The floristic compositions of vascular epiphytes of a seasonally inundated forest on the coastal plain of Ilha do Mel Island, Brazil

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Abstract: A 3 000 m^2 area of seasonally inundated forest on the island of Ilha do Mel (25º30" S 48º23" W) in Paraná, Brazil, was sampled by collecting plants from all strata, using climbing equipment when necessary. The area harbors 103 species of epiphytes, in 49 genera and 20 families, of which 28 species are pteridophytes and 75 magnoliophytes (64 Liliopsida, 11 Magnoliopsida). The most common families are Orchidaceae, Bromeliaceae, Polypodiaceae and Araceae, and frequent genera are *Vriesea, Epidendrum, Maxillaria, Pleurothallis* and *Prosthechea*. Eight families were represented by one species each. Most species were classified as obligatory holoepiphytes (62 %), followed by the relatively more rare preferential holoepiphytes (13 %), facultative epiphytes (11 %), hemiepiphytes (9 %) and accidental epiphytes (6 %). Rev. Biol. Trop. 54 (3): 935-942. Epub 2006 Sept. 29.

Key words: Brazil, Atlantic rain forest, coastal plain forest, floristic composition, Orchidaceae, Restinga, vascular epiphytes.

Epiphytes comprise a significant proportion of the plant diversity of tropical forests and may represent as much as 50 % of the plant species in these forests (Gentry and Dodson 1987b). Humid tropical forests are exceptionally notable due to the richness and abundance of epiphytes (Madison 1977). Diversity and richness of epiphytic orchids, for example, is great in the tropics and declines rapidly as the latitude approaches 30º, which is the limit of the influence of tropical air masses (Waechter 1998b). However, many endemic temperate epiphytes occur in the Southern Hemisphere, in strong contrast to the Northern Hemisphere, where mostly outlying species representing large tropical genera occurs (Benzing 1990).

While several studies have examined epiphyte floristic in Brazil (Gottsberger and Morawetz 1993 in the Amazon; Aguiar *et al.* 1981, Cervi and Dombrowski 1985, Cervi *et al.* 1988, Waechter 1992, 1998a, Dittrich *et al*. 1999, Kersten and Silva 2002 in subtropical forests; Pinto *et al.* 1995, Dislich and Mantovani 1998 in seasonal forests; Waechter 1986, 1992, Fontoura *et al.* 1997, Labiak and Prado 1998, Piliackas *et al.* 2000, Kersten and Silva 2001 in tropical formations), this study addresses the epiphytic community of a seasonally inundated coastal plain forest on the island of Ilha do Mel in the state of Paraná, in southern Brazil. This forest, has close affinities with the threatened and poorly studied Atlantic Coastal Forest of southeastern Brazil, and is an area of endemism for many plant and animal species (Pimm 2001). Identification of epiphytic species in this forest provides the first step in understanding their distribution and abundance as well as paving the way for further studies of the ecology and evolution of this community.

MATERIALS AND METHODS

The study area comprises 3 000 m^2 of the coastal plain of the island Ilha do Mel, in the state of Paraná, Brazil. Flooded during the

rainy seasons, this relatively closed forest contains three main strata: the lower stratum contains herbaceous plants, leaf litter and shoots, the middle stratum bushes and samplings, and the upper stratum, which may reach over 20 m, with few dominant species (Silva 1998).

Plants were collected from all strata, using climbing equipment when necessary (Ingram and Lowman 1995), samples of each fertile species were collected as a reference collection to be maintained in herbaria. Collected epiphytes were identified by specialist, using published literature, or by comparison with herbaria specimens in the UPCB (Herbarium of the Botany Department at the Federal University of Paraná) and MBM (Herbarium of the Municipal Botanical Museum). All the material gathered was prepared for and placed in the UPCB. Floristic similarity was compared among sites using the Jaccard Similarity Index.

Taxonomy followed Cronquist (1988) for Magnoliophyta and Moran (1995) for Pteridophyta. Epiphytes, based on their observed relationship with their host plant, were characterized as obligatory holoepiphyte, preferential holoepiphytes, facultative holoepiphyte, accidental holoepiphyte, primary and secondary hemiepiphyte, based on Benzing (1990).

RESULTS

The many species (n = 103) of epiphytes were distributed among 20 families, in 49 genera. Pteridophyta contributed 10 families, 15 genera and 28 species. The rest were within the Magnoliophyta, and included 10 families: Liliopsida contained three families, with 27 genera and 64 species; Magnoliopsida contained seven families, with seven genera and 11 species. The most speciose families were Orchidaceae (18 genera and 42 species), Bromeliaceae (six genera and 16 species), Polypodiaceae (five genera with 11 species), and Araceae (three genera and six species). Eight families were represented by one species each (four dicots and four pteridophytes, Table 1).

Seven species classified as accidental epiphytes or climbing lianas, (*Marcgravia polyantha*, *Norantea brasiliensis* - Marcgraviaceae, *Polybotrya cylindrica* - Dryopteridaceae, *Prunus mirtyfolia* - Rosaceae, *Mikania* sp. - Asteraceae and *Conomorpha peruviana* - Myrsinaceae) were not included in the species list discussed here in, even though similar species were included in epiphyte checklist by Ingram *et al.* (1996) and Nadkarni (1986).

The most species rich genera were *Vriesea* (Bromeliaceae) and *Maxillaria* (Orchidaceae), each with eight species. Next was *Epidendrum* (Orchidaceae) with six species, *Pleurothallis* (Orchidaceae) with five species and *Trichomanes* (Hymenophyllaceae) and *Prosthechea* (Orchidaceae) with four species each. Five genera had three species each (*Elaphoglossum, Octomeria, Campyloneurum, Polypodium* and *Tillandsia*), and 11 genera had two species, while the remaining 28 genera were each represented by one species. The epiphytic categories were distributed among obligatory holoepiphytes (62 %, including all of the Orchidaceae), preferential holoepiphytes (13 %), facultative epiphytes (11 %), hemiepiphytes (9 %) and accidental holoepiphytes (6 %).

DISCUSSION

A total of 201 vascular plant species have been identified to date in the study area (M.C.M. Marques pers. com., Silva 1998), of which 51 % (103 spp.) are epiphytes and 41 % (86 spp.) are characteristic holoepiphyte. Indeed, over 59 % of the species are canopy dependent (including climbing lianas). This high proportion of epiphytes is greater than that reported in any other forest studied (Gentry and Dodson 1987a). In Jamaica (Kelly 1985) only 25 % of the total flora were epiphytes, in La Selva they comprise 25 % and in Centinela Ridge this proportion grows to 35 % (Both in Gentry and Dodson 1987b), in Costa Rica (Ingram *et al* 1996) 25 % of total species were expected to grow epiphytically and in Macaé de Cima (Fontoura *et al.* 1997) 27 % of the

TABLE 1
Species list for this study, followed by epiphyte type and catalog number in the UPCB herbarium

FAMILY Species	Type	UPCB
ARACEAE		
Anthurium itanhaense Engl.	HMSF	43154
Anthurium pentaphyllum (Aubl.) G. Don	HMS	38556
Anthurium scandens (Aubl.) Engl.	HLC	43097
Monstera adansonii Schott	HMS	43100
Philodendron bipinnatifidum Schott ex Endl.	HMP	41893
Philodendron corcovadense Kunth	HMS	43155
ASPLENIACEAE		
Asplenium serra Langsd. & Fisch.	HLA	25795
BLECHNACEAE		
Blechnum serrulatum Rich.	HLA	23761
BROMELIACEAE		
Aechmea nudicaulis (L.) Griseb.	HLF	43112
Aechmea ornata Baker.	HLF	40563
Bromelia antiacantha Bertol.	HLA	13940
Catopsis sessiliflora (Ruiz & Pav.) Mez.	HLF	41712
Nidularium innocentii Lem.	HLF	43113
Tillandsia gardneri Lindl.	HLC	27323
Tillandsia geminiflora Brongn.	HLC	43111
Tillandsia tenuifolia L.	HLC	31877
Vriesea atra Mez	HLC	30457
Vriesea carinata Wawra	HLC	43115
Vriesea gigantea Mart. ex Schult. f.	HLC	22859
Vriesea philippocoburgii Wawra	HLF	30444
Vriesea procera (Mart. ex Schult.f.) Wittm.	HLC	43115
Vriesea rodigasiana E.Morren	HLF	43135
Vriesea scalaris E. Morren	HLC	43110
Vriesea vagans (L.B. Sm.) L.B. Sm.	HLF	30445
CACTACEAE		
Rhipsalis cereuscula Haw.	HLC	42361
Rhipsalis teres (Vell.) Steud	HLC	40823
CECROPIACEAE		
Coussapoa microcarpa (Schott) Rizzini	HMP	15064
CLUSIACEAE		
Clusia criuva Cambess.	HMPF	24873
DAVALLIACEAE		
Nephrolepis biserrata (Sw.) Schott	HLA	30440
Nephrolepis rivularis (Vahl.) Mett. ex Krug	HLA	31275
DENNSTAEDTIACEAE		
Lindsaea quadrangularis Raddi	HLA	43134
DRYOPTERIDACEAE		
Rumohra adiantiformis (G. Forst) Ching	HLF	13446
GESNERIACEAE		
Codonanthe devosiana Lem.	HLC	15037
Codonanthe gracilis (Mart.) Hanst.	HLC	43102
HYMENOPHYLACEAE		
Trichomanes cristatum Kaulf.	HLC	43133
Trichomanes hymenoides Hedw.	HLC	43108
Trichomanes krauzii Hook & Greeg.	HLC	43136
Trichomanes pyxidiferum L.	HLC	43107
LOMARIOPSIDACEAE		
Elaphoglossum crassinerve Moore	HLC	31301
Elaphoglossum lingua (C. Presl) Brack.	HLC	43106
Elaphoglossum subarborescens Rosent.	HLC	43105
LYCOPODIACEAE		
Huperzia flexibilis (Fée) B.Øllg.	HLC	25834
Huperzia mandiocana (Raddi) Trevis.	HLC	43132
MORACEAE		
Ficus luschnathiana (Miq.) Miq.	HMPF	40994
ORCHIDACEAE		
Campylocentrum linearifolium Schltr. ex Mansf.	HLC	43151
Cattleya forbesii Lindl.	HLC	43117
Dichaea anchorifera Cogn.	HLC	43096
Epidendrum latilabre Lindl.	HLC	43146
Epidendrum paniculatum Ruiz et Pavan	HLC	13919
Epidendrum ramosum Jacq.	HLC	40495

TABLE 1 (*Continued*)
Species list for this study, followed by epiphyte type and catalog number in the UPCB herbarium

FAMILY Species	Type	UPCB
Epidendrum rigidum Jacq.	HLC	43142
Epidendrum strobiliferum Rchb. f.	HLC	22839
Jacquiniella globosa (Jacq.) Schltr.	HLC	8279
Lankesterella ceracifolia Ames	HLC	14551
Lockhartia lunifera Rchb.f.	HLC	36407
Maxillaria brasiliensis Brieb.& Illg	HLC	43144
Maxillaria chlorantha Lindl.	HLC	43149
Maxillaria imbricata Barb.Rodr.	HLC	43610
Maxillaria marginata Fenzl.	HLC	40529
Maxillaria parahybunensis Cogn.	HLC	43608
Maxillaria rodriguesii Cogn.	HLC	42787
Maxillaria rufescens Lindl.	HLC	43156
Maxillaria sp. 1	HLC	--
Octomeria crassifolia Lindl.	HLC	40107
Octomeria fibrifera Schltr.	HLC	32124
Octomeria gracilis Barb. Rodr.	HLC	43118
Oncidium ciliatum Lindl.	HLC	47305
Oncidium uniflorum Booth.	HLC	43140
Physosiphon spiralis Lindl.	HLC	43147
Pleurothallis corticicola Schltr.	HLC	47649
Pleurothallis marginalis Rchb. f.	HLC	39863
Pleurothallis matinhensis Hoehne	HLC	43098
Pleurothallis saundersiana Rchb.f.	HLC	43138
Pleurothallis seriata Lindl.	HLC	43153
Polystachya caespitosa Barb.Rodr.	HLC	43150
Polystachya concreta (Jacq.) Garay & H.R. Sweet	HLC	43143
Prosthechea fragrans (Sw.) W.E.Higgins	HLC	43116
Prosthechea inversa (Lindl.) W.E.Higgins	HLC	37392
Encyclia patens Hook	HLC	43099
Prosthechea pygmaea (Hook) W.E.Higgins	HLC	43152
Prosthechea vespa (Vell.) W.E.Higgins	HLC	43139
Reichenbachanthus reflexus (Lindl.) C.Porto & Brade	HLC	43145
Scaphyglottis modesta (Rchb. f.) Schltr.	HLC	43141
Stelis fraterna Lindl.	HLC	43148
Stelis sp.	HLC	37380
Trigonidium latifolium Lindl.	HLC	43119
PIPERACEAE		
Peperomia emarginella (Sw. ex Wikstr.) C. DC.	HLC	40824
Peperomia glabella (Sw.) A.Dietr.	HLF	43120
Peperomia urocarpa Fisch. & C.A. Mey.	HLF	43101
POLYPODIACEAE		
Campyloneurum acrocarpon Fée	HLC	43130
Campyloneurum nitidum C. Presl.	HLC	43128
Campyloneurum rigidum J.Sm.	HLC	43129
Microgramma percussa (Cav.) de la Sota	HLC	43121
Microgramma vacciniifolia (Langsd. & Fisch.) Copel	HLC	43124
Pecluma recurvata (Kaulf.) M.G.Price	HLC	39044
Pleopeltis pleopeltifolia (Raddi) Alston	HLC	43122
Pleopeltis astrolepis (Liebm.) E. Fourn.	HLC	43127
Polypodium catharinae Langsd.& Fisch.	HLC	43013
Polypodium chnoophorum Kunze	HLC	31311
Polypodium hirsutissimum Raddi	HLC	43125
RUBIACEAE		
Hillia parasitica Jacq.	HMS	40729
VITTARIACEAE		
Radiovittaria stipitata (Kuntze) E.H. Crane	HLC	43131
Vittaria lineata (L.) Sm.	HLC	43154

(HL= holoepiphyte, HM= hemiepiphyte, O= obligatory, P= preferential, F= facultative, A= accidental, P= primary, S= secondary)

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flora was epiphytic. This epiphyte quotient (Hosokawa 1950) is even greater than the presented in Engwald (2000) who found that the 191 species documented comprises 45 % of total flora species. Nearby in Brazil, in an Araucaria forest, epiphytes constitute 22 % of the flora (Dittrich *et al.* 1999). Nearby, in a seasonal forest in Argentina, epiphytes were reported to be represented by fewer species than were trees, while no precise numbers were provided (Brown 1990). Hence, the flora of Ilha do Mel includes surprisingly many epiphytes, and supports the premise that characteristic epiphytes are an important part of the tropical forest plant communities (Madison 1977), and that they are responsible for an important part of the diversity of these complex ecosystems (Gentry and Dodson 1987b).

The four most species rich families (Orchidaceae, Bromeliaceae, Polypodiaceae, Araceae) together are represented here by 75 species being the largest families elsewhere (Benzing 1990, Gentry and Dodson 1987b, Kress 1986, Madison 1977). Orchidaceae that worldwide represents 10 % of the total terrestrial vascular flora (Atwood 1986) represents 40 % of the epiphytic and 20 % of the total species on our work. The absence of the family Ericaceae in this study as in many others areas in Brazil (Cervi and Dombrowski 1985, Cervi *et al.* 1988, Waechter 1986, 1992, 1998a, Fontoura *et al.* 1997, Dislich and Mantovani 1998, Dittrich *et al.* 1999, Kersten and Silva 2001, 2002) should be surprising according to Kress (1986), given that it is a common family in Central America (Sudgen and Robins 1979, Nadkarni 1986, Ingram *et al.* 1996).

Only two areas studied in Brazil had greater species-richness than that presented here (Table 2). One study (Torres, Waechter 1986) is located approximately 400 km south of Ilha do Mel at 30º S. This region is described as a transition zone (Takhtajan 1986), at the interface of seasonal forests and mixed rainforests, and so contains species that are typical of both (eg *Blechnum binervatum* - Blechnaceae*, Tillandsia stricta* and *T. mallemontii* - Bromeliaceae) and of Atlantic Forests (eg *Hymenophyllum vestitum* in the family Hymenophyllaceae). The second (Fontoura *et al.* 1997) located on Rio de Janeiro is much larger and includes montana and altomontana forest having a high ecosystem diversity and so a higher species diversity. The area studied here is more species-rich than any other coastal plains in southern Brazil (Kersten and Silva 2001), any other area outside of the influence of the Atlantic Ocean in southern Brazil (Cervi and Dombrowski 1985, Cervi *et al.* 1988, Dislich and Mantovani 1998, Dittrich *et al.* 1999, Kersten and Silva 2002), as well as areas under the influence of temperate air masses (Aguiar *et al.* 1981, Waechter 1998a). This pattern is probably due to the tropical origins of the epiphytic component of this forest. Four study sites in Central America (Kelly 1995, Nadkarni *et al.* 1995, Ingram *et al.* 1996, Engwald *et al.* 2000) had greater species-richness than this study but all of them had a much greater study area, varying from 5 times greater (1.5 ha in Engwald *et al.* 2000) to more than 13 times greater (4 ha in Nadkarni *et al.* 1995, Ingram *et al*. 1996).

The epiphytic community of Ilha do Mel (here and Kersten and Silva 2001) was most similar (Table 2) to Torres (Waechter 1986, 1992) and Ubatuba (Piliackas *et al*. 2000), and less so with Macaé de Cima (Fontoura *et al.* 1997) and Montenegro and Triunfo (Aguiar *et al.* 1981). Torres and Ubatuba owe their similarities to their similar formations and their proximity with Ilha do Mel. Macaé was less similar to Ilha do Mel due to its greater number of species, and Montenegro and Triunfo due to fewer species.

Holoepiphytes formed the vast majority of species here, a trend that is apparently common (Kelly 1985, Pinto *et al.* 1995, Dittrich *et al.* 1999, Kersten and Silva 2001, 2002). Facultative epiphytes, with 10-15 % of the total, form the second most important group of epiphytes. In this second group, *Aechmea nudicaulis*, *Codonanthe gracilis*, *Peperomia glabella,* and *Clusia criuva* were often found as free living plants as well as epiphytes (Silva 1998). Hemiepiphytes comprised nine species, with three being primary hemiepiphytes (*Clusia criuva*, *Ficus* cf. *luschnathiana* and *Coussapoa microcarpa*) and the remainder were secondary epiphytes.

TABLE 2
Epiphyte specie richness in Brazilian studies

Location/Reference	# of Species	Forest Type	Area
Ilha do Mel, Paranaguá, PR, 25º30'S, 48º23'W this study	103	DR	0.3
Ilha do Mel, Paranaguá, PR, 25º30'S, 48º23'W Kersten and Silva 2001	77	DR	0.3
Macaé de Cima, RJ, 22º23'S, 42º47'W Fontoura *et al.* 1997	306	DR	n.r.
Torres I and II, RS, 29º21'S, 49º45'W Waechter 1986, 1992	115 (I) 93 (II)	DR	n.r.
Curitiba, PR, 25º25'S, 49º18'W Dittrich *et al.* 1999	72	MR	50
UFPR, 25º25'S, 49º18'W Cervi *et al.* 1985 1988	32	MR	n.r.
Osório, RS, 29º58'S, 50º14'W Waechter 1998	53	SF	1
USP, 23º33'S, 46º43'W Dislich and Mantovani 1998	38	SF	0.2
Estação Ecológica do Taim, RS, 32º33'S, 55º26'W Waechter 1992	24	SF	n.r.
Montenegro/Triunfo, RS, 29º50'S, 51º27'W Aguiar *et al.* 1981	17	SF	n.r.

Forest type is abbreviated as follows: MR= Mixed Rainforest, DR= Dense Rainforest, SF= Seasonal Forest. Area is in hectares, n.r. indicates the study did not report area.

Seven other species were accidental epiphytes, mentioned here but not considered in comparisons of communities. Examples are *Bromelia antiacantha* in spite of its usually terrestrial life style, was found as an epiphyte (see Aguiar *et al.* 1981, Waechter 1998a). Two species normally found as terrestrial trees (*Prunus myrtifolia* and *Conomorpha peruviana*) and one vine (*Micania* sp.) were also observed as epiphytes. It is unknown whether these accidental epiphytes may survive to reproduce as epiphytes. Perhaps they represent the type of transition from free-living plant to the epiphytic habit that may have been important in the evolution of some epiphytic plants.

In summary, the vascular epiphyte component of this plant community in southern Brazil comprises over half (51 %) of the vascular plant species in the community. Orchidaceae and Bromeliaceae are the two most species-rich families. While most species are characteristic holoepiphytes, 25 % of this community is divided between hemiepiphytes, facultative holoepiphytes and accidental epiphytes.

RESUMEN

Se muestreó plantas de todos los estratos en una área de 3 000 m^2 de selva estacionalmente inundada en Ilha do Mel (25º30 "S 48º23' W), Paraná, Brazil. El área tiene 103 especies de epífitas en 49 géneros y 20 familias, de las cuales 28 especies son pteridófitas y 75 magnoliófitas (64 Liliopsida, 11 Magnoliopsida). Las familias más comunes son Orchidaceae, Bromeliaceae, Polypodiaceae y Araceae, y los géneros más frecuentes *Vriesea, Epidendrum, Maxillaria, Encyclia* y *Pleurothallis*. Ocho familias solamente están representadas por una especie cada una. La mayoría de las especies son loepífitas obligadas (62 %), seguidas de las relativamente escasas holoepífitas preferenciales (13 %), epífitas facultativas (11 %), hemiepífitas (9 %) y epífitas accidentales (6 %).

Palabras clave: Brazil, selva lluviosa atlántica, selva de planicie costera, composición florística, Orchidaceae, Restinga, epifitas vasculares.

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