

Species composition of climbers in seasonal semideciduous forest fragments of Southeastern Brazil

Karin dos Santos^{1,4}, Luiza Sumiko Kinoshita² & Andréia Alves Rezende³

¹Department of Phanerogamic Botany,
Swedish Museum of Natural History, SE-104 05, Stockholm, Sweden

²Departamento de Botânica, Instituto de Biologia,
Universidade Estadual de Campinas – UNICAMP,
CP 6109, CEP 13083-970, Campinas, SP, Brazil

³Departamento de Ciências Biológicas, Centro Universitário de Rio Preto,
Rua Yvette Gabriel Atique, 45, CEP 15025-400, São José do Rio Preto, SP, Brazil

⁴Author for correspondence: Karin dos Santos, e-mail: karin.santos@nrm.se

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Abstract: In this study we evaluated floristic composition patterns of communities of climbers within ten inventories carried out in semideciduous forest fragments of southeastern Brazil. One of the inventories is original, being carried out for the present study in Ribeirão Cachoeira forest, Campinas, São Paulo State, Southeastern Brazil. This inventory was then pooled together to other nine climbers' inventories made in other forests of Southeastern Brazil to form a data base, which was examined regarding species richness, similarity, species distribution and climbing methods. The total number of species obtained was 355, belonging to 145 genera and 43 families. The ten most diverse families Bignoniaceae (45 species), Fabaceae (42), Malpighiaceae (36), Asteraceae (31), Apocynaceae (29), Sapindaceae (28), Convolvulaceae (21), Cucurbitaceae (14), Passifloraceae (10), and Euphorbiaceae (8) contributed to 74.4% of the total number of species recorded. The commonest climbing method in the studied sites was main stem or branch twining, accounting for 178 species or 50.1% of the total, the second commonest was tendril climbing (121 species, 34.1%), and the least, scrambling (56 species, 15.8%). We found a high percentage of exclusive species i.e., those occurring in only one forest site, which accounted for 49.3% of the total recorded. The mean similarity among forest sites (30%) may be considered low. The climbing species contribution to the total wood plant richness recorded on the forests sites was very high in some of the sites (up to 52.5%). These results indicated the importance of climber communities to plant diversity for semideciduous forests in Southeastern Brazil, enhancing the regional diversity and the conservation value of these forest remnants.

Keywords: *lianas, climbing mechanism, floristic, similarity, NMS.*

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Resumo: No presente estudo avaliamos as variações na composição de espécies das comunidades de trepadeiras abordando dez inventários florísticos realizados em fragmentos de floresta estacional semidecidual do sudeste do Brasil. Um destes inventários é inédito e foi realizado especialmente para o presente estudo. Comparamos este levantamento a outros nove inventários florísticos de trepadeiras realizados em outras florestas do sudeste para investigar aspectos como riqueza, similaridade, distribuição de espécies e mecanismos de escalada. Ao todo foram encontradas 355 espécies, pertencentes a 145 gêneros e 43 famílias. As dez famílias mais ricas Bignoniaceae (45 espécies), Fabaceae (42), Malpighiaceae (36), Asteraceae (31), Apocynaceae (29), Sapindaceae (28), Convolvulaceae (21), Cucurbitaceae (14), Passifloraceae (10), e Euphorbiaceae (8) representaram 74,4% do total de espécies encontrado. Considerando os mecanismos de escalada, observamos o predomínio de espécies volúveis (178 espécies ou 50,1%), sobre espécies com gavinhas (121 espécies, 34,1%), e apoiadoras (56 espécies, 15,8%). A porcentagem de espécies exclusivas, i.e. aquelas que ocorreram em apenas uma das localidades estudadas, foi de 49,3% do total amostrado e pode ser considerada alta. Além disso, a similaridade entre as florestas analisadas foi bastante baixa e a contribuição das espécies de trepadeiras para a diversidade de plantas lenhosas nestas áreas foi bastante elevada em algumas áreas, chegando a 52,5%. Estes resultados indicaram a importância das comunidades de trepadeiras para a diversidade vegetal nas florestas semidecíduais do sudeste do Brasil, aumentando a valor de conservação desses remanescentes florestais.

Palavras-chave: *lianas, mecanismos de escalada, ordenação NMS, similaridade.*

Introduction

The semideciduous seasonal forest of the Southeastern Brazil is probably one of the most threatened and fragmented ecosystems on earth. The maintenance of its biodiversity depends on the conservation of small fragments spread over an agricultural landscape. The biological studies on these forest remnants have improved a lot during the last three decades, enhancing the required background for management and conservation actions. However, climbers' communities have been neglected by most of those studies, which focused mainly on trees. This study comes as a small contribution towards fulfilling this gap.

Climbers are an abundant and diverse group of plants in forests throughout the world, particularly in the tropics. They can constitute ~25% of woody stem density and represent from 25 to 44% of the woody species diversity in tropical forests (Gentry 1991, Pérez-Salicrup et al. 2001), providing a remarkable food source for the associated fauna and, by physically linking trees together, furnishing canopy-to-canopy access for arboreal animals (Emmons & Gentry 1983, Morellato & Leitão Filho 1996). Thus, the importance of improving the knowledge about lianas (woody climbers) lies on the crucial ecological role they play in many aspects of tropical forest dynamics.

Lianas are commonly seen as structural parasites, invaders or weedy species, which respond positively to increased CO₂ concentrations, light penetration and forest disturbance, and consequently thrive in fragmented/disturbed landscapes (Putz 1984, Laurance 1991, 1997, Laurance et al. 2001, Phillips et al. 2002). When abundant, this life form is considered to be an inconvenient for economic and conservational reasons. Abundant lianas can reduce the silvicultural value of a forest by reducing tree growth and fecundity, and increasing tree mortality and stem deformation (Stevens 1987, Putz 1991, Pérez-Salicrup & Barker 2000, Phillips et al. 2005). Additionally, tree supporting lianas are more prone to break and cause logging damage on their neighbours due to intercrown connections between adjacent trees, enhancing tree turnover in heavy infested forests (Appanah & Putz 1984, Vidal et al. 1997, Phillips et al. 2005). Lianas can also arrest or suppress gap-phase regeneration, and harm some species while promoting others (Schnitzer et al. 2000). All these factors indicate that forest dynamics and composition can be altered due to lianas' influence, with implications for forest's conservation and sustainability (Putz 1984, Stevens 1987, Pérez-Salicrup & Barker 2000, Schnitzer et al. 2000, Schnitzer & Carson 2001, Phillips et al. 2002, 2005).

Few quantitative and qualitative data are available to evaluate these claims in the semideciduous seasonal forests of southeastern Brazil. This ecosystem is facing an extremely high anthropogenic pressure given its high degree of forest fragmentation, disturbance history, and location, among the larger cities and the most industrialized region of Brazil. Heavy liana infestations are expected for this region, however, little is known about variations in their communities and the contribution of their species to overall diversity in these forests (but see Udulutsch et al. 2004, Tibiriçá et al. 2006, Rezende et al. 2007). Further investigations and data are highly desirable and required to address these questions in semideciduous seasonal forests of southeastern Brazil (Udulutsch et al. 2004). Floristic inventories are the first step towards a better understanding of climbers' communities in this region; they provide the basic information for further investigations and to support management and conservation policies.

The goal of this study is to contribute to increase the knowledge of communities of climbers in the Southeastern Brazil by describing their floristic composition in a semideciduous seasonal forest fragment of Campinas municipality, State of São Paulo, and providing a

preliminary evaluation of the floristic patterns of their communities by comparing the current floristic inventory to other nine inventories carried out in different semideciduous forest fragments of Southeastern Brazil.

Material and Methods

The tropical semideciduous forest from Southeastern Brazil occurs in areas with rainfall between 1,250 and 2,550 mm. The vegetation is characterized by dense forests with high tree species diversity. The average canopy stature is 15 m with emergent trees reaching up to 35 m tall. There are two distinct seasons, the rainy summer, from December through February and the dry winter, from June through August. During the dry season approximately 40% of the trees composing the canopy are deciduous to some degree (Morellato & Leitão Filho 1992). The canopy is commonly dominated by families Myrtaceae, Fabaceae, Meliaceae, Apocynaceae and Euphorbiaceae. The most dominant species are *Esenbeckia leiocarpa* Engl.,

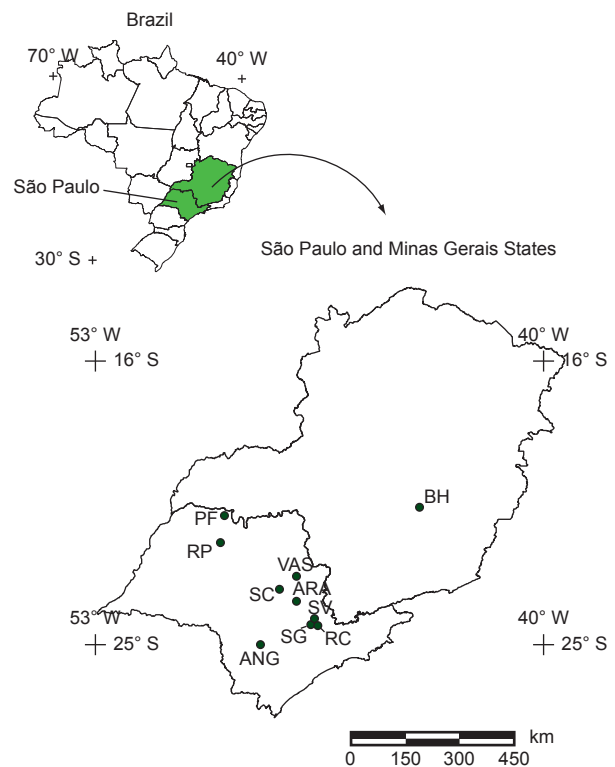


Figure 1. Locations of the 10 semideciduous forest sites of southeastern Brazil. ANG = Angatuba (Torres 1989); ARA = Araras (Udulutsch et al. 2004); BH = Belo Horizonte (Lombardi et al. 1999); RC = Mata Ribeirão Cachoeira forest (Present study); RP = São José do Rio Preto (Rezende & Ranga 2005); PF = Paulo de Faria (Rezende et al. 2007); SC = São Carlos (Hora & Soares 2002); SG = Santa Genebra (Morellato & Leitão Filho 1996); SV = Fazenda São Vicente (Bernacci & Leitão Filho 1996); VAS = Vassununga (Tibiriçá et al. 2006).

Figura 1. Localização dos dez fragmentos de floresta estacional semidecidual estudados no sudeste do Brasil. ANG = Angatuba (Torres 1989); ARA = Araras (Udulutsch et al. 2004); BH = Belo Horizonte (Lombardi et al. 1999); RC = Mata Ribeirão Cachoeira (Presente estudo); RP = São José do Rio Preto (Rezende & Ranga 2005); PF = Paulo de Faria (Rezende et al. 2007); SC = São Carlos (Hora & Soares 2002); SG = Santa Genebra (Morellato & Leitão Filho 1996); SV = Fazenda São Vicente (Bernacci & Leitão Filho 1996); VAS = Vassununga (Tibiriçá et al. 2006).

Piptadenia gonoacantha (Mart.) J.F.Macbr., *Trichilia clauseni* C.DC., *Croton floribundus* Spreng., *Gallesia integrifolia* (Spreng.) Harms, *Lonchocarpus muehlbergianus* Hassl., and *Aspidosperma polyneuron* Müll.Arg. (K. Santos et al. unpubl. data).

The floristic inventory of the present study was carried out at the Ribeirão Cachoeira Forest, which is the second largest (244.9 ha) of the former continuous semideciduous seasonal forest of Campinas municipality, State of São Paulo. The species composition of climbers was sampled randomly, by walking along the network of paths within the forest fragment and also at forest edges. Every climber found in reproductive state was collected for later identification and recorded for the checklist. Collecting was done mainly from March through December 1996. Identification followed the usual taxonomic techniques and vouchers have been deposited in the UEC Herbarium (Department of Botany, Institute of Biology, State University of Campinas – UNICAMP). Family classification followed APG II (APG 2003).

There are many different kinds of climbers, differing in climbing strategy, morphology and ecology (Gentry 1991). In this study we included woody, subwoody and herbaceous climbing plants which can be defined as plants that begin their life cycles as seedlings rooted in the ground and rely on other plants for physical support in order to reach the top of the forest canopy, never losing the contact with the ground as they keep rooted in the soil permanently. This means that we excluded hemiepiphytes and epiphytes. Nonetheless, because the majority of the species being considered in this study is woody and also because the other inventories treated here followed the same definition, we may also refer to the studied group of plants using the more widespread term lianas, especially when referring to available literature focusing the theme.

The obtained list of species plus other nine floristic inventories of climbers carried out in different locations of the southeastern Brazil were pulled together to build a presence/absence main matrix data.

Only forests belonging to the seasonal semideciduous forests domain were included, being eight forest inventories from the interior of the São Paulo state and one from the State of Minas Gerais (Figure 1, Table 1). The sampling methods and criteria of inclusion adopted by each study included in the main matrix data varied little, most of them adopted the same methods as in the current inventory (Table 1).

Only taxa identified up to species level were included in the presence/absence main matrix, and the full list was checked for synonymies among taxa. For all species recorded on the main matrix, the climbing mechanisms were determined based on field observation, personal knowledge and/or reference to literature. Species were classified into one of the following categories according to Putz (1984) and Hegarty (1991): a) tendril climbers, b) main stem or branch twiners, and d) scramblers.

We examined the patterns of climbers composition using non-metric multidimensional scaling (NMS) ordination in PC-ORD version 4.0 (McCune & Mefford 1999). The ordinations were based on the Sorenson's similarity matrices of species presence-absence data. We also accessed liana species' contribution to the total wood plant richness recorded on the studied forests sites by calculating the proportion of climber species in relation to the total wood species number (trees, shrubs and climbers). The number of trees/shrubs species in each site was also compiled from the literature for most studied sites, with exception of Belo Horizonte (BH), São José do Rio Preto (RP), and Vassununga (VAS).

Results

Considering all the forests inventories pulled together, we found a total of 355 species of climbers belonging to 145 genera and 43 families (Table 2). The ten most diverse families were Bignoniaceae (45 species), Fabaceae (42), Malpighiaceae (36), Asteraceae (31), Apocynaceae (29), Sapindaceae (28), Convolvulaceae (21),

Table 1. List of the ten semideciduous seasonal forests where liana inventories were conducted in southeastern Brazil.

Tabela 1. Lista dos dez inventários florísticos de lianas realizados em florestas estacionais semidecíduais do sudeste do Brasil.

Forest site	Coordinates	Area ^a	Sample method	Inclusion criteria ^b	Reference
Angatuba (ANG)	23° 29' S and 48° 45' W	1394	Random walks	Reproductive material	Torres (1989)
Araras (ARA)	22° 21' S and 47° 28' W	230	Random walks	Reproductive material	Udulutsch et al. (2004)
Belo Horizonte (BH)	19° 52' S and 43° 58' W	150	Plots	DBH ≥ 0.5 cm	Lombardi et al. (1999)
Paulo de Faria (PF)	19° 55' S and 49° 32' W	650	Plots	DBH ≥ 1 cm	Rezende et al. (2007); Stranghetti & Ranga (1998)
Ribeirão Cachoeira (RC)	22° 49' S and 46° 55' W	244.9	Random walks	Reproductive material	Present study
Santa Genebra (SG)	22° 44' S and 47° 06' W	250	Random walks	Reproductive material	Morellato & Leitão Filho 1996
São Carlos (SC)	21° 57' S and 47° 50' W	112	Plots	DBH ≥ 2.5 cm	Hora & Soares 2002
São José do Rio Preto (RP)	20° 48' S and 49° 22' W	168.63	Random walks	Reproductive material	Rezende & Ranga 2005
São Vicente (SV)	22° 55' S and 47° 03' W	70	Random walks/ Plots	Unspecified	Bernacci & Leitão Filho 1996
Vassununga (VAS)	21° 41' S and 47° 34' W	127.08	Random walks	Reproductive material	Tibiricá et al. 2006

^a = Forest fragment size in hectares; ^b = this column refers to the criteria adopted by each study to select the plants to be included in the survey. Where DBH = diameter at breast high; Reproductive material = all the plant stems were collected as long as they were found in reproductive state (flowering or fruiting).

^a = Área do fragmento florestal em hectares; ^b = esta coluna se refere ao critério de inclusão adotado na amostragem. Onde DBH = diâmetro à altura do peito; Reproductive material = todas as plantas encontradas em estado reprodutivo (flor ou fruto) foram coletadas.

Table 2. List of 43 families and 355 liana species occurring at the 10 semideciduous forest sites of Southeastern Brazil (See Table 1 and Figure 1 for sites legend). *Climbing methods, where ten = tendril climbers; twi = branch/stem twiners; scr = scramblers. x = indicates species occurrence.

Tabela 2. Lista das 43 famílias e 355 espécies de lianas encontradas nos dez fragmentos de floresta estacional semidecidual estudados no sudeste do Brasil (Siglas dos fragmentos como na Figura 1 e Tabela 1). *Mecanismos de escalada, onde ten= gavinhas; twi = volúveis; scr = escandentes. X = ocorrência da espécie.

Family and species	Climb*	ANG	ARA	BH	PF	RC	RP	SC	SG	SV	VAS
ACANTHACEAE											
<i>Mendoncia puberula</i> Mart.	twi	-	x	-	-	-	-	-	x	-	-
<i>Mendoncia velloziana</i> Mart.	twi	-	x	-	-	-	-	-	x	-	-
AGAVACEAE											
<i>Herreria salsaparilha</i> Mart.	twi	-	-	-	x	x	x	-	-	-	-
ALSTROEMERACEAE											
<i>Alstroemeria nemorosa</i> Gardner	twi	-	x	-	-	-	-	-	-	-	-
<i>Bomarea martiana</i> Schen.	scr	x	-	-	-	-	-	-	-	-	-
AMARANTHACEAE											
<i>Chamissoa altissima</i> (Jacq.) Kunth	scr	x	x	-	x	-	-	-	x	x	x
<i>Hebanthe paniculata</i> Mart.	twi	x	-	-	x	x	x	-	x	x	x
APOCYNACEAE											
<i>Araujia sericifera</i> Brot.	twi	-	-	-	-	-	x	-	-	-	-
<i>Calotropis procera</i> (Aiton) R.Br.	scr	-	-	-	-	-	-	-	-	-	x
<i>Condylocarpon isthmicum</i> (Vell.) A.DC.	twi	x	x	-	-	x	-	x	x	-	x
<i>Ditassa anomala</i> Mart.	twi	-	-	-	-	-	-	-	x	-	-
<i>Forsteronia glabrescens</i> Müll.Arg.	twi	-	-	-	-	-	x	-	-	-	-
<i>Forsteronia leptocarpa</i> (Hook. & Arn.) A.DC.	twi	-	x	-	-	-	-	-	x	-	-
<i>Forsteronia pilosa</i> (Vell.) Müll.Arg.	twi	-	x	-	x	x	-	-	-	-	x
<i>Forsteronia pubescens</i> A.DC.	twi	-	x	-	x	x	x	x	-	-	x
<i>Forsteronia refracta</i> Müll.Arg.	twi	-	x	-	-	-	-	-	-	-	x
<i>Forsteronia rufa</i> Müll.Arg.	twi	-	-	-	-	-	-	-	x	-	-
<i>Forsteronia velloziana</i> (A.DC.) Woodson	twi	-	-	x	-	-	-	-	-	-	-
<i>Gonioanthea hilariana</i> (E.Fourn.) Malme	twi	-	x	-	-	-	-	-	-	-	-
<i>Gonolobus rostratus</i> (Vahl) Schult.	twi	-	-	-	-	-	-	-	x	-	-
<i>Gonolobus selloanus</i> (E.Fourn.) Bacigalupo	twi	-	x	-	-	-	-	-	-	-	-
<i>Mesechites mansoanus</i> (A.DC.) Woodson	twi	-	-	-	-	-	x	-	-	-	-
<i>Orthosia urceolata</i> E.Fourn.	twi	-	x	-	-	-	-	-	-	-	-
<i>Oxypetalum appendiculatum</i> Mart.	twi	-	-	-	-	-	-	-	x	-	-
<i>Oxypetalum balansae</i> Malme	twi	-	-	-	-	-	x	-	-	-	-
<i>Oxypetalum erianthum</i> Decne.	twi	-	-	-	x	-	x	-	-	-	-
<i>Oxypetalum molle</i> Hook. & Arn.	twi	-	-	-	-	-	-	-	x	-	-
<i>Prestonia coalita</i> (Vell.) Woodson	twi	-	x	-	x	x	x	-	x	x	x
<i>Prestonia duseinii</i> (Malme) Woodson	twi	-	-	-	-	-	x	-	-	-	-
<i>Prestonia lagoensis</i> (Müll.Arg.) Woodson	twi	-	-	-	x	-	-	-	-	-	-
<i>Prestonia riedelii</i> (Müll.Arg.) Markgr.	twi	-	-	-	-	-	-	-	x	-	-
<i>Prestonia tomentosa</i> R.Br.	twi	-	-	-	x	x	x	-	x	-	-
<i>Sarcostemma clausum</i> (Jacq.) Schult.	twi	-	-	-	-	-	-	-	-	-	x
<i>Schubertia grandiflora</i> Mart. & Zucc.	twi	-	-	-	-	x	x	-	-	-	-
<i>Secondatia densiflora</i> A.DC.	twi	-	-	-	x	-	x	-	-	-	-
<i>Tassadia propinqua</i> Decne.	twi	-	-	-	-	-	-	-	x	-	-
ARACEAE											
<i>Philodendron propinquum</i> Schott	twi	-	-	-	-	-	-	-	-	x	-
ARISTOLOCHIACEAE											
<i>Aristolochia arcuata</i> Mast.	twi	-	x	-	-	x	-	-	x	-	-
<i>Aristolochia esperanzae</i> Kuntze	twi	-	-	-	-	-	x	-	-	-	-
<i>Aristolochia galeata</i> Mart.	twi	x	x	-	-	-	-	-	x	-	-
<i>Aristolochia melastoma</i> Silva Manso ex Duch.	twi	-	x	-	-	-	-	-	x	x	-

Climbers from semideciduous forest of Southeastern Brazil

Table 2. Continued...

Family and species	Climb*	ANG	ARA	BH	PF	RC	RP	SC	SG	SV	VAS
ASTERACEAE											
<i>Baccharis quitensis</i> Kunth	scr	-	X	-	-	-	-	-	-	-	X
<i>Bidens brasiliensis</i> Sherff	twi	-	-	-	-	-	-	-	X	-	-
<i>Bidens squarrosa</i> Kunth	twi	-	X	-	-	-	-	-	-	-	-
<i>Calea pinnatifida</i> (R.Br.) Less.	scr	X	X	-	-	X	-	-	X	-	-
<i>Chromolaena maximilianii</i> (Schrader) R.M.King & H.Rob.	scr	-	X	-	-	-	-	-	-	-	-
<i>Cyrtocymura scorpioides</i> (Lam.) H.Rob.	scr	-	X	-	-	X	-	-	-	-	X
<i>Dasyphyllum brasiliense</i> (Spreng.) Cabrera	scr	X	-	-	X	X	X	-	X	-	-
<i>Dasyphyllum flagellare</i> (Casar.) Cabrera	scr	X	-	-	-	-	-	-	-	-	-
<i>Dasyphyllum spinescens</i> (Less.) Cabrera	scr	-	-	-	-	-	-	-	X	X	-
<i>Dasyphyllum synacanthum</i> (Baker) Cabrera	scr	-	-	X	-	-	-	-	-	-	-
<i>Eupatorium megaphyllum</i> Baker	scr	-	X	-	-	-	-	-	-	-	-
<i>Eupatorium vauthierianum</i> DC.	scr	-	X	-	-	-	-	-	-	-	-
<i>Heterocondylus vitalbae</i> (DC.) R.M.King & H.Rob.	twi	-	X	-	-	-	-	-	X	-	-
<i>Mikania bififormis</i> DC.	twi	X	-	-	-	-	-	-	-	-	-
<i>Mikania cordifolia</i> (L.f.) Willd.	twi	-	-	-	-	-	X	-	-	-	-
<i>Mikania cynanchifolia</i> Hook. & Arn. ex Baker	twi	-	-	-	-	-	-	-	X	-	-
<i>Mikania glomerata</i> Spreng.	twi	X	X	-	-	X	-	-	X	X	X
<i>Mikania hemisphaerica</i> Sch.Bip. ex Baker	twi	-	-	-	-	-	-	-	-	X	-
<i>Mikania hirsutissima</i> DC.	twi	-	-	X	-	-	-	-	X	-	-
<i>Mikania lundiana</i> DC.	twi	-	-	-	-	-	-	-	-	-	X
<i>Mikania micrantha</i> Kunth	twi	-	X	-	-	X	X	-	X	X	X
<i>Mikania pyramidata</i> Donn.Sm.	twi	-	X	-	-	-	-	-	-	-	-
<i>Mikania ramosissima</i> Gardner	twi	-	X	-	-	-	-	-	-	-	X
<i>Mikania salviaefolia</i> Gardner	twi	-	-	X	-	-	-	-	-	-	-
<i>Mikania triangularis</i> Baker	twi	-	X	-	-	-	-	-	X	X	-
<i>Mutisia coccinea</i> A.St.-Hil.	twi	X	X	-	-	-	-	-	X	-	-
<i>Pseudogynoxys cumingii</i> (Benth.) H.Rob. & Cuatrec.	scr	-	-	-	-	-	-	-	-	X	X
<i>Trixis antimenorrhoea</i> (Schrank) Kuntze	scr	-	-	-	-	-	-	-	X	X	-
<i>Trixis divaricata</i> (Kunth) Spreng.	scr	-	X	-	-	-	-	-	-	-	-
<i>Vernonanthura crassa</i> (Vell.) H.Rob.	scr	-	X	-	-	-	-	-	-	-	-
<i>Vernonanthura diffusa</i> (Less.) H.Rob.	scr	-	X	-	-	-	-	-	-	-	-
BASELLACEAE											
<i>Anredera cordifolia</i> (Ten.) Steenis	twi	-	-	-	-	-	-	-	X	-	-
BIGNONIACEAE											
<i>Adenocalymma bracteatum</i> (Cham.) DC.	ten	-	X	-	X	X	X	X	X	-	X
<i>Adenocalymma dusenii</i> Kraenzl.	ten	X	-	-	-	-	-	-	-	-	-
<i>Adenocalymma marginatum</i> (Cham.) DC.	ten	-	X	-	-	X	-	-	X	X	X
<i>Adenocalymma paulistarum</i> Bureau & K.Schum.	ten	-	X	-	-	-	-	-	-	-	X
<i>Amphilophium paniculatum</i> (L.) Kunth	ten	-	X	-	X	X	X	X	X	-	-
<i>Anemopaegma chamberlaynii</i> (Sims) Bureau & K.Schum.	ten	-	X	-	-	X	-	X	X	X	-
<i>Arrabidaea chica</i> (Bonpl.) Verl.	ten	-	X	-	X	-	X	-	-	-	X
<i>Arrabidaea conjugata</i> (Vell.) Mart.	ten	-	-	-	-	X	-	X	-	-	X
<i>Arrabidaea craterophora</i> (DC.) Bureau	ten	-	-	X	-	-	X	-	-	-	-
<i>Arrabidaea florida</i> DC.	ten	-	-	-	-	X	X	-	-	-	X
<i>Arrabidaea formosa</i> (Bureau) Sandwith	ten	-	X	X	X	-	-	-	-	-	-
<i>Arrabidaea leucopogon</i> (Cham.) Sandwith	ten	-	-	-	X	-	X	-	-	-	-
<i>Arrabidaea mutabilis</i> Bureau & K.Schum.	ten	-	-	-	-	-	-	X	-	-	-
<i>Arrabidaea pubescens</i> (L.) A.H.Gentry	ten	-	X	-	-	-	-	-	-	-	-

Table 2. Continued...

Family and species	Climb*	ANG	ARA	BH	PF	RC	RP	SC	SG	SV	VAS
<i>Arrabidaea pulchella</i> (Cham.) Bureau	ten	x	x	-	x	-	-	-	-	-	x
<i>Arrabidaea pulchra</i> (Cham.) Sandwith	ten	-	x	x	-	-	-	-	-	-	-
<i>Arrabidaea samydoides</i> (Cham.) Sandwith	ten	x	x	x	-	-	-	-	x	-	-
<i>Arrabidaea selloi</i> (Spreng.) Sandwith	ten	-	x	-	x	x	-	x	x	-	x
<i>Arrabidaea triplinervia</i> (Mart. ex DC.) Baill.	ten	x	x	x	x	x	x	x	x	x	-
<i>Bignonia binata</i> Thunb.	ten	-	-	-	-	-	-	-	-	-	x
<i>Bignonia campanulata</i> Cham.	ten	-	x	-	-	x	-	x	x	x	x
<i>Clytostoma sciuripabulum</i> (K.Schum.) Bureau & K.Schum.	ten	-	x	-	-	-	-	-	-	-	x
<i>Cuspidaria convoluta</i> (Vell.) A.H.Gentry	ten	-	x	-	-	-	-	-	x	-	-
<i>Cuspidaria floribunda</i> (DC.) A.H.Gentry	ten	-	x	-	-	-	x	-	x	-	x
<i>Distictella elongata</i> (Vahl) Urb.	ten	-	-	-	-	-	-	-	-	-	x
<i>Distictella granulosa</i> (Klotzsch) Urb.	ten	-	-	-	-	-	-	-	-	x	-
<i>Distictella magnoliifolia</i> (Kunth) Sandwith	ten	-	-	-	-	x	-	-	-	-	-
<i>Fridericia speciosa</i> Mart.	ten	x	x	-	x	x	-	x	x	-	-
<i>Lundia obliqua</i> Sond.	ten	x	x	-	x	x	x	x	x	x	x
<i>Lundia virginalis</i> DC.	ten	-	-	-	-	-	-	-	x	-	-
<i>Macfadyena mollis</i> (Sond.) Seem.	ten	-	x	-	-	-	-	-	-	-	x
<i>Macfadyena unguis-cati</i> (L.) A.H.Gentry	ten	x	x	x	x	x	x	x	x	x	x
<i>Mansoa difficilis</i> (Cham.) Bureau & K.Schum.	ten	x	x	-	-	-	-	x	x	x	x
<i>Melloa quadrivalvis</i> (Jacq.) A.H.Gentry	ten	-	x	-	-	-	-	x	-	x	-
<i>Paragonia pyramidata</i> (Rich.) Bureau	ten	-	-	-	x	-	x	x	x	-	x
<i>Pithecoctenium crucigerum</i> (L.) A.H.Gentry	ten	-	x	-	-	-	-	x	x	x	x
<i>Pleonotoma stichadenia</i> K.Schum.	ten	-	-	x	-	-	-	-	-	-	-
<i>Pleonotoma tetraquetra</i> (Cham.) Bureau	ten	-	x	-	x	-	-	-	x	-	x
<i>Pyrostegia venusta</i> (Ker Gawl.) Miers	ten	x	x	x	x	-	x	x	x	x	x
<i>Stizophyllum perforatum</i> (Cham.) Miers	ten	-	x	x	-	x	x	x	x	x	x
<i>Tynanthus cognatus</i> (Cham.) Miers	ten	-	-	-	-	x	-	-	x	-	-
<i>Tynanthus elegans</i> Miers	ten	-	x	-	x	-	-	x	-	-	-
<i>Tynanthus fasciculatus</i> (Vell.) Miers	ten	-	x	-	-	-	-	-	x	-	x
<i>Tynanthus labiatus</i> (Cham.) Miers	ten	-	-	-	-	x	-	-	-	-	-
<i>Tynanthus micranthus</i> Corr.Mélo ex K.Schum.	ten	-	-	-	-	-	-	-	-	-	x
BORAGINACEAE											
<i>Cordia polycephala</i> (Lam.) I.M.Johnst.	scr	x	-	-	-	-	-	-	-	-	-
<i>Tournefortia bicolor</i> Sw.	scr	-	-	-	-	-	-	-	x	-	-
<i>Tournefortia elegans</i> Cham.	scr	-	x	-	-	-	-	-	-	-	-
<i>Tournefortia paniculata</i> Vent.	scr	-	x	-	-	-	x	-	-	-	-
<i>Tournefortia rubicunda</i> Salzm. ex DC.	scr	-	-	-	-	x	x	-	-	-	-
<i>Tournefortia villosa</i> Salzm. ex DC.	scr	-	-	-	-	-	-	-	x	-	-
CACTACEAE											
<i>Pereskia aculeata</i> Mill.	scr	-	x	-	-	x	-	x	x	x	x
CAMPANULACEAE											
<i>Centropogon argutus</i> E.Wimm.	scr	-	-	-	x	-	-	-	-	-	-
Cannabaceae											
<i>Celtis iguanaea</i> (Jacq.) Sarg.	scr	-	x	-	x	-	-	-	-	-	x
CELASTRACEAE											
<i>Anthodon decussatum</i> Ruiz & Pav.	ten	-	x	-	x	x	-	-	-	-	x
<i>Cheiloclinium cognatum</i> (Miers) A.C.Sm.	ten	-	-	-	x	-	-	-	-	-	-
<i>Hippocratea volubilis</i> L.	ten	x	x	x	-	x	x	x	x	x	-
<i>Peritassa calypsoides</i> (Cambess.) A.C.Sm.	scr	-	-	-	-	-	-	-	x	-	-
<i>Pristimera andina</i> Miers	twi	-	-	-	-	x	-	x	x	-	-
<i>Semialarium paniculatum</i> (Mart. ex Schult.) N.Hallé	scr	-	-	-	-	-	-	x	-	-	x

Table 2. Continued...

Family and species	Climb*	ANG	ARA	BH	PF	RC	RP	SC	SG	SV	VAS
COMBRETACEAE											
<i>Combretum discolor</i> Taub.	twi	-	-	-	x	-	-	-	-	-	-
COMMELINACEAE											
<i>Dichorisandra hexandra</i> (Aubl.) Standl.	scr	-	x	-	-	-	-	-	-	-	-
CONVOLVULACEAE											
<i>Bonamia burchellii</i> (Choisy) Hallier	twi	-	-	-	-	-	x	-	-	-	-
<i>Ipomoea acuminata</i> (Vahl) Roem. & Schult.	twi	-	-	-	-	-	-	-	x	-	-
<i>Ipomoea alba</i> L.	twi	-	-	-	-	-	-	-	-	-	x
<i>Ipomoea brasiliana</i> Meisn.	twi	-	x	-	-	-	-	-	-	-	-
<i>Ipomoea cairica</i> (L.) Sweet	twi	-	-	-	-	x	-	-	x	x	-
<i>Ipomoea coccinea</i> L.	twi	-	-	-	-	x	-	-	-	-	-
<i>Ipomoea hederifolia</i> L.	twi	-	x	-	x	-	x	-	x	-	x
<i>Ipomoea nil</i> (L.) Roth	twi	-	x	-	-	-	-	-	-	-	-
<i>Ipomoea pes-caprae</i> (L.) R.Br.	twi	-	-	-	-	-	-	-	-	-	x
<i>Ipomoea purpurea</i> (L.) Roth	twi	x	-	-	x	-	-	-	-	-	-
<i>Ipomoea quamoclit</i> L.	twi	-	x	-	-	-	-	-	x	-	x
<i>Ipomoea saopaulista</i> O'Donell	twi	-	x	-	-	x	-	-	-	-	-
<i>Ipomoea syringifolia</i> Meisn.	twi	-	x	-	-	-	-	-	-	-	-
<i>Ipomoea tubata</i> Nees	twi	-	-	-	-	-	-	-	-	-	x
<i>Jacquemontia ciliata</i> Sandwith	twi	-	x	-	-	-	-	-	-	-	-
<i>Jacquemontia densiflora</i> (Meisn.) Hallier f.	twi	-	-	-	x	-	x	-	-	-	-
<i>Jacquemontia evolvuloides</i> Meisn.	twi	-	-	-	-	-	x	-	-	-	-
<i>Jacquemontia velutina</i> Choisy	twi	-	-	-	-	-	x	-	-	-	-
<i>Merremia aegyptia</i> (L.) Urb.	twi	-	-	-	x	-	-	-	-	-	-
<i>Merremia cissoides</i> (Lam.) Hallier f.	twi	-	-	-	-	-	x	-	-	x	-
<i>Merremia macrocalyx</i> (Ruiz & Pav.) O'Donell	twi	x	x	x	x	x	x	-	x	-	x
CUCURBITACEAE											
<i>Cayaponia esvelina</i> (Silva Manso) Cogn.	ten	-	-	-	x	-	-	-	-	-	-
<i>Cayaponia tayuya</i> (Vell.) Cogn.	ten	-	-	-	x	x	x	-	-	-	-
<i>Ceratosanthes hilariana</i> Cogn.	ten	-	-	-	x	-	-	-	-	-	-
<i>Luffa cylindrica</i> M.Roem.	ten	-	-	-	-	-	-	-	-	-	x
<i>Melothria cucumis</i> Vell.	ten	-	-	-	-	-	-	-	-	x	x
<i>Melothria fluminensis</i> Gardner	ten	-	-	-	-	-	x	-	x	-	-
<i>Melothria warmingii</i> Cogn.	ten	-	-	-	-	-	x	-	-	-	-
<i>Momordica charantia</i> L.	ten	-	x	-	x	-	x	-	x	-	x
<i>Psiguria ternata</i> (M. Roem.) C.Jeffrey	ten	-	x	-	-	-	-	-	-	x	x
<i>Psiguria triphylla</i> (Miq.) C.Jeffrey	ten	-	-	-	x	-	x	-	-	-	-
<i>Psiguria warmingiana</i> (Cogn.) C.Jeffrey	ten	-	x	-	-	-	-	-	-	-	-
<i>Wilbrandia hibiscoides</i> Silva Manso	ten	-	-	-	-	-	-	-	x	-	-
<i>Wilbrandia longibracteata</i> Cogn.	ten	-	x	-	-	-	-	-	-	-	-
<i>Wilbrandia verticillata</i> Cogn.	ten	-	-	-	x	-	-	-	-	x	-
DILLENIACEAE											
<i>Davilla rugosa</i> Poir.	twi	-	x	x	-	-	-	x	x	-	x
<i>Doliocarpus dentatus</i> (Aubl.) Standl.	twi	-	-	x	-	-	x	-	-	-	-
<i>Tetracera oblongata</i> DC.	twi	x	-	-	-	-	-	-	-	-	-
<i>Tetracera willdenowiana</i> Steud.	twi	-	-	-	-	-	-	-	-	-	x
DIOSCOREACEAE											
<i>Dioscorea altissima</i> Lam.	twi	-	-	-	-	-	-	-	-	x	-
<i>Dioscorea dodecaneura</i> Vell.	twi	-	x	-	-	-	x	-	-	-	-
<i>Dioscorea macrocapsa</i> R.Knuth	twi	-	-	-	-	-	-	-	x	-	-
<i>Dioscorea macrocarpa</i> Uline	twi	-	-	-	-	-	-	-	x	-	-

Table 2. Continued...

Family and species	Climb*	ANG	ARA	BH	PF	RC	RP	SC	SG	SV	VAS
<i>Dioscorea monandra</i> Hauman	twi	-	-	-	X	-	-	-	-	-	X
<i>Dioscorea multiflora</i> Griseb.	twi	-	-	-	-	X	X	-	-	X	X
<i>Dioscorea pseudomacrocapsa</i> G.M.Barroso, E.F.Guim. & Sucre	twi	-	-	-	-	-	-	-	X	-	-
EUPHORBIACEAE											
<i>Bia alienata</i> Didr.	twi	-	X	-	-	-	-	-	X	-	-
<i>Dalechampia olfersiana</i> Müll.Arg.	twi	-	-	-	-	-	-	-	X	-	-
<i>Dalechampia pentaphylla</i> Lam.	twi	-	-	-	X	-	X	-	X	X	X
<i>Dalechampia scandens</i> L.	twi	-	X	-	-	-	X	-	-	-	-
<i>Dalechampia stipulacea</i> Müll.Arg.	twi	-	X	-	-	-	-	-	X	-	X
<i>Dalechampia triphylla</i> Lam.	twi	-	X	-	-	X	X	-	X	-	-
<i>Romanoa tamnoides</i> (A.Juss.) Radcl.-Sm.	twi	-	-	-	X	-	-	-	-	-	-
<i>Tragia volubilis</i> L.	twi	-	-	-	-	X	-	-	-	X	-
FABACEAE											
<i>Acacia adhaerens</i> Benth.	scr	-	-	-	-	-	-	-	-	X	-
<i>Acacia paniculata</i> Willd.	twi	-	X	X	-	-	-	X	-	-	X
<i>Acacia plumosa</i> Mart. ex Colla	scr	-	-	-	-	-	-	X	-	-	-
<i>Bauhinia leiopetala</i> Benth.	ten	-	-	X	-	-	-	-	-	-	-
<i>Bauhinia microstachya</i> (Raddi) J.F.Macbr.	ten	-	-	-	X	X	-	X	-	X	-
<i>Bauhinia siqueiraei</i> Ducke	ten	-	-	-	-	-	-	-	-	-	X
<i>Calopogonium caeruleum</i> (Benth.) C.Wright	twi	-	-	-	X	-	-	-	-	-	-
<i>Calopogonium mucunoides</i> Desv.	twi	-	-	-	X	-	X	-	-	-	-
<i>Camptosema ellipticum</i> (Desv.) Burkart	twi	-	-	-	-	-	X	-	-	-	-
<i>Canavalia grandiflora</i> Benth.	twi	-	-	-	-	X	X	-	-	-	-
<i>Canavalia palmeri</i> (Piper) Standl.	twi	-	-	-	X	-	-	-	-	-	-
<i>Canavalia parviflora</i> Benth.	twi	-	-	-	-	-	-	-	X	-	-
<i>Canavalia picta</i> Mart. ex Benth.	twi	-	-	-	-	-	-	-	X	X	-
<i>Centrosema arenarium</i> Benth.	twi	-	-	-	X	-	-	-	-	-	-
<i>Centrosema grandiflorum</i> Benth.	twi	-	-	-	X	-	-	-	-	-	-
<i>Centrosema pascuorum</i> Mart. ex Benth.	twi	-	-	-	X	-	-	-	-	-	-
<i>Centrosema plumieri</i> (Turpin ex Pers.) Benth.	twi	-	-	-	X	-	-	-	-	-	-
<i>Centrosema pubescens</i> Benth.	twi	X	-	-	X	-	X	-	-	-	-
<i>Centrosema sagittatum</i> (Humb. & Bonpl. ex Willd.) Brandegee	twi	-	X	-	X	X	X	-	-	-	-
<i>Centrosema venosum</i> Mart. ex Benth.	twi	-	-	-	X	-	-	-	-	-	-
<i>Centrosema vexillatum</i> Benth.	twi	-	-	-	X	-	-	-	-	-	-
<i>Centrosema virginianum</i> (L.) Benth.	twi	X	-	-	X	-	-	-	-	-	-
<i>Chaetocalyx brasiliensis</i> (Vogel) Benth.	twi	-	-	-	X	-	-	-	-	-	-
<i>Clitoria falcata</i> Lam.	twi	-	-	-	-	-	X	-	-	-	-
<i>Dalbergia frutescens</i> (Vell.) Britton	scr	-	-	-	-	-	-	X	X	-	-
<i>Dioclea latifolia</i> Benth.	twi	-	-	-	-	X	-	-	-	-	-
<i>Dioclea rufescens</i> Benth.	twi	-	-	-	-	-	-	-	X	-	-
<i>Dioclea violacea</i> Mart. ex Benth.	twi	-	-	-	-	-	-	-	X	-	-
<i>Dioclea virgata</i> (Rich.) Amshoff	twi	-	-	-	X	-	-	-	-	-	-
<i>Galactia striata</i> (Jacq.) Urb.	twi	-	-	-	-	-	-	-	-	X	-
<i>Machaerium dimorphandrum</i> Hoehne	scr	-	-	-	-	-	-	X	-	-	-
<i>Machaerium oblongifolium</i> Vogel	scr	-	X	-	X	-	-	-	-	-	X
<i>Machaerium uncinatum</i> (Vell.) Benth.	scr	-	-	X	-	-	-	-	-	-	-
<i>Macroptilium atropurpureum</i> (DC.) Urb.	twi	-	-	-	-	X	X	-	-	-	-
<i>Macroptilium bracteatum</i> (Nees & C. Mart.) Maréchal & Baudet	twi	-	-	-	-	-	X	-	-	-	-

Climbers from semideciduous forest of Southeastern Brazil

Table 2. Continued...

Family and species	Climb*	ANG	ARA	BH	PF	RC	RP	SC	SG	SV	VAS
<i>Mucuna pruriens</i> (L.) DC.	twi	-	-	-	X	-	X	-	-	-	-
<i>Phaseolus lunatus</i> L.	twi	-	-	-	X	-	-	-	-	-	-
<i>Rhynchosia phaseoloides</i> (Sw.) DC.	twi	-	-	-	X	X	X	-	X	-	-
<i>Teramnus uncinatus</i> (L.) Sw.	twi	-	-	-	-	-	X	-	-	X	-
<i>Vigna candida</i> (Vell.) Maréchal, Mascherpa & Stainier	twi	-	-	-	-	-	-	-	X	X	-
<i>Vigna caracalla</i> (L.) Verdc.	twi	-	-	-	X	-	-	-	-	-	-
<i>Vigna peduncularis</i> (Kunth) Fawc. & Rendle	twi	-	-	-	X	-	-	-	-	-	-
LOGANIACEAE											
<i>Strychnos brasiliensis</i> (Spreng.) Mart.	scr	-	-	X	-	-	-	-	-	-	-
MALPIGHIACEAE											
<i>Banisteriopsis adenopoda</i> (A.Juss.) B.Gates	twi	X	X	X	-	-	-	-	X	-	X
<i>Banisteriopsis anisandra</i> (A.Juss.) B.Gates	twi	-	-	X	-	-	-	-	X	X	-
<i>Banisteriopsis argyrophylla</i> (A.Juss.) B.Gates	twi	-	-	X	-	-	X	-	X	-	-
<i>Banisteriopsis lutea</i> (Griseb.) Cuatrec.	twi	-	X	-	X	-	-	-	X	-	X
<i>Banisteriopsis muricata</i> (Cav.) Cuatrec.	twi	-	-	-	-	X	X	-	X	-	-
<i>Banisteriopsis nitrosiodora</i> (Griseb.) O'Donell & Lourteig	twi	-	-	-	-	-	X	-	-	-	-
<i>Banisteriopsis oxyclada</i> (A.Juss.) B.Gates	twi	X	X	X	X	-	X	-	-	X	X
<i>Banisteriopsis pubipetala</i> (A.Juss.) Cuatrec.	twi	-	-	X	-	-	X	-	X	-	-
<i>Dicella bracteosa</i> (A.Juss.) Griseb.	twi	-	X	-	-	X	-	-	X	X	X
<i>Heteropterys aceroides</i> Griseb.	twi	-	-	-	X	-	-	-	X	-	-
<i>Heteropterys acutifolia</i> A.Juss.	twi	-	-	-	-	-	-	-	X	-	-
<i>Heteropterys argyrophaea</i> A.Juss.	twi	-	-	-	X	-	-	-	-	-	-
<i>Heteropterys bicolor</i> A.Juss.	twi	-	-	-	-	-	-	-	X	-	-
<i>Heteropterys byrsonimifolia</i> A.Juss.	twi	-	X	-	-	-	-	-	-	-	-
<i>Heteropterys campestris</i> A.Juss.	twi	-	-	X	-	-	-	-	-	-	-
<i>Heteropterys dumetorum</i> (Griseb.) Nied.	twi	-	-	-	X	-	X	-	-	-	-
<i>Heteropterys escalloniifolia</i> A.Juss.	twi	-	-	X	X	-	-	-	-	-	-
<i>Heteropterys intermedia</i> (A.Juss.) Griseb.	twi	-	X	-	-	-	-	-	-	-	-
<i>Heteropterys pauciflora</i> A.Juss.	twi	-	-	-	-	-	-	X	X	-	X
<i>Janusia guaranitica</i> (A.St.-Hil.) A.Juss.	twi	-	-	-	-	-	X	-	-	-	-
<i>Mascagnia anisopetala</i> (A.Juss.) Griseb.	twi	-	-	-	-	-	-	-	X	X	X
<i>Mascagnia chlorocarpa</i> (A.Juss.) Griseb.	twi	-	-	-	X	-	X	X	-	-	X
<i>Mascagnia cordifolia</i> (A.Juss.) Griseb.	twi	-	X	X	-	X	X	-	X	-	X
<i>Mascagnia lasiandra</i> (A.Juss.) Nied.	twi	-	X	-	-	-	-	-	-	-	-
<i>Mascagnia sepium</i> (A.Juss.) Griseb.	twi	-	-	-	-	-	-	-	X	-	-
<i>Peixotoa paludosa</i> Turcz.	twi	-	-	X	-	-	-	-	-	-	-
<i>Peixotoa reticulata</i> Griseb.	twi	-	-	-	-	-	X	-	-	-	-
<i>Stigmaphyllon lalandianum</i> A.Juss.	twi	-	X	-	-	-	-	X	X	-	X
<i>Stigmaphyllon puberulum</i> Griseb.	twi	-	-	-	X	-	-	-	-	-	-
<i>Stigmaphyllon tomentosum</i> A.Juss.	twi	-	-	-	-	-	-	-	-	-	X
<i>Tetrapteryx chamaecerasifolia</i> A.Juss.	twi	-	-	X	-	-	-	-	-	-	-
<i>Tetrapteryx guilleminiana</i> A.Juss.	twi	-	-	-	-	-	-	X	X	X	X
<i>Tetrapteryx multiglandulosa</i> A.Juss.	twi	X	-	-	-	-	-	-	-	-	X
<i>Tetrapteryx phlomoides</i> (Spreng.) Nied.	twi	-	X	-	-	-	-	-	-	-	-
<i>Tetrapteryx ramiflora</i> A.Juss.	twi	-	-	-	-	-	-	-	-	-	X
<i>Tetrapteryx xylosteifolia</i> A.Juss.	twi	-	-	-	-	-	-	-	X	-	-
MALVACEAE											
<i>Byttneria australis</i> A.St.-Hil.	scr	-	X	-	-	-	-	-	-	-	-
<i>Byttneria catalpifolia</i> Jacq.	scr	-	X	-	-	-	-	-	X	-	X

Table 2. Continued...

Family and species	Climb*	ANG	ARA	BH	PF	RC	RP	SC	SG	SV	VAS
<i>Byttneria laevigata</i> Schott ex Pohl	scr	-	-	X	-	-	-	-	-	-	-
MARCRAVIACEAE											
<i>Marcgravia polyantha</i> Delpino	scr	-	-	-	-	X	-	-	-	-	-
MENISPERMACEAE											
<i>Cissampelos andromorpha</i> DC.	twi	-	X	-	X	-	-	-	-	-	-
<i>Cissampelos glaberrima</i> A.St.-Hil.	twi	-	X	-	X	X	X	-	X	X	-
<i>Cissampelos pareira</i> L.	twi	-	X	-	X	-	X	-	-	-	X
<i>Odontocarya acuparata</i> Miers	twi	-	X	-	-	-	-	-	-	-	-
NYCTAGINACEAE											
<i>Bougainvillea spectabilis</i> Willd.	scr	-	-	X	-	-	-	-	-	-	-
<i>Pisonia aculeata</i> L.	scr	-	-	-	-	-	-	-	X	-	-
PASSIFLORACEAE											
<i>Passiflora amethystina</i> J.C.Mikan	ten	-	X	-	X	-	-	-	X	-	-
<i>Passiflora capsularis</i> L.	ten	X	X	-	-	X	-	-	-	X	-
<i>Passiflora cincinnata</i> Mast.	ten	-	-	-	-	-	X	-	-	-	-
<i>Passiflora foetida</i> L.	ten	-	-	-	-	X	X	-	-	-	-
<i>Passiflora galbana</i> Mast.	ten	-	-	X	-	-	-	-	-	-	-
<i>Passiflora miersii</i> Mart.	ten	-	-	-	-	-	X	-	X	-	-
<i>Passiflora sidiifolia</i> M.Roem.	ten	-	-	-	-	X	-	-	-	X	-
<i>Passiflora suberosa</i> L.	ten	-	-	-	-	X	X	-	X	X	-
<i>Passiflora tricuspis</i> Mast.	ten	-	-	-	X	-	X	-	-	-	-
<i>Passiflora vespertilio</i> L.	ten	-	-	-	-	-	-	-	X	-	-
PIPERACEAE											
<i>Sarcorhachis obtusa</i> (Miq.) Trel.	twi	-	-	-	-	-	-	-	-	X	-
POLYGALACEAE											
<i>Bredemeyera floribunda</i> Willd.	scr	X	X	X	X	-	X	-	-	-	-
<i>Diclidanthera laurifolia</i> Mart.	twi	-	X	-	-	X	-	-	X	-	-
<i>Securidaca sellowiana</i> Klotzsch	ten	X	-	-	X	-	-	-	-	-	-
RANUNCULACEAE											
<i>Clematis dioica</i> L.	twi	X	X	X	-	X	-	-	X	X	X
<i>Gouania latifolia</i> Reissek	ten	-	X	-	-	-	-	-	X	-	-
<i>Gouania ulmifolia</i> Hook. & Arn.	ten	X	-	-	-	-	X	-	-	-	-
<i>Gouania virgata</i> Reissek	ten	-	X	-	X	X	X	-	X	X	X
ROSACEAE											
<i>Rubus brasiliensis</i> Mart.	scr	-	-	-	-	-	-	-	-	X	-
<i>Rubus urticifolius</i> Poir.	scr	-	X	-	-	-	-	-	-	-	-
RUBIACEAE											
<i>Chiococca alba</i> (L.) Hitchc.	scr	-	X	X	X	X	X	-	X	X	-
<i>Coccocypselum lanceolatum</i> (Ruiz & Pav.) Pers.	scr	X	-	-	-	-	-	-	-	-	-
<i>Coutarea hexandra</i> (Jacq.) K.Schum.	scr	-	-	-	-	X	-	-	-	-	-
<i>Manettia cordifolia</i> Mart.	twi	X	X	-	X	X	X	-	X	-	X
<i>Manettia luteorubra</i> (Vell.) Benth.	twi	-	-	-	-	-	-	-	-	-	X
SAPINDACEAE											
<i>Cardiospermum corindum</i> L.	ten	-	-	-	-	-	X	-	-	-	-
<i>Cardiospermum grandiflorum</i> Sw.	ten	-	X	-	X	-	X	-	X	X	-
<i>Paullinia elegans</i> Cambess.	ten	-	X	-	-	-	X	-	-	-	X
<i>Paullinia firma</i> Radlk.	ten	-	-	-	X	-	-	-	-	-	-
<i>Paullinia meliifolia</i> Juss.	ten	X	-	-	-	-	-	-	-	X	X
<i>Paullinia pinnata</i> L.	ten	-	-	-	-	-	-	-	X	-	-
<i>Paullinia rhomboidea</i> Radlk.	ten	-	-	-	-	X	-	-	X	-	X
<i>Paullinia seminuda</i> Radlk.	ten	-	-	-	-	X	-	-	-	-	-

Climbers from semideciduous forest of Southeastern Brazil

Table 2. Continued...

Family and species	Climb*	ANG	ARA	BH	PF	RC	RP	SC	SG	SV	VAS
<i>Paullinia spicata</i> Benth.	ten	-	X	-	-	X	X	-	-	-	X
<i>Paullinia trigonia</i> Vell.	ten	-	-	-	-	-	-	-	-	X	-
<i>Serjania caracasana</i> (Jacq.) Willd.	ten	-	X	-	X	X	X	X	X	X	X
<i>Serjania communis</i> Cambess.	ten	-	-	-	X	-	-	-	X	X	-
<i>Serjania elegans</i> Cambess.	ten	X	-	-	-	-	-	-	-	-	-
<i>Serjania fuscifolia</i> Radlk.	ten	-	X	-	-	X	-	-	-	-	X
<i>Serjania glabrata</i> Kunth.	ten	-	X	-	-	-	-	-	-	-	-
<i>Serjania hebecarpa</i> Benth.	ten	-	-	-	X	-	X	-	X	-	-
<i>Serjania laruotteana</i> Cambess.	ten	-	X	-	X	X	X	X	-	-	X
<i>Serjania lethalis</i> A.St.-Hil.	ten	-	X	X	X	X	X	-	-	-	X
<i>Serjania meridionalis</i> Cambess.	ten	X	X	-	-	X	X	-	-	-	X
<i>Serjania multiflora</i> Cambess.	ten	X	-	-	-	-	X	-	X	X	-
<i>Serjania paradoxa</i> Radlk.	ten	-	-	-	-	-	-	-	-	-	X
<i>Serjania perulacea</i> Radlk.	ten	-	-	-	-	-	-	-	-	X	-
<i>Serjania reticulata</i> Cambess.	ten	X	X	-	-	-	-	-	X	-	-
<i>Serjania tristis</i> Radlk.	ten	-	-	-	-	-	X	-	-	-	-
<i>Thinouia mucronata</i> Radlk.	ten	-	-	-	-	-	-	X	X	-	-
<i>Urvillea laevis</i> Radlk.	ten	-	X	-	X	X	X	X	X	X	X
<i>Urvillea ulmacea</i> Kunth	ten	X	X	-	-	X	X	X	X	X	X
<i>Urvillea uniloba</i> Radlk.	ten	-	-	-	X	X	-	-	-	-	-
SMILACACEAE											
<i>Smilax brasiliensis</i> Spreng.	ten	-	-	-	-	-	-	-	X	-	-
<i>Smilax campestris</i> Griseb.	ten	X	-	-	-	X	X	-	X	-	-
<i>Smilax elastica</i> Griseb.	ten	-	X	-	-	-	-	-	X	-	-
<i>Smilax fluminensis</i> Steud.	ten	-	X	-	-	-	X	-	X	X	-
<i>Smilax polyantha</i> Griseb.	ten	-	-	-	-	-	X	-	-	-	-
<i>Smilax rufescens</i> Griseb.	ten	-	X	-	-	-	-	-	-	-	-
<i>Smilax spicata</i> Vell.	ten	X	-	-	-	-	-	-	-	-	-
SOLANACEAE											
<i>Solanum alternatopinnatum</i> Steud.	scr	-	X	-	X	-	-	-	-	-	-
<i>Solanum concinnum</i> Sendtn.	scr	-	-	-	-	-	-	-	X	-	-
<i>Solanum pabstii</i> L.B.Sm. & Downs	scr	-	-	-	-	-	-	-	X	-	-
<i>Solanum swartzianum</i> Roem. & Schult.	scr	-	X	-	-	-	-	-	-	-	-
<i>Solanum wendlandii</i> Hook.f.	scr	-	-	-	-	-	-	-	X	-	-
TRIGONIACEAE											
<i>Trigonia nivea</i> Cambess.	twi	X	-	-	-	X	-	-	X	X	-
VERBENACEAE											
<i>Aloysia virgata</i> (Ruiz & Pav.) Pers.	scr	-	X	-	-	-	-	-	-	-	-
<i>Petrea volubilis</i> L.	scr	X	X	-	-	X	X	-	X	X	-
VIOLACEAE											
<i>Anchietea pyrifolia</i> A.St.-Hil.	twi	X	-	X	-	-	-	-	-	X	-
<i>Anchietea salutaris</i> A.St.-Hil.	twi	-	-	-	-	-	-	-	X	-	-
VITACEAE											
<i>Cissus campestris</i> (Baker) Planch.	ten	-	-	-	X	-	-	-	-	-	-
<i>Cissus erosa</i> Rich.	ten	-	-	-	X	-	X	-	-	-	-
<i>Cissus serroniana</i> (Glaz.) Lombardi	ten	-	X	-	-	-	-	-	-	-	-
<i>Cissus simsiana</i> Schult. & Schult.f.	ten	-	-	-	-	-	-	-	-	X	-
<i>Cissus subrhomboidea</i> (Baker) Planch.	ten	-	-	-	-	-	X	-	-	-	-
<i>Cissus sulcicaulis</i> (Baker) Planch.	ten	-	X	-	-	-	-	-	-	-	-
<i>Cissus verticillata</i> (L.) Nicolson & C.E.Jarvis	ten	-	X	-	-	X	X	-	X	-	-

Table 3. Characteristics of liana species composition in ten semideciduous forest sites of Southeastern Brazil. Sites legend as in Table 1 and Figure 1.**Tabela 3.** Características da composição florística de lianas nos dez fragmentos de floresta estacional semidecidual estudados no sudeste do Brasil. Siglas dos fragmentos como na Figura 1 e Tabela 1.

	Forest sites										Total
	ANG	ARA	BH	PF	RC	RP	SC	SG	SV	VAS	
Richness ^a											
Liana species	48	138	39	96	79	104	39	135	69	94	355
Families	22	32	17	23	27	24	8	32	27	20	43
Exclusive species	9	34	13	25	7	22	3	35	11	16	175
Tree species ^b	188	162	-	87	175	-	109	250	202	-	-
Richest families ^{a,c}											
Bignoniaceae	9	29	9	15	16	13	18	22	12	24	45
Fabaceae	2	3	3	21	6	11	5	7	6	3	42
Malpighiaceae	3	10	10	8	3	10	4	17	5	13	36
Asteraceae	6	17	3	1	5	3	0	12	7	7	31
Apocynaceae	1	9	1	7	6	11	2	11	1	7	29
Climbing mechanism ^a											
Tendrils climbers	21	57	13	39	38	45	25	48	32	43	121
Twining	18	56	19	49	32	53	9	70	28	41	178
Scramblers	9	25	7	8	9	6	5	17	9	10	56

^a = number of species; ^b = Number of tree species for referred site compiled from ANG: Torres (1989); ARA: Pagano & Leitão Filho (1987); PF: Rezende et al. (2007); RC: Santos and Kinoshita (2003); SC: Hora (1999); SG: Morellato (1995); ^c = rankof the five richest family when considering all the sites pulled together, and the number of species of these families occurring in each forest site; - = non available information.

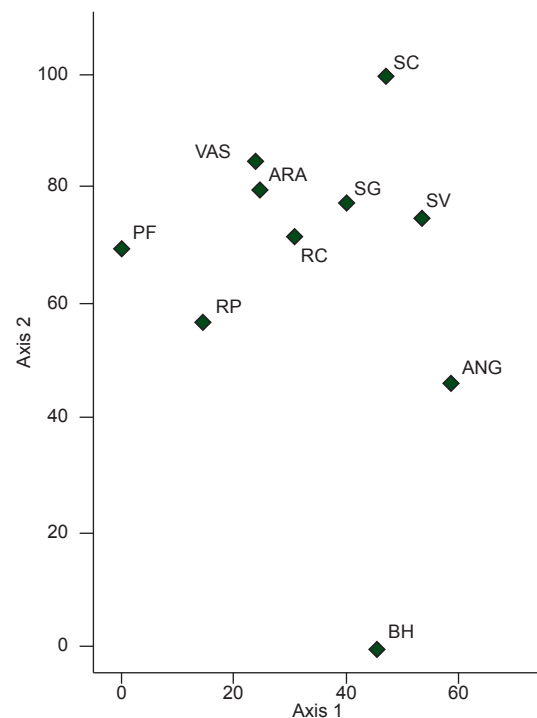
^a = número de espécies; ^b = número de espécies arbóreas encontradas no referido fragmento compilado de ANG: Torres (1989); ARA: Pagano & Leitão Filho (1987); PF: Rezende et al. (2007); RC: Santos & Kinoshita (2003); SC: Hora (1999); SG: Morellato (1995); ^c = ranking das famílias mais ricas quando considerado o total de espécies encontradas em todos os fragmentos e o número de espécies dessas famílias em cada uma das áreas; - = informação não disponível.

Cucurbitaceae (14), Passifloraceae (10), and Euphorbiaceae (8). These families contributed to 74.4% of the total species richness, whereas another 20 families were represented by only one or two species. The set of richest families varied little between the analysed forest sites (Table 3).

The contribution of the climbing species to the total number of wood species recorded on the examined forests ranged from 20.3% to 52.5% (Table 3). The exclusive species i.e., those occurring in only one forest site, accounted for 49.3% (175 species) of the total recorded (Table 3), 17.2% were present in two sites and 11% of the species occurred in three sites. Only one species, *Macfadyena unguis-cati* (L.) A.H.Gentry was common to all the studied forests.

The commonest climbing method within forest sites were main stem or branch twining, accounting for 178 species or 50.1% of the total recorded, followed by tendril climbing (121 species, 34.1%), and scrambling (56 species, 15.8%). Comparing the mean proportion of species ($\pm 95\%$ confidence interval) in climbing mechanisms among forest sites, we found that 12.7% (+3.3 –3.01%) were scramblers, 44.1% (+6.1 –6.0%) were tendril climbers, and 42.7% (+6.5 –6.4%) were twining. The proportions of species in climbing mechanisms varied little among forest sites (Table 3). The highest proportion of twining was observed at Santa Genebra (SG) and the lowest at São Carlos (SC) (Table 3).

The mean (\pm SE) similarity among forest sites was 30.2% (+1.45 –1.47%), ranging from 14.8 to 52.6%. The NMS ordination of the ten forest sites based on presence/absence of climbing species showed a cluster including 9 forest sites (Figure 2). Only Belo Horizonte (BH) forest site appeared isolated from the others. The NMS ordination represented 81.4% of the variation in the dataset, with 59.2% loaded on axis 1 and 22.2% on axis 2.

**Figure 2.** Two-dimensional MNS plot for the 10 semideciduous forest sites of southeastern Brazil. Sites legend as in Table 1 and Figure 1.**Figura 2.** Ordenação bidimensional MNS obtida para os dez fragmentos de floresta estacional semidecidual estudados no sudeste do Brasil. Siglas dos fragmentos como na Figura 1 e Tabela 1.

Discussion

Climbing species composition is described to be a function of stand age, geographical location, altitude and disturbance (DeWalt et al. 2000, Laurance et al. 2001, Parthasarathy et al. 2004). In our ordination analysis the geographical location appears to play a major role on the observed similarity among forests, since the only forests plotted separated from all others (BH) is also the one located farthest apart geographically. Our results corroborate those found by Rezende & Ranga 2005, which compared some of the floristic inventories (including BH), using Jaccard index and clustering analysis UPGMA.

The list of the most speciose families on forest sites confirms partially Gentry's (1991) predictions that the communities of climbers in the neotropics may vary little from one forest site to another, in terms of floristic composition of families, with Bignoniaceae and/or Fabaceae almost always among the richest families. Bignoniaceae was the richest family in nine out of ten forest sites examined in the present study. Fabaceae was the second richest family when considering all the sites together, but it did not figure within the five richest families in every forest site, for instance in Araras (ARA) and Vassununga (VAS) this family presented only three species, figuring in tenth and eighth place in the ranking of the richest families, respectively. Gentry (1995) suggested that the Bignoniaceae tend to be the richest family in climbing species in neotropical forests with a strong dry season, such as the semideciduous forest of Southeastern Brazil. This family is the fifth richest family in climbing species in the neotropics (Gentry 1991). The largest Bignoniaceae tribe, Bignonieae, includes nearly half of the genera (47 of 104) and more than one third of the family's species (360 of 860) (Lohmann 2006). The entire tribe is composed exclusively or predominantly by tendrillate lianas and most of them are represented within Brazilian limits, having probably evolved there (Gentry 1980). It is possible that these factors are correlated with the high diversity of family Bignoniaceae on studied sites.

The proportion of species comprised by the ten richest families (74.4%) is in accordance to what has been reported for the neotropics (64-69%; Gentry 1991, DeWalt et al. 2000), and again confirms Gentry (1991) predictions.

Twining is frequently cited as the most common climbing method within liana communities, being the most species diverse and also the most abundant (Putz & Chai 1987, Hegarty & Caballé 1991, DeWalt et al. 2000, Laurance et al. 2001, Parthasarathy et al. 2004). Our results agreed with this when considering the whole pool of species, but when analyzing forest sites separately, we found that tendrill species predominated over twiners in six locations. Campanello et al. (2007) also found tendrill climbers as a majority of species in an Atlantic Forest patch in Argentina. The high proportion of tendrill climbers in most of the studied sites is also an effect of the large amount of Bignoniaceae species in the data, since most of them are tendrillate species. Nonetheless, the supremacy of twiners and tendrillate species over scrambler species was found in all the studied sites and in most tropical forests elsewhere (Hegarty & Caballé 1991). The absence of obviously specialized climbing organs in scrambler species is pointed out by Gentry (1991) as the possible reason for their relatively lower success than twiners and tendrillate species. According to Putz (1984), the main factor influencing the richness and abundance of different climbing mechanisms seems to be the support availability. Twiners can climb larger supports than do tendrill climbers. Thus, forests with high density of small stems, characteristic of the earlier successional stages and gaps, tend to present a larger proportion of tendrill climbers, while in mature forests twiners may be more successful due to their ability to climb larger supports (DeWalt et al. 2000, Laurance et al. 2001). Nonetheless, further investigation with

appropriate designed experiments is required to address this question properly in semideciduous forests.

Climbing species contributed for up to 52.5% of the total wood plant species recorded on the studied sites. According to Gentry & Dodson (1987) lianas can account for up to 25% of wood stem diversity on tropical forests. Thus, the climbers' contribution to the total wood species richness in some sites, such as RC, PF, and ARA, can be considered high. As stated by Udulutsch et al. (2004), it is evident that climbers may represent a great proportion of the species richness in semideciduous forests of Southeastern Brazil, which clearly enforces the need for further investigations and the conservation value of these forest fragments.

Comparisons among forest inventories differing in sampling methods are always difficult and should be interpreted with caution. Therefore, further investigation, especially with the inclusion of quantitative data, is strongly recommended to enhance the knowledge on lianas communities in semideciduous forests of Southeastern Brazil. Nevertheless, the high liana species contribution to the total wood plant richness found here, allied to the observation that almost half of species were present in just one site (49.3%), and the low mean similarity between analyzed forests indicates the importance of liana communities to the plant diversity in semideciduous forests of Southeastern Brazil. Climbing species appeared to compose unique floras in each forest site, enhancing the regional diversity and the conservation value of forest remnants.

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