

Cactaceae from Reserva Biológica do Alto da Serra de Paranapiacaba, Santo André, São Paulo State, Brazil

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ABSTRACT - (Cactaceae from Reserva Biológica do Alto da Serra de Paranapiacaba, Santo André, São Paulo State, Brazil). A taxonomic treatment of Cactaceae species from Paranapiacaba Biological Reserve and surroundings is presented. An identification key and descriptions of 14 species, with notes regarding their ecology and conservation are included. The species identified were: *Hatiora salicornioides* (Haw.) Britton & Rose, *Lepismium houlettianum* (Lem.) Barthlott., *Rhipsalis baccifera* subsp. *shaferi* (Britton & Rose) Barthlott & N.P. Taylor, *R. burchelli* Britton & Rose, *R. campos-portoana* Loefgr., *R. elliptica* G. Lindb. ex K. Schum., *R. floccosa* Salm-Dyck ex Pfeiff., *R. juengeri* Barthlott & Taylor, *R. neves-armondii* K. Schum., *R. olivifera* N.P. Taylor & Zappi, *R. paradoxa* (Salm-Dyck ex Pfeiff.) Salm-Dyck, *R. pulchra* Loefgr., *R. puniceodiscus* G. Lindb. and *R. teres* (Vell.) Steud.

Keywords: Atlantic Forest, conservation, ecology, taxonomy

RESUMO - (Cactaceae da Reserva Biológica do Alto da Serra de Paranapiacaba, Santo André, SP, Brasil). Este trabalho apresenta o tratamento taxonômico das espécies de Cactaceae da Reserva Biológica do Alto da Serra de Paranapiacaba e arredores. Incluíram-se uma chave de identificação e descrições de 14 espécies com notas a respeito de sua ecologia e conservação. As espécies identificadas foram: *Hatiora salicornioides* (Haw.) Britton & Rose, *Lepismium houlettianum* (Lem.) Barthlott., *Rhipsalis baccifera* subsp. *shaferi* (Britton & Rose) Barthlott & N.P. Taylor, *R. burchelli* Britton & Rose, *R. campos-portoana* Loefgr., *R. elliptica* G. Lindb. ex K. Schum., *R. floccosa* Salm-Dyck ex Pfeiff., *R. juengeri* Barthlott & Taylor, *R. neves-armondii* K. Schum., *R. olivifera* N.P. Taylor & Zappi, *R. paradoxa* (Salm-Dyck ex Pfeiff.) Salm-Dyck, *R. pulchra* Loefgr., *R. puniceodiscus* G. Lindb. e *R. teres* (Vell.) Steud.

Palavras-chave: conservação, ecologia, Mata Atlântica, taxonomia

Introduction

Cactaceae is a neotropical family with 124 genera and 1,438 species easily recognized by its spiny stems, with long differentiated shoots producing photosynthetic leaves and short shoots (areoles) with a spine or spine cluster (Hunt *et al.* 2006, Zappi *et al.* 2007, Calvente 2010). About 10% of Cactaceae species are epiphytes adapted to more humid regions, distributed from Mexico to Argentina and the centers of diversity of the family are Mexico, Brazil east coast and the Andes (Hunt *et al.* 2006, Zappi *et al.* 2007, Calvente 2010). According to Zappi *et al.* (2010), there are 233 species of Cactaceae in Brazil, distributed in 37 genera. Species of *Rhipsalis* may be found

in African and Asian continents (Zappi *et al.* 2007, Calvente 2010).

Brazilian east coast rainforests hold almost 30% of Cactaceae species, with 74% of them endemic to the Atlantic Forest, one of the most threatened tropical rainforests in the world (Myers *et al.* 2000, Calvente 2010). Its vegetation consists of ombrophilous, dense and evergreen tropical rainforest, currently reduced to only 7.5% of its original size, with forest remnants distributed along disconnected areas, with only 35.9% legally protected (Myers *et al.* 2000, Coutinho 2009).

There are 13 genera and 43 species of Cactaceae in Atlantic Forest of São Paulo State, being *Rhipsalis* the most diverse genera with 22 species (Zappi *et al.* 2007). In a survey conducted in Rio de Janeiro

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State, Calvente *et al.* (2005) showed the occurrence of 45 species, the genus *Rhipsalis* being the most representative, with 23 species. Lombardi (1991) also conducted a survey in São Paulo State and described 16 species of *Rhipsalis* with cylindrical cladodes. Lately, Lombardi (1995) repeated it for the *Rhipsalis* with flattened cladodes describing six species. In the metropolitan region of São Paulo City there are important remnants of Atlantic Forest as Reserva Biológica do Alto da Serra de Paranapiacaba (Santo André), Reserva Floestal do Morro Grande (Cotia) and Reserva do Curucutu (São Paulo).

Reserva Biológica do Alto da Serra de Paranapiacaba (PBR) is located at Paranapiacaba district, near the Industrial Center of Cubatão, which is one of the most polluted industrial hub in the world, and has conspicuously influenced PBR's vegetation with air pollution in the past.

According to Phanerogamic Flora of Paranapiacaba Biological Reserve (Kirizawa *et al.* 2009) there are seven species of Cactaceae in PBR, five belonging to genus *Rhipsalis*: *R. campos-portoana* Loefgr., *R. elliptica* G. Lindb. ex K. Schum., *R. pulvinigera* (G. Lindb.) Barthlott & N.P. Taylor (= *R. floccosa* subsp. *pulvinigera* (G. Lindb.) Barthlott & N.P. Taylor), *R. pucineodiscus* G. Lindb., and *R. teres* (Vell.) Steud. The other two species reported are *Lepismium houlettianum* (Lem.) Barthlott. and *Hattoria salicornioides* (Haw.) Britton & Rose. However, Zappi *et al.* (2007) cite several other species of Cactaceae for the Atlantic Forest of São Paulo, which are not listed in PBR's checklist.

A compelling argument in favor of cactus conservation is their economic potential, if used sustainably, both at the local level and for international trade (Taylor & Zappi 2004). Cactaceae species are highly appreciated as ornamental plants, and attracts numerous collectors throughout the world, decreasing some natural cacti populations. These and other human influences as pollution caused the decline of cacti endemic species habitats, making the studies on the taxonomy and evolutionary biology an emergent priority in this group (Calvente 2010). A floristic study on Cactaceae species from PBR seems reasonable, since its real diversity is not known. Zappi *et al.* (2007), for instance, cite several species of Cactaceae to the Atlantic Forest of São Paulo that are not listed to PBR's checklist. Besides, the occurrence of certain species may help to understand the influence of air pollution in this area, since epiphytic species

of Cactaceae are efficient indicators of atmospheric pollution, due to absorption of chemical elements from the atmosphere (Elias *et al.* 2006).

Thus, the goal of this study was to conduct a floristic study of Cactaceae species from Reserva Biológica do Alto da Serra de Paranapiacaba, including its geographical boundaries in Vale da Fumaça and Vale do Rio Mogi.

Material and methods

The District of Paranapiacaba belongs to the municipality of Santo André (São Paulo Metropolitan Region) and currently comprises three legally protected areas: Reserva Biológica do Alto da Serra de Paranapiacaba (PBR), with restricted access, Parque Natural de Paranapiacaba, under the responsibility of Santo André City, and a portion of Parque Estadual da Serra do Mar, under the responsibility of Instituto Florestal. As stated by the Brazilian System of Conservation Units (Ministério do Meio Ambiente 2006), a Biological Reserve is a protected area of restricted access, aiming the biological conservation and scientific research. Reserva Biológica do Alto da Serra de Paranapiacaba was created in 1909, belongs to Instituto de Botânica and function as a biological laboratory to study plants and animals and for environmental education (Lopes *et al.* 2009). The main limits of PBR are SP-122 highway, part of the trail of Vale do Rio Mogi and part of the trail of Vale da Fumaça. These regions have well preserved forests which boards PBR's area and general information about biotic and abiotic factors can be found in Lopes *et al.* (2009a).

Specimens were collected from August 2008 to August 2009. Plants were collected in areas near the main trails of PBR as well as the bordering trails in Vale da Fumaça and Vale do Rio Mogi. All specimens were deposited in UNIP Herbarium. Paranapiacaba Biological Reserve Phanerogamic Flora housed at SP and SPF herbaria were also analyzed. In case of available material from the studied area deposited in the SP herbarium lacked flowers or fruits additional collections for *Lepismium houlettianum* (Lem.) Barthlott, *Rhipsalis baccifera* subsp. *shaferi* (Britton & Rose) Barthlott & N. P. Taylor, *R. burchelli* Britton & Rose, *R. campos-portoana* Loefgr., *R. floccosa* Salm-Dyck ex Pfeiff., *R. juengeri* Barthlott & N.P. Taylor, *R. olivifera* N.P. Taylor & Zappi, *R. paradoxa* (Salm-Dick ex Pfeiff.) Salm-Dick,

R. pulchra Loefgr. and *R. puniceodiscus* G. Lindb. were analyzed.

Number of seeds per fruit were described. However the collections of *Rhipsalis paradoxa* (Salm-Dick ex Pfeiff.) Salm-Dick had no fertile material available for counting seeds. The collections

of *Rhipsalis neves-armondii* K. Schum. also did not have a minimum number of fruits for analysis. Therefore, the fruits were not taken aiming to preserve the collections. Calvente *et al.* (2005) indicates the importance of recording characteristics such as color of flowers and fruits in the collections as they are lost after herborization.

Results and Discussion

Key to Cactaceae from Reserva Biológica do Alto da Serra de Paranapiacaba

1. Plants basicaulous or caulous (never acrocaulous); cladodes partially flattened with cylindrical and ligneous base 2. *L. houlettianum*
1. Plants acrocaulous or subacrocaulous (except basal cladodes); cladodes totally cylindrical, totally flattened or clavated
 2. Cladodes with clavated apex; plants acrocaulous 1. *H. salicornioides*
 2. Cladodes cylindrical or flattened; plants acrocaulous or subacrocaulous
 3. Cladodes flattened
 4. Cladodes 2-4-branched; ripe fruits pink 6. *R. elliptica*
 4. Cladodes 2-branched; ripe fruits light green 10. *R. olivifera*
 3. Cladodes cylindrical
 5. Cladodes ribbed and winged 11. *R. paradoxa*
 5. Cladodes smooth, unribbed and unwinged
 6. Pericarpel immersed
 7. Fruits intense yellow; perianth segments ca. 11; stamens ca. 38 13. *R. puniceodiscus*
 7. Fruits white, deep pink or slightly purplish; perianth segments 7-8; stamens 68-82
 8. Cladodes 3-6 mm diameter, pendulous; flowers saucer shaped 7. *R. floccosa*
 8. Cladodes up to 3 mm diameter, suberect; flowers campanulate 9. *R. neves-armondii*
 6. Pericarpel emerged
 9. Flowers campanulate; perianth segments 8-12
 10. Stamens with orange base; cladodes 17-35 cm long 12. *R. pulchra*
 10. Stamens without orange base; cladodes 2-5.5 cm long
 11. Stamens white with pinkish base; fruit orange 5. *R. campos-portoana*
 11. Stamens white; fruit translucent with reddish apex 4. *R. burchelli*
 9. Flowers saucer shaped; perianth segments 5-8
 12. Stamens with yellowish base; pericarpel tubular 8. *R. juengeri*
 12. Stamens without yellowish base; pericarpel hemispheric, subglobose or obovoid
 13. Cladodes 5.3-8.7 cm long, up to 2 mm diameter 14. *R. teres*
 13. Cladodes 9-16 cm long, 3-5 mm diameter 3. *R. baccifera* subsp. *shaferei*

1. *Hatiora salicornioides* (Haw.) Britton & Rose in L.H. Bailey, Stand. Cycl. Hort. 3: 1433. 1915. Illustrations in Taylor & Zappi (2004) and Zappi *et al.* (2007).

Epiphytes or lithophytes. Cladodes acrocaulous, 2-8-branched; apex clavated, 1.5-2.5 cm long, base with ca. 1 mm and apex with 1-3 mm diameter. Young cladodes spiny. Flower terminal, 0.7-1.1 cm diameter, 1 per areole, semitubular; perianth segments 15, the external 5-6 × 3 mm, triangular, intense yellow with orange apex, the internal 8-10 × 1.5-2 mm, lanceolate,

yellow; pericarpel ca. 3 × 3 mm, hemispheric, green, emerged; ca. 53 stamens, ca. 6 mm long, white, included; style white, ca. 9 mm long, inserted, stigma 4-lobed, lobes ca. 1 mm long. Fruit deep pink, globose, 1 per cladode, 4-5 × 4-6 mm. Seeds dark brown to black, 0.5-1 × 1 mm, 9-27 per fruit.

Phenology and habitat: Flowers were collected in August and September and fruits in March. It shows a wide distribution in southeastern and southern Brazil, in the Atlantic Forest and in the Semi-deciduous Forests, from Bahia to Paraná (Zappi *et al.* 2007, 2010).

Specimens examined: BRASIL. SÃO PAULO: Santo André, Distrito de Paranapiacaba, Paranapiacaba Biological Reserve, 30-IX-1982, *A.C. Maruffa s.n.* (SP194425); idem, 20-IX-1983, *M. Sugiyama & M. Kirizawa 336* (SP); Distrito de Paranapiacaba, Fumaça Valley, 23-VIII-2008, *Z.R. Mendes 1* (UNIP); idem, 7-III-2009, *Z.R. Mendes 9* (UNIP).

This species is easily found as lithophytic near rivers in sites with high luminosity. It can be characterized by the presence of brownish cladodes, a character not previously reported for this species in São Paulo. However, Zappi & Taylor (1990) described this species for the Flora of Serra do Cipó (Minas Gerais) with thick basal segments and brownish bark. When it is lithophytic, it shows a cylindrical, ligneous and erect extensive cladode up to 30 cm long and 3-5 mm diameter. When epiphytic, it shows evergreen cladodes. This species presents rather diverse morphology, partly related to growth conditions (Zappi & Taylor 1990), with globular and vinaceous cladodes when exposed to sunlight and with clavated and green cladodes when growing in the shade.

2. *Lepismium houlettianum* (Lem.) Barthlott, Bradleya 5: 99. 1987.

Illustrations in Bauer & Waechter (2006) and Taylor & Zappi (2004).

Epiphytes. Cladodes basicaulous or caulous, partially flattened with cylindrical and ligneous base; flattened part serrate; 13-30 × 1.7-5.5 cm, ca. 1.5 mm diameter; suberect. Flower developing on the surface of branches, one flower per areole, 1-1.8 cm diameter; pericarpel 2 × 4 mm, angled, pink, emerged; perianth segments 9-10, erect or suberect, white or slightly pink; stamens ca. 20, 7-11 mm long, included, style ca. 10 mm long, exsert, stigma 3-lobed, lobes ca. 3 mm long. Fruit light green or pale yellowish, tubular, up to 11 per cladode, ca. 5 × 9 mm. Seeds dark brown to black, ca. 0.5 × 1 mm, 27-29 per fruit. Phenology and habitat: Flowers were collected in May and June and fruits were collected in August. This species occurs in the Atlantic Forest of Minas Gerais, Espírito Santo, Rio de Janeiro, São Paulo, Paraná, and Santa Catarina (Zappi *et al.* 2007, 2010).

Specimens examined: BRASIL. SÃO PAULO: Santo André, Distrito de Paranapiacaba, Paranapiacaba Biological Reserve, 4-VI-1990, *M. Kirizawa & S. Chiea 2338* (SP); idem, 23-V-2009, *Z.R. Mendes & R. Sebastiani 16* (UNIP); Distrito de Paranapiacaba, Fumaça Valley, 23-VIII-2009, *Z.R. Mendes 20* (UNIP).

Adicional specimens examined. BRASIL. SÃO PAULO: Itararé, 18-VIII-1995, *V.C. Souza et al. 8804* (SP); Mairiporã, P.E. Cantareira, 7-VI-2005, *F.A.R.D. Arzolla et al. 847* (SP).

Lepismium differs from the other genera by its branching pattern. While *Hatiora* and *Rhipsalis* show an acrocaulous or subacrocaulous branching (except basal cladodes), *Lepismium* shows only basicaulous or caulous branching, never acrocaulous. *Lepismium houlettianum* has cladodes with a cylindrical basal portion and the distal part flattened. The faded cladodes remain attached to the plant. Calvente (2005) considered this species as near threatened and characteristic of preserved places.

3. *Rhipsalis baccifera* subsp. *shaferei* (Britton & Rose)

Barthlott & N.P. Taylor, Bradleya 13: 64. 1995. Illustration in Zappi *et al.* (2007).

Epiphytes or lithophytes. Cladodes acrocaulous or subacrocaulous, 2-5-branched, cylindrical, 9-16 cm long, 3-5 mm diameter, pendulous. Flower lateral to subterminal, saucer shaped, 1-2 flowers per areole, 0.5-0.7 cm diameter; perianth segments 5-7, patent, the external ca. 2 × 1 mm, triangular, greenish to brownish, the internal 3-4 × 1.5-2 mm, lanceolate to linear, white to slightly yellowish; pericarpel 2-3 × 2 mm, subglobose to obovoid, green, smooth, emerged; stamens 20-25, 2-3 mm long, white, same height of style; style 2-3 mm long, white, stigma 2-3-lobed, lobes ca. 0.5 mm long. Fruit white or light pink, globose, 1 per cladode, 6-8 × 6-10 mm. Seeds black, ca. 0.5 × 1 mm, 10-31 per fruit.

Phenology and habitat: Fruits were collected in March and May. This species occurs in Paraguay, southeast Bolivia, northeast Argentina and Brazil (São Paulo State), with its distribution extending to Asia and Africa (Zappi *et al.* 2007, Calvente 2010).

Specimens examined: BRASIL. SÃO PAULO: Santo André, Distrito de Paranapiacaba, Fumaça Valley, 7-III-2009, *Z.R. Mendes 10* (UNIP); idem, 2-V-2009, *Z.R. Mendes 11* (UNIP).

Adicional specimens examined: BRASIL. MINAS GERAIS: Laranjal, 24-XI-1982, *J.R. Pirani et al. 252* (SP). GUYANA. Gunn's Esequibo River, 3-X-1989, *M.J. Jansen-Jacobs et al. 1951* (SP)

R. baccifera can be confused with *R. teres* by the habit. However, according to Zappi *et al.* (2007), *R. baccifera* shows the pericarpel more developed

than the perianth segments, unlikely *R. teres*. There are three subspecies of *R. baccifera*: *R. baccifera* subsp. *baccifera*, widely distributed in Brazilian territory; *R. baccifera* subsp. *hileiabaiana* N.P. Taylor & Barthlott, endemic to Cerrado areas in Bahia State; and *R. baccifera* subsp. *shaferi* (Britton & Rose) Barthlott & N.P. Taylor, common in the Cerrado and in the Atlantic Forest regions of southeast Brazil. Only *R. baccifera* subsp. *shaferi* is found in Paranapiacaba Biological Reserve.

4. *Rhipsalis burchelli* Britton & Rose, Cactaceae 4: 225. 1923.

Illustrations in Britton & Rose (1923) and Taylor & Zappi (2004).

Epiphytes. Cladodes acrocaulous or subacrocaulous, 2-5-branched, cylindrical, 3.9-5.5 cm long, 1-1.5 mm diameter, pendulous. Flower terminal or subterminal, campanulate, 1-2 per areole, 1.2-1.7 cm diameter; perianth segments 9-11, the external ca. 6 × 4 mm, ovate, white, the internal ca. 11 × 3 mm, lanceolate, white; pericarpel ca. 3 × 2 mm, globose, greenish, emerged; stamens 20-30, ca. 7 mm long, white, included; style white, 7-8 mm long, included, stigma 3-4-lobed, lobes ca. 3 mm. Fruit translucent with reddish apex, globose, 1 per cladode, ca. 6 × 7 mm. Seeds dark brown, ca. 0.5 × 1 mm, 6-19 per fruit.

Phenology and habitat: Flowers and fruits were collected in March. This species occurs in the Atlantic Forest of Minas Gerais, Espírito Santo, São Paulo and Paraná (Zappi *et al.* 2007).

Specimens examined: BRASIL. SÃO PAULO: Santo André, Distrito de Paranapiacaba, Paranapiacaba Biological Reserve, 3-III-2009, Z.R. Mendes & C.J.F. Oliveira 5 (UNIP).

Adicional specimens examined: BRASIL. SÃO PAULO: Salesópolis, Boracéia, 19-XI-1949, M. Kuhlmann 2013 (SP).

This species differs from *R. campos-portoana* on the size of terminal cladodes, the color of stamens and fruits. While *R. burchelli* has translucent fruits with reddish apex, white stamens, and cladodes 3.9-5.5 cm long, *R. campos-portoana* Loefgr. has orange fruits, white stamens with pinkish base, and cladodes 2-4 cm long.

5. *Rhipsalis campos-portoana* Loefgr., Arch. Jard. Bot. Rio de Janeiro 2: 35, tab. VII. 1918.

Illustrations in Zappi *et al.* (2007) and Bauer & Waechter (2006).

Epiphytes. Cladodes acrocaulous or subacrocaulous, 2-4-branched, cylindrical, 2-4 cm long, 1.5-2 mm diameter, pendulous. Flower terminal or subterminal, campanulate, 1-2 per areole, 1.2-1.7 cm diameter; perianth segments 9-12, the external ca. 3 × 5 mm, ovate, white, the internal ca. 11 × 2.5 mm, lanceolate, white; pericarpel ca. 3 × 2 mm, globose, greenish, emerged; stamens 20-35, up to 7 mm long, white with pink base, included; styles white, 7-8 mm long, included, stigma 3-lobed, lobes ca. 3 mm long. Fruit orange, globose, 1 per cladode, ca. 5-6 × 6.5-7 mm. Seeds dark brown, ca. 0.5 × 1-1.5 mm, 2-6 per fruit.

Phenology and habitat: Flowers and fruits were collected from August to November. This species occurs in the Atlantic Forest and in Altitudinal Forests from Minas Gerais, Rio de Janeiro, São Paulo, Paraná and Santa Catarina (Zappi *et al.* 2007).

Specimens examined: BRASIL. SÃO PAULO: Santo André, Distrito de Paranapiacaba, Paranapiacaba Biological Reserve, 30-IX-1982, A.C. Maruffa *et al.* 51 (SP); idem, 26-XI-1980, N.A. Rosa 3239 (SP); idem, 8-X-1947, M. Kuhlmann 2706 (SP); idem, 25-VIII-1987, M. Kirizawa 1906 (SP); idem, 1-XI-1988, M. Kirizawa 2093 (SP); idem, 24-IX-1985, T.P. Guerra & M. Kirizawa 132 (SP); idem, 27-VIII-1980, E. Forero *et al.* 7628 (SP); idem, 25-IX-1992, G.T. Gonçalves s.n. (SP256045).

Adicional specimens examined: BRASIL. SÃO PAULO: Barra do Turvo, 14-II-1995, J.P. Souza *et al.* 64 (SP).

These collections were initially treated as *R. burchelli*, probably by the great similarity between the species.

6. *Rhipsalis elliptica* G. Lindb. ex K. Schum. in Mart., Fl. bras. 4(2): 293. 1890.

Illustrations in Taylor & Zappi (2004) and Zappi *et al.* (2007).

Epiphytes or lithophytes. Cladodes acrocaulous, 2-4-branched, flattened, margin wavy, 5-14 cm long, 2.2-5.5 cm large, 1-2 mm thick, pendulous. Flower lateral or subterminal, saucer shaped, 1-2 per areole, 1.2-1.8 cm diameter; perianth segments 8, the external ca. 4-4.5 × 2-3 mm, triangular, yellow, the internal ca. 6-7 × 2-3 mm, lanceolate, white to yellow; pericarpel 3-4 × 3.5-5 mm, tubular, greenish-yellow, emerged; stamens 73-83, up to 1.1 cm long, white, exserted; styles white, 5-7 mm long, exserted, stigma

3-4-lobed, lobes ca. 3 mm long. Fruit pink when ripe, tubular, 2 per cladode, 5 × 7-8 mm. Seeds black, ca. 0.5 × 1 mm, 4-16 per fruit.

Phenology and habitat: Flowers were collected in May and fruits in March. This species is common in eastern Brazil, occurring from Minas Gerais to Rio Grande do Sul in the Atlantic Forest, Restinga vegetation and Semideciduous Forest (Zappi *et al.* 2007, 2010).

Specimens examined: BRASIL. SÃO PAULO: Santo André, Distrito de Paranapiacaba, Paranapiacaba Biological Reserve, 30-V-1985, *M. Kirizawa & G. Truffem 1470* (SP); idem, 3-III-2009, *Z.R. Mendes & C.J.F. Oliveira 7* (UNIP); Distrito de Paranapiacaba, Fumaça Valley, 2-V-2009, *Z.R. Mendes 13* (UNIP).

This species is widely distributed throughout Fumaça Valley and have epiphytic and lithophytic habits. The flowers have a pleasant and mild aroma. *R. elliptica* shows totally pink fruits, while *R. olivifera* shows green fruits sometimes with a pink border around the apex.

The number of stamens of specimens from PBR, was higher than reported by Zappi *et al.* (2007). According to Calvente (2010), *R. elliptica* has two subspecies, *R. elliptica* subsp. *elliptica* and *R. elliptica* subsp. *microflora* Calvente, that differ in the dimension of floral structures, but both occur in the Atlantic Forest. Probably the typical subspecies *elliptica* occurs in Paranapiacaba, because *R. elliptica* subsp. *microflora* is not reported for São Paulo State. According to Calvente (2010), *Rhipsalis elliptica* subsp. *elliptica* is distinct from *R. elliptica* subsp. *microflora* by the larger flowers. This specimens studied presented the flowers 12-18 mm in diameter, 73-83 stamens and pink fruits. These characteristics are similar to those of *R. elliptica* subsp. *elliptica* described by Calvente (2010), with flowers 11-14 mm diam., stamens 60-100 and deep magenta to white fruit.

7. *Rhipsalis floccosa* Salm-Dyck ex Pfeiff., Enum. Diagn. Cact.: 134. 1837.

Illustrations in Bauer & Waechter (2006) and Taylor & Zappi (2004).

Epiphytes or lithophytes. Cladodes acrocaulous, 2-8-branched, cylindrical, 8.5-22 cm long, 3-6 mm diameter, basal cladode extended up to 34 cm from the phorophyte, pendulous. Flower lateral, saucer shaped, 1 per areole, 0.7-0.9 cm diameter; perianth segments 7, the external 2-3 × 3-3.5 mm, triangular, yellowish, the internal 1.5 × 4.5-5 mm, lanceolate, yellowish;

pericarpel 1.5 × 2 mm, hemispheric, immersed; stamens 82, 2.5-3 mm long, yellowish-white, exserted; styles yellowish-white, up to 3.5 mm long, exserted, stigma 3-lobed, lobes ca. 1 mm long. Fruit white or slightly purplish-pink, globose, 1-9 per cladode, 4-6 × 5-7 mm. Seeds black to dark brown, ca. 0.5 × 1 mm, 2-14 per fruit.

Phenology and habitat: Flowers and fruits were collected in March and May. It is a relatively abundant species, occurring in montane and riparian forests, also in forest clumps. It occurs in Venezuela, Peru, Bolivia, Argentina, Paraguay and Brazil (Pernambuco, Sergipe, Bahia, Minas Gerais, Espírito Santo, Rio de Janeiro, São Paulo, Paraná, Santa Catarina and Rio Grande do Sul) (Zappi *et al.* 2007).

Specimens examined: BRASIL. SÃO PAULO: Santo André, Distrito de Paranapiacaba, Paranapiacaba Biological Reserve, VI-1991, *N.P. Taylor & E. Gonçalves 1638* (SP); idem, 3-III-2009, *Z.R. Mendes & C.J.F. Oliveira 6* (UNIP); Distrito de Paranapiacaba, Fumaça Valley, 7-III-2009, *Z.R. Mendes 8* (UNIP); idem, 2-V-2009, *Z.R. Mendes 14* (UNIP).

Adicional specimens examined: BRASIL. SÃO PAULO: Biritiba Mirim, 10-V-1984, *A. Custodio Filho 2395* (SP).

According to Zappi *et al.* (2010) there are three subspecies of *R. floccosa*: *R. floccosa* subsp. *floccosa*, common in parts of northeast and southeast of Brazil; *R. floccosa* subsp. *oerophila* N.P. Taylor & Zappi, found in Cerrado and Caatinga areas from Bahia and Minas Gerais States; and *R. floccosa* subsp. *pulvinigera* (G. Lindb.) Barthlott & N.P. Taylor, which occurs in Cerrado and Atlantic Forest areas in southeastern and southern Brazil. For measuring the flowers, dried material was used, but the color view can be altered. In Bauer & Waechter (2006), Lombardi (1991) and Zappi *et al.* (2007), the perianth segments have reddish apex and can vary from white to greenish yellow. However, the color of pericarpel is not described. The stamens have been described as white in Bruxel & Jasper (2005) and Zappi *et al.* (2007) and yellowish in Bauer & Waechter (2006). Only Bauer & Waechter (2006) described the color of the style as greenish-white.

8. *Rhipsalis juengeri* Barthlott & N.P. Taylor, Bradleya 13: 69,72, pl. 29-30. 1995.
Illustration in Taylor & Zappi (2004).

Epiphytes. Cladodes acrocaulous, 2-6-branched, cylindrical, 4.8-7.5 cm long, 1.5-3.5 mm diameter,

basal cladode extended up to 18 cm from the phorophyte, pendulous. Flower subterminal, saucer shaped, 1-3 per areola, 4×6 mm diameter; perianth segments 5, the external ca. 2×2 mm, ovate, yellowish green, the internal ca. 4×2 mm, lanceolate, yellowish-green; pericarpel 1.5×2 mm, tubular, light green, emerged; stamens ca. 20, ca. 3 mm long, white with yellowish base, exserted; style white, 4 mm long, exserted, stigma 3-lobed, lobes ca. 1 mm long. Fruit globose, 1-2 per cladode, $4-5 \times 4-5$ mm. Seeds black, ca. 0.5×1 mm, 8-13 per fruit.

Phenology and habitat: Flowers were collected in January. This is a rare species, occurring in highland forests from Minas Gerais and in the Atlantic Forest and hillside forests from São Paulo (Zappi *et al.* 2007).

Specimens examined: BRASIL. SÃO PAULO: Santo André, Distrito de Paranapiacaba, River Mogi Valley, 24-I-2009, Z.R. Mendes 3 (UNIP).

Adicional specimens examined: BRASIL. MINAS GERAIS: Conceição de Ibitipoca, PE de Ibitipoca, 13-I-2007, A.M. Calvente 266 (SPF); idem, 11-III-2004, R.C. Forzza 3204 (SPF).

The numbers of stamens observed is lower than that described by Zappi *et al.* (2007). *R. juengeri* produces fruits with color ranging from magenta to pinkish (Zappi *et al.* 2007).

9. *Rhipsalis neves-armondii* K. Schum. in Mart., Fl. bras. 4(2): 284. 1890. Illustration in Zappi *et al.* (2007).

Epiphytes. Cladodes acrocaulous or subacrocaulous, 2-6-branched, cylindrical, 6.5-13 cm long, up to 3 mm diameter, suberect. Flower lateral, campanulate, 1 per areole, 1-1.5 cm diameter; perianth segments 8, the external 5×4 mm, lanceolate, white with greenish apex, the internal 7×3 mm, lanceolate, white; pericarpel ca. 2×2.5 mm, setaceous, green yellowish, immersed; stamens ca. 68, up to 5.5 mm long, slightly pinkish-white, inserted; style white, ca. 8 mm long, inserted, stigma 5-lobed, lobes 1-2 mm long. Fruit deep pink, globose, 1 per cladode, ca. 5×6 mm. Seeds dark brown, ca. 0.5×1 mm, up to 6 per fruit.

Phenology and habitat: Flowers and fruits were collected in January. This species occurs only in Rio de Janeiro, São Paulo and Paraná (Zappi *et al.* 2007).

Specimens examined: BRASIL. SÃO PAULO: Santo André, Distrito de Paranapiacaba, Rio Mogi Valley, 24-I-2009, Z.R. Mendes 2 (UNIP).

The number of stamens and perianth segments observed differ from those reported by Zappi *et al.* (2007). In our study, ca. 68 stamens and ca. 8 perianth segments were counted, while Zappi *et al.* (2007) pointed 11-13 stamens and 35-50 perianth segments. This is a rare species with the flowering areoles being extremely dispersed throughout the cladodes. The collections did not contain sufficient quantity of fruits for counting seeds.

10. *Rhipsalis olivifera* N.P. Taylor & Zappi, Cactaceae Cons. Initiat. 3: 8. 1997.

Illustrations in Calvente (2010).

Epiphytes. Cladodes acrocaulous, 2-branched, flattened, margin wavy, 7.3-11.2 cm long, 3.7-7.4 cm large, ca. 1.5 mm thick, pendulous. Flower lateral, saucer shaped, 1-3 per areola, 1.2-1.7 cm diameter; perianth segments ca. 8, the external $1.5-2 \times 4-5$ mm, lanceolate, the internal $1.5-2 \times 7-8$ mm, lanceolate; pericarpel $3-4 \times 4-5$ mm, hemispheric, emerged; stamens 41-43, 4-5 mm long, white, exserted; style white, ca. 8 mm long, exserted, stigma 2-3-lobed, lobes 2 mm long. Fruit light green when ripe, tubular, 5 per cladode, $4-5 \times 6-8$ mm, pulp greenish, translucent. Seeds black to dark brown, $0.5 \times 1-1.5$ mm, 11-50 per fruit.

Phenology and habitat: Fruits were collected in May and August. This species is distributed in the Atlantic Forest and altitudinal forests from Rio de Janeiro and São Paulo (Zappi *et al.* 2007).

Specimens examined: BRASIL. SÃO PAULO: Santo André, Distrito de Paranapiacaba, Paranapiacaba Biological Reserve, 23-V-2009, Z.R. Mendes & R. Sebastiani 15 (UNIP); Distrito de Paranapiacaba, Fumaça Valley, 23-VIII-2009, Z.R. Mendes 18 (UNIP).

Adicional specimens examined: BRASIL. SÃO PAULO: Engenheiro Passos, 3-VI-1995, Parra *et al.* 5 (SP).

Rhipsalis elliptica and *R. olivifera* are very similar in the vegetative organs. The color of fruit at maturity is the main difference between the species, being light green in *R. olivifera* (sometimes with a pink border around de apex) and pink in *R. elliptica*. The morphological proximity is corroborated by phylogenetic studies. According to Calvente (2010), this species is easily identified by the pale pinkish flowers and large stem segments. The species is poorly described. On a survey of Cactaceae for the state of Rio de Janeiro presented by Calvente *et al.* (2005) only one specimen (holotype) was examined. Zappi

et al. (2007) describes the perianth segments cream to green, pericarpel dark green and stamens white.

11. *Rhipsalis paradoxa* (Salm-Dick *ex* Pfeiff.)

Salm-Dick, *Cact. Hort. Dyck.* ed. I: 39; ed. II: 59, 228. 1849. [publ. 1850].

Illustrations in Zappi *et al.* (2007), Bauer & Waechter (2006), Lombardi (1991) and Taylor & Zappi (2004).

Epiphytes. Cladodes acrocaulous, 2-branched, cylindrical, 12-67 cm long, the cladodes showing ribs with twisted wings, up to 5 cm long, basal cladodes 7, acrocaulous along the plant, pendulous. Young cladodes spiny. Flower lateral, saucer shaped, 1 per areole, ca. 1.2 cm diameter; pericarpel ca. 3 × 4 mm, rounded, yellow, immersed; perianth segments 10, the external ca. 4 × 5 mm, ovate, yellowish, the internal 5 × 6 mm, elliptical, yellowish; stamens ca. 100, 4-7 mm long, pale yellow, exserted; style ca. 8 mm long, exserted, stigma 5-lobed, lobes 1-2 mm long. Fruit not seen.

Phenology and habitat: Flowers were collected in January. This species occurs in Rio de Janeiro and Santa Catarina in the Atlantic Forest and Semideciduous Forests (Zappi *et al.* 2007).

Specimens examined: BRASIL. SÃO PAULO: Santo André, Distrito de Paranapiacaba, Mogi River Valley, 24-I-2009, Z.R. Mendes 4 (UNIP).

Adicional specimens examined: BRASIL. SÃO PAULO: Iguape, E.E. Juréia-Itatins, 28-XI-1991, M.C.H. Mamede 495 *et al.* (SP).

Some vegetative characteristics are sufficient to identify this species, as the large cladodes and twisted wings, up to 5 cm. Fruits are not available in the collections analysed. However there is some variations on fruit description in literature. Bauer & Waechter (2006) described the fruits as magenta with 4-5 mm diameter, Zappi *et al.* (2007) described the fruits as white with ca. 7 mm diameter and Lombardi (1991) cited only white fruits.

12. *Rhipsalis pulchra* Loefgr., *Arch. Jard. Bot. Rio de Janeiro* 1: 75, tab. 5. 1915.

Illustration in Taylor & Zappi (2004).

Epiphytes. Cladodes acrocaulous or subacrocaulous, 2-3-branched, cylindrical, 17-35 cm long, 3-4 mm diameter, pendulous. Flower lateral or subterminal, campanulate, 1 per areole, 1-2 cm diameter; perianth segments 11, the external 3 × 6 mm,

triangular, white, the internal 8 × 10 mm, lanceolate, white; pericarpel 3 × 3 mm, hemispheric, pinkish, emerged; stamens ca. 67, up to 6 mm long, white with orange base, inserted; style white, ca. 8 mm long, exserted, stigma 4-lobed, lobes ca. 2 mm long. Fruit orange with red apex, globose, 1 per cladode, ca. 8 × 11 mm. Seeds with black colour, ca. 0.5 × 1 mm, 4-22 per fruit.

Phenology and habitat: Flowers and fruits were collected in May. This species occurs in Minas Gerais, Rio de Janeiro and São Paulo, usually in montane forests above 1.500 m (Zappi *et al.* 2007).

Specimens examined: BRASIL. SÃO PAULO: Santo André, Distrito de Paranapiacaba, Fumaça Valley, 2-V-2009, Z.R. Mendes 12 (UNIP).

Adicional specimens examined: BRASIL. SÃO PAULO: São José do Barreiro, 13-X-2007, A.M. Calvente 364 (SPF). MINAS GERAIS: Conceição de Ibitipoca, Parque Estadual de Ibitipoca, 13-I-2007, A.M. Calvente 264 (SPF).

The number of perianth segments and stamens observed is lower than those reported by Zappi *et al.* (2007). In this study ca. 67 stamens were counted and ca. 11 perianth segments, while in Zappi *et al.* (2007) counted ca. 70 stamens and 13-14 perianth segments.

13. *Rhipsalis puniceodiscus* G. Lindb., *Gartenflora* 42: 233. 1893.

Illustration in Lombardi (1991).

Epiphytes. Cladodes acrocaulous, 2-3-branched, cylindrical, 17-40.5 cm long, 3-4 mm diameter, pendulous. Flower lateral, saucer shaped, 1 per areole, 0.8-1.2 cm diameter; perianth segments 11, the external 3 × 3 mm, triangular, white, the internal 2 × 5-5.5 mm, lanceolate, white; pericarpel 2 × 3 mm hemispheric, greenish, immersed; stamens ca. 38, 3-4.5 mm long, white, exserted; style white, ca. 5 mm long, exserted, stigma 3-lobed, lobes ca. 1 mm long. Fruit intense yellow, globose, 1 per cladode, 5-6 × 5-6 mm. Seeds with black colour, ca. 0.5 × 1 mm, 2-5 per fruit.

Phenology and habitat: Fruits were collected in June and August. The species occurs in Rio de Janeiro, São Paulo, Paraná, Santa Catarina and Rio Grande do Sul (Zappi *et al.* 2007).

Specimens examined: BRASIL. SÃO PAULO: Santo André, Distrito de Paranapiacaba, Paranapiacaba Biological Reserve, 6-VI-1991, N. Taylor &

E. Gonçalves 1636 (SP); Fumaça Valley, 23-VIII-2009, Z.R. Mendes 19 (UNIP).

Adicional specimens examined: BRASIL. SÃO PAULO: São Paulo, P.E. Fontes do Ipiranga, 30-XI-1982, M.R.C. Santos *et al.* 47 (SP); Bonsucesso de Itararé, Lagoinha, 3-VI-1994, V.C. Souza *et al.* 6086 (SP).

It is found within PBR and Fumaça Valley areas. Zappi *et al.* (2007) describe the flower of *R. puniceodiscus* with 12 to 14 perianth segments, ranging its color from white, pale yellowish to green according to the position; having 70-110 stamens with yellowish apex, and a reddish or orange base. Zappi *et al.* (2007) described stamens with reddish or orange base and yellowish apex. This species was considered a rare occurrence in Rio de Janeiro State by Calvente *et al.* (2005).

14. *Rhipsalis teres* (Vell.) Steud., Nomencl. Bot., ed. 2, 2: 449. 1841.

Illustrations in Zappi *et al.* (2007), Bauer & Waechter (2006) and Taylor & Zappi (2004).

Epiphytes. Cladodes acrocaulous, 3-branched, cylindrical, 5.3-8.7 cm long, up to 2 mm diameter, suberect. Flower lateral or subterminal, saucer shaped, 1 per areole, 0.6-0.8 cm diameter; perianth segments 8, the external 3 × 4 mm, triangular, bright brown, the internal 5 × 2 mm, lanceolate, white; pericarpel ca. 2 × 2 mm, hemispheric, greenish, emerged; stamens ca. 25, up to 4 mm long, white, same height of style; style white, ca. 4 mm long, stigma 3-lobed, lobes ca. 1 mm long. Fruit green to white, pale blue violet or reddish when ripe, globose, up to 2 per cladode. Seeds with black colour, ca. 0.5 × 1 mm, 3-7 per fruit.

Phenology and habitat: Flowers and fruits were collected in March. It is a widely distributed species, occurring in southern and southeastern Brazil (Zappi *et al.* 2007).

Specimens examined: BRASIL. SÃO PAULO: Santo André, Distrito de Paranapiacaba, Paranapiacaba Biological Reserve, 28-III-1983, T.P. Guerra *s.n.* (SP186341); idem, 26-III-1991, A.L. Gonçalves *s.n.* (SP248239).

The measures of the cladodes of *R. teres* mentioned in this study are higher than those reported by Zappi *et al.* (2007). In this study the cladodes were measured 5.3-8.7 cm long, while in Zappi *et al.* (2007) the cladodes were measured 2-5 cm long.

Cactaceae showed no preference for a specific tree bark, since all species were found on several types of stems, more frequently the ones that support greater amount of substrate. The epiphytic cacti species in PBR seem to prefer shaded environments to environments with an medium luminosity; and very humid habitats, close to rivers or lakes.

Part of the reproduction of the species analyzed can occur by fragmentation of the cladodes and the broken parts produce roots that can reach the substrate and continue its growth. Their dispersal is by zoochory. Boeni & Pizo (2007) observed and described some bird species feeding the fruits of *R. teres*: *Coereba flaveola* Linnaeus 1758, *Euphonia pectoralis* Latham 1802, *Euphonia cyanocephala* Vieillot 1818 and *Turdus rufiventris* Vieillot 1818. These mutualistic relationships suggest that of conservational projects aiming the conservation of both cacti and birds are needed, since some of these birds have exuberant plumage and therefore are targets for hunters. The color and odor of *R. juengeri* fruits are attractive to bats (Schlumpberger *et al.* 2006).

An ecological relationship was observed between a species of arachnid and a species of *Rhipsalis*, in some environments and seasons. When disturbed, the spider showed a camouflage system, stretching its body like a cladode. The spider was not collected but species of some families (Therididae, Deinopidae, and Uloboridae) have this behavior to keep their body stretched and paralyzed, mimicking twigs (Jocqué & Dippenaar-Shoeman 2006). The spider uses the branches of the plant to build its web and protecting against small predators.

According to the Paranapiacaba Biological Reserve Phanerogamic Flora, there are seven species of Cactaceae in this area (Kirizawa *et al.* 2009), but *R. pulvinigera* was currently treated as *R. floccosa* subsp. *pulvinigera* (Zappi *et al.* 2007). However, for this study eight species were recognized in the Reserva Biológica do Alto da Serra de Paranapiacaba and six species in its surrounding areas, which had not been previously considered. *R. burchelli* and *R. olivifera* are new records for the reserve, while the other species discussed here, *R. baccifera*, *R. juengeri*, *R. neves-armondii*, *R. paradoxa* and *R. pulchra* were collected in surrounding areas. The latter three deserve special attention on *R. neves-armondii*, *R. olivifera* and *R. pulchra* are considered near threatened due to restricted distribution in the São Paulo State, occurring only in conservation areas (Mamede *et al.* 2007).

The species cited in this study do not appear in Appendix 1 of CITES (2011), thus they are not considered endangered. However, all other Cactaceae species that are not in Appendix 1 appear in Appendix 2 of CITES (2011) and its commercialization should be compatible with their preservation. According to the red list of threatened species of flora (IUCN 2010), *L. houlletianum*, *R. elliptica*, *R. floccosa*, and *R. paradoxa* are classified as Least Concern.

About 174 species of Cactaceae that occur in Brazil are endemic (Zappi *et al.* 2010). Among the native species of Brazil, 43 occur in Atlantic Forest areas of São Paulo State. PBR and its surroundings contain about one-third of this diversity (14 species), emphasizing the importance of District of Paranapiacaba for the conservation of Cactaceae in São Paulo State.

Three species occurring in PBR are not endemic to the Atlantic Forest, *L. houlletianum*, *R. baccifera* and *R. floccosa* (Zappi *et al.* 2010). The lack of floristic studies can influence the recently published rates of plant species endemism (Myers *et al.* 2000). Thus, the data presented here can contribute to strategies for preserving Atlantic Forest areas.

Of the fourteen species observed here, three are cited for Ilha do Cardoso (São Paulo State, Brazil): *L. houlletianum*, *R. campos-portoana* and *R. teres* (Rodrigues & Barros, 2008). This reinforces the high diversity of Cactaceae in Reserva Biológica do Alto da Serra de Paranapiacaba.

Bruxel & Jasper (2005) found five genera and eleven species in Rio Taquari watershed in Rio Grande do Sul (Brazil). Seven were epiphytic, *Lepismium cruciforme*, *L. houlletianum*, *L. lumbricoides*, *L. warmingianum*, *Rhipsalis cereuscula*, *R. floccosa*, and *R. teres*. *L. houlletianum*, *R. floccosa*, and *R. teres* also occur in PBR.

Bauer & Waechter (2006) conducted a taxonomic study of epiphytic Cactaceae throughout the state of Rio Grande do Sul (Brazil) and found six genera and thirteen species, two are commonly found as occasional epiphytes, *Cereus alacriportanus* Pfeiff. and *Opuntia monacantha* Haw. The other eleven species are *Epiphyllum phyllanthus* (L.) Haw., *Hatiora rosea* (Lagerh.) Barthlott, *Lepismium cruciforme* (Vell.) Miq., *L. houlletianum* (Lem.) Barthlott., *L. lumbricoides* (Lem.) Barthlott., *L. warmingianum* (K. Schum.) Barthlott., *Rhipsalis campos-portoana* Loefgr., *R. cereuscula* Haw., *R. floccosa* Salm-Dyck ex Pfeiff., *R. paradoxa* (Salm-Dyck ex Pfeiff.) Salm-Dyck

and *R. teres* (Vell.) Steud. Five are recognized for Reserva Biológica do Alto da Serra de Paranapiacaba

The results suggest that even though Reserva Biológica do Alto da Serra de Paranapiacaba is considered an area of restricted biodiversity, it would have an even greater importance if its boundaries were extended. This means that a greater number of species could be protected with the increase of its total area.

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