considered insular samples of the mainland Atlantic Forest complex, and they harbor many mainland plant communities, i.e., altitudinal gradients of dense ombrophilous forests and pioneer formations: *restinga*, rock outcrop vegetation, and mangrove swamps.

The vascular flora of QGI originated from the mainland Atlantic Forest complex, and the vast majority of its species (including most species associated with anthropically disturbed areas) are autochthonous to that southeastern Brazilian complex, occurring frequently in dense ombrophilous forests or *restinga*. This pattern was also reported for FRA (Ferreira et al. 2007) and CAG (Bovini et al. 2014). Some species are widespread on those three sets of islands (e.g., *Sesuvium portulacastrum*, *Temnadenia odorifera*, *Syagrus romanzoffiana*, *Cyrtocymura scorpioides*, *Cereus fernambucensis*, *Ipomoea cairica*, *Maranta divaricata*, *Guapira opposita*, *Sporobolus virginicus*, *Talinum paniculatum* and *Chiococca alba*).

The Dense Ombrophilous Forest on QGI showed a very low richness of arboreal species (S = 17), contrasting with high richness often found in continental remnants of this formation (e.g., Scudeller et al. 2001). The island forest also showed an unusual oligarchic structure, with a predominance of *Guapira opposita*, *Rudgea minor*, and *Aspidosperma australe* (B.C. Kurtz et al., unpubl. data). QGI is essentially a small rocky outcrop with few areas with deep soils, which limits the growth, distribution, and diversity of tree species. This edaphic aspect could partly explain the low species richness of this life form and its distinct original physiognomy in contrast to continent forests or those of other large islands (e.g., Barros et al. 1991).

The tree species on QGI are mostly zoochoric, producing small fleshy fruits or arilate seeds consumed by the island's avifauna (e.g., Pineschi 1990, Lorenzi 1998, 2000, Passos & Oliveira 2004). Due to the absence of frugivorous mammals on QGI (Marques et al. 2002), birds are apparently the main local dispersers of those diaspores, and several species are known to feed on the fruits of *Guapira opposita*, *Myrsine guianensis*, and *Syagrus romanzoffiana*, which fructify during long periods of time and represent an important food resource for the local avifauna (Montanhini 2010). Two omnivorous passerines that visit the island at different times of the year are the main dietary items of the endemic and critically endangered pit viper *Bothrops insularis* (Marques et al. 2012).

The historical use of the island, especially during the period when the lighthouse was manually operated (1909–1925), strongly influenced the current vegetation cover of QGI and its flora. According to information obtained from the Brazilian Navy, the original Dense Ombrophilous Forest was reduced to construct the lighthouse and its support buildings, to establish a subsistence farm and, possibly, to create animal pasture. These changes were most likely made by cutting and burning the original vegetation (the latter was apparently a common practice that apparently gave rise to the island's name – 'Big Burn Island'; Bataus & Reis 2011). Thus, there were intentional and unintentional introductions of several foreign plant species to QGI. This set of species seems to be well-established now on the island, competing with the original vegetation and preventing its full recovery. Although the largest area of anthropogenic vegetation (located near the lighthouse) has not expanded over the last 10 years, its natural recovery appears to be extremely slow (B.C. Kurtz et al., unpubl. data). Additionally, many of the species recorded by A. Gehrt in the early 1920's were not encountered during our more recent expeditions.

The flora of QGI can be further analyzed by considering the composition of its life forms. The number of tree species (S = 17) corresponds to roughly half the number of climbers (S = 31), a group that is widely considered an indicator of disturbance in tropical forests (Gerwing 2001; Laurance et al. 2001). The herbaceous flora (S = 52) is the richest among the various life forms on QGI, with several species occurring exclusively in the anthropogenic vegetation. Additionally, although the mainland Atlantic Forest shows very high vascular hemiepiphytic/epiphytic species richness (2,256 species or 15.4% of its vascular flora; Freitas et al. 2016), our surveys showed a low richness of this group of plants on the island, making it plausible to argue that the past uses of QGI were responsible for major changes in its already impoverished insular flora.

Of the two species considered invasive in the Atlantic Forest complex (Instituto Hórus 2017), molasses grass (*Melinis minutiflora*; 'capim gordura') is abundant in the anthropogenic vegetation sites on QGI. It has been observed that massive occurrences of this grass are related to a number of factors that prevent the regeneration of natural environments – such as changes in nutrient cycles, light availability, soil microclimate, and wind velocity. Also, high infestations of molasses grass directly interfere with natural regeneration by creating a thick layer of plant material that lends considerable competitive advantage over other species of the lower stratum, including seedlings and saplings (Barger et al. 2003; Martins et al. 2004). *Oeceoclades maculata*, on the other hand, does not currently appear to behave as invasive species on QGI.

The introduction and establishment of allochthonous species is not a problem exclusive to QGI. Many small islands distributed along the southeastern coast of Brazil are partially covered by alien species (pers. obs.). The islands that make up CAG (Bovini et al. 2014), for example, are partially covered by *Megathyrsus maximus* (Jacq.) B.K. Simon & S.W.L. Jacobs, a grass of African origin, and 13% of the surface of FRA (Ferreira et al. 2007) is occupied by *Leucaena leucocephala* (Lam.) de Wit, an arboreal American legume. These two alien species have great invasive potential in the Atlantic Forest complex (Instituto Hórus 2017), and the introduction of invasive alien species has been highlighted as one of the main threats to island biota around the world (Kreft et al. 2008, Serafini et al. 2010).

As such, we recommend permanent and routine monitoring of the vegetation cover of QGI, using both high-resolution satellite images and field studies, to evaluate changes in areas covered by anthropogenic vegetation. Managers should consider controlling alien species, especially the invasive grass *Melinis minutiflora*, and planting seedlings of native species identified in this study. These activities will be essential to the *in situ* conservation of the critically endangered *Bothrops insularis*.

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Author Contributions

Bruno Coutinho Kurtz: substantial contribution in the concept and design of the study; contribution to data collection, analysis, interpretation, and manuscript preparation.

Vinicius Castro Souza: substantial contribution in the concept and design of the study; contribution to data collection, analysis, interpretation, and manuscript preparation.

Adriana Melo Magalhães: contribution to data collection, analysis, and interpretation.

Juliana de Paula-Souza: substantial contribution in the concept and design of the study; contribution to data collection, analysis, interpretation, and manuscript preparation.

Alexandre Romariz Duarte: contribution to data collection.

Gilberto Oliveira Joaquim-Jr.: contribution to data collection.

Conflicts of interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

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