

Orchids of the State Park of Serra do Tabuleiro, Southern Brazil

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Abstract

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Orchidaceae show a high diversity of species in Brazil, especially in the Atlantic Forest Biome. Over the course of a 12-month study in the State Park of Serra do Tabuleiro in Southern Brazil, collections were made of orchids occurring in areas of *restinga* and riparian vegetation. A total of 92 orchid species were registered, belonging to three sub-families and 51 genera. *Octomeria* was the best represented genus with ten species. Among all collections, two species are new records for Santa Catarina state, and 20 species is reported for the first time in the studied region. Regarding to conservation, 17 species (19%) are currently included with different threat labellings in any of the red lists of threatened plant species of Brazil. Among the total of orchids registered, 55 species (59%) are characteristic holoepiphytes, 47 species (51%) are restricted to the Atlantic Forest, 77 species (84%) occur in the riparian vegetation, and only nine species (10%) are restricted to *restinga* vegetation. The remarkable richness of orchids found in the present study highlights the importance for conservation the studied forest remnants. The historical of environmental degradation of the *restinga* vegetation can be negatively influencing the current floristic composition of the orchid community.

Keywords: Orchidaceae, Atlantic Forest, biogeographic boundaries, forest conservation, fragmentation, *restinga*, riparian forest.

INTRODUCTION

Orchidaceae are usually considered to be one of the widest families of Angiosperms, with around 20000 species (Dressler, 1993). According to Barros & al. (2015), the family is well represented in Brazil with 238 genera and about 2553 species, 1636 of which are endemic to the country.

In the state of Santa Catarina, Southern Brazil, the family is still poorly known. In the most recent checklist of Orchidaceae published for that state, Klein & al. (1978) listed 295 species for the whole Florianópolis Island plus nine neighbouring municipalities.

The State Park of Serra do Tabuleiro covers an area of 87405 ha, which represents approximately 1% of the state of Santa Catarina, and is very close to Florianópolis Island. It reaches nine municipalities and several coastal islands. All these different areas comprise a great diversity of natural environments, ranging from coastal environments to inland habitats that represent five of the six phyto-geographic regions found in the state. The park is still

Resumen

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Las *Orchidaceae* presentan una gran diversidad de especies en Brasil, especialmente en el Bioma de la Mata Atlántica. Tras estudiar durante un año el Parque Estatal de Serra do Tabuleiro, se realizaron numerosas recolecciones de las orquídeas presentes en áreas de *restinga* y bosque de ribera. Se registraron 92 especies de orquídeas, pertenecientes a 3 subfamilias y 51 géneros. *Octomeria* fue el género mejor representado, con 10 especies. De los táxones observados, 2 especies son novedad para el estado de Santa Catarina, y 20 especies se citan por primera vez en la región estudiada. Respecto a su conservación, 17 especies (19%) están actualmente incluidas con distintos grados de amenaza en alguna de las listas rojas de flora amenazada de Brasil. De todas las orquídeas observadas, 55 especies (59%) son holoepífitos típicos, 47 especies (51%) se restringen a la Mata Atlántica, 77 especies (84%) crecen en los bosques ribereños, y sólo 9 especies (10%) se restringen a la vegetación de *restinga*. La destacable riqueza de orquídeas evidenciada en el presente estudio viene a destacar la importancia de conservar los fragmentos de bosque estudiados. El registro histórico de la degradación ambiental de la vegetación de *restinga* puede influir negativamente a la composición florística de la comunidad de orquídeas de estas zonas.

Palabras clave: Orchidaceae, Mata Atlántica, límites biogeográficos, conservación florestal, fragmentación, *restinga*, bosque de ribera.

considered the southern boundary for many species with tropical distribution, thus constituting an important phyto-geographic barrier (Klein, 1978; 1980; 1981). It comprises areas of Atlantic Forest (Mata Atlántica) formed by riparian and *restinga* vegetation.

The Atlantic Forest is considered as one of the richest biomes of the planet in biodiversity, and also one of the most severely threatened ecosystems; less than 10% of its original area remains well conserved (Galindo-Leal & Câmara, 2005). The state of Santa Catarina is totally included into this biome and at present possesses only 23.5% of its forest remnants in good estate of conservation (Fundação SOS Mata Atlántica, 2013). Studies with vascular species undertaken on plant communities growing close to water courses (riparian vegetation), although still scarce, show that they constitute very diverse ecosystems due to their high environmental heterogeneity (Kageyama & Gandara, 2000). According to Battilani & al. (2005), riparian vegetation is crucial to maintain the local ecosystem integrity and it plays an important role for conservation of high diversity sites.

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Littoral plant communities, that constitute the *restinga* vegetation, occur on the coastal flats and possess a wide diversity of habitats (Klein, 1980; Scherer & al., 2005). Recent studies (Fraga & Peixoto, 2004, Rocha & Waechter, 2010) highlighted the species richness of orchids in this ecosystem. However, Falkenberg (1999) and Scherer & al. (2005) noted that the impact of human activities has caused strong degradation and fragmentation of the coastal environments, hampering the current understanding of patterns of both abundance and distribution of the local flora.

These factors together increase the threat on the orchid flora of the State Park of Serra do Tabuleiro and also in the state of Santa Catarina as a whole, and point out the importance to take urgent steps for the study and maintenance of biodiversity in these areas. An inventory of the orchids of the State Park of Serra do Tabuleiro may help to determine species subjected to some threat and to prepare future red lists of species of threatened flora for Santa Catarina and other regions of Brazil.

The objectives of the present study were: 1) to record the diversity of Orchidaceae in remnants of *restinga* and riparian vegetation in the Atlantic Forest, and 2) to update and depict the current geographic distribution of these species, threat category in red lists and their life forms, as the basic step for future studies on conservation of local biodiversity.

MATERIAL AND METHODS

Study region

The State Park of Serra do Tabuleiro (Fig. 1) is located in the central part of the coast of Santa Catarina state (Lat. 27°41'09"S to 28°12'42"S, Long. 48°49'20"W to 48°25'08"W), to SW of Florianópolis Island. The main orientation is on N-S direction and lesser in E-W direction, following the mountain ranges of Cambirela, Tabuleiro and Capivari. The altitude gradient ranges from the sea level in the coastal areas, up to over 1200 m in Serra do Tabuleiro (Klein, 1978; 1981).

The climate is characterized by mild and rainy summers, and humid and warm winters. The average annual rainfall is 1600 mm and the annual average temperature is 20.3°C (INMET, 2011).

The present study covered a total area of 34400 m² distributed along eight transects in eight sites (Appendix 1): two of them in *restinga* vegetation (20000 m²), and six of them in riparian vegetation (14400 m²). These transects were characterized according to their location, morphology and vegetation type, as indicated below:

- i) Site 1, and Site 2, (Fig. 1 & Appendix 1), both transects were located so as to avoid sites disturbed by fires that occurred in the region between 2001 and 2008, as surveyed by Pereira & al. (2009). Sampling was settled with 100 m side squares, distancing a maximum of 100 m of the beach line and totalling 20000 m² of area. The areas are covered by *restinga* vegetation, with herbaceous and woody layers. This vegetation occurs exclusively in coastal flats, which are geomorphological units constituted by marine sediments, along the Brazilian coast at altitudes varying from sea level up to 30 m towards inland

the continent (Klein, 1980). According to Falkenberg (1999), the herbaceous and subshrub layers of *restinga* vegetation are constituted mainly by small plants that endure higher luminosity and stronger sea influence, therefore comprising plant communities closer to the sea. The shrubby layer includes taller species (between 1 to 5 m in height).

- ii) The other six transects (Fig. 1 & Appendix 1) were located along both sides of several rivers and around small river islands. Site 3, and Site 8, each with an extension of 800 m and a total area of 3200 m². Site 4, Site 5, Site 6, and Site 7, each with an extension of 500 m and a total area of 4000 m². Morphologically, all these areas are formed by deep river valleys with an intense dissection, with very steep slopes and with a drainage network of waterfalls. The Atlantic Forest is represented on the slopes of the Serra do Tabuleiro, between 30 and 400 m altitude; forming part of a set of mountain plant communities with physiognomic variations, which is known as *Floresta Ombrófila Densa* and which constituting the largest part of forest diversity in the region (Klein, 1980). The riparian vegetation is a characteristic type of plant community found along the river courses, which vary according to ecological and biogeographic features of territories, their altitudes, and the dominant plant community of each site (Rodrigues & Gandolfi, 2001).

Plant survey

Field work was carried out between March and October 2010. Orchid specimens were collected from soil, rocks and phorophytes (up to 5 m in height) in *restinga* (herbaceous, subshrubby and shrubby layers), and in riparian vegetation. All samples were deposited in the herbaria ABH and FLOR (acronyms according to Thiers, 2015).

Species identification was achieved by using specialized literature, namely Pabst & Dungs (1975; 1977), Miller & Warren (1996), Stancik (2004) and Miller & al. (2006). Herbarium materials from FLOR, FURB, HBR, ICN and MBM (acronyms according Thiers, 2015), were also used for comparison. Authors of plant names as well as the nomenclatural update of names follow IPNI (2015). The systematic position of the genera of Orchidaceae is according to Chase & al. (2003). However, Dendrobiinae and Bulbophyllinae are circumscribed following Dressler (1993).

Geographic distributions of species were updated through the list of Klein & al. (1978) and Barros & al. (2015).

Species classification into the different categories follows the existing information from the official lists of threatened plant species for the states (Santa Catarina: Klein, 1990; Paraná: SEMA, 1995; Rio Grande do Sul: SEMA, 2014; São Paulo: SEMA, 2004; Espírito Santo: IPEMA, 2007) and the whole country (Martinelli & Moraes, 2014). When categories of two or more lists were in conflict, the most recent (since updated) labelling was selected. Only those taxa identified to species rank were used to outline geographic distribution and threat categories.

The Ecological Category (EC) of each species was determined by direct visual observations in the field as being: (a) characteristic holoepiphyte (HLC), which occurs on phorophytes; (b) facultative holoepiphyte (HLF), based on the

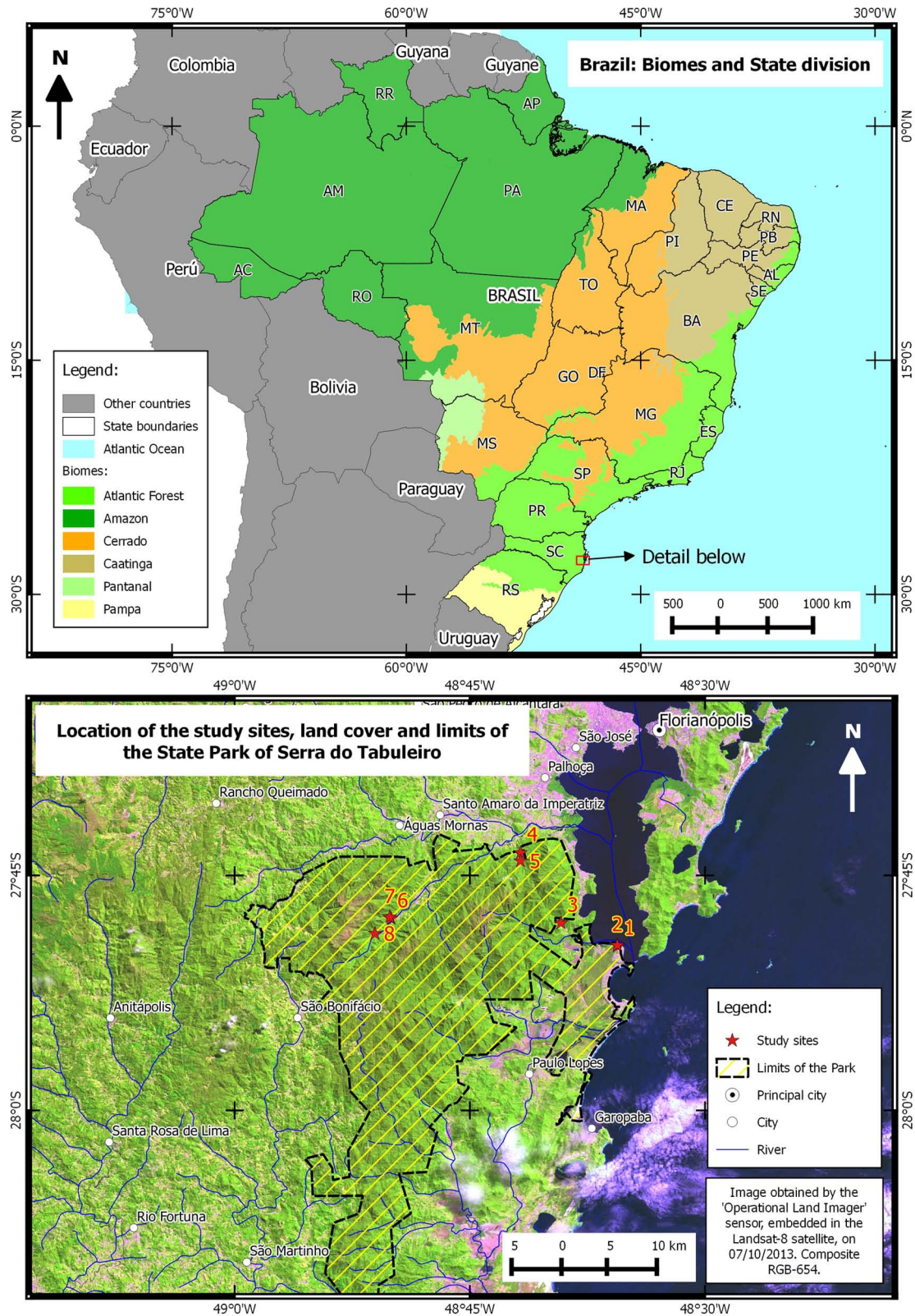


Fig. 1. Location of the study sites, land cover and limits of the State Park of Serra do Tabuleiro, Santa Catarina, Brazil. Source: compiled from IBGE (2014), MMA (2015) and USGS (2015).

type of relationship with the type of substrate (phorophytes or rocks); (c) hemiepiphyte (HEM) (Benzing 1990); and (d) terrestrial (TER) (Dressler, 1981).

All collections in the State Park of Serra do Tabuleiro were authorized by the Fundação do Meio Ambiente de Santa Catarina - FATMA (Aut. N° 002/2010/GERUC/DPEC).

Thematic cartography was made with QGIS (for geographic information system and treatment of orbital images). The location of transects on the field was determined using a GPS.

RESULTS

Species richness

A total of 92 taxa of Orchidaceae were identified, which belong to 51 genera distributed in three subfamilies, 11 tribes and 13 subtribes (Table 1). Subfamily Epidendroideae was the most representative with 41 genera (80%), followed by Orchidoideae with seven genera (16%), Vanilloideae with two genera (4%) (Table 1). Of the 92 recorded taxa, three were not identified at the species rank: *Campylocentrum* sp., *Pelexia* sp. and *Vanilla* sp. (probably an exemplar of *V. dietschiana* Edwall), as well as an adult plant of small size (± 110 cm) that showed flower remnants insufficient for identification.

Octomeria was the best represented genus with 10 species, followed by *Epidendrum* with six species; *Bifrenaria* and *Stelis* each with five species; *Anathallis* and *Maxillaria* each with four species; *Gomesa*, *Pabstiella* and *Polystachya* each with three species; *Acianthera*, *Brasiliorchis*, *Campylocentrum*, *Christensonella*, *Dichaea*, *Dryadella*, *Phymathidium* and *Vanilla* each with two species. The remaining 33 genera were represented by one species (Table 2).

Geographic distribution and conservation of endangered species

With regard to the geographic distribution in the states of Brazil, all the specimens recorded to species rank ($n=89$) occur in two or more states of the country (Table 2).

Some species ($n=6$; 7%) can be found in at least four phyto-geographic domains, as is the case of *E. secundum*, *L. nervosa*, *O. grandiflora*, *O. maculata*, *P. concreta* and *S. lanceolata*. However, the Atlantic Forest (MA) has the largest number of exclusive species ($n=47$; 53%). Out of 89 taxa identified to species rank, 33 species (37%) are distributed through the state of Santa Catarina, but they do not reach the southern state of Rio Grande do Sul (Table 2).

Based on available checklists (Klein & al., 1978; Barros & al., 2015) and data from herbaria, of a total of 89 taxa identified to species rank, two species are recorded for the first time in the state of Santa Catarina, and 20 species are new for the municipalities of Palhoça and Santo Amaro da Imperatriz (Table 2), which are partially included within the limits of the State Park of Serra do Tabuleiro (Fig. 1).

According to all official lists of the Brazilian states, 17 species (19%) are labelled in some degree of threat: six species (7%) as endangered (ED), seven species (8%) as vulnerable (VU), two species (2%) as critically endangered (CE) and two species (2%) as presumably extinct (Table 2).

Habitat selectivity and ecological category

As for the distribution of species ($n=92$) in the different vegetation types, the largest number of species ($n=77$; 84%) occurred exclusively in riparian vegetation (RP), while only nine species (10%) exclusively in the *restinga* vegetation (RE) (Table 2 & Fig. 2). However, some species ($n=6$; 7%), namely

Table 1. Systematic position of the genera of Orchidaceae recorded in the State Park of Serra do Tabuleiro, Santa Catarina, Brazil, according to Chase & al. (2003). Dendrobieae and Bulbophyllinae accord with circumscription by Dressler (1993)

Subfamilies	Tribe	Subtribe	Genus	
Epidendroideae	Cymbidieae	Catasetinae	<i>Cyrtopodium</i>	
		Eulophiinae	<i>Oeceoclades</i>	
		Maxillariinae	<i>Bifrenaria</i>	
			<i>Brasiliorchis</i>	
			<i>Christensonella</i>	
			<i>Heterotaxis</i>	
			<i>Maxillaria</i>	
			<i>Ornithidium</i>	
			<i>Rhetinantha</i>	
			Oncidiinae	<i>Gomesa</i>
			<i>Ornithocephalus</i>	
			<i>Phymathidium</i>	
		<i>Rodriguezia</i>		
Dendrobieae	Dendrobieae	<i>Bulbophyllum</i>		
		Epidendreae	Laeliinae	<i>Brassavola</i>
Epidendroideae	Cymbidieae	Maxillariinae	<i>Cattleya</i>	
			<i>Encyclia</i>	
			<i>Epidendrum</i>	
			Ponerinae	<i>Isochilus</i>
			Pleurothallidinae	<i>Acianthera</i>
				<i>Anathallis</i>
				<i>Barbosella</i>
				<i>Dryadella</i>
				<i>Lepanthopsis</i>
				<i>Myoxanthus</i>
				<i>Octomeria</i>
				<i>Pabstiella</i>
				<i>Phloeophila</i>
<i>Platystele</i>				
<i>Pleurothallis</i>				
<i>Specklinia</i>				
<i>Stelis</i>				
<i>Trichosalpinx</i>				
Sobralieae	Zygopetalinae	<i>Eleanthus</i>		
		<i>Dichaea</i>		
Malaxideae	Zygopetalinae	<i>Paradisanthus</i>		
		<i>Liparis</i>		
Triphoreae	Zygopetalinae	<i>Malaxis</i>		
		<i>Psilochilus</i>		
Vandaeae	Angraecinae	<i>Campylocentrum</i>		
		Polystachyinae	<i>Polystachya</i>	
Orchidoideae	Orchideae	Orchidinae	<i>Habenaria</i>	
		Spiranthinae	<i>Eurystyles</i>	
		<i>Lankesterella</i>		
		<i>Mesadenella</i>		
Vanilloideae	Pogonieae	Vanilleae	<i>Pelexia</i>	
			<i>Sacoila</i>	
			<i>Serapias</i>	
			<i>Cleistes</i>	
Vanilloideae	Pogonieae	Vanilleae	<i>Vanilla</i>	

Table 2. List of taxa recorded in the State Park of Serra do Tabuleiro, Santa Catarina, Brazil. Species are cited for the first time: 1=state of the Santa Catarina; 2=region studied, data based on lists of the Klein & al. (1978) and Barros & al. (2015). Vegetation type (VG): RE=*restinga* vegetation; RP=riparian vegetation. Categories of threatened (CT): ED=endangered, CE=critically endangered, and VU=vulnerable, EX=presumably extinct. Ecological category (EC): HLC=characteristic holoepiphyte, HLF=facultative holoepiphyte, HEM=hemiepiphyte (Benzing 1990) and TER=terrestrial (Dressler 1981). Geographic distribution by states of Brazil: RR=Roraima, AP=Amapá, PA=Pará, AM=Amazônia, TO=Tocantins, RO=Rondônia, PI=Piauí, CE=Ceará, RN=Rio Grande do Norte, PB=Paraíba, PE=Pernambuco, AL=Alagoas, SE=Sergipe, BA=Bahia, DF=Distrito Federal, GO=Goiás, MT=Mato Grosso, MS=Mato Grosso do Sul, ES=Espirito Santo, MG=Minas Gerais, RJ=Rio de Janeiro, SP=São Paulo, PR=Paraná, SC=Santa Catarina, and RS=Rio Grande do Sul. Phytogeographic domain (PD): AM=Amazônia, CA=Caatinga, CE=Cerrado, MA=Atlantic Forest. Di=data deficient

Genus and species	Geographic distribution	PD	CT	VG	EC	Voucher
<i>Acianthera ramosa</i> (Barb.Rodr.) F.Barros	GO,DF,MG,SP,SC ²	CE,MA		RE/RP	HLC	ABH 57597 – FLOR 39574
<i>Acianthera saundersiana</i> (Rchb.f.) Pridgeon & M.W.Chase	BA,MG,RJ,SP,PR,SC,RS	CA,CE,MA		RP	HLC	ABH 57598 – FLOR 8661
<i>Anathallis paranaensis</i> (Schltr.) Pridgeon & M.W.Chase	BA,RJ,PR,SC,RS	CA,MA		RP	HLC	ABH 57601
<i>Anathallis rubens</i> (Lindl.) Pridgeon & M.W.Chase	PE,BA,MG,RJ,SP,PR,SC,RS	CA,CE,MA		RP	HLC	ABH 57599
<i>Anathallis sclerophylla</i> (Lindl.) Pridgeon & M.W.Chase	RO,CE,PE,BA,RJ,SP,PR,SC	CA,CE,MA		RP	HLC	ABH 57600 – FLOR 38479
<i>Anathallis sororcula</i> (Schltr.) Luer	SP,PR,SC ²	MA		RP	HLC	ABH 57602
<i>Barbosella dusenii</i> (Samp.) Schltr.	RJ,SP,PR,SC ²	MA		RP	HLC	ABH 57603 – FLOR 41825
<i>Bifrenaria aureofulva</i> Lindl.	BA,MG,ES,RJ,SP,PR,SC,RS	CA,CE,MA	ED	RP	HLC	ABH 57604
<i>Bifrenaria harrisoniae</i> (Hook.) Rchb.f.	MG,ES,RJ,SP,PR,SC ² ,RS	MA		RP	HLC	ABH 57606 – FLOR 8475
<i>Bifrenaria inodora</i> Lindl.	MG,ES,RJ,SP,PR,SC,RS	MA		RP	HLC	ABH 57607
<i>Bifrenaria stefanae</i> V.P.Castro	MG,RJ,SP,PR,SC ^{1,2}	MA		RP	HLC	ABH 57605
<i>Bifrenaria tetragona</i> (Lindl.) Schltr.	ES,RJ,SP,PR,SC,RS	MA	ED	RP	HLF	FLOR 41618
<i>Brasiliorchis marginata</i> (Lindl.) R.B.Singer, S.Koehler & Carnevali	BA,MG,ES,RJ,SP,PR,SC,RS	MA		RP	HLC	ABH 57608
<i>Brasiliorchis picta</i> (Hook.) R.B.Singer, S.Koehler & Carnevali	MS,MG,ES,RJ,SP,PR,SC,RS	MA		RP	HLC	FLOR 41819
<i>Brassavola tuberculata</i> Hook.	TO,PA,PE,BA,AL,SE,MG,RJ,SP,PR,SC,RS	CA,CE,MA		RP	HLC	FLOR 41817
<i>Bulbophyllum glutinosum</i> (Barb.Rodr.) Cogn.	MG,ES,RJ,SP,PR,SC	MA		RP	HLF	ABH 57609 – FLOR 9575
<i>Campylocentrum aromaticum</i> Barb.Rodr.	MG,RJ,SP,PR,SC ² ,RS	CE,MA		RP	HLC	ABH 57610
<i>Campylocentrum</i> sp.	Di	Di	Di	RP	HLC	FLOR 9559
<i>Cattleya intermedia</i> Graham ex Hook.	RJ,SP,PR,SC,RS	MA	VU	RP	HLC	ABH 57611 – FLOR 9559
<i>Christensonella paranaensis</i> (Barb.Rodr.) S.Koehler	MG,ES,RJ,SP,PR,SC,RS	MA		RP	HLF	ABH 57613 – FLOR 9560
<i>Christensonella subulata</i> (Lindl.) Szlach., Mytnik, Górniak & Smiszek	MT,BA,MG,ES,RJ,SP,PR,SC	MA		RP	HLF	ABH 57614 – FLOR 44005
<i>Cleistes libonii</i> (Rchb.f.) Schltr.	BA,MG,RJ,SP,PR,SC	MA	VU	RP	TER	ABH 57615 – FLOR 41636
<i>Cyrtopodium flavum</i> (Nees) Link & Otto ex Rchb.f.	PB,PE,BA,AL,SE,MG,ES,RJ,SP,PR,SC,RS	CE,MA		RE	TER	ABH 57616 – FLOR 38483
<i>Dichaea cogniauxiana</i> Schltr.	BA,MT,MG,ES,RJ,SP,PR,SC,RS	CE,MA	ED	RP	HLC	ABH 57617
<i>Dichaea pendula</i> (Aubl.) Cogn.	RO,AM,PA,BA,CE,PB,PE,MG,ES,RJ,SP,PR, SC,RS	AM,MA		RP	HLC	ABH 57618 – FLOR 38476
<i>Dryadella edwallii</i> (Cogn.) Luer	MG,SP,RJ,PR,SC	MA		RP	HLC	ABH 57620 – FLOR 9561
<i>Dryadella zebrina</i> (Porsch) Luer	ES,RJ,SP,PR,SC,RS	MA		RP	HLC	ABH 57619 – FLOR 8467
<i>Elleanthus brasiliensis</i> (Lindl.) Rchb.f.	CE,PE,BA,MG,ES,RJ,SP,PR,SC,RS	MA		RP	HLF	ABH 57621 – FLOR 8647
<i>Encyclia patens</i> Hook.	PE,AL,BA,SE,MG,ES,RJ,SP,PR, PR,SC,RS	CE,MA		RP	HLC	ABH 57622 – FLOR 41415
<i>Epidendrum fulgens</i> Brongn.	RJ,SP,PR,SC,RS	MA		RE	HLF	ABH 57623 – FLOR 4138
<i>Epidendrum geniculatum</i> Barb. Rodr.	ES,RJ,SP,PR,SC	MA	VU	RP	HLF	FLOR 22777
<i>Epidendrum latilabre</i> Lindl.	PA,AM,PE,BA,MG,ES,RJ,SP,PR,SC,RS	AM,MA		RP	HLC	ABH 57626
<i>Epidendrum paranaense</i> Barb.Rodr.	BA,MG,ES,RJ,SP,PR,SC ²	CA,CE,MA	ED	RP	HLC	ABH 57625 – FLOR 8649
<i>Epidendrum proligerum</i> Barb.Rodr.	AL,PE,BA,MG,ES,RJ,SP,PR,SC,RS	MA	VU	RP	HLC	ABH 57627

Table 2. (Continued)

Genus and species	Geographic distribution	PD	CT	VG	EC	Voucher
<i>Epidendrum secundum</i> Jacq.	RO,AP,PA,AL,AM,TO,CE,PB,SE,PE,BA,MT,GO,DF, MG,ES,RJ,SP,PR,SC,RS	AM,CA,CE,MA	ED	RE/RP	HLF	ABH 57624 – FLOR
<i>Eurystyles cotyledon</i> Wawra	PE,MG,ES,SP,RJ,PR,SC,RS	MA		RP	HLC	ABH 57628
<i>Gomesa ciliata</i> (Lindl.) M.W.Chase & N.H.Williams	CE,BA,MG,ES,RJ,SP,PR,SC,RS	MA		RP	HLC	ABH 57629 – FLOR 39562
<i>Gomesa hookeri</i> (Rolfe) M.W.Chase & N.H.Williams	PE,BA,MG,RJ,SP,PR,RS,SC ²	MA		RP	HLC	ABH 57631 – FLOR 39563
<i>Gomesa praetexta</i> (Rchb.f.) M.W.Chase & N.H.Williams	BA,ES,RJ,SP,PR,SC ²	MA	VU	RP	HLC	ABH 57630
<i>Habenaria pleiophylla</i> Hoehne & Schltr.	MG,RJ,SP,PR,SC	MA		RE	TER	ABH 57632 – FLOR 9564
<i>Heterotaxis brasiliensis</i> (Brieger & Illg) F.Barros	RN,PE,BA,MG,ES,RJ,SP,PR,SC ² ,RS	MA		RE	TER	FLOR 8636 – ABH 57633
<i>Isochilus linearis</i> (Jacq.) R.Br.	RO,AL,CE,PE,BA,DF,MS,MG,ES,SP,RJ,PR,SC,RS	CE,MA		RP	HLF	FLOR 0215
<i>Lankesterella ceracifolia</i> (Barb.Rodr.) Mansf.	BA,ES,RJ,SP,PR,SC,RS	CA,MA		VU RP	HLC	ABH 57634
<i>Lepanthopsis floripecten</i> (Rchb.f.) Ames	PE,ES,RJ,SP,PR,SC	MA		EX RP	HLC	ABH 57635
<i>Liparis nervosa</i> (Thunb.) Lindl.	PA,AM,RO,RR,PE,BA,AL,SE,MT,GO,DF,MSMG,ES,RJ,SP,PR,SC	AM,CA,CE,MA		RE/RP	TER	ABH 57636 – FLOR 8642
<i>Malaxis excavata</i> (Lindl.) Kuntze	PE,BA,DF,MG,ES,RJ,SP,PR,SC,RS	CE,MA		VU RP	TER	ABH 57637 – FLOR 8494
<i>Maxillaria bradei</i> Schltr. ex Hoehne	MG,RJ,SP,PR,SC	MA		RP	HLF	ABH 57638 – FLOR 9565
<i>Maxillaria leucaimata</i> Barb.Rodr.	PA,AM,CE,PE,BA,MG,ES,RJ,SP,PR,SC	AM,MA		RP	HLC	ABH 57639
<i>Maxillaria lindleyana</i> Schltr.	MG,ES,RJ,SP,PR,SC	MA		RP	HLF	FLOR 9566
<i>Maxillaria ochroleuca</i> Lodd. ex Lindl.	RR,PE,AL,BA,MG,ES,RJ,SP,PR,SC	AM,CE,MA		RP	HLF	ABH 57640 – FLOR 9576
<i>Mesadenella cuspidata</i> (Lindl.) Garay	MT,CE,PE,GO,DF,MGES,RJ,SP,PR,SC,RS	CE,MA		RE/RP	TER	ABH 57642 – FLOR 9577
<i>Myoxanthus exasperatus</i> (Lindl.) Luer	PE,BA,MG,ES,RJ,SP,PR,SC	CE,MA		RP	HLF	ABH 67643 – FLOR 43893
<i>Octomeria alexandri</i> Schltr.	PE,BA,ES,RJ,SP,SC ^{1,2} ,RS	CE,MA		EX RP	HLF	ABH 57644 – FLOR 9678
<i>Octomeria chloidophylla</i> (Rchb.f.) Garay	RJ,SC	MA		RP	HLF	ABH 57649
<i>Octomeria crassifolia</i> Lindl.	BA,MT,MG,ES,RJ,SP,PR,SC,RS	MA		RP	HLC	ABH 67652 – FLOR 9568
<i>Octomeria diaphana</i> Lindl.	MG,ES,RJ,SP,PR,SC,RS	MA		RP	HLC	ABH 57653
<i>Octomeria gracilis</i> Lodd. ex Lindl.	MG,ES,RJ,SP,PR,SC,RS	MA		RP	HLC	ABH 57648 – FLOR 9567
<i>Octomeria grandiflora</i> Lindl.	RR,AP,PA,AM,AC,MA,PB,BA,MG,ES,RJ,SP,PR,SC	AM,CA,CE,MA		RP	HLC	ABH 57646 – FLOR 8628
<i>Octomeria juncifolia</i> Barb.Rodr.	MG,ES,RJ,SP,PR,SC,RS	MA		RP	HLC	ABH 57651-FLOR 8632
<i>Octomeria oxychela</i> Barb.Rodr.	MS,MG,ES,RJ,SP,PR,SC ² ,RS	CE,MA		RP	HLC	ABH 57650
<i>Octomeria riograndensis</i> Schltr.	PR,SC,RS	MA		RP	HLC	ABH 57645
<i>Octomeria umbonulata</i> Schltr.	SP,PR,SC,RS	MA		RP	HLC	ABH 57647
<i>Oeceoclades maculata</i> (Lindl.) Lindl.	RR,PA,AM,TO,AC,RO,MA,PI,CE,RN,PB,PE,AL,SE,MT,GO,DF,MS,MG,BA,ES,RJ,SP,PR,SC ² ,RS	AM,CA,CE,MA		RE/RP	TER	ABH 57654 – FLOR 8666
<i>Ornithidium pendens</i> (Pabst) Senghas	AM,RO,MG,ES,RJ,SP,PR,SC ² ,RS	AM,MA		RP	HLC	ABH 57655
<i>Ornithocephalus myrticola</i> Lindl.	BA,MG,ES,RJ,SP,PR,SC,RS	CE,MA		CE RP	HLC	ABH 57656 – FLOR 41649
<i>Pabstiella campestris</i> (Barb.Rodr.) Luer	MG,RJ,SP,PR,SC,RS	MA		RP	HLC	FLOR 8613
<i>Pabstiella fusca</i> (Lindl.) Chiron & Xim.Bols.	BA,MG,ES,RJ,SP,PR,SC,RS	CE,MA		RP	HLC	ABH 57657
<i>Pabstiella martinensis</i> (Hoehne) Luer	PR,SC ² ,RS	MA		RP	HLC	ABH 57664
<i>Paradisanthus micranthus</i> (Barb.Rodr.) Schltr.	BA,ES,RJ,SP,PR,SC	MA		RP	TER	ABH 57658
<i>Pelexia</i> sp.	Di	Di		RE	TER	ABH 57659
<i>Phloeophila nummularia</i> (Rchb.f.) Garay	MG,RJ,SP,SC	MA		RP	HLC	ABH 57660

Table 2. (Continued)

Genus and species	Geographic distribution	PD	CT	VG	EC	Voucher
<i>Phymatidium delicatulum</i> Lindl.	PE,BA,MG,ES,RJ,SP,PR,SC,RS	MA	ED	RP	HLC	ABH 57662
<i>Phymatidium falcifolium</i> Lindl.	BA,ES,RJ,SP,PR,SC	MA	CE	RP	HLC	ABH 57661
<i>Platystele oxyglossa</i> (Schltr.) Garay	MG,ES,RJ,SP,SC ²	MA		RP	HLC	ABH 57663
<i>Pleurothallis podoglossa</i> Hoehne	SP,PR,SC	MA		RP	HLC	ABH 57665
<i>Polystachya caespitosa</i> Barb.Rodr.	RJ,PR,SC,RS	MA		RP	HLF	ABH 57668 – FLOR 8643
<i>Polystachya concreta</i> (Jacq.) Garay & H.R.Sweet	RR,AP,PA,AM,TO,RO,MA,CE,PE,AL,MT,GO,DF,MS,MG,ES,SP,PR,SC ² ,RS	AM,CA,CE,MA		RP	HLC	ABH 57667
<i>Polystachya foliosa</i> (Hook.) Rchb.f. in W.G.Walpers	RR,AP,PA,AM,TO,AC,MA,AL,BA,MG,ES,GO,DF,MG,SP,PR,SC,RS	AM,CE,MA		RP	HLF	FLOR 43895
<i>Psilochilus modestus</i> Barb.Rodr.	AM,PE,BA,MG,ES,RJ,SP,PR,SC,RS	AM,MA		RE	TER	ABH 57669 – FLOR 9579
<i>Rhettinantha notylioglossa</i> (Rchb.f.) M.A.Blanco	RR,PE,BA,MG,ES,RJ,SP,PR,SC,RS	AM,MA		RP	HLF	ABH 57670 – FLOR 8653
<i>Rodriguezia decora</i> (Lem.) Rchb.f.	DF,SP,PR,SC,RS	CE,MA		RE	TER	ABH 57671 – FLOR 9569
<i>Sacoila lanceolata</i> (Aubl.) Garay	AC,AP,PA,AM,MA,TO,CE,PB,PI,SE,PE,BA,AL,MT,MS,GO,DF,MG,ES,RJ,SP,PR,SC,RS	AM,CA,CE,MA		RP	TER	ABH 57672
<i>Serapias nitida</i> Vell.	DF,GO,BA,ES,SP,MG,RJ,PR,SC ² ,RS	CE,MA		RE	TER	ABH 57673 – FLOR 9570
<i>Specklinia grobyi</i> (Bateman ex Lindl.) F.Barros	AM,AP,PA,RR,BA,MT,MG,ES,RJ,SP,PR,SC,RS	AM,CA,MA		RP	HLC	ABH 57674 – FLOR 8482
<i>Stelis aprica</i> Lindl.	CE,PE,BA,MG,ES,RJ,SP,PR,SC,	CE,CA,MA		RP	HLF	ABH 57675 – FLOR 8610
<i>Stelis deregularis</i> Barb.Rodr.	AL,BA,ES,RJ,SP,PR,SC,RS	MA		RP	HLF	ABH 57677 – FLOR 8487
<i>Stelis intermedia</i> Poepp. & Endl.	AL,BA,MG,ES,RJ,PR,SC ²	MA		RP	HLF	ABH 57679
<i>Stelis megantha</i> Barb.Rodr.	AL,CE,BA,MG,ES,RJ,SP,PR,SC,RS	MA		RP	HLC	ABH 57676 – FLOR 8615
<i>Stelis parvifolia</i> (Ruiz & Pav.) Pers.	SP,SC	MA		RP	HLC	ABH 57678 – FLOR 9582
<i>Trichosalpinx montana</i> (Barb.Rodr.) Luer	PE,MG,ES,RJ,SP,PR,SC ²	MA		RP	HLC	ABH 57680 – FLOR 9583
<i>Vanilla chamissonis</i> Klotzsch	AM,PE,BA,MT,GO,DF,MG,ES,RJ,SP,PR,SC	CA,CE,MA		RE/RP	HEM	ABH 57681
<i>Vanilla</i> sp.	Di	Di		RP	HEM	ABH 57682

A. ramosa, *E. secundum*, *L. nervosa*, *M. cuspitata*, *O. maculata* and *V. chamissonis*, occur in both habitats (Table 2).

The predominant ecological category was the characteristic holopiphyte (HLC) (Table 2), represented by 55 species (60%), which was followed by facultative holopiphyte (HLF) with 21 species (23%) and terrestrial (TER) with 14 species (15%). The hemiepiphytes were less common, with only two species (2%) (Fig. 2), both belonging to the genus *Vanilla* (Table 2).

Characteristic holopiphytes (HLC) and facultative holopiphytes (HLF) were better represented in riparian vegetation (n=53; 58% and n=18; 20%, respectively). Terrestrial species (TER) were better represented in *restinga* vegetation (n=10; 11%). Characteristic holopiphyte (HLC) were not exclusive in *restinga* vegetation (Table 2 & Fig. 2).

DISCUSSION

The richness of orchid species found in the present study can be considered high when compared to other studies on Orchidaceae in different regions of Brazil. In the Southern region, Rocha & Waechter (2006) studied terrestrial orchids in the area of *restinga* vegetation and found 42 species distributed in 24 genera. In the same area, Buzatto & al. (2007)

cited 50 species and 35 genera from an area of riparian vegetation. In the Southeast region, Fraga & Peixoto (2004) cited 73 species distributed in 41 genera, in the *restinga* vegetation; and Cunha & Forzza (2007) in an area covered by Atlantic Forest and *restinga* vegetations found 26 species in 18 genera. In other regions, Pansarin & Pansarin (2008) recorded 125 species in an area mesophytic-semideciduous forest, and Menini-Neto & al. (2009) cited 89 species in three areas of Atlantic Forest, montane forest and semi-deciduous forest at different altitudes.

For the state of Santa Catarina, no recent floristic surveys on Orchidaceae are available and those extant are outdated, a fact that makes further precise comparisons extremely difficult. Nonetheless, if the results are compared to that of Klein & al. (1978), it is noticeable that the species richness found here appears to be not very much representative. However, some relevant factors must be considered for a better understanding of the results. The studied area was limited to a few remnants of herbaceous and shrubby *restinga* vegetation still found in the region, and the sampling in riparian vegetation was restricted by up to five meters in height on the phorophytes. In fact, our study though performed in the same region covered a smaller area when compared to that of Klein & al. (1978), which was much wider in

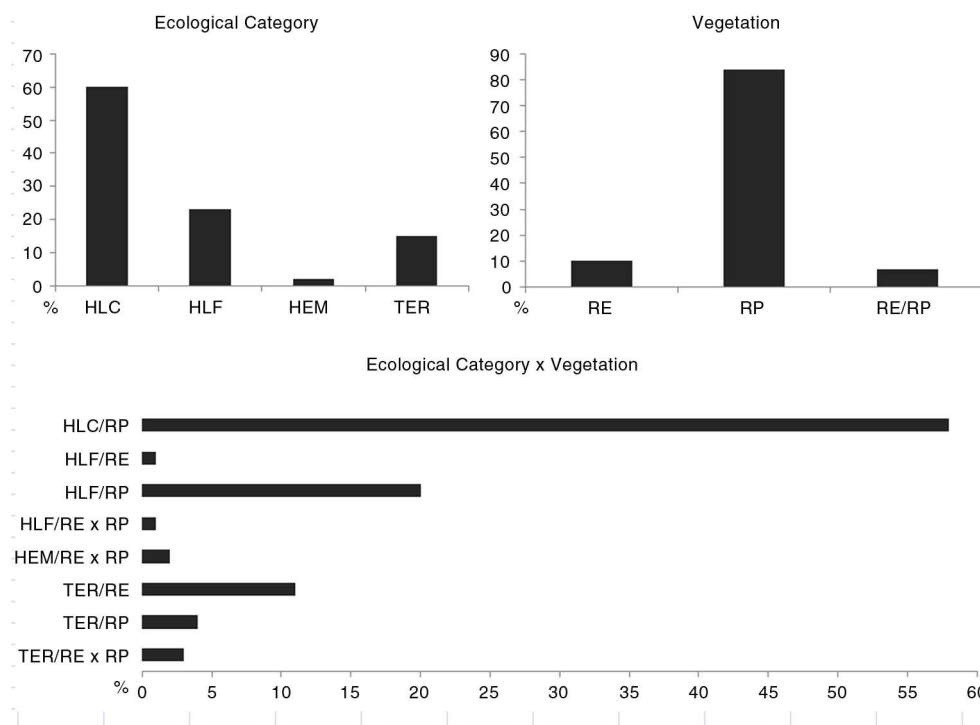


Fig. 2. Orchids recorded in *restinga* (RE) and riparian vegetation (RP) in the Atlantic Forest, Santa Catarina, Brazil. Data expressed in percentages by their ecological category and comparison of the vegetation between ecology category, based on the total number of species recorded ($n=92$): HLC=characteristic holoepiphyte, HLF=facultative holoepiphyte, HEM=hemiepiphyte (Benzing 1990) and TER=terrestrial (Dressler 1981). Characteristic holoepiphyte (HLC) were not exclusive in *restinga* vegetation.

both geographic and ecologic terms. However, we report 20 new records for the same region of the study, demonstrating that there is still a great diversity. Undoubtedly, if the studied area were greater, including other types of vegetation, and also the canopy of the forest, the number of species recorded probably would be much greater.

The State Park of Serra do Tabuleiro was created to preserve an area that had already undergone processes of environmental deface, generated by logging, agriculture and urbanizing activities. Certainly, when taken into account the study of Orchidaceae by Fraga & Peixoto (2004) and Rocha & Waechter (2006), made in areas of *restinga* vegetation in the state of Rio Grande do Sul, also in southern Brazil, the specific diversity found in our study is extremely low. The fragmentation and haphazard occupation of coastal areas are identified by those authors as negative factors for the conservation of *restinga* vegetation and for orchids themselves. According to Rocha & Waechter (2006), when performed in a short period of time studies on herbaceous terrestrial species in the *restinga* vegetation probably underestimate the total specific richness of Orchidaceae. This mainly occurs because of the difficulty to observe many species that often are represented by tiny and isolated individuals, with low frequency and/or without leaves during anthesis.

Orchids occur in up to two phytogeographic domains, although the great majority is found only in Atlantic Forest. It is believed that for species of Atlantic Forest there would be a continuum in their distributions in the N-S direction (Klein, 1980). However, this is not always the rule. Some species such as *P. falcifolium*, *P. nummularia* and *S. parvifolia* occur without gaps up to the state of São Paulo, and

they only reappear in the state of Santa Catarina to the south. It is also possible that the lack of detailed studies on Orchidaceae in the states of Paraná and Santa Catarina make difficult a more accurate phytogeographic understanding of their distribution patterns. Furthermore, our results show that 37% of the studied species are found continuously from the northern states southwards to Santa Catarina, but they do not reach the state of Rio Grande do Sul (in the very South of Brazil). According to Klein (1978; 1980), Serra do Tabuleiro is the most important phytogeographic barrier in southern Brazil impeding that many plants species can move in a north-south direction. In fact, Orchidaceae are among the leading families that are not able to cross this geographic boundary, so that one-third of the orchid species growing in the north, disappear in the southern part of that mountain range (Klein, 1980).

Although up to seventeen of the studied species are listed on any of the Brazilian regional red lists of endangered species list, only one of them is included in the most recent list of endangered species of the Brazilian flora, published by Ministério do Meio Ambiente (MMA, 2015). Nonetheless, at a local scale a number of those species (as well as others not included in the lists) can be in serious concern. It is therefore urgent to generate regional and local lists as an effective conservation tool for threatened species. Provided that many changes have occurred in the last 18 years that affected areas of natural vegetation through the whole country, it can be assumed that the threat degree for many species should also change. Galindo-Leal & Câmara (2005) suggested that the entire Biome of Atlantic Forest is seriously threatened. According to a survey of Fundação SOS Mata Atlântica

(2013), the deforestation rate in the state of Santa Catarina increased up to 7% between 2000 and 2005. Although a reduction in that rate was recorded between 2008 and 2010, deforestation continues to be a significant threat in the state. In relation to the forest remnants of 2008, currently 0.17% (3626 ha) of forests have already been lost, the *restinga* vegetation being the most seriously affected with 0.10% (75 ha) of its cover deforested (Fundação SOS Mata Atlântica, 2013).

The characteristic holoepiphyte was the most common ecologic category among the studied specimens and this agrees with other studies on Orchidaceae in Brazil (Barros, 2004; Fraga & Peixoto, 2004; Cunha & Forzza, 2007; Buzzato & al., 2007; Menini-Neto & al., 2009, Medeiros & Jardim, 2011). According to Benzing (1990), Orchidaceae are well known for their success in tree colonization, being orchids about two out of three epiphytes on every tree. However, many of them behave as facultative holoepiphytes, commonly also found growing on rocks on the banks of rivers and in small river islands, as demonstrated by the present study. Similarly, Falkenberg (2003) describes that the epiphytic habitats can easily be compared to the rocky habitats since both share a similar ecological situation, and in many cases epiphytic species can even grow best on rocks, if light conditions are satisfactory.

In terms of conservation, it is of paramount importance to preserve all diversity of vegetation types found in the State Park of Serra do Tabuleiro this would ensure the maintenance of different habitats suitable for colonization and perpetuation of orchid populations. Conservation figures such as 'plant micro-reserves' (cf. Laguna, 2001; Laguna & al., 2004) would be useful for that purpose, since they are small plots that require active management to maintain vegetation spots unchangeable along time, therefore avoiding community (and also species) successional replacement. This is especially relevant in the riparian vegetation, in which most species are found, including several threatened species. Indeed, the orchid community from the *restinga* vegetation shows lower diversity rates when compared to riparian vegetation. However, the history of environmental degradation endured by the studied coastal area of the State Park of Serra do Tabuleiro may be influencing negatively the current floristic composition of Orchidaceae in the *restinga* vegetation.

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APPENDIX 1. Characteristics of the collection sites

Sites	Coordinates	Elevation	Sampling date	Voucher
1 BRAZIL. Palhoça: Mouth river Maciambú, Sonho beach. <i>Restinga</i> vegetation.	27°49'30.3"S 48°35'34.5"W	0-10 m	23-III-2010	ABH-57597 - ABH-57616 - ABH-7629 - ABH-57632 - ABH-57654 - ABH-57673 - ABH-57681 - FLOR-38483 - FLOR-39564 - FLOR-38642 - FLOR-39570 - FLOR-39577 - FLOR-4138
2 BRAZIL. Palhoça: Mouth the river Maciambú, Sonho beach. <i>Restinga</i> vegetation.	27°49'27.5"S 48°35'35.6"W	0-10 m	10-IV-2010	ABH-57611 - ABH-57623 - ABH-57631 - ABH-57633 - ABH-57659 - ABH-57671 - FLOR-8636 - FLOR-39574 - FLOR-39562 - FLOR-39569
3 BRAZIL. Palhoça: River Maciambú Pequeno. Riparian vegetation.	27°48'02.2"S 48°39'11.16"W	100-125 m	3-IV-2010	ABH-57598 - ABH-57614 - ABH-57645 - ABH-57656-ABH - 57658-ABH - 57675-FLOR - 38661 - FLOR-39560 - FLOR-39678 - FLOR-40215 - FLOR-43893
4 BRAZIL. Palhoça: River Cachoeira do Amarinho. Riparian vegetation.	27°43'33.3"S 48°41'46.0"W	75-100 m	1-V-2010	ABH-57601 - ABH-57609 - FLOR-39575 - ABH-39559 - FLOR-44005 - ABH-57618 - ABH-38649 - ABH-57624 - ABH 57636 - FLOR-39565 - ABH-57640 - ABH-57642 - ABH-57652 - ABH-57679 - ABH-5762 - FLOR-39566 - FLOR-43893 - FLOR-39568 - FLOR-38628 - FLOR-43895 - FLOR-38653 - FLOR-38610 - FLOR-38615 - ABH-57676 - FLOR-41636 - FLOR-41649
5 BRAZIL. Palhoça - Santo Amaro da Imperatriz: River Cachoeira do Amarinho. Riparian vegetation	27°44'05.0"S 48°41'46.0"W	200-250 m	3-V-2010	ABH-57604 - FLOR-38475 - ABH-57606 - FLOR-38476 - FLOR-39561 - FLOR-57625 - ABH-57638 - ABH-57639 - ABH-57646 - FLOR-38666-ABH-57665 - ABH-57667 - FLOR-57667 - FLOR-39579 - ABH-57669 - ABH-57670 - FLOR-41817 - FLOR-44005 - FLOR-43895
6 BRAZIL. Santo Amaro da Imperatriz: Tributary river Vargem do Braço. Riparian vegetation.	27°47'45.5"S 48°50'01.4"W	345-385 m	17-V-2010	ABH-57602 - FLOR-3922 - FLOR-39559 - ABH-57613 - ABH-57617 - ABH-57620 - FLOR-38467 - ABH-57619 - ABH-57626 - FLOR-9563 - ABH-57649 - ABH-57648 - ABH-57650 - ABH-57657 - ABH-57664 - ABH-57661 - ABH-57668 - FLOR-38643 - ABH-57672 - FLOR-38487 - ABH-57677 - ABH-57680 - FLOR-41819 - FLOR-41415 - FLOR-41825
7 BRAZIL. Santo Amaro da Imperatriz: Tributary river Vargem do Braço. Riparian vegetation.	27°47'39.5"S 48°50'06.5"W	354-390 m	16-V-2010	ABH-57599 - ABH-57603 - ABH-57607 - ABH-57615 - FLOR-38647 - ABH-57621 - FLOR-39576 - ABH-57653 - FLOR-39567 - ABH-57648 - ABH-57655 - ABH-57663 - FLOR-41618
8 BRAZIL. Santo Amaro da Imperatriz: Tributary river Vargem do Braço. Riparian vegetation.	27°48'42.9"S 48°51'03.1"W	360-400 m	16-X-2010	ABH-57600 - FLOR-38479 - ABH-57605 - ABH-57608 - ABH-57610 - ABH-57622 - FLOR-22777 - ABH-57627 - ABH-57628 - ABH-57630 - ABH-57634 - ABH-57635 - FLO-38494 - ABH-57637 - FLOR-38632 - ABH-57651 - ABH-57666 - FLOR-38613 - ABH-57660 - ABH-57662 - FLOR-38482 - ABH-57674 - FLOR-38582 - ABH-57678 - FLOR-39583