



Paullinieae (Sapindaceae) of the restingas of Rio de Janeiro, Brazil: taxonomy and distribution

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Abstract: Paullinieae is a predominantly neotropical tribe comprising six genera (*Cardiospermum*, *Lophostigma*, *Paullinia*, *Serjania*, *Thinouia* and *Urvillea*), of which *Lophostigma* is the only one not found in Brazil. This study was conducted in the sandy coastal plains (restingas) of Rio de Janeiro state, which from the mouth of the Itabapoana river in the north, bordering Espírito Santo state, to Ponta da Trindade (including Ilha Grande) in the south, bordering São Paulo state. This ecosystem has great biodiversity, but has been constantly threatened by deforestation, human occupation and degradation resulting from tourism. In this area we found 30 species in five genera: *Cardiospermum* (1 sp.), *Paullinia* (9 spp.), *Serjania* (15), *Thinouia* (2) and *Urvillea* (3). The taxonomic treatment includes a key to identify the taxa, and for each species a morphological description, illustrations, a map of its geographical distribution, ecological information, phenological data, and conservation status. Most species occurred in ridge forests, followed by dune thicket and non-flooded scrub formations. Among of the 30 species, four (*Paullinia coriacea*, *P. ternata*, *Serjania fluminensis* and *S. littoralis*) were recorded only in the sandy coastal plains, and four are endemic to Rio de Janeiro state (*Serjania eucardia*, *S. fluminensis*, *S. littoralis* and *S. tenuis*). In addition, four species are already included in the Red List of Brazilian Flora and another three are indicated in this study as threatened. This research is important not only to improve knowledge of Paullinieae species found in Rio de Janeiro's sandy coastal plains, but also to provide information to be used for conservation measures in the State, as well as in other coastal plains of Brazil.

Keywords: Climbing plants; Atlantic Forest; southeastern Brazil; conservation; coastal vegetation.

Paullinieae (Sapindaceae) das restingas do estado do Rio de Janeiro, Brasil: taxonomia e distribuição

Resumo: Paullinieae é uma tribo predominantemente neotropical e compreende seis gêneros (*Cardiospermum*, *Lophostigma*, *Paullinia*, *Serjania*, *Thinouia* e *Urvillea*), dos quais *Lophostigma* é o único gênero não encontrado no Brasil. Este estudo foi conduzido nas restingas do estado do Rio de Janeiro, que começam na foz do rio Itabapoana, na fronteira com o estado do Espírito Santo e se estende até a Ponta da Trindade (incluindo a Ilha Grande), próximo à fronteira com o estado de São Paulo. Este ecossistema possui grande biodiversidade, mas tem sido constantemente ameaçado pelo desmatamento, ocupação humana e ações de degradação decorrentes do turismo. Nesta área foram encontradas 30 espécies pertencentes a cinco gêneros: *Cardiospermum* (1 spp), *Paullinia* (9 spp), *Serjania* (15), *Thinouia* (2) e *Urvillea* (3). O tratamento taxonômico incluiu descrição e chave para identificação das espécies, informações sobre as formações vegetacionais das restingas onde cada táxon ocorre, além de ilustrações e mapas de distribuição geográfica das espécies. A maioria das espécies ocorre em floresta de cordão arenoso, seguidas das espécies de vegetação arbustiva fechada de cordão arenoso e arbustiva aberta não inundável. Entre as 30 espécies, quatro delas (*P. coriacea*, *P. ternata*, *S. fluminensis* e *S. littoralis*) são encontradas apenas nas formações de restinga e quatro espécies são endêmicas do Rio de Janeiro (*S. eucardia*, *S. fluminensis*, *S. littoralis* e *S. tenuis*). Além disso, quatro espécies já estão incluídas na Lista Vermelha da Flora do Brasil e outras três estão indicadas neste estudo.

Este trabalho é importante não apenas para melhorar o conhecimento das espécies de Paullinieae encontradas nas restingas do Rio de Janeiro, mas também para fornecer informações a serem utilizadas em medidas de conservação no Estado e nas demais regiões de restinga do Brasil.

Palavras-chave: *Trepadeiras; Floresta Atlântica; sudeste do Brasil; conservação; vegetação costeira.*

Introduction

The family Sapindaceae comprises approximately 1,900 species, distributed mainly in tropical and subtropical regions, with a few genera in temperate regions (Buerki et al. 2021). It is distributed throughout Brazil (Radlkofer 1931–1934; Somner 1997) and has the largest and richest area of distribution in the Amazon region (Barroso et al. 1991). In Brazil there are 32 genera with 436 species (Sapindaceae in Flora e Funga do Brasil 2022). The representatives of this family are trees, treelets, shrubs, lianas and herbaceous climbers (Acevedo-Rodríguez 2011), the two latter life forms showing a pair of tendrils at the base of the inflorescence rachis (Ferrucci 1991, Somner 1997). The species of greatest economic interest in the family is *Paullinia cupana* Kunth, popularly known as *guaraná*, and mostly used in high energy foods, drinks and dietary supplements, as well as a medication to reduce fever, stimulate metabolism, antioxidant and antibacterial activity and induce antiplatelets (Guarim Neto et al. 2000, Hamerski et al. 2013).

Radlkofer (1931–1934) divided the Sapindaceae into, 14 tribes and four subtribes, with the genus comprising climbing plants included in the Paullinieae tribe. A recent study on the phylogeny of this tribe (Acevedo-Rodríguez et al. 2017) corroborates the Radlkofer classification and includes six genera: *Cardiospermum* L. (15 spp), *Lophostigma* Radlk. (2 spp), *Paullinia* L. (220 spp), *Serjania* Mill. (240 spp), *Thinouia* Triana (12 spp) & Planch. and *Urvillea* Kunth. (20 spp) (Acevedo-Rodríguez et al. 2017, Chery et al. 2019, Ferrucci & Steinmann 2019, Medeiros et al. 2020).

Paullinieae (509 spp) is a predominantly neotropical tribe with a couple of species naturally extending into Africa and Madagascar, however, the most of species are distributed in tropical and subtropical areas of the American continent (Acevedo-Rodríguez et al. 2017, Ferrucci & Steinmann 2019), concentrated in South America. We can find a large number of *Paullinia* in the Amazon region (Somner 2001), and *Serjania* has three major distribution centers: one in the southern region of Mexico, another in the central plateau of Brazil and the third in the Brazilian Atlantic Forest (Acevedo-Rodríguez 1993). In Brazil we can find about 50% (258 spp) belonging to the Paullinieae tribe: *Paullinia* (102), *Serjania* (121), *Cardiospermum* (7) *Thinouia* (11) and *Urvillea* (16) (Sapindaceae in Flora e Funga do Brasil 2022).

The family has been recorded in the cerrado, caatinga, pampa, pantanal and Atlantic Forest domains (Araujo 2000, Guarim Neto 1994, Reitz 1980, Sapindaceae in Flora e Funga do Brasil 2022). In Rio de Janeiro state, 134 species were recorded in 20 genera, 63% of these species belong to the tribe Paullinieae, represented by *Cardiospermum* (4 spp.), *Paullinia* (22), *Serjania* (48), *Urvillea* (6) and *Thinouia* (5) (Sapindaceae in Flora e Funga do Brasil 2022, Somner et al. 2014).

According to Gentry (1991), lianas are concentrated in a few families, including the Sapindaceae, which is among the richest in number of species. Floristic and phytosociological surveys of lianas conducted in some regions of the semideciduous seasonal forest in São Paulo state (Hora & Soares 2002, Udulutsch et al. 2004, Rezende

& Ranga 2005, Tibiriçá et al. 2006) and at the Ecological Reserve of Macaé de Cima in Rio de Janeiro state (Lima et al. 1997) highlighted this family as among the three with the largest number of species. In the sandy coastal plains in Rio de Janeiro, the family is considered one of the ten richest, of which almost 75% of the species are lianas (Araujo 2000).

The sandy coastal plains were formed by sedimentation during the Quaternary Period along the Brazilian coast (Suguio & Tessler 1984). This ecosystem covers an area of approximately 1,200 km², about 2.8% of the Rio de Janeiro state's territory (Araujo & Maciel 1998). It consists of a set of physiognomically distinct plant communities under marine and fluvial-marine influence (CONAMA 1996), which are collectively termed *restinga* by Araujo (1992). Floristic surveys show that sandy coastal plains have 356 restricted to this vegetation type, including 295 endemic species (BFG 2015), and the ecosystem has undergone intensive and extensive deforestation, mainly due to human occupation (real estate speculation and tourism), making the study of the flora a priority for knowledge acquisition and conservation (Rocha et al. 2004).

According to Rizzini (1997), the restinga flora originated from the Atlantic Forest and is so recent that there has been little species divergence, given that its species are very similar to those found in other areas of the Atlantic Forest (Araujo & Scarano 2007). However, Araujo & Lacerda (1987) report that species from other ecosystems are also found, namely from the Atlantic Forest to the Amazon Rainforest.

The main objectives of the present taxonomic study were thus to identify and describe the species of Paullinieae that occur in the different restinga vegetation formations of the state of Rio de Janeiro, and respectively indicate and classify the endemic species and those threatened with extinction.

Material and Methods

1. Study area and field expeditions

The coast of Rio de Janeiro is in four state government regions: Costa verde, Metropolitana, Baixadas Litorâneas e Norte Fluminense. In the north, it starts at the mouth of the Itabapoana river (21°17'S; 40°57'W), on the border with Espírito Santo state, and extends southeast to Ponta da Trindade (including Ilha Grande) (23°21'S; 44°43'W), on the border with São Paulo state. In this study, the nine subdivisions of Rio de Janeiro's sandy coastal plains proposed by Menezes & Araujo (2005) and Araujo (2000) were adopted. Sampling was carried out in the following areas: municipality of São Francisco de Itabapoana (Santa Clara and Gargaú districts); sandy coastal plain of Jurubatiba (Quissamã, Carapebus and Macaé), Rio das Ostras (ARIE de Itapebussus, Praia das Virgens, Areias Negras and Praia da Joana), Armação de Búzios (Praia da Gorda, Praia da Ferradura and Praia de Tucuns), Cabo Frio (APA Pau-brasil, Praia do Perú, Cabo Frio dunes, Marine Radiogoniometric Station and Florestinha condominium), Araruama (Massambaba APA), Saquarema (Reserva Ecológica Estadual de Jacarepiá), Rio de Janeiro (Restinga de Grumari and Restinga da Marambaia) and Paraty (Praia de São Gonçalo, Paraty-Mirim, Juatinga, Praia do Sono, Trindade and

Praia Brava). No collections were made by the authors of this study in the State Biological Reserve (REBIO) at Praia do Sul; however, a thorough collection was made there by Dorothy Dunn de Araujo in the 1990s, which is well represented by exsiccates in the herbarium of the Botanical Garden of Rio de Janeiro (RB).

2. Sampling and taxonomic treatment

Periodic field expeditions were carried out to the selected areas from June 2007 to September 2008. The dried specimens prepared from field collections were incorporated into the herbaria of the Research Institute of the Botanical Garden of Rio de Janeiro (RB) and the Botany Department of the Federal Rural University of Rio de Janeiro (RBR). Fertile samples were also preserved in 70% alcohol, thus facilitating the observation of morphological characteristics.

The collections of Sapindaceae found in the main herbaria of Rio de Janeiro state (GUA now included in RB, HB, R, RB and RBR) were studied and reviewed. In addition, the digital databases available on the websites of INCT – Herbário Virtual da Flora e dos Fungos (speciesLink Website 2021) and Re flora (Re flora – Herbario virtual 2020) were consulted to obtain more records of species in the restingas of Rio de Janeiro.

In this study, all genera of Paullinieae, with the exception of *Lophostigma* (two species occur in Bolivia, Ecuador and Peru), were taxonomically treated.

Specimens were identified using the specialized literature (especially Radlkofer 1931–1934 and Flora do Brasil 2020), and by comparison with the materials deposited in herbaria RB and RBR, and determined by specialists of the family.

The geographical distributions of the taxa were established from the collections found in the herbaria of the state of Rio de Janeiro, other herbaria available online, and from specialized literature which deals with the species studied: Radlkofer (1931–1934), Reitz (1980), Somner & Barroso (1988), Acevedo-Rodríguez (1990), Ferrucci (1991), Acevedo-Rodríguez (1993), Guarim Neto (1994), Martínez (1997), Somner (1997), Ferrucci (1998), Somner (2001 b) and Somner et al. (2009).

The taxa were described morphologically and illustrated using a Carl Zeiss stereoscopic microscope, equipped with a camera lucida. Subsequently, an analytical key was constructed to identify the species treated here. The abbreviation of the names of the authors of species binomials follow Flora do Brasil (2020), The International Plant Name Index (IPNI 2021) and The World Flora Online (WFO 2022). The acronyms for the herbaria are in accordance with the Index Herbariorum (Thiers 2017). The terminology used for leaf architecture and indument follows Hickey & King (2000), and that for fruits is according to Barroso et al. (1999). The abbreviations used are: fl. – flowers; fr. – fruits; s.d. – no dates; s.n. – no numbers; st. – sterile.

For every species catalogued in the study area, we recorded its occurrence in each restinga vegetational formation, and its geographic distribution in Brazil and other countries. For the description of the vegetation of Brazil we used the classification of Veloso et al. (1991), and for the restinga vegetation formations we adopted Menezes & Araujo (2005).

For citation of examined material, at least one specimen per municipality (Mun.) was selected when there were many specimens for the same location, and a list of all studied specimens is presented (see in the section “Data availability”).

For making the distribution maps we used the geographic coordinates when available in the specimen label data, and when these were absent, we used Google Earth (Google Earth website 2022) to georeference the points using precise information from the specimen localities, and these data were used to build the maps with QGIS software (QGIS.org 2020).

The extinction threats of all species were examined and their conservation status was then classified according to IUCN (2019) categories and criteria: for the extent of occurrence (EOO) a polygon was made on the map to measure the area formed by the triangulation of the points of occurrence for each taxon, and the quantitative criteria and subcategories was based on geographic range information. Important references were also consulted, such as Livro Vermelho da Flora do Brasil (Martinelli & Moraes 2013), Livro Vermelho da Flora Endêmica do Estado do Rio de Janeiro (Martinelli et al. 2018) and the Centro Nacional de Conservação da Flora (CNCFlora) database.

In this work we presented morphologic descriptions and identification key of the species, as well as taxonomic comments, phenological data, geographic distribution, occurrence in the vegetation formations and conservation status of the taxa.

Results

The climbing plants of tribe Paullinieae (Sapindaceae) are represented in Rio de Janeiro’s restinga vegetation by 30 species in five genera: *Cardiospermum* (Fig. 1A,D), *Paullinia* (Fig. 1C,E), *Serjania* (Fig. 1B,F), *Thinouia* (Fig. 1G) and *Urvillea* (Fig. 1H): *Cardiospermum corindum* L., *Paullinia coriacea* Casar., *P. ferruginea* Casar., *P. meliifolia* Juss., *P. micrantha* Cambess., *P. pseudota* Radlk., *P. revoluta* Radlk., *P. ternata* Radlk., *P. trigonia* Vell., *P. weinmannifolia* Mart., *Serjania caracasana* (Jacq.) Willd., *S. clematidifolia* Cambess., *S. communis* Cambess., *S. confertiflora* Radlk., *S. corrugata* Radlk., *S. cuspidata* Cambess., *S. dentata* (Vell.) Radlk., *S. eucardia* Radlk., *S. fluminensis* Acev. Rodr., *S. ichthyoctona* Radlk., *S. littoralis* Somner & Ferrucci, *S. pernambucensis* Radlk., *S. salzmanniana* Schldt., *S. tenuis* Radlk., *S. thoracoides* Radlk., *Thinouia mucronata* Radlk., *T. restingae* Ferrucci & Somner, *Urvillea glabra* Cambess., *U. rufescens* Cambess. and *U. stipitata* Radlk.

Among these species, 23 are restricted to Brazil (only *Cardiospermum corindum*, *Paullinia meliifolia*, *Serjania caracasana*, *S. clematidifolia*, *S. communis*, *S. confertiflora* and *Thinouia mucronata* also occur in other countries) and these are mainly found in the southeastern and southern regions of the country. Twenty-eight species also occur in three other vegetation formations of the Atlantic Forest domain (dense ombrophilous forests, seasonal deciduous forests, seasonal semi deciduous forests). Sixteen species are distributed in the coastal regions of Brazil, of which four are endemic to Rio de Janeiro state (*Serjania eucardia*, *S. fluminensis*, *S. littoralis* and *S. tenuis*), and only two are restricted to the sandy coastal plains (*Serjania fluminensis* and *S. littoralis*). In addition, 11 species were also found in other phytogeographic domains such as savanna (*cerrado*), *caatinga* and gallery forests (Table 1).

In the sandy coastal plains, woody climbers of the Sapindaceae were recorded in eight vegetation formations. The formation with the highest species richness was the ridge forest (27 species), followed by dune thickets (12), non-flooded scrub (10), seasonally flooded forests (5),

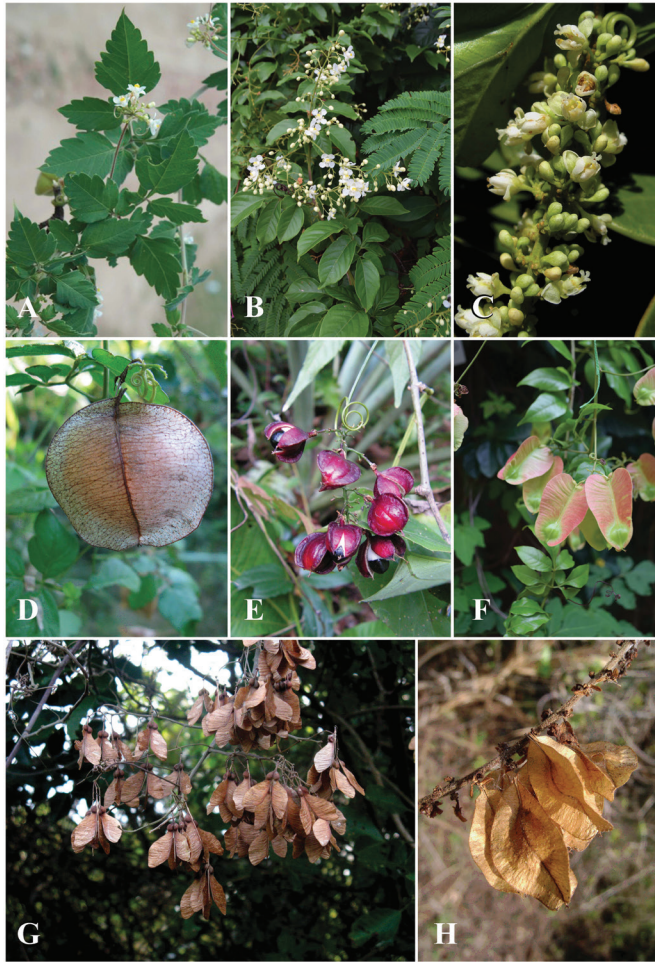


Figure 1. Flowers of – A. *Cardiospermum corindum* L.; B. *Serjania corrugata* Radlk.; C. *Paullinia weinmanniifolia* Mart. Fruits of – D. *Cardiospermum corindum* L.; E. *Paullinia meliifolia* Juss.; F. *Serjania corrugata* Radlk.; G. *Thinouia restingae* Ferrucci & Somner; H. *Urvillea rufescens* Cambess.

flooded scrub (4), ridge palmoids and beach thickets (2 species each), and only *Cardiospermum corindum* was found in beach graminoid (Table 2). *Serjania truncata* was recorded by Radlkofer (1931–1934) for Rio de Janeiro state as occurring in the municipality of Cabo Frio, collected by H. Schenck (without collector's number). However, this species was not found in any of the national or international herbaria consulted (online search), nor was it observed in the field survey, and so we were not able to describe it or confirm its occurrence in the sandy coastal plains.

Paullinieae (Kunth) DC., Prodr. 1: 601. 1824

Woody or herbaceous climbers, exceptionally erect shrubs or hemi-cryptophytic shrubs, monoecious, with a pair of tendrils, lenticellate; very often with white, milky latex; stems in cross section with a single vascular cylinder or multiple vascular cylinders; stipules minute to foliaceous, persistent or deciduous. Leaves alternate, with a distal leaflet, variously pinnate trifoliolate, biternate, partially tripinnate, rarely unifoliolate; leaflets generally with pilose domatia on the abaxial surface. Thyse axillary or terminal, racemiform, spiciform or paniculiform, or cauliflorous. Flowers functionally unisexual, zygomorphic or actinomorphic (*Thinouia*); sepals 4–5, concave; petals 4–5, free, unguiculate; petals 5, spatulate, each leading to a basal,

petaloid, bifid appendage (*Thinouia*) or petals 4 (other genera), with glandular trichomes, and hooded appendages with fleshy yellow crests, the two symmetrical posterior ones having a deflected ligule just below the crest, the other two anterior appendages asymmetrical and unilobed; disk extrastaminal, less often annular (*Thinouia*) or unilateral (other genera) and 2- or 4-lobed; stamens 8, surrounding a pistillode; anthers dorsifixed and introrse, rimose; ovary superior, tricarpeal, trilocular, one ovule per carpel; staminodes 8, similar to stamens, surrounding a gynoeceum; stigma trifid. Fruits a septifragal capsule or schizocarps with three samaroid mericarps, with seminiferous portion of the mericarp proximal (*Thinouia*) or distal (*Serjania*); seeds ariloid or exarillate; embryo with straight, curved or plicate cotyledons; radicle-hypocotyl axis short.

Key for identification of Paullinieae species in the restingas of the state of Rio de Janeiro

1. Fruit a schizocarp, with three samaroid mericarps
 2. Thyse umbelliform; flowers actinomorphic; petals 5, samaroid mericarps with seminiferous portion in the proximal part of mericarp, with upward vertical wings
 3. Leaflet sub-coriaceous, with entire margin *Thinouia restingae*
 3. Leaflet chartaceous, with serrate-dentate margin *Thinouia mucronata*
 2. Thyse never umbelliform, generally racemiform, rarely sub-spiciform; flower zygomorphic; petals 4; samaroid mericarps with seminiferous portion in the distal part of mericarp, with descending vertical wings
4. Stem in cross section with only one vascular cylinder
 5. Leaves trifoliolate
 6. Stem puberulous when young, glabrescent when mature, with orange glandular trichomes, not hollow; leaflets not conduplicate, margin entire, less frequently with 1 or 2 glandular obtuse teeth in basal third, with a yellowish cartilaginous line; samaroid mericarps 1.4–2.4 × 1.3–2.5 cm *Serjania littoralis*
 6. Stem hollow, glabrous, without glandular trichomes; leaflets conduplicate, margin dentate-repand, without a yellow cartilaginous line; samaroid mericarps 3.2–3.4 × 2.7–3 cm *Serjania dentata*
 5. Leaves biternate or 5-foliolate
 7. Stem ferruginous-tomentose; samaroid mericarps sub-coriaceous, ferruginous-tomentose *Serjania pernambucensis*
 7. Stem pubescent or velutinous-pubescent; samaroid mericarps chartaceous, glabrous or puberulous
 8. Stem velutinous-pubescent; leaves always biternate, not bullate, leaflets densely velutinous-pubescent on both surfaces; samaroid mericarps 3.8–5 × 3.6–4.5 cm, puberulous, with dorsal crest 2–5 mm wide *Serjania eucardia*

8. Stem pubescent; leaflet 5-foliolate or biternate, bullate, leaflets pubescent on both surfaces; samaroid mericarps 1.7–2.8 × 1.5–2 cm, glabrous, lacking dorsal crest *Serjania salzmannaiana*
4. Stem compound or divided, with 5 radiate vascular cylinder
9. Stem in cross section divided, with 5 radiate vascular cylinders and one tiny central vascular cylinder; leaves fragrant when dry; reddish glandular trichomes distributed throughout the plant *Serjania corrugata*
9. Stem in cross section composed of one central vascular cylinder and 3–10 smaller peripheral vascular cylinders; leaves not fragrant when dry; without reddish glandular trichomes distributed throughout the plant
10. Stem composed of one central vascular cylinder and 8–10 smaller peripheral vascular cylinders
11. Terminal leaflets elliptic, margin entire or dentate-repand; schizocarp sub-coriaceous, up to 4.7 cm long, seminiferous portion of mericarp with a dorsal crest *Serjania fluminensis*
11. Terminal leaflets lanceolate or rhomboidal to ovate, margin serrate-dentate or serrate-crenate; schizocarp chartaceous, up to 2.9 cm long, seminiferous portion of mericarp without a dorsal crest
12. Stem with conspicuous ribs; stipules ovate, 0.5–1 mm long; terminal leaflet rhombic to ovate, margin serrate-crenate; ovary tomentose; schizocarp chartaceous, 2.5–2.7 × 2–2.2 cm, with a lateral depression in the seminiferous portion of the mericarp *Serjania clematidifolia*
12. Stem with inconspicuous ribs; stipules triangular; 1–1.5 mm long; terminal leaflet lanceolate, margin serrate-dentate; ovary puberulous; schizocarp sub-coriaceous, 2.7–4.7 × 2.4–4.4 cm, without a lateral depression in the seminiferous portion of the mericarp *Serjania caracasana*
10. Stem composed of one central vascular cylinder and 3 smaller vascular peripheral cylinders
13. Stem 6-costate, leaflets with dentate-incise margin, with a pair of basal incisions *Serjania confertiflora*
13. Stem 3-costate; leaflets with margin entire, serrate-crenate or serrate-dentate, lacking a pair of basal incisions
14. Leaves biternate
15. Margin of leaflets serrate-crenate; sepals 4; samaroid mericarp with seminiferous portion laterally flattened; seeds elliptic-lenticular *Serjania communis*
15. Margin of leaflets entire or serrate-dentate; sepals 5; samaroid mericarps with seminiferous portion globose; seeds globose
16. Leaflets coriaceous, both surfaces glabrous, margin entire; crest of posterior appendage of petals bicorniculate; schizocarp 2.7–2.8 cm long; cotyledons more-or-less straight *Serjania ichtyoctona*
16. Leaflets chartaceous, adaxial surface pubescent on the midvein and abaxial surface rarely puberulous, margin serrate-dentate; crest of posterior appendage of petals erose; schizocarp 1.5–1.7 cm long; cotyledon externally curved and internally biplicate *Serjania thoracoides*
14. Leaves trifoliolate
17. Stipules linear; leaflets with acute or cuspidate apex; stem ferruginous-hirsute at the angles; samaroid mericarps pubescent; cotyledons more-or-less straight *Serjania cuspidata*
17. Stipules deltoid; leaflets with acuminate apex; stem lacking ferruginous-hirsute trichomes at the angles; samaroid mericarps glabrous; cotyledon externally curved and internally biplicate *Serjania tenuis*
1. Fruit a septifragal capsule
18. Capsules sub-chartaceous, seeds with small aril around the hilum
19. Stem 5–6-costate; leaves biternate; capsule not winged, subglobose to globose or large-obovoid, totally inflated *Cardiospermum corindum*
19. Stem tricostate; leaves trifoliolate; capsule three winged, ellipsoid, inflated only in the central portion
20. Leaflets with margin serrate, with 2 or 3 pairs of teeth close to the apex; capsules glabrous *Urvillea glabra*
20. Leaflets with margin dentate-crenate or serrate-dentate, with teeth along the entire margin; capsule pubescent
21. Adaxial surface of leaflets with orange glandular trichomes; leaflet margin dentate-crenate; flowers ca. 2.5 mm long; capsules 1.8–2.2 cm long *Urvillea rufescens*
21. Adaxial surface leaflets without orange glandular trichomes; leaflet margin serrate-dentate; flowers 5–6 mm long; capsules 2.3–2.8 cm long *Urvillea stipitata*
18. Capsules crustaceous or coriaceous, seed with fleshy ariloid, covering the seed entirely or up to 3/4 of its surface
22. Leaflet abaxial surface and fruit epicarp densely ferruginous-tomentose; capsules not winged, crustaceous, stipe 1.8–3 cm long *Paullinia ferruginea*

22. Leaflet abaxial surface and fruit epicarp not densely ferruginous-tomentose; capsules winged, coriaceous, stipe 0.5–1.5 mm long
23. Leaves trifoliolate
24. Capsules suborbicular, with extra triangular appendages *Paullinia weinmanniifolia*
24. Capsules obovate or obtriangular, without extra triangular appendages
25. Leaves deciduous in the flowering period; leaflets sub-chartaceous, margin obtuse-dentate; thyrses cauliflorous, fasciculate; sepals 5; capsules obtriangular, 2.6–3 cm long, pubescent *Paullinia ternata*
25. Leaves not deciduous in the flowering period; leaflets sub-coriaceous, margin entire; thyrses not cauliflorous; sepals 4; capsules obovate, 1.4–1.7 cm long, glabrous *Paullinia coriacea*
23. Leaves pinnately 5-foliolate, or biternate, or 11–13-foliolate
26. Leaves pinnately 5-foliolate
27. Capsules suborbicular, with extra triangular appendages *Paullinia weinmanniifolia*
27. Capsules obovate or ob-triangular, without triangular appendages
28. Leaflets glabrous on both sides; basal leaflets generally with one or two pairs of extra basal reduced leaflets; capsules obovate, glabrous, with laterally inflected margin *Paullinia pseudota*
28. Leaflets pubescent on both sides or abaxial surface pubescent only on midvein; basal leaflets without extra basal reduced leaflets; capsules obtriangular, pubescent, without laterally inflected margin *Paullinia revoluta*
26. Leaves biternate or pinnately 11–13-foliolate
29. Stipules leafy, falcate, cuneiform or asymmetric; sepals 5; capsules with lanose endocarp; cotyledons more-or-less straight *Paullinia meliifolia*
29. Stipules not leafy, deltoid; sepals 4; capsules with endocarp tomentose only on the valve margins; cotyledons curved externally and biplicate internally
30. Stem sub-cylindric, 5-costate; stipules triangular; petiole unwinged, bicanaliculate; leaflet margins entire; capsules obtriangular *Paullinia revoluta*
30. Stem cylindric, striate; stipules deltoid; petiole marginate; leaflet margins serrate-dentate; capsules elliptic or obovate
31. Stem brown or dark brown *Paullinia trigonia*
31. Stem yellowish brown *Paullinia micrantha*

***Cardiospermum corindum* L., Sp. pl. ed. 2: 526. 1762**

Semi-woody climbers; stem greenish, 5–6 costate, hollow, pubescent, with a single vascular cylinder in cross section; stipules subulate, 1–1.5 mm long; petiole unwinged, canaliculate; rachis marginate or canaliculate. Leaves biternate; leaflets 1.4–4 × 0.5–2 cm, ovate, sub-chartaceous, apex attenuate to acuminate, mucronate, margin serrate-dentate, adaxial surface puberulous on the midvein, abaxial surface puberulous, without domatia, mixed craspedodromous venation. Thyrses axillary, racemiform, 0.6–1.4 long, with (3)4 or more sub-verticillate cincinni, peduncle of cincinni 0.6–1.5 cm long, pilose; bracts triangular. Flowers zygomorphic, 6–8 mm long; sepals 4; petals 4, obovate, crest of posterior petal appendage erose or emarginate; nectariferous lobes 4, posterior ovoid, anterior ovoid, much reduced; stamens 1.5–3.5 mm long; puberulous fillets, staminodes 2–2.5 mm long; ovary ca. 2 mm long, trigonous-ellipsoid, villose. Capsules 2.7–4.3 × 2.2–4 cm, unwinged, subglobose to globose, or large-obovoid, totally inflated, chartaceous, puberulous, stipe 1–5 mm long, endocarp glabrous; seeds 3, globose; aril semi-circular, sometimes emarginate; embryo with outer cotyledon curved and inner biplicate (Figures 1A, 4A–D).

Cardiospermum corindum is a cosmopolitan species. In America, it extends from the United States to central Argentina, and in Brazil occurs in all most states. It is found in the following plant formations: restinga, dense ombrophilous forests, seasonal deciduous forests, seasonal semi-deciduous forests and savanna (Figures 2A, 3). In the restinga, this species is found in the beach graminoid, non-flooded scrub and ridge forest formations. Flowering and fruiting occur throughout the year. According to CNCFlora (2012), this species is evaluated by its conservation status as endangered Least Concern (LC).

This species can be identified easily by the thyrses, comprising three, four or more sub-verticillate cincinni, and the sub-globose to globose or large-obovoid, totally inflated fruits with three seeds.

Selected materials: **BRAZIL**. RIO DE JANEIRO: Mun. Armação dos Búzios, Restinga da Praia Gorda, 9.VI.2008, fl. e fr., *M.S. Faria et al.* 86 (RB, RBR); idem, 9.VI.2008, fl., *M.S. Faria et al.* 87 (RB); Mun. Cabo Frio, Estação Radiométrica da Marinha, 2.IV.2008, fr., *M.S. Faria et al.* 69 (RB, RBR); Mun. Niterói, Ponta de Itaipu, 6.IX.78, fl. e fr., *G. Martinelli* 4907 (RB); Mun. Rio das Ostras, Restinga de Balneário das Graças, 1.V.1999, fl., *H.N. Braga* 262 (RB); Mun. Rio de Janeiro, Restinga da Barra da Tijuca, 3.IX.1979, fr., *Paulino s.n.* (HB 68460); Mun. Saquarema, R. E. E. de Jacarepiá, restinga de Ipitangas, 28.IX.1990, fl. e fr., *G.V. Somner et al.* 618 (RBR).

***Paullinia coriacea* Casar., Nov. Stirp. Bras. Dec. 3: 27. 1842**

Woody climbers or suberect shrubs; stem brown, grayish-brown or yellowish brown, sub-cylindrical, striate, glabrous, with a single vascular cylinder in cross section; stipules deltoid, 0.5–1 mm long; petiole unwinged, canaliculate. Leaves trifoliolate; leaflets 2.2–8 × 1.3–4 cm, elliptic or ovate-lanceolate, sub-coriaceous, apex acute or obtuse, margin revolute, both side glabrous, with domatia, venation brochidodromous. Thyrses axillary and terminal, racemiform, 1–4.5 cm long, pubescent;

Table 1. Brazilian vegetational formations where the climbing Sapindaceae species studied here are found.

Espécies	Rest.	DOF	SDF	SSF	Sav.	Caat.	GF
<i>Cardiospermum corindum</i>	x	x	x	x	x		
<i>Paullinia coriacea</i> *	x						
<i>Paullinia ferruginea</i> *	x	x					
<i>Paullinia meliifolia</i>	x	x		x			
<i>Paullinia micrantha</i> *	x	x	x				
<i>Paullinia pseudota</i> *	x	x			x		
<i>Paullinia revoluta</i> *	x	x		x		x	
<i>Paullinia ternata</i> *	x						
<i>Paullinia trigonia</i> *	x	x		x			
<i>Paullinia weinmanniifolia</i> *	x	x		x			
<i>Serjania caracasana</i>	x	x	x	x	x		
<i>Serjania clematidifolia</i>	x	x	x		x		
<i>Serjania communis</i>	x	x		x	x		
<i>Serjania confertiflora</i>	x	x			x		
<i>Serjania corrugata</i> *	x	x					
<i>Serjania cuspidata</i> *	x	x					
<i>Serjania dentata</i> *	x	x	x				
<i>Serjania eucardia</i> **	x	x					
<i>Serjania fluminensis</i> **	x						
<i>Serjania ichthyoctona</i> *	x	x	x	x			
<i>Serjania littoralis</i> **	x						
<i>Serjania pernambucensis</i> *	x	x		x	x		
<i>Serjania salzmanniana</i> *	x	x		x	x		
<i>Serjania tenuis</i> **	x	x					
<i>Serjania thoracoides</i> *	x	x					
<i>Thinouia mucronata</i>	x	x		x			x
<i>Thinouia restingae</i> *	x	x		x			
<i>Urvillea glabra</i> *	x	x					
<i>Urvillea rufescens</i> *	x	x		x			
<i>Urvillea stipitata</i> *	x	x			x		
Total	30	26	6	13	9	1	1

Restinga (Rest.); Dense Ombrophylous Forest (DOF); Seasonal Deciduous Forest (SDF); Seasonal Semideciduous Forest (SSF); Savana (Sav.); Caatinga (Caat.); Gallery Forest (GF). *: restricted species to Brazil; **: restricted species to Rio de Janeiro.

bracts triangular. Flowers zygomorphic, 3.5–4.5 mm long; sepals 4; petals 4, crest of posterior petal appendage erose or emarginate; nectariferous lobes 4, posterior ovoid, anterior orbicular, reduced; stamens 1.5–2 mm long, pubescent fillets, surrounding a pistilode, staminodes 1–2 mm long, surrounding a gynoeceium; ovary 1–1.5 mm long, trigonous-ovoid, puberulous on the angles. Capsules 1.4–1.7 × 1–8 cm, winged, obovate, sub-coriaceous, glabrous, stipe ca. 0.5 mm long, endocarp tomentose on the valve margins; seeds 1–3, obovoid; ariloid bilobate; embryo with outer cotyledon curved and inner biplicate (Figures 4E–I).

Paullinia coriacea is endemic to Brazil, occurring in the states of Paraná, Rio de Janeiro and São Paulo (Figures 2A, 3). It is found

exclusively in the sandy coastal plain formations, and occurs in the ridge palmoid, non-flooded scrub, dune thicket, seasonally flooded swamp and ridge forest formations. Flowering occurs from December to July and fruiting from January to October. The conservation status of this species is evaluated here as vulnerable (VU), with an extent of occurrence (EOO) of approximately 10600 km² (B1 <20000 km²). It occurs exclusively in some restinga areas, environments that have been suffering from degradation (B2b (i,iii)).

In this study, this species differs from other *Paullinia* by the following characters: trifoliolate leaves; leaflet glabrous, with entire margin, venation brochidodromous; endocarp tomentose on the valve margins; seeds 1–3.

Table 2. Climbing Sapindaceae species and their occurrence in the vegetation formations of the fluminenses's restingas.

Species	BG	RP	nFS	FS	DT	BT	SFF	RF
<i>Cardiospermum corindum</i>	x		x					x
<i>Paullinia coriacea</i>		x	x		x		x	x
<i>Paullinia ferruginea</i>								x
<i>Paullinia meliifolia</i>						x		x
<i>Paullinia micrantha</i>								x
<i>Paullinia pseudota</i>					x	x		x
<i>Paullinia revoluta</i>								x
<i>Paullinia ternata</i>								x
<i>Paullinia trigonia</i>							x	x
<i>Paullinia weinmanniifolia</i>		x	x	x	x			
<i>Serjania caracasana</i>							x	x
<i>Serjania clematidifolia</i>								x
<i>Serjania communis</i>								x
<i>Serjania confertiflora</i>								x
<i>Serjania corrugata</i>			x					
<i>Serjania cuspidata</i>			x		x			x
<i>Serjania dentata</i>			x	x	x			x
<i>Serjania eucardia</i>			x		x			x
<i>Serjania fluminensis</i>								x
<i>Serjania ichthyoctona</i>			x	x				x
<i>Serjania littoralis</i>								x
<i>Serjania pernambucensis</i>								x
<i>Serjania salzmanniana</i>			x	x	x		x	x
<i>Serjania tenuis</i>								x
<i>Serjania thoracoides</i>					x			
<i>Thinouia mucronata</i>					x			x
<i>Thinouia restingae</i>					x			x
<i>Urvillea glabra</i>			x					x
<i>Urvillea rufescens</i>					x		x	x
<i>Urvillea stipitata</i>					x			x
Total	1	2	10	4	12	2	5	27

BG – Beach Graminoid; DT – Dune Thicket; nFS – non-Flooded Scrub; FS – Flooded Scrub; RP – Ridge Palmoid; BT – Beach Thicket; SFF – Seasonally Flooded Forest; RF – Ridge Forest.

Selected materials: **BRAZIL**. RIO DE JANEIRO: Mun. Angra dos Reis, Ilha Grande, Reserva Biológica Estadual da Praia do Sul, Praia do Leste, 15.V.1984, fr., *D. Araujo*, 6270 (GUA); Mun. Armação de Búzios, Praia Rasa, sitio Tauá, 8.I.2002, fl., *R.C.C. Reis et al.* 247 (RB); Mun. Arraial do Cabo, próximo a enseada de Tucuns, 29.III.2005, fr., *D. Araujo* 10874 (GUA); Mun. Cabo Frio, Estação Radiométrica da Marinha, 2.IV.2008, fr., *M.S. Faria et al.* 72 (RB); Mun. Mangaratiba, Ilha da Marambaia, próximo a lagoa vermelha, 6.VII.1993, fr., *G.V. Somner & A. Ururahy* 761 (RBR); Mun. Maricá, Restinga de Maricá, 18.VI.1937, fl., *A. Souza* 1684 (R); Mun. Niterói, Itaipuaçu, 15.II.1985, fr., *V.F. Ferreira* 3953 (GUA); Mun. Parati, próximo ao Rio São Gonçalo, 10.VII.2008, fr., *M.S. Faria* 109 (RB); Mun. Rio de Janeiro, Restinga da Marambaia, 2.IX.2007, fr., *M.S. Faria & A. Pacheco Jr.* 27 (RB).

Paullinia ferruginea Casar., Nov. Stirp. Bras. Dec. 3: 28. 1842

Woody climbers or erect shrubs; stem yellowish brown, cylindrical, 8–10-costate, hollow, young densely ferruginous-tomentose, mature glabrescent, with a single vascular cylinder in cross section; stipules triangular, 1–1.5 mm long; petiole and rachis unwinged, canaliculate. Leaves 5-foliolate; leaflets 4–10.7 × 2.8–6 cm, ovate or elliptic, subcoriaceous, apex obtuse, acute or acuminate, margin remotely dentate, adaxial surface sub-glabrous or pubescent ferruginous, abaxial surface densely ferruginous hirsute-tomentose, sometimes with pocket domatia, venation semicraspedodromous. Thyse axillary and terminal, spiciform, 2.5–9 cm long, ferruginous hirsute-tomentose; bracts triangular. Flowers zygomorphic, 3.5–4 mm; sepals 4; petals 4, crest of posterior petal appendage emarginate or bifid; nectariferous lobes 2, posterior ovoid,

Paullinieae of the restingas of Rio de Janeiro

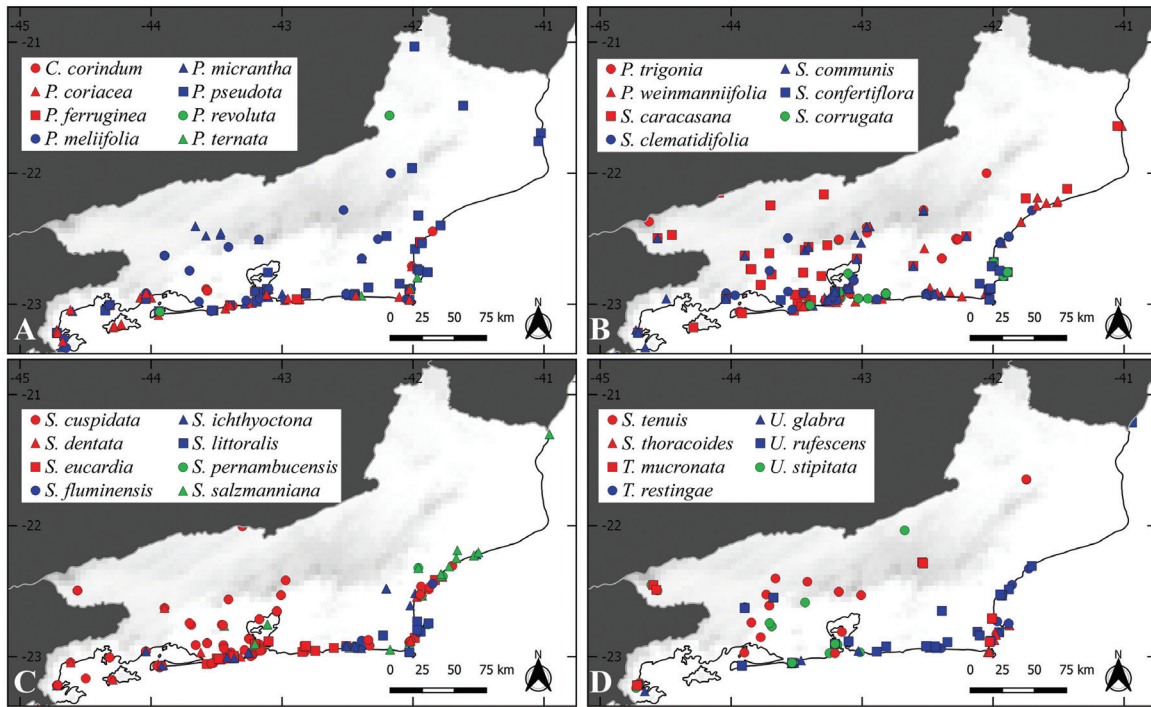


Figure 2. Distribution maps of climbing species of Sapindaceae in Rio de Janeiro.

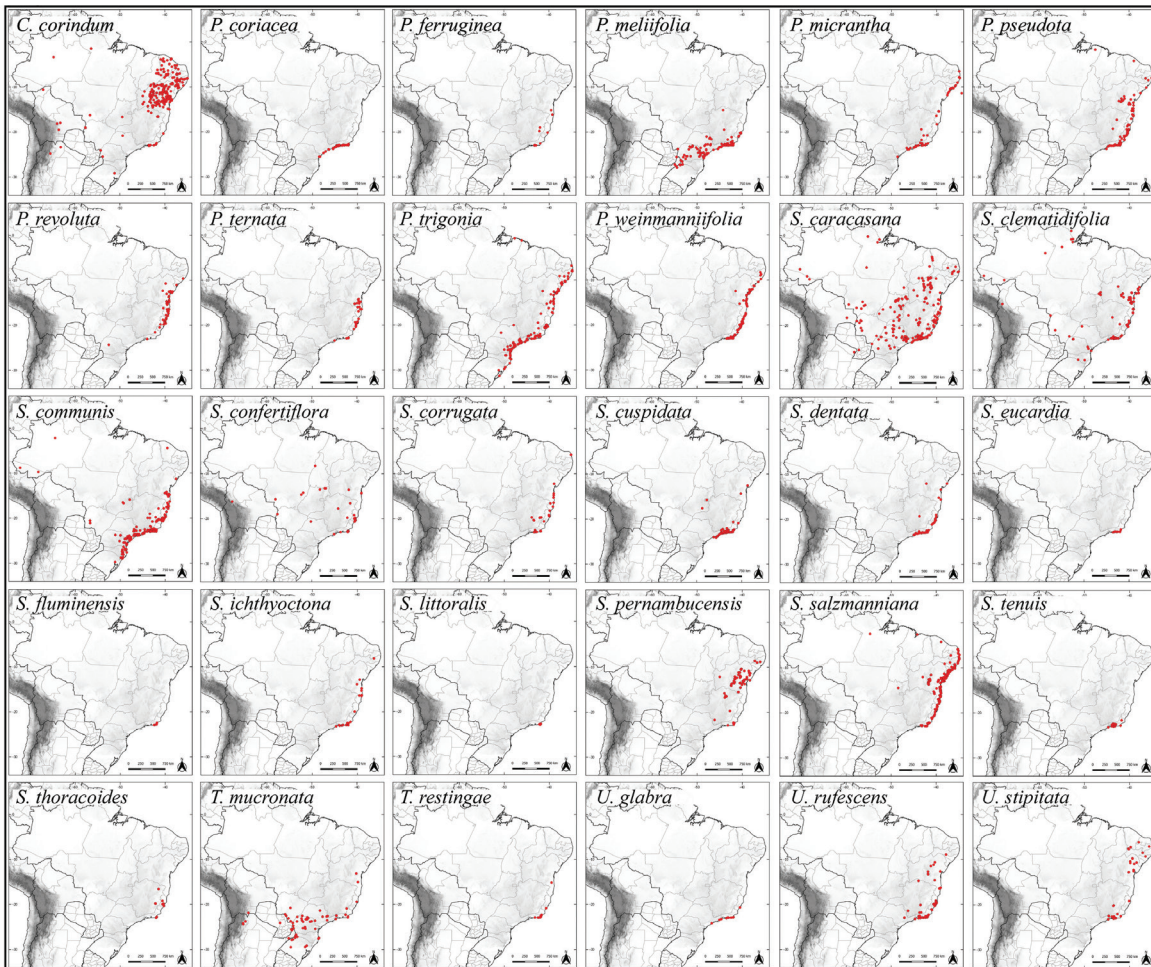


Figure 3. Maps of the complete distribution of climbing species of Sapindaceae studied here.

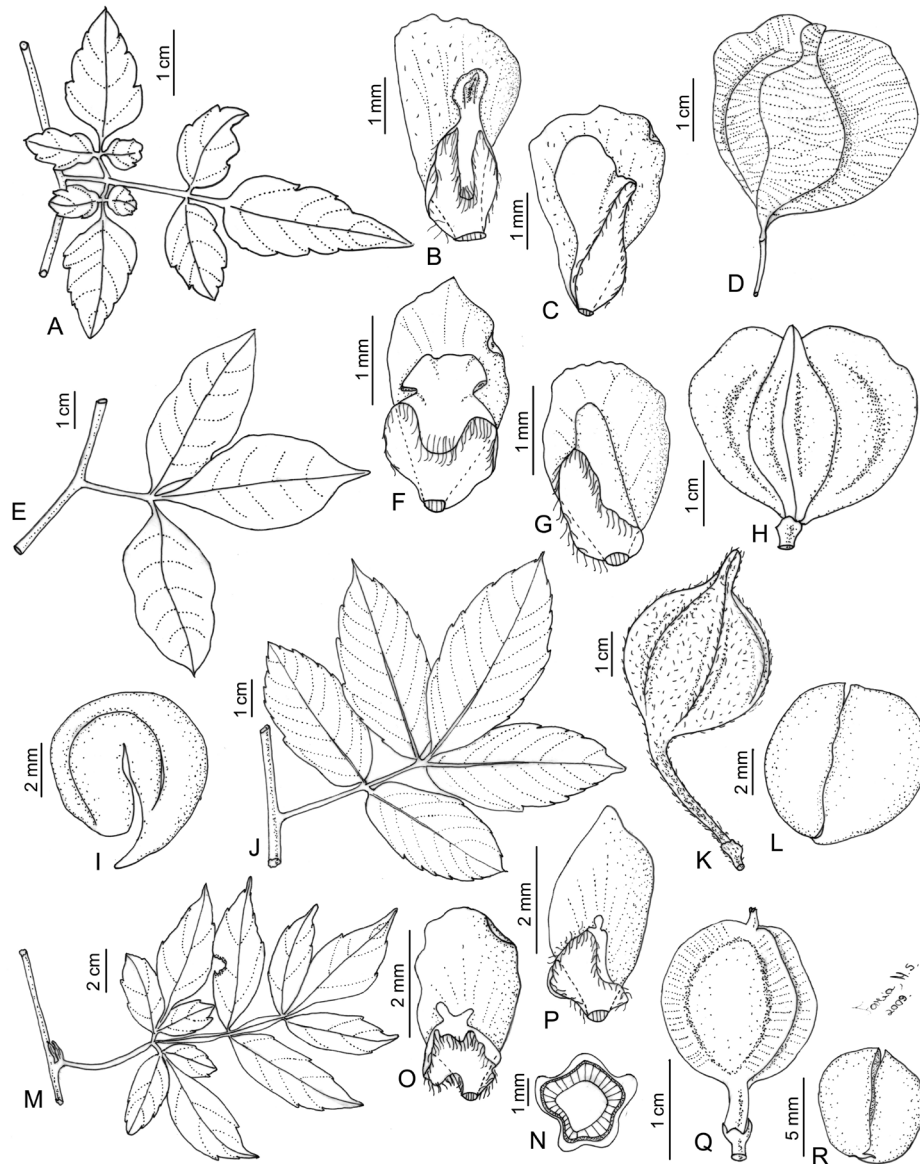


Figure 4. *Cardiospermum corindum* – A. biternate leaf; B. posterior petal; C. anterior petal; D. fruit. *Paullinia coriacea* – E. trifoliolate leaf; F. posterior petal; G. anterior petal; H. fruit; I. embryo. *P. ferruginea* – J. 5-foliolate leaf; K. fruit; L. embryo. *P. meliifolia* – M. biternate leaf; N. cross section of the stem; O. posterior petal; P. anterior petal; Q. fruit; R. embryo. (A–D: M. S. Faria & L. Pederneras 86; E: M. S. Faria et al. 72; F–G: D. Sucre et al. 6443; H–I: M. S. Faria & A. Pacheco Jr. 27; J–L: A.P. Duarte 110; M–N: D. Sucre 1913; O–P: D. Sucre 3964; Q–R: D. Sucre 3139. Illustrator M. S. Faria)

anterior absent; stamens 2–3 mm long, villose fillets, surrounding a pistilode, staminodes 2–2.2 mm long, surrounding a gynoeceium; ovary ca. 2 mm long, ellipsoid, densely ferruginous-tomentose. Capsules 1.4–1.7 × 1.1–1.9 cm, unwinged, globose, crustose, densely ferruginous-tomentose, stipe 1.8–3 cm long, endocarp pubescent; seed solitary; arilloid bilobate; embryo with cotyledons more-or-less straight (Figures 4J–L).

Paullinia ferruginea is endemic to Brazil, occurring in the states of Bahia, Espírito Santo, Minas Gerais and Rio de Janeiro in restinga (ridge forest) or in dense ombrophilous forests (Figures 2A, 3). Flowering occurs in October and fruiting in April and July. The taxon has been evaluated based on the IUCN (2019) criteria as Least Concern (LC).

In this study, this species differs from other *Paullinia* by the following characters: densely ferruginous-tomentose indumentum in the whole plant, long-petiolate; capsules unwinged, globose, 6-costate, crustose; seed solitary.

Selected materials: **BRAZIL.** RIO DE JANEIRO: Mun. Rio de Janeiro, Restinga da Gávea, 7.X.1867, fr., *A. Glaziou 1323* (R); Mun. Maricá, Área de Proteção Ambiental (APA) de Maricá, em frente à INFRAERO, borda da floresta de restinga, 26.V.2010, fl. fr., *G.V. Somner et al. 1521* (RBR); Entre Paineira e Corcovado, 19.V.1959, fr., *A.P. Duarte 478 & E. Pereira* (US); Mun. Botafogo, Mundo Novo, IV.1920, fl., fr., *J.G. Kuhlmann s/n* (RB 15.631).

***Paullinia meliifolia* A. Juss., Ann. Mus. Natl. Hist. Nat. 4: 347. 1804**

Woody climbers; stem grayish-brown or greenish-brown, 5–6-furrowed when young, sub-cylindrical when mature, hirsute, glabrescent to glabrous, with a single vascular cylinder in cross section; stipules 0.8–1.8 cm long, leafy, falcate, cuneiform; petiole unwinged, canaliculate; rachis winged. Leaves biternate or pinnately 11–13-foliolate, basal leaflets trifoliolate; leaflets 2.1–11 × 1–4.9 cm, lanceolate, sub-chartaceous, apex acuminate to cuspidate, margin serrate-dentate, subrevolute, adaxial surface puberulous on the midvein and abaxial surface pubescent, with domatia, venation mixed craspedodromous. Thyse axillary and terminal, racemiform, 1.5–12 cm long, puberulous; bracts triangular. Flowers zygomorphic, 6–7.5 mm; sepals 5; petal 4, crest of posterior petal appendage emarginate; lobes nectariferous 4, posterior ovoid, anterior orbicular, reduced; stamens 2–2.5 mm long, puberulous fillets, surrounding a pistilode, staminodes 1–2 mm long, surrounding a gynoeceium, ovary ca. 1.5 mm long, trigonous-ovoid, puberulous at the angles. Capsules 1.5–1.9 × 1.2–1.7 cm, winged, obovoid, subcoriaceous, glabrous, stipe 1–4.5 mm long, endocarp lanose; seed solitary, ovoid or ellipsoid; ariloid bilobate; embryo with cotyledons more-or-less straight (Figures 4M–R).

Paullinia meliifolia occurs in northeastern Argentina, the eastern region of Paraguay and in the Brazilian states of Espírito Santo, Mato Grosso do Sul, Minas Gerais, Paraná, Rio de Janeiro, Rio Grande do Sul, Santa Catarina and São Paulo (Figures 2A, 3). It is found in the following plant formations: sandy coastal plain, dense ombrophilous forest and seasonal semideciduous forest formations. In restinga, it occurs in beach thicket and ridge forest formations. Flowering occurs from October to December and in February, and fruiting from September to July. The taxon has been evaluated based on the IUCN (2019) criteria as Least Concern (LC).

In this study, this species differs from other *Paullinia* by the following characters: young stem 5–6-costate or 5–6-furrowed, mature stem sub-cylindrical, stipules leafy, falcate cuneiform; leaves biternate or 11–13-foliolate; capsules 3-winged, seed solitary.

Selected materials: **BRAZIL**. RIO DE JANEIRO: Mun. Arraial do Cabo, Reserva Ecológica Estadual de Massambaba, próximo a lagoa salgada, 26.X.1993, fr., *G.V. Somner s.n* (RB 313040); Mun. Cabo Frio, Restinga de Cabo Frio, 26.X.1968, fl., *D. Sucre 3964* (RB); idem, 7. VI. 1968, fr., *D. Sucre, 3138* (RB); Mun. Mangaratiba, 16.II.2001, fr., *L.F.T. Menezes & M.C. Souza 792* (RBR); Mun. Niterói, Itaipuaçu, 15.X.1991, fr., *V.F. Ferreira 3943* (GUA); Mun. Rio das Ostras, Restinga da Praia Virgem, 14.XII.1999, fl. e fr., *H.N. Braga, 722* (RB); Mun. Rio de Janeiro, Restinga da Tijuca, 4.IV.1943, fr., *O.X.B. Machado s.n* (RB 75365); Mun. Saquarema, Reserva Ecológica Estadual de Jacarepiá, 12.II.1992 fl., *D. Araujo & C. Farney 9583* (GUA).

***Paullinia micrantha* Cambess., A. St.-Hil., A. Juss. & Cambess., Fl. Bras. Merid. 1: 373. 1828**

Woody climbers; stem yellowish brown, cylindrical, 5–6-striate, puberulous, with a single vascular cylinder in cross section. Leaves pinnate, 11–13 foliolate or biternate, with basal leaflets trifoliolate; stipules 0.5–1 mm long, triangular; petiole unwinged, canaliculate;

rachis bi-canaliculate to winged; leaflets 1–10 × 0.5–3 cm, subcoriaceous, sub-rhomboidal, elliptic or ovate, apex acute, rarely acuminate, margin serrate-dentate, adaxial surface puberulous only on midvein, abaxial surface puberulous, with domatia, venation mixed craspedodromous. Thyse axillary and terminal, racemiform, 3.5–10.5 cm long, indument yellow-pilose; bracts 1–1.5 mm long, triangular. Flowers zygomorphic, 3–3.5 mm; sepals 4; petals 4, crest of posterior petal appendage erose or emarginate; nectariferous lobes 4, posterior ovoid, anterior ovoid, reduced; stamens 1–2.5 mm long, tomentose fillets, surrounding a pistilode, staminodes 1.5–2.3 mm long, surrounding a gynoeceium; ovary ca. 1.5 mm long, trigonous-ellipsoid, with glandular trichomes, and pubescent on the angles. Capsules 1.2–1.7 × 0.9–1 cm, obovate, winged, subcoriaceous, glabrous, stipe 1–5 mm long, endocarp tomentose on the valve margins; seeds 3 (1–2), trigonous-obovoid; ariloid bilobate; embryo with outer cotyledon curved and inner biplicate (Figures 5A–D).

Paullinia micrantha is endemic to Brazil, occurring in the states of Alagoas, Bahia, Espírito Santo, Minas Gerais, Paraíba, Paraná, Pernambuco, Rio de Janeiro, São Paulo and Sergipe (Figures 2A, 3). It is found in the following plant formations: sandy coastal plain, dense ombrophilous forest and seasonal semideciduous forest formations. In restinga, it occurs in ridge forests. Fruiting occurs in September. The taxon has been evaluated based on the IUCN (2019) criteria as least concern (LC).

In this study, this species differs from other *Paullinia* by the following characters: stem yellowish brown, cylindrical, 5–6-striate, puberulous and capsules 3-winged.

Selected materials: **BRAZIL**. RIO DE JANEIRO: Mun. Paraty, Tarituba, beira do mar, à direita do bar, 29/III/2005, st., *J.D. Urdampilheta & S. Obando 299* (UEC); Mun. Rio das Ostras, praia das Areias Negras, encosta do primeiro costão rochoso, na borda da estrada de barro, 24.IX.2008, fr., *M.S. Faria 133* (RB); Vassouras, 2-III-1940, fl., *H. Monteiro Filho 192* (RBR).

***Paullinia pseudota* Radlk., Vidensk. Meddel. Naturhist. Foren. Kjøbenhavn 1890: 242 (1891)**

Woody climbers; stem dark brown, grayish-brown or reddish-brown, cylindrical, striate, with a single vascular cylinder in cross section; stipules 1–1.5 mm long, deltoid; petiole unwinged, canaliculate; rachis unwinged or bi-canaliculate. Leaves 5-foliolate, generally with 1 or 2 pairs of reduced extra basal leaflets (0.2–1 cm long); leaflets 3–9.3 × 0.9–3.4 cm, elliptic to lanceolate, sub-coriaceous, apex acute to acuminate, margin entire, revolute, both surface glabrous, with domatia, venation brochidodromous. Thyse axillary and terminal, racemiform, 1.5–6.5 cm long, tomentose; bracts triangular. Flowers zygomorphic, 2.5–5 mm long; sepals 4, petals 4, crest of posterior petal appendage erose or emarginate; nectariferous lobes 4, posterior ovoid, anterior orbicular, reduced; stamens 1.5–2 mm long, puberulous fillets, surrounding a pistilode, staminodes 1.5–2 mm long, surrounding a gynoeceium, ovary ca. 1 mm long, trigonous-ellipsoid, puberulous on the angles. Capsules 1.5–1.7 × 1.5–1.6 cm, obovate, winged, subcoriaceous, with inflected margins, glabrous, stipe 2–5 mm long, endocarp tomentose on the valve margins; seeds 3 (1–2), trigonous-ovoid; ariloid bilobate; embryo with curved and inner cotyledon biplicate (Figures 5E–I).

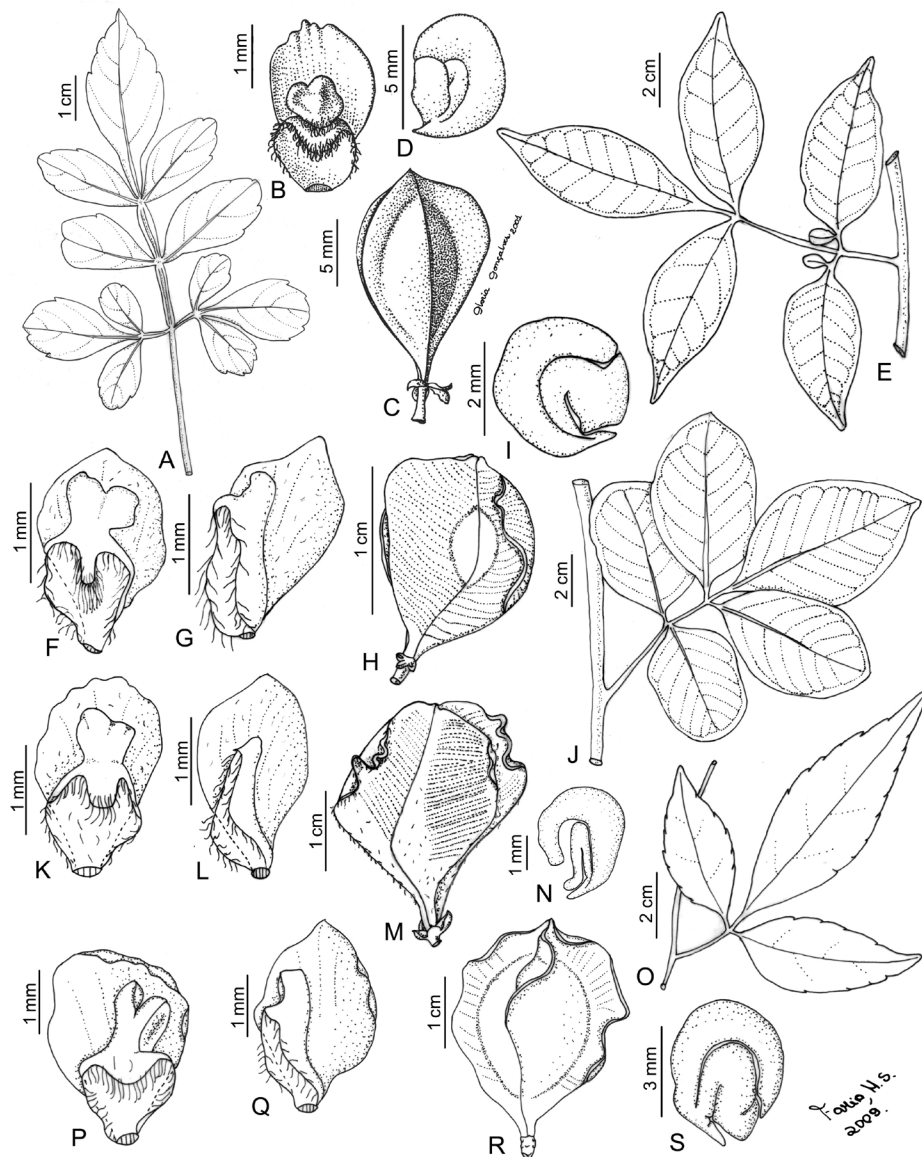


Figure 5. *Paullinia micranta* – A. binate leaf; B. posterior petal; C. fruit; D. embryo. *P. pseudota* – E. 5-foliolate leaves; F. posterior petal; G. anterior petal; H. fruit; I. embryo. *P. revoluta* – J. 5-foliolate leaf; K. posterior petal; L. anterior petal; M. fruit; N. embryo. *P. ternata* – O. trifoliolate leaf; P. posterior petal; Q. anterior petal; R. fruit; S. embryo (A–B: G.V. Sommer 950, C–D: G.V. Sommer 956; E: M.S. Faria et al. 88; F–G: C. Farney 2231; H–I: H. G. Dantas, 474; J–L: H.C. Lima et al. 2960; M–N: L. F. T. Menezes & Souza 188; O–Q: P.I.S. Braga 2221; R–S: C. Farney 2431. Illustrators A, E–S: M. S. Faria and B–D: G. Gonçalves).

Paullinia pseudota is endemic to Brazil, occurring in the states of Alagoas, Bahia, Ceará, Espírito Santo, Minas Gerais, Pará, Paraíba, Pernambuco, Rio de Janeiro, São Paulo and Sergipe (Figures 2A, 3). It is found in the following plant formations: sandy coastal plain, dense ombrophilous forest and savanna formations. In restinga, it occurs in dune thickets, beach thickets and ridge forests. Flowering from December to April and fruiting from December to June. The taxon has been evaluated based on the IUCN (2019) criteria as Least Concern (LC).

In this study, this species differs from other *Paullinia* by the following characters: stem cylindrical, striate, glabrous; leaves 5-foliolate, usually with one or two extra pairs of basal reduced leaflets, margin entire, venation brochidodromous, capsules winged, with margin inflexed; seeds 3 (1–2).

Selected materials: **BRAZIL.** RIO DE JANEIRO: Mun. Angra dos Reis, Ilha Jipóia, Praia de Jurubaiba, 7.I.1990, bt., *A.M.S. da F.Vaz 701* (RB); Mun. Armação de Búzios, Praia da Gorda, 9.VI.2008, fr., *M.S. Faria et al. 88* (RB,RBR); idem, 15.II.2000, fl., *D. Fernandes & A. Oliveira 424* (RB); Mun. Arraial do Cabo, Reserva Ecológica Estadual de Massambaba, próximo à Lagoa Salgada, 21.II.1989, fl. e fr., *D. Araújo & N. Crud 8706* (GUA); Mun. Barra de São João, 20.III.1979, fl., *G. Martinelli et al. 5657* (RB); Mun. Cabo Frio, Vila do Sol, 1.IV.2008, fr., *M.S. Faria & L. Pederneiras 63* (RB); Mun. Casimiro de Abreu, Praia Brava, 28.V.1986, fr., *D. Araújo & N. Crud, 7500* (GUA); Mun. Macaé, entre Carapebus e Cabiunas, 13.III.2004, fr., *E.J. Lucas 271* (RB); Mun. Rio das Ostras, Balneário das Garças, 18.IV.1999, fl., *H. do N. Braga 202* (RB); Mun. Rio de Janeiro, Restinga da Praia de Grumari, 21.V.2000, fr., *A. Oliveira & D. Fernandes 131* (RB); Mun. Mangaratiba, Restinga da Marambaia,

14.V.2002, fr., *G.V. Somner et al. 1016* (RBR); Mun. São João da Barra, Grussaí, 16.V.1989, fr., *D. Araujo 8833* (GUA); Mun. Saquarema, Reserva Ecológica de Jacarepiá, 6.VI.2007, fr., *M.S. Faria 14* (RB).

***Paullinia revoluta* Radlk. Monogr. *Paullinia*: 251. 1895**

Woody climbers or erect shrubs; stem brown, subcylindrical, 5-costate, pubescent when young, glabrescent when mature, with a single vascular cylinder in cross section; stipules 1.5–2 mm long, deltoid; petiole unwinged, canaliculate; rachis unwinged, canaliculate or marginate. Leaves 5-foliolate or biternate; leaflets 2.6–9.1 × 1.5–5.8 cm, ovate, elliptic, subcoriaceous; apex acuminate, margin entire, revolute, both surfaces pubescent, or abaxial surface pubescent only on midveins, with domatia, venation brochidodromous. Thyse axillary and terminal, racemiform, 1.5–8.1 cm long, pubescent; bracts triangular. Flowers zygomorphic, 6–7 mm long; sepals 4; petals 4, crest of posterior petal appendage erose; nectariferous lobes 4, posterior ovoid, anterior orbicular, reduced; stamens 5–3 mm long, puberulous fillets, surrounding a pistilode, staminodes 1.5–2.5 mm long, surrounding a gynoeceium; ovary ca. 1.5 mm long, trigonous-ovoid, puberulous on the angles. Capsules 1.7–3.2 × 0.7–2.5 cm, obtriangular, winged, subcoriaceous, sericeous, stipe 1–3 mm long, endocarp tomentose on the valve margins; seeds 3 (1–2), trigonous-ovoid; ariloid bilobate; embryo with outer cotyledon curved and inner biplicate (Figures 5J–N).

Paullinia revoluta is endemic to Brazil, occurring in the states of Alagoas, Bahia, Espírito Santo, Minas Gerais, Paraná, Rio de Janeiro and Sergipe (Figures 2A, 3). It is found in the following plant formations: sandy coastal plain, dense ombrophilous forest, seasonal semideciduous forest and caatinga formations. In restinga, it occurs in ridge forests. Fruiting occurs in July. The taxon has been evaluated based on the IUCN (2019) criteria as Least Concern (LC).

In this study, this species differs from other *Paullinia* by the following characters: leaflet number varying but generally 5-foliolate, rarely biternate, leaflets with entire revolute margins, capsules large 3-winged (1.7–3.2 × 0.7–2.5 cm), endocarp tomentose on valve margins; seeds 3 (1–2).

Selected materials: **BRAZIL**. RIO DE JANEIRO: Mun. Mangaratiba, restinga da praia da Marambaia, 13.VII.1998, fr. *L.F.T. Menezes & Souza 188* (RBR).

***Paullinia ternata* Radlk. Monogr. *Paullinia*: 317. 1895**

Woody climbers; stem grayish, cylindrical, striate, glabrous, with a single vascular cylinder in cross section; stipules 4–4.5 cm long, linear-subulate; petiole unwinged, canaliculate. Leaves trifoliolate, deciduous in the flowering period; leaflets 3.5–9.2 × 1.3–2.9 cm, lanceolate to elliptic, sub-chartaceous, apex cuspidate, margin serrate-crenate, both surfaces glabrous, with domatia, venation mixed craspedodromous. Thyse cauliflorous, fasciculate, 3.5–9.5 cm long, pubescent; bracts triangular. Flowers zygomorphic, ca. 5.5 mm long; sepals 5; petals 4, crest of posterior petal appendage emarginate; nectariferous lobes 4, posterior ovoid, anterior oblong, reduced; stamens 1.5–2 mm long, puberulous fillets, surrounding a pistilode, staminodes 1.5–2 mm long, surrounding a gynoeceium; ovary ca. 1 mm long, trigonous-ellipsoid, pubescent. Capsules 2.6–3.1 × 1.7–2.5 cm, winged, obovate or suborbicular, subcoriaceous, pubescent, stipe ca. 2 mm long, endocarp tomentose on valves margins; seeds 3 (1–2),

ellipsoid; ariloid bilobate; embryo with outer cotyledon curved and inner biplicate (Figures 5O–S).

Paullinia ternata is endemic to Brazil, occurring in Bahia, Espírito Santo, Minas Gerais, Rio de Janeiro and São Paulo. It is found in the following plant formations: restinga (ridge forest), or in dense ombrophilous forests (Figures 2A, 3). Fruiting occurs from June to August. The taxon has been evaluated based on the IUCN (2019) criteria as Least Concern (LC).

In this study, this species differs from other *Paullinia* by the following characters: leaves trifoliolate, sub-chartaceous, margin slightly serrate-crenate, thyrses cauliflorous, fasciculate; endocarp tomentose on the valve margins; seeds 3 (1–2).

Selected materials: **BRAZIL**. RIO DE JANEIRO: Mun. Armação de Búzios, Estrada Cabo Frio-Búzios, 5.VI.1998, fr., *J.M.A. Braga 4860* (RB); Mun. Saquarema, R.E.E. Jacarepiá, Restinga de Ipitangas, 25.VI.1990, fr., *D. Araujo & C. Farney 2431* (GUA, RB).

***Paullinia trigonia* Vell. Fl. Flum. 159, tab. 30. 1825; Icon. 30. 1829**

Woody climbers or suberect shrubs; stem brown or reddish-brown, cylindrical, striate, pubescent, with a single vascular cylinder in cross section; stipules deltoid; petiole unwinged, canaliculate; rachis winged. Leaves generally biternate or rarely 11–13-foliolate, basal leaflet trifoliolate; leaflets 3.6–8.8 × 1.2–3.9 cm, sub-rhomboidal, elliptic, ovate, chartaceous, apex obtuse to acute, entire to serrate-dentate, margin revolute, both surfaces pubescent on veins, with domatia, venation mixed craspedodromous. Thyse axillary and terminal, racemiform, 2–10.8 cm long, pubescent; bracts triangular. Flowers zygomorphic, 5–6.5 mm long; sepals 4; petals 4, crest of posterior petal appendage emarginate; nectariferous lobes 4, posterior oblong, anterior orbicular, reduced; stamens 1–2 mm long, pubescent fillets, surrounding a pistilode, staminodes 1–2 mm long, surrounding a gynoeceium; ovary ca. 1.5 mm long, trigonous-ovoid, puberulous on the angles, and with glandular trichomes. Capsules 1.2–2.5 × 0.5–1 cm, elliptic or obovate, keeled or winged, subcoriaceous, glabrous, stipe 0.5–3 mm long, endocarp tomentose on valve margins; seeds 3 (1–2), trigonous-ovoid; ariloid bilobate; embryo with outer cotyledon curved and inner biplicate (Figures 6A–E).

Paullinia trigonia is endemic to Brazil, occurring in the states of Alagoas, Bahia, Espírito Santo, Minas Gerais, Pará, Paraíba, Paraná, Pernambuco, Rio de Janeiro, Rio Grande do Sul, Santa Catarina, São Paulo and Sergipe (Figures 2B, 3). It is found in the following plant formations: sandy coastal plain, dense ombrophilous forest and seasonal semideciduous forest formations. In the restinga, it occurs in seasonally flooded swamps and ridge forests. Flowering occurs in March and fruiting from February to June. The taxon has been evaluated based on the IUCN (2019) criteria as Least Concern (LC).

In this study, this species differs from other *Paullinia* by the following characters: stem reddish-brown, leaves generally biternate or rarely pinnately 11–13-foliolate; capsules keeled or winged; seeds 3 (1–2).

Selected materials: **BRAZIL**. RIO DE JANEIRO: Mun. Mangaratiba, Restinga da Marambaia, 11.VI.2004, fr., *L.F.T. Menezes et al. 1155* (RBR); idem, 26.VI.2004, fr., *Carvalho 1* (RBR); Mun. Niterói, Saco de São Francisco, 27.III.1938, fl., *M. Barreto 13004* (HB, R, RB); Mun. Rio de

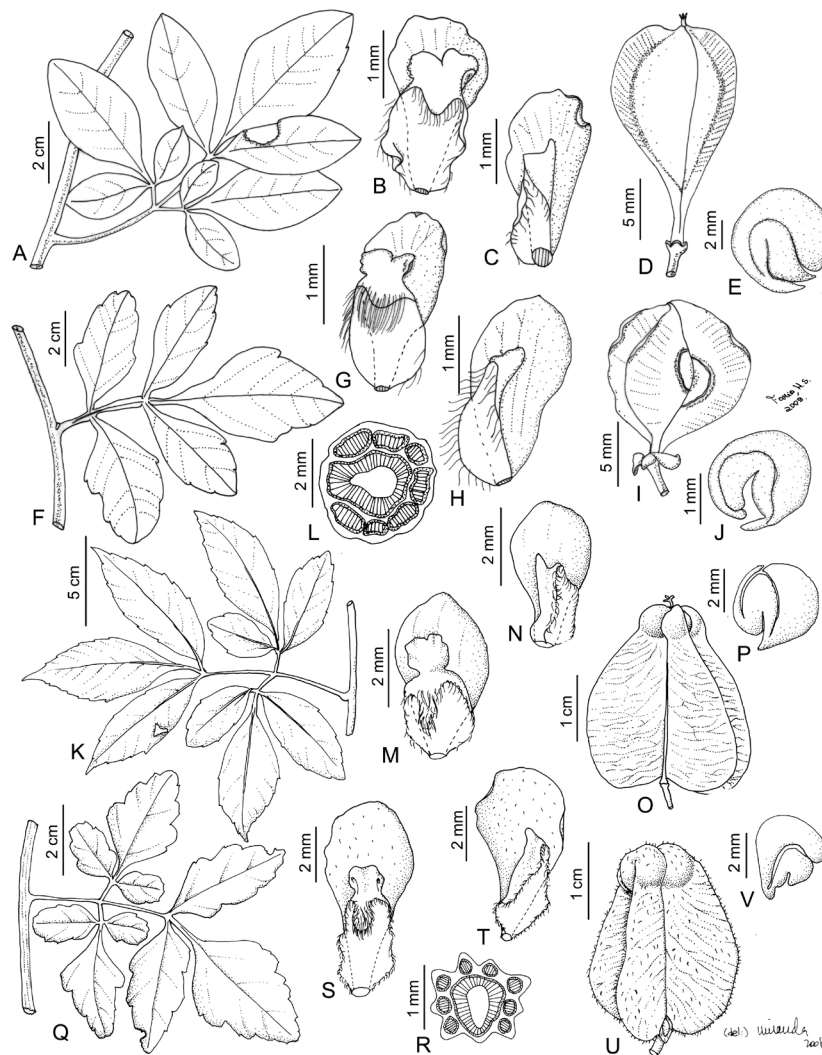


Figure 6. *Paullinia trigonia* – A. biternate leaf; B. posterior petal; C. anterior petal; D. fruit and E. embryo. *P. weinmanniifolia* – F. 5-foliolate leaf; G. posterior petal; H. anterior petal; I. fruit and J. embryo. *Serjania caracasana* – K. biternate leaf; L. cross-section of the stem; M. posterior petal; N. anterior petal; O. fruit; P. embryo. *S. clematidifolia* – Q. biternate leaf; R. cross-section of the stem; S. posterior petal; T. anterior petal; U. fruit and V. embryo. (A–C: C. Luchiarri et al. 314; D–E: G. Martinelli et al. 11761; F–H: M.S. Faria & L. Pederneiras 65; I–J: M.G. Bovini & L. C. Giordano 775; K–N: M.S. Faria, 91; O–P: Mautone et al. 179; Q–T: A. Souza et al. 3384; U–V: D. Medeiros, 13. Illustrators A–J: M. S. Faria and K–V: C. Miranda).

Janeiro, Lagoa Marapendi, 10.IV.1972, fr., *J. Almeida 1442* (RB), Mun. Mangaratiba, Ilha da Marambaia, Praia da Gaeta, na floresta de cordão arenoso, 29.VII.2006, fr., *G.V. Somner et al. 1150* (RBR).

***Paullinia weinmanniifolia* Mart. Flora 20(2): Beibl. 91. 1837**

Woody climbers, suberect or erect arching shrubs; stem brown, grayish-brown or grayish, cylindrical, striate, pubescent when young, glabrescent when mature, with a single vascular cylinder in cross section; stipules ca. 1 mm long, deltoid; petiole unwinged, canaliculate; rachis winged. Leaves frequently 5-foliolate or biternate, rarely trifoliolate; leaflets 2.5–7.5 × 1.2–3.4 cm, subrhomboidal, ovate or elliptic, subcoriaceous, apex obtuse to acute, margin repand-crenate, both surface with rare trichomes on midveins, with domatia, venation mixed craspedodromous. Thyrses axillary and terminal, racemiform, 1.3–7 cm long, pubescent; bracts triangular. Flowers zygomorphic, 4–5 mm; sepals 4; petals 4, crest of posterior petal appendage erose, emarginate or bifid; nectariferous lobes 4, posterior ovoid, anterior ovoid, reduced;

stamens 1.5–2.5 mm long, puberulous fillets, surrounding a pistilode, staminodes 1–1.5 mm long, surrounding a gynoeceum; ovary ca. 1.5 mm long, trigonous-ovoid, puberulous on the angles. Capsules 1.2–1.5 × 0.8–1.2 cm, winged, suborbicular, sub-coriaceous, glabrous, stipe 1–1.5 mm long, extra triangular appendage on the pericarp, endocarp tomentose on the valve margins; seeds 3 (1–2), trigonous-ellipsoid; ariloid bilobate; embryo with outer cotyledon curved and inner biplicate (Figures 1C, 6F–J).

Paullinia weinmanniifolia is endemic to Brazil, occurring in the states of Alagoas, Bahia, Espírito Santo, Maranhão, Pernambuco, Rio de Janeiro and Sergipe (Figures 2B, 3). It is found in the following plant formations: sandy coastal plain, dense ombrophilous forest and seasonal semideciduous forest formations. In restinga, it occurs in ridge palmoid, non-flooded scrub, flooded scrub and dune thicket formations. Flowering occurs from March to June and November to December and fruiting from November to September. The taxon has been evaluated based on the IUCN (2019) criteria as Least Concern (LC).

In this study, this species differs from other *Paullinia* by the following characters: leaves frequently 5-foliolate or biternate, rarely trifoliolate; capsules with extra triangular appendage on the pericarp; seeds 3 (1–2). In this species variation was observed in the number of leaflets in the same specimen. First, the terminal leaflet of the trifoliolate leaves divides and the leaf becomes 5-foliolate; then each basal leaflet divides and the leaf becomes biternate.

Selected materials: **BRAZIL**. RIO DE JANEIRO: Mun. Araruama, Lagoa de Araruama, próximo a Enseada da Figueira, 5.V.1982, fl., *D. Araujo & R.F. de Oliveira 5052* (GUA); Mun. Arraial do Cabo, Praia do Foguete, 24.VIII.1987, fr., *D. Araujo & R.F. de Oliveira 7978* (GUA); Mun. São João da Barra, III.1939, fr., *A. Sampaio 8067* (R); Mun. Barra de São João, 20.III.1979, fl., *G. Martinelli 5656* (RB); Mun. Cabo Frio, Vila do Sol, 1.IV.2008, fl., *M.S. Faria & L. Pederneras 64* (RB, RBR); Mun. Carapebus, PARNA Jurubatiba, 10.VI.2008, fr. *M.S. Faria et al. 93* (RB); Mun. Macaé, PARNA Jurubatiba, 12.VI.2007, fr., *M.S. Faria et al. 16* (RB, RBR); Mun. Maricá, Lagoa do Padre, 8.IX.1975, fr., *H.P. Bautista 165* (RB). Niterói, Ponta de Itaipu, 6.IX.1978, fr., *G. Martinelli 4903* (RB); Mun. Quissamã, PARNA Jurubatiba, 24.IX.2008, fr., *M.S. Faria et al. 129* (RB); Mun. Rio das Ostras, Restinga da Praia Virgem, 10.VI.2000, fr., *H. do N. Braga 1113* (RB); Mun. Rio de Janeiro, Restinga de Jacarepaguá, 7.V.1958, fl., *E. Pereira et al. 3708* (HB); Mun. São João da Barra, Atafona, 22.VII.1975, fr., *A.L. Peixoto 561* (RB); Mun. Saquarema, 5 km ao oeste do centro da cidade Sambaqui da Beirada, 7.VIII.1987, fr., *D. Araujo & A. Araujo 7925* (GUA).

Serjania caracasana (Jacq.) Willd., Sp. Pl. 2 (1): 465. 1799

Woody climbers; stem brown, sub-cylindrical, 7–10-costate with inconspicuous ribs, glabrous, in cross section composed of one large central vascular cylinder and eight smaller peripheral cylinders; stipules 1–1.5 mm long, triangular; petiole unwinged, canaliculate; rachis unwinged, bicanaliculate. Leaves biternate; leaflets 1.8–13.5 × 1–5 cm, lanceolate, ovate, chartaceous, apex acute to acuminate, margin serrate-dentate, adaxial surface with trichomes on midveins, abaxial surface glabrous, with domatia, venation semicraspedodromous. Thyse axillary and terminal, racemiform, 2–12.5 cm long, puberulous; bracts triangular. Flowers zygomorphic, 7–9 mm long; sepals 5; petal 4, crest of posterior petal appendage erose; nectariferous lobes 4, posterior ovoid, anterior sub-elliptic reduced; stamens 2.5–4.5 mm long, puberulous fillets, surrounding a pistilode, staminodes 2–2.5 mm long, surrounding a gynoeceium; ovary ca. 1.5 mm long, trigonous-ovoid, puberulous. Schizocarps 2.5–2.9 × 2.4–2.9 cm, ovate-cordate, chartaceous, glabrous, seminiferous portion of inflated mericarp without dorsal crest, endocarp glabrous; seeds 1–3, subglobose, without aril; embryo with outer cotyledon curved and inner biplicate (Figures 6K–P).

Serjania caracasana occurs in Argentina, Brazil, Bolivia, Colombia, Costa Rica, Cuba, Guatemala, Mexico, Paraguay, Peru and Venezuela. In Brazil, there are records for the following states: Amapá, Amazonas, Bahia, Ceará, Espírito Santo, Goiás, Mato Grosso do Sul, Mato Grosso, Minas Gerais, Pará, Paraíba, Paraná, Pernambuco, Piauí, Rio de Janeiro, Rondônia, Roraima, São Paulo and Tocantins (Figures 2B, 3). It is found in the following plant formations: restinga, dense ombrophilous forests, seasonal deciduous forests, seasonal semi-deciduous forests and savannas. In restinga, it occurs in seasonally flooded swamps and ridge forests. Flowering occurs from June to July and fruiting from June to

October. The taxon has been evaluated based on the IUCN (2019) criteria as Least Concern (LC).

In this study, the species differs from other *Serjania* by the following characteristics: stem composed of one large central cylinder and eight smaller peripheral cylinders in cross section, leaflets lanceolate, with serrate-dentate margins, fruit schizocarp glabrous, with seminiferous portion of mericarp inflated and without a dorsal crest.

Selected materials: **BRAZIL**. RIO DE JANEIRO: Mun. Angra dos Reis, Ilha Grande, Reserva Biológica Estadual da Praia do Sul, 13.VI.1984, fl., *D.S. Pedrosa & H.Q.B. Fernandes 1110* (GUA); Mun. Cabo Frio, Condomínio Florestinha, 9.VI.2008, fl., *M.S. Faria et al. 91* (RB); Mun. Macaé, a 4 km de Quissamã, restinga arbustiva, 5.VI.1979, fr., *D. Araujo & N. Crud 3101* (GUA); Mun. Mangaratiba, Ilha da Marambaia, praia da Armação, 24.IX.1991, fr., *G.V. Somner et al. 673* (RBR); Mun. Quissamã, Mata da Fazendinha, 28.X.1994, fr., *D. Araujo 10147* (GUA); Mun. Rio de Janeiro, Restinga de Grumari, 29.VI.1972, fl., *J.A. Jesus 1680* (RB); idem, 4.VII.1973, fl., *J.A. Jesus 2406* (RB); idem, 1.VIII.1977, fr., *L. Moutane et al. 179* (RB); idem, 30.VI.1987, fl., *A. F. Vaz 455* (RB).

Serjania clematidifolia Cambess., in A. St.-Hil., A. Juss. & Cambess., Fl. Bras. Mer. 1: 361. 1828

Woody climbers; stem brown or dark brown, 9–10 costate, with conspicuous ribs, pubescent-tomentose, in cross section composed of one large central vascular cylinder and 8–9 smaller peripheral cylinders; stipules 0.5–1 mm long, ovate, petiole unwinged, canaliculate; rachis unwinged, bicanaliculate or marginate. Leaves biternate; leaflets 2.2–7.6 × 1.5–4 cm, rhomboidal to ovate, and elliptic, subchartaceous, apex acute, margin serrate-crenate, adaxial surface pubescent on midvein, abaxial surface pubescent, with domatia, venation mixed craspedodromous. Thyse axillary and terminal, racemiform, 5.5–9.5 cm long, tomentose; bracts lanceolate. Flowers zygomorphic, 8–8.5 mm long; sepals 5; petals 4, crest of posterior petal appendage erose; nectariferous lobes 4, posterior orbicular, anterior orbicular, reduced; stamens 3.5–4.5 mm long, tomentose fillets, surrounding a pistilode, staminodes 1–1.5 mm long, surrounding a gynoeceium; ovary ca. 3 mm long, trigonous-obovoid, tomentose. Schizocarps 2.5–2.7 × 2–2.2 cm, ovate-cordate, chartaceous, densely pubescent, seminiferous portion of mericarp globose, laterally concave, without dorsal crest, endocarp lanose; seeds 1–3, subglobose, without aril; embryo with outer cotyledon curved and inner biplicate (Figures 6Q–V).

Serjania clematidifolia occurs in Bolivia and in Brazil in the following states: Amapá, Amazonas, Bahia, Espírito Santo, Goiás, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Pará, Paraná, Rio de Janeiro, Rio Grande do Norte, Santa Catarina, São Paulo and Tocantins (Figures 2B, 3). It is found in the following plant formations: restinga, dense ombrophilous forests, seasonal deciduous forests, savannas and the Amazon dryland forest. In restinga, it occurs in ridge forests. Flowering occurs in October and December and fruiting from March to April and from July to November. The taxon has been evaluated based on the IUCN (2019) criteria as Least Concern (LC).

In this study, this species differs from other *Serjania* by the following characteristics: 9–10 costate stem, with conspicuous ribs; leaflets with serrate-crenate margins; fruits with seminiferous portion of the mericarp globose, laterally concave and without a dorsal crest.

Selected materials: **BRAZIL**. RIO DE JANEIRO: Mun. Macaé, restinga próximo a lagoa de Cabiúnas, fl., 14.XII.1990, *A. Souza et al.* 3384 (R); Mun. Mangaratiba, Restinga da Marambaia, Praia Grande, 23.VII.1991, fr., *G.V. Somner et al.* 647 (RBR); Mun. Maricá, 25.VII.1988, fl. fr., *A. Souza et al. s.n.* (R); Mun. Niterói, São Gonçalo, Itaoca, Praia de São João, 31.VII.1994, fl., *D.C.P. Silva et al.* 123 (GUA); Mun. Rio das Ostras, ARIE Itapebussus, 17.X.2007, fr., *M.S. Faria* 36 (RB, RBR); Mun. Rio de Janeiro, Copacabana, s. d., fl. e fr., *C. Diogo s.n.* (R); Mun. Saquarema, Reserva Ecológica Estadual de Jacarepiá, 27.IV.1996, fl., *A.Q. Lobão et al.* 139 (RB); idem, 26.VIII.1991, fl., *G.V. Somner & M.F. Freitas* 653 (RB); Mun. Reserva Ecológica Estadual de Jacarepiá, 31.VII.1996, fl., fr., *G.V. Somner et al.* 800 (RBR); Mun. Sumaré, 17.VII.1968, fr., *D. Medeiros* 13 (HB, RB).

***Serjania communis* Cambess., in A. St.-Hil., A. Juss. & Cambess., Fl. Bras. Mer. 1:362. 1828**

Semi-woody climbers; stem greenish-brown, subcylindrical, obtusely triangular, with three major ribs, pubescent; in cross section composed of one central vascular cylinder and three smaller equidistant peripheral cylinders; stipules ca. 1 mm long, deltoid; petiole and rachis unwinged, bicanaliculate. Leaves biternate, leaflets 1.3–5.5 × 0.7–1.7 cm, ovate to lanceolate, sub-chartaceous, apex acute to acuminate; margin dentate-serrate, both surfaces pubescent, without domatia, venation semicraspedodromous. Thyrses axillary and terminal, racemiform, 2–15 cm long; bracts triangular. Flowers zygomorphic, 6.5–8.5 mm; sepals 4; petals 4, crest of posterior petal appendages erose or emarginate; nectariferous lobes 4, posterior ovoid to ellipsoid, anterior ellipsoid, reduced; stamens 3.5–4.5 mm long, pubescent fillets, surrounding a pistilode, staminodes 2.5–3 mm long, surrounding a gynoeceum; ovary 1.5–2 mm long, trigonous-ovoid, pubescent. Schizocarps 2–2.6 × 2–2.1 cm, ovate-cordate, chartaceous, with pubescent wings; seminiferous portion of mericarp laterally flattened, pubescent, dorsal crest 2.5–3 mm wide, endocarp villose; seeds 1–3, elliptic-lenticular, lacking aril; embryo with sub-straight cotyledons (Figures 7A–F).

Serjania communis occurs in Colombia, Venezuela, Ecuador, Peru and Bolivia. In Brazil, it has been recorded in the states of Acre, Amazonas, Bahia, Ceará, Distrito Federal, Espírito Santo, Goiás, Mato Grosso do Sul, Minas Gerais, Paraná, Rio de Janeiro, Rio Grande do Sul, Santa Catarina, São Paulo and Sergipe (Figures 2B, 3). It is found in the following plant formations: restinga, dense ombrophilous forests, seasonal semi-deciduous forests, lowland forests and the savanna. In restinga, it occurs in ridge forests. Flowering occurs from April to August and fruiting from July to September. The taxon has been evaluated based on the IUCN (2019) criteria as Least Concern (LC).

In this study, the species differs from other *Serjania* by the following characteristics: sub-cylindrical, obtusely triangular stem, with three major ribs, in cross section composed of one central cylinder and three smaller equidistant peripheral cylinders; fruits with seminiferous portion of mericarp laterally flattened, with a dorsal crest 2.5–3 mm wide; embryo with cotyledons sub-straight. The taxon's name refers to its wide distribution.

Selected materials: **BRAZIL**. RIO DE JANEIRO: Mun. Armação dos Búzios, Restinga da Praia do Forno, 19.VIII.1998, fl., *D. Fernandes*

34 (RB); Mun. Cabo Frio, Condomínio Florestinha, 9.VI.2008, fl., *M.S. Faria* 92 (RB); Mun. Parati, APA Cairuçu, 14.VI.1994, fl., *M.G. Bovini & L.C. Giordano* 495 (RB); Mun. Rio de Janeiro, Barra da Tijuca, 11.VII.1964, fr., *W. Hoehne* 5738 (RB); Mun. Saquarema, Reserva Ecológica Estadual de Jacarepiá, Restinga de Ipitangas, 28.IX.1990, fr., *G.V. Somner* 612 et al. (RBR).

***Serjania confertiflora* Radlk., Consp. Sect. Sp. Serjan.: 4. 1874**

Woody climbers; stem brown, 6-costate, with very prominent ribs, pubescent when young, glabrescent when mature, in cross section composed of one large central vascular cylinder and three smaller equidistant peripheral cylinders; stipules 0.5–1.5 mm long, triangular; petiole and rachis unwinged, canaliculate. Leaves biternate; leaflets 1.5–5.3 × 1.2–4.4 cm, ovate to lanceolate, chartaceous, apex acuminate, margin incised-dentate, with one pair of basal incisions, pubescent on the veins in both surfaces, with domatia, venation mixed craspedodromous. Thyrses axillary and terminal, racemiform, 1–3.5 cm long, pubescent; bracts triangular. Flowers zygomorphic, ca. 5.5 mm; sepals 5; petals 4, crest of posterior petal appendages erose or emarginate; nectariferous lobes 4, posterior ovoid, anterior ovoid, reduced; stamens 2–3 mm long, puberulous fillets, surrounding a pistilode, staminodes 2–2.5 mm long, surrounding a gynoeceum; ovary 1.5–2 mm long, trigonous-obovoid, puberulous. Schizocarps 1.8–2 × 1.9–2 cm, ovate-cordate, wings glabrous; seminiferous portion of mericarp inflated, glabrous; dorsal crest 1.5–4 mm wide, endocarp lanose; seeds 1–3, ellipsoid; without aril; embryo with outer cotyledon curved and inner biplicate (Figures 7G–L).

Serjania confertiflora occurs in Brazil, Bolivia, northern Paraguay and northwestern Argentina. In Brazil, it occurs in the states of Bahia, Espírito Santo, Goiás, Mato Grosso do Sul, Mato Grosso, Minas Gerais, Rio de Janeiro, São Paulo and Tocantins (Figures 2B, 3). It is found in the following plant formations: sandy coastal plain, dense ombrophilous forest and savanna formations. In restinga, it occurs in ridge forests. Flowering occurs in May and fruiting in June and August. The taxon has been evaluated based on the IUCN (2019) criteria as Least Concern (LC).

In this study, the species differs from other *Serjania* by the following characteristics: stem 6-costate, with very prominent ribs, composed in cross section of one large central cylinder and three equidistant smaller peripheral cylinders; leaflets with dentate-incised margins, with a pair of basal incisions; thyrses with subverticillate cincinni, fruits with seminiferous portion of mericarp inflated, glabrous; dorsal crest 1.5–4 mm wide.

Selected materials: **BRAZIL**. RIO DE JANEIRO: Mun. Armação dos Búzios, Praia de Tucuns, 28.V.2000, fl., *D. Fernandes & A. Oliveira* 522 (RB); Mun. Cabo Frio, restinga entre a Praia de Focas e Praia de Fornos, 14.VIII.1986, fr., *P. Acevedo-Rodríguez* 1451 (RB); Mun. Idem, Condomínio Florestinha, 11.VI.1998, fr., *L. Emygdio et al.* 6235 (R).

***Serjania corrugata* Radlk., Consp. Sect. Sp. Serjan. 131. 1874**

Woody climbers; stem brown and reddish-brown, 5-costate, puberulous, in cross section composed of one small central vascular cylinder and 5 radiate vascular cylinders, reddish glandular trichomes all over the plant; stipules ca. 0.5 mm long, ovate; petiole unwinged, canaliculate; rachis unwinged, bicanaliculate or marginate. Leaves biternate; leaflets 4.2–7.6 × 1–3.2 cm, lanceolate, sub-chartaceous, apex acuminate; margin entire, frequently with one tooth near base,

Paullinieae of the restingas of Rio de Janeiro

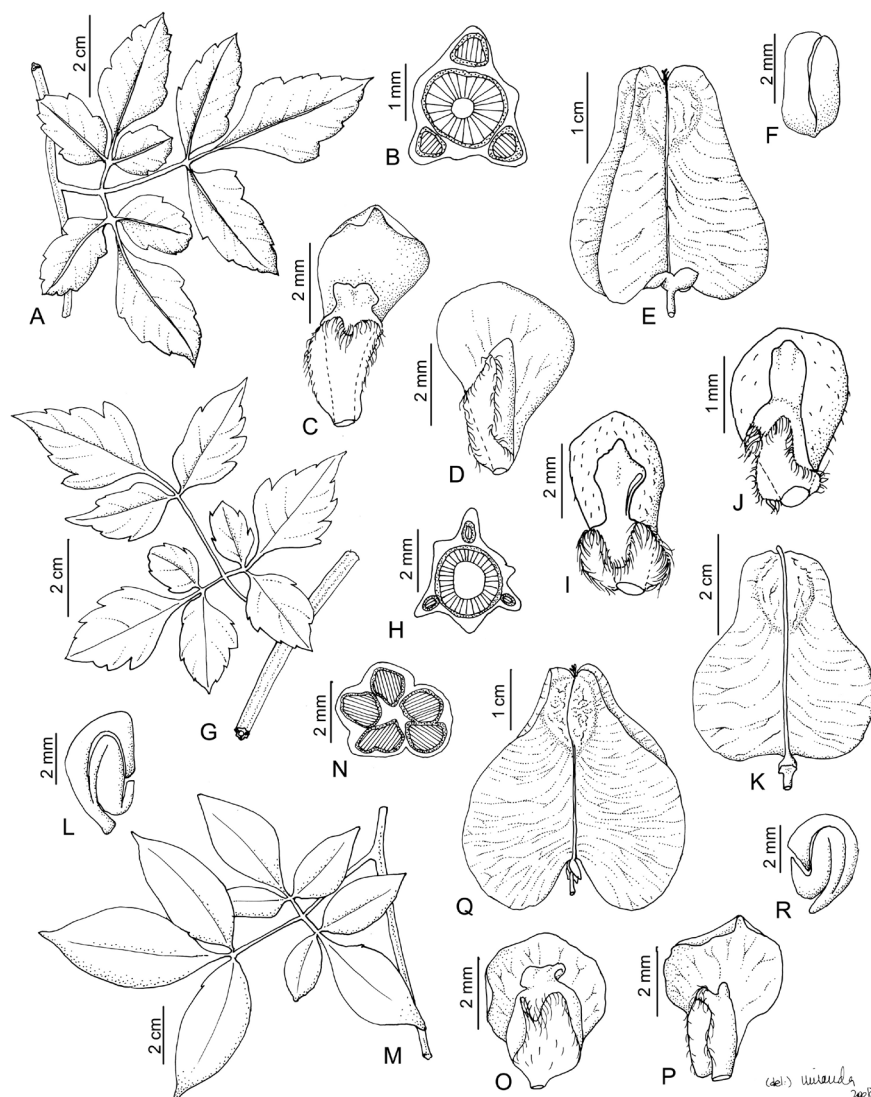


Figure 7. *Serjania communis* – A. biternate leaf; B. cross-section of the stem; C. posterior petal; D. anterior petal; E. fruit and F. embryo. *S. confertiflora* – G. biternate leaf; H. cross-section of the stem; I. posterior petal; J. anterior petal; K. fruit; L. embryo. *S. corrugata* – M. biternate leaf; N. cross-section of the stem; O. posterior petal; P. anterior petal; Q. fruit and R. embryo. (A–B: M.S. Faria 92; C–D: M.G. Bovini & L.C. Giordano 495, E–F: W. Hoehne 5738; G–J: D. Fernandes & A. Oliveira 522; K–L: P. Acevedo-Rodríguez 1451; M–R: M–N: M.G. Bovini 506; O–P: A.P. Duarte 113; Q–R: M. S. Faria. Illustrator C. Miranda).

adaxial surface bright, puberulous on midvein and abaxial surface totally pubescent, with domatia, venation brochidodromous. Thyse axillary and terminal, racemiform, 0.9–8.9 cm long, pubescent; bracts triangular. Flowers zygomorphic, 6–7 mm long; sepals 5; petals 4, crest of posterior petal appendages erose; nectariferous lobes 4, posterior ovate, anterior suborbicular, reduced; stamens 4–5 mm long, puberulous fillets, surrounding a pistilode, staminodes 2–3 mm long, surrounding a gynoeceium; ovary ca. 2 mm long, trigonous-obovoid, pubescent. Schizocarps 3.3–3.7 × 2.6–3 cm, large ovate-cordate, chartaceous, frequently with reddish-puberulent wings when young; seminiferous portion of mericarp inflated, puberulent; dorsal crest ca. 4 mm wide; endocarp lanose; seeds 1–3, obovoid; without aril; embryo with outer cotyledon curved and inner biplicate (Figures 7M–R).

Serjania corrugata is endemic to Brazil, occurring in the states of Bahia, Espírito Santo, Minas Gerais, Rio de Janeiro and Rio Grande do Norte (Figures 2B, 3). It is found in the following plant formations: restinga and dense ombrophilous forest formations. In restinga, it occurs

in non-flooded scrubs. Flowering occurs from January to May and fruiting in January, April, and May and from July to September. The taxon has been evaluated based on the IUCN (2019) criteria as Least Concern (LC).

In this study, the species differs from other *Serjania* by the following characteristics: stem in cross section with one small central vascular cylinder and 5 radiate vascular cylinders; leaves odoriferous when dry; leaflets shiny on adaxial surface, margin entire, frequently with one tooth near the base; reddish glandular trichomes all over the plant; fruits frequently reddish, large, with dorsal crest ca. 4 mm.

Selected materials: **BRAZIL**. RIO DE JANEIRO: Mun. Armação dos Búzios, Praia Rasa, 15.I.1979, fl. e fr., *G. Martinelli 563* (RB); Mun. Cabo Frio, Praia das Dunas, 3.IV.2008, fr., *M.S. Faria & L. Pederneiras 79* (RB); Mun. Maricá, na estrada voltando para Maricá, 14.IV.1988, fl. e fr., *R. Marquette 127* (RB); Mun. Niterói, Restinga de Piratininga, 11.I.1891, fr., *Schwacke s.n.* (R); Mun. Rio de Janeiro, restinga de Jacarepaguá, Pedra de Itauna, lado oeste, 25.V.1973, fr., *D.S.D. Araújo 191* (RB).

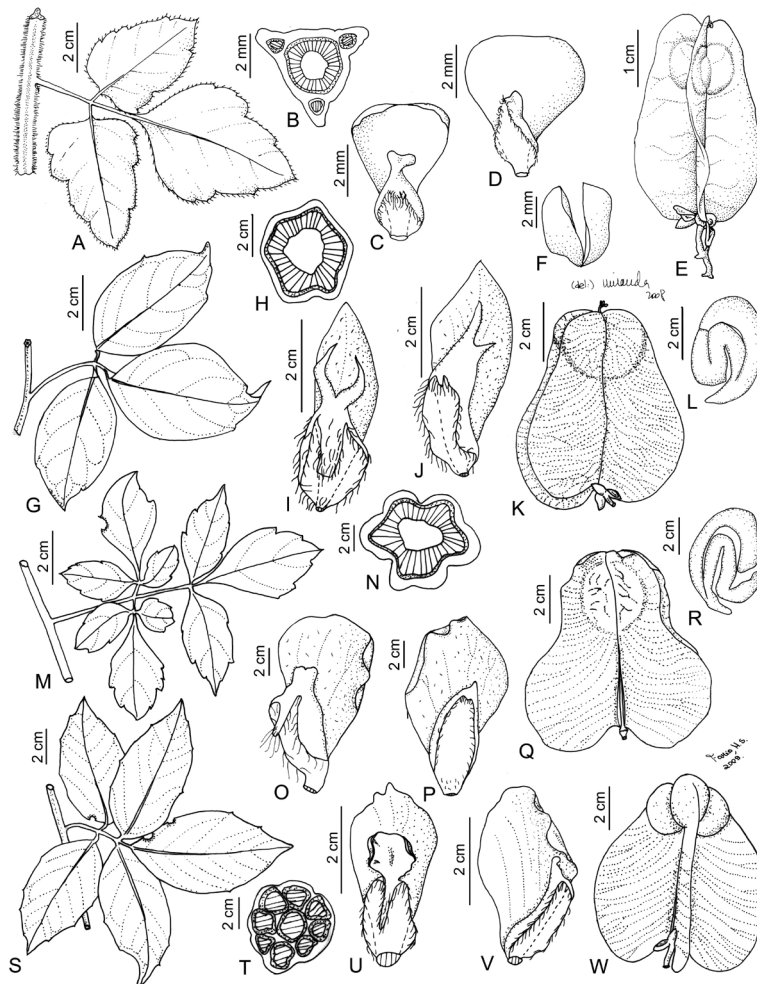


Figure 8. *Serjania cuspidata* – A. trifoliolate leaf; B. cross-section of the stem; C. posterior petal; D. anterior petal; E. fruit and F. embryo. *S. dentata* – G. trifoliolate leaf; H. cross-section of the stem; I. posterior petal; J. anterior petal; K. fruit; L. embryo. *S. eucardia* – M. biternate leaf; N. cross-section of the stem; O. posterior petal; P. anterior petal; Q. fruit; R. embryo. *S. fluminensis* – S. 5-foliolate leaf; T. cross-section of the stem; U. posterior petal; V. anterior petal and W. fruit. (A–E: M.S. Faria et al. 29; F–I: J. Fontella 2892; J–K: M.F. Freitas 35; L–M: O. Hoehne 5983; N–O: W. Hoehne 5961; P–Q: J. Almeida 1461; R–S, W: M.S. Faria et al. 84; T–V: G.V. Somner 756. Illustrators A–F: C. Miranda and G–W: M. S. Faria).

***Serjania cuspidata* Cambess. in St. Hil., Juss. & Cambess.
Fl. Bras. Mer. 1:356. 1824**

Semi-woody climbers; stem reddish brown, triangular (with prominent ferruginous-hirsute angles), hollow, in cross section composed of a large central vascular cylinder and three smaller equidistant, peripheral cylinders; stipules 4–4.5 mm long, linear; petiole unwinged, canaliculate. Leaves trifoliolate; leaflets 2.7–6 × 2.2–6 cm, ovate-subrhomboidal or ovate, sub-chartaceous, apex acuminate or cuspidate, margin serrate-dentate, both surfaces densely pubescent, venation mixed craspedodromous. Thyse axillary, racemiform, 4–17 cm long, pubescent; bracts linear. Flowers zygomorphic, 0.9–1.2 mm long; sepals 4; petals 4, crest of posterior petal appendages erose or emarginate; nectariferous lobes 4, posterior ovate, anterior reduced; stamens 3–5 mm long, puberulous fillets, surrounding a pistilode, staminodes 2–3.5 mm long, surrounding a gynoeceium; ovary 1.5–2 mm long, trigonous-obovoid, pubescent. Schizocarps 2–3.7 × 1.5–2.6 cm, ovate-cordate, chartaceous, pubescent; seminiferous portion of mericarp laterally flattened, endocarp glabrous; dorsal crest 1–2 mm wide; seeds 1–3, lenticular; without aril; embryo with sub-straight cotyledons (Figures 8A–F).

Serjania cuspidata is endemic to Brazil, occurring in the states of Bahia, Minas Gerais, Rio de Janeiro and São Paulo (Figures 2C, 3). It is found in the following plant formations: restinga and dense ombrophilous forests. In restinga, it occurs in non-flooded scrub, dune thicket and ridge forest formations. Flowering occurs from January to June and from August to November and fruiting from January to May and from July to December. The taxon has been evaluated based on the IUCN (2019) criteria as Least Concern (LC).

In this study, this species differs from other *Serjania* by the following characteristics: triangular stem, with ferruginous-hirsute trichomes on the angles; leaves trifoliolate; large fruits, with seminiferous portion of the mericarp laterally flattened, dorsal crest 1–2 mm wide; embryo with sub-straight cotyledons.

Selected materials: **BRAZIL.** RIO DE JANEIRO: Mun. Angra dos Reis, Ilha Grande, Reserva Biológica Estadual da Praia do Sul, na Praia do Sul, 16.V.1984, fl. e fr., *D. Araujo 6284* (GUA); Mun. Araruama, APA de Massambaba, 4.III.2008, fl., *M.S. Faria et al. 58* (RB); Mun. Cabo Frio, Però, Condomínio Acqua, 3.IV.2008, fl. e fr., *M.S. Faria et al. 78* (RB); Mun. Macaé, Restinga de Cabiúnas, próximo ao Canal Macaé-Campos,

5.V.1981, fl., *D. Araujo & N. Crud 4397* (GUA); Mun. Mangaratiba, Ilha da Marambaia, restinga da Praia Grande, 14.V.2002, fr., *G.V. Somner et al. 1017* (RBR); Mun. Maricá, Barra de Maricá, 28.XI.1988, fr., *A. Souza & H. Pereira 2557* (R); Mun. Niterói, São Gonçalo. Itaoca, Praia de São João, 13.III.1994, fl., *J.P.P. Carauta et al. s.n* (GUA41771); Mun. Parati, Praia de São Gonçalo, 10.VII.2008, fr., *M.S. Faria et al. 111* (RB); Mun. Rio das Ostras, Área de Relevante Interesse Ecológico Itapebussus (ARIE), 15.X.2007, fl. e fr., *M.S. Faria et al. 29* (RB); idem, 15.X.2007, fr., *M.S. Faria et al. 30* (RB); Mun. Rio de Janeiro, Restinga da Tijuca, 8.X.1946, fr., *A. Edmundo 364* (RB); Mun. Saquarema, R.E.E. de Jacarepiá, 10.IX.1995, fl., fr., *A.Q. Lobão 42* (RB).

Serjania dentata (Vell.) Radlk., Consp. Sect. Sp. Serjan.

144. 1874

Woody climbers; stem brown, 5-angled, hollow, geniculate, glabrous, with a single vascular cylinder in cross section; stipules 0.5–1.5 mm long, triangular; petiole unwinged, canaliculate. Leaves trifoliolate; leaflets 2.9–10.3 × 1.3–6.4 cm, ovate to elliptic, chartaceous, when dried conduplicate, apex acute to acuminate, margin repand-dentate, without yellowish cartilaginous line, revolute, both surface glabrous, without domatia, venation semicraspedodromous. Thyrses axillary and terminal, racemiform, 1.6–12.5 cm long, pubescent; bracts deltoid. Flowers zygomorphic, 6–8 mm long; sepals 5; petals 4, posterior petal appendages with bicorniculate crest; nectariferous lobes 4, crest of posterior petals appendage corniculiform, anterior ovoid, reduced; stamens 2.5–4 mm long, pubescent fillets, surrounding a pistilode, staminodes 1.5–2.5 mm long, surrounding a gynoeceum; ovary ca. 2 mm long, trigonous-ovoid, pubescent. Schizocarps 2.5–3.4 × 2.7–3 cm, ovate-cordate, chartaceous; glabrous; seminiferous portion of mericarp inflated; dorsal crest 1–2 mm wide, endocarp glabrous; seeds 1–3, trigonous-ellipsoid; without aril; embryo with outer cotyledon curved and inner biplicate (Figures 8G–L).

Serjania dentata is endemic to Brazil, occurring in the states of Bahia, Espírito Santo, Minas Gerais, Rio de Janeiro and São Paulo (Figures 2C, 3). It is found in the following plant formations: sandy coastal plain, dense ombrophilous forest and seasonal deciduous forest formations. In restinga, it occurs in non-flooded scrub, flooded scrub, dune thickets and ridge forests. Flowering occurs from January to June and from September to November and fruiting from July to September and in November. The taxon has been evaluated based on the IUCN (2019) criteria as Least Concern (LC).

In this study, the species differs from other *Serjania* by the following characteristics: stem 5-angled, hollow, geniculate; leaves trifoliolate, with repand-dentate margin, when dried the leaflets are conduplicate; crest of posterior petal appendages bicorniculate; fruits with seminiferous portion of mericarp inflated; dorsal crest 1–2 mm wide.

Selected materials: **BRAZIL**. RIO DE JANEIRO: Mun. Angra dos Reis, Ilha Grande, Reserva Biológica Estadual da Praia do Sul, Praia do Sul, 6.II.1996, fl., *D. Araujo, 10396* (GUA); Mun. Cabo Frio, entre Lagoa Mirim e praia de Massambaba, 28.III.1978, fl. e fr., *G. Martinelli 4120* (RB); Mun. Casimiro de Abreu, restinga entre Barra de S. João e Rio das Ostras, 21.III.1979, fl. e fr., *P.P. Jouvin 429* (RB); Mun. Macaé, restinga, 30.I.1997, fl. e fr., *V. Capello 45* (HB, R); Mun. Mangaratiba, Restinga da Marambaia, Campo de provas do exército Km 2, estrada ao lado do Porto Velho do Marinha, 26.VII.2003, fr., *G.V. Somner 1103* (RB, RBR); Mun. Maricá, Restinga da Barra de

Maricá, 29.III.1989, fl., *M.F. Freitas et al. 35* (RB); Mun. Parati, Praia de São Gonçalo, 10.VII.2008, fr., *M.S. Faria 110* (RB); Mun. Rio das Ostras, Restinga da Praia Virgem, 11.I.2001, fr., *H. do N. Braga 1812* (RB); Mun. Niterói, Jacuné, na orla da estrada, restinga a 2 km da praia de Jacuné, 10.VIII.1986, fr., *P. Acevedo-Rodríguez 1415* (RB); Mun. Rio de Janeiro, Restinga da Tijuca, 9.IV.1946, fl., *O.X. de B. Machado s.n* (RB 75358); Mun. Saquarema, Reserva Ecológica Estadual de Jacarepiá, 22.I.1993, fl., *J. Fontella 2892* (RB).

Serjania eucardia Radlk., Consp. Sect. Sp. Serjan. 121. 1875

Woody climbers; stem dark brown, 5–6-costate, crenate-sinuous, hollow, velutinous-pubescent, with glandular trichomes, in cross section with a single vascular cylinder; stipules 1–2.5 mm long, deltoid; petiole unwinged, canaliculate, rachis unwinged, bi-canaliculate. Leaves biternate; leaflets 1.6–12.5 × 0.9–8.2 cm, large-rhomboidal, ovate, sub-chartaceous, apex acuminate to cuspidate, subserrate-dentate margin; both surfaces densely velutinous-pubescent, venation semicraspedodromous. Thyrses axillary and terminal, racemiform, 2.2–9 cm long, pubescent; bracts triangular. Flowers zygomorphic, 9–12 mm long; sepals 5; petals 4, crest of posterior petal appendages emarginate; nectariferous lobes 4, posterior orbicular, anterior orbicular, reduced; stamens 2.5–4.5 mm long, pubescent fillets, surrounding a pistilode, staminodes 3–4.5 mm long, surrounding a gynoeceum; ovary 4–4.5 mm long, trigonous-obovoid, with ferruginous-glandular trichomes. Schizocarps 3.8–5 × 3.6–4.5 cm, ovate-cordate, subcoriaceous, wings puberulous; seminiferous portion of mericarp inflated, puberulous; dorsal crest 2–5 mm wide, endocarp villose; seeds 1–3, obovoid; without aril; embryo with outer cotyledon curved and inner biplicate (Figures 8M–R).

Serjania eucardia is endemic to Rio de Janeiro (Figures 2C, 3), occurring in restinga and dense ombrophilous forests. In restinga, it is found in non-flooded scrub, dune thickets and ridge forests. Flowering occurs from January to April and in December and fruiting in January, February, from April to June and in August and October. This species is evaluated here by its conservation status as endangered (EN), emphasizing its restricted distribution. Its extent of occurrence (EOO) is approximately 1000 km² (B1 <5000 km²), and is found exclusively in the restinga of Rio de Janeiro, environments that have been continuously degraded (B2b (ii,iii)).

In this study, the species differs from other *Serjania* by the following characteristics: stem 5–6 costate, velutinous, composed of only a single vascular cylinder in cross section; leaflets large-rhomboidal, densely pubescent-velutinous on both surfaces; large fruits, with inflated seminiferous portion; dorsal crest 2–5 mm wide.

Selected materials: **BRAZIL**. RIO DE JANEIRO: Mun. Cabo Frio, Ponta do Gabriel ao nível do mar, 17.IV.1952, fr., *L.B. Smith et al. 6660* (R); Mun. Niterói, Jaconé, restinga na orla da estrada, 2 Km de praia de Jaconé, 10.VIII.1986, fr., *P. Acevedo-Rodríguez 1418* (RB); Mun. Macaé, na estrada para Lagoa Comprida, 27.IV.1982, fr., *D. Araujo & N. Crud 4983* (GUA); Mun. Mangaratiba, Restinga da Marambaia, entrada por Barra de Guaratiba, 28.I.2005, fl. e fr., *G.V. Somner 1172* (RB); Mun. Maricá, Bambuí, 3.III.1976, fl., *R.F. de Oliveira 161* (GUA); Mun. Rio de Janeiro, ca. 6 Km do Canal de Sernambetiba, 20.I.1970, fl., *J. Fontella et al. 416* (RB); idem, restinga da Barra da Tijuca, 30.XII.1964, fl., *W. Hoehne 5961* (RB); idem, Lagoa Marapendi, estrada do Autódromo, 10.IV.1972, fr., *J. Almeida 1461* (RB); Mun. Saquarema, Restinga de Jaconé, 30.V.1978, fr., *H.C. de Lima 559* (RB).

***Serjania fluminensis* Acev.-Rodr., Brittonia 39(3) 348. 1987**

Woody climbers; stem brown, sub-cylindrical, 8-costate, pubescent, in cross section composed of one central vascular cylinder and 8–10 smaller peripheral cylinders; stipules ca. 0.5 mm long, triangular; petiole unwinged, canaliculate; rachis unwinged, bicanaliculate. Leaves 5-foliolate, leaflets 4.4–14 × 2–5.9 cm, elliptic, ovate, chartaceous, apex cuspidate, margin entire or repand-dentate, subrevolute, both surfaces glabrous, without domatia, venation semicraspedodromous. Thyse axillary and terminal, 5.8–8.8 cm long, pubescent; bracts triangular. Flowers zygomorphic, 9–10 mm long; sepals 5; petals 4, crest of posterior petal appendages erose; nectariferous lobes 4, posterior ovoid, anterior ovoid, reduced; stamens 2.5–5 mm long, tomentose fillets, surrounding a pistilode, staminodes 2.5–3.5 mm long, surrounding a gynoeceium; ovary ca. 2 mm long, trigonous-obovoid, pubescent and with glandular trichomes. Schizocarps 2.7–4.7 × 2.4–4.4 cm, ovate-cordate, sub-coriaceous, wings glabrous, seminiferous portion of mericarp globose, without dorsal crest, endocarp lanose; seeds 1–3, obovoid; without aril; embryo not observed (Figures 8S–W).

Serjania fluminensis is endemic to the northern coast of Rio de Janeiro state, occurring in ridge forests of restinga (Figures 2C, 3). This species is infrequent in Rio de Janeiro's restinga and further collections are needed to better establish the details of its phenology. Flowering is recorded from May to June and fruiting in August, October, February, and from May to June. According to Somner et al. (2018), this species is evaluated by its conservation status as endangered (EN). In this study, we established that *S. fluminensis* has an extent of occurrence (EOO) of approximately 1500 km² (B1 <5000 km²), and is found exclusively in the restinga of Rio de Janeiro, whence there are only a few records. This habitat has suffered loss in quality caused by tourism and real estate development (B2a ≤5 and b (i,ii,iii,iv)).

In this study, the species differs from other *Serjania* by showing the following characteristics: stem composed in cross section of one vascular central cylinder and 8–10 smaller peripheral cylinders, leaves 5-foliolate, leaflets large and fruits with globose seminiferous portion, without a dorsal crest. The description of the flowers is presented here for the first time.

Selected materials: **BRAZIL**. RIO DE JANEIRO: Mun. Armação de Búzios, restinga da Praia da Gorda, 15.II.2000, fr., *D. Fernandes & A. Oliveira 423* (RB); Mun. Cabo Frio, APA Pau-Brasil, 9.VI.2008, fr., *M.S. Faria et al. 84* (RB); Mun. Rio das Ostras, Restinga de Balneário das Garças, 1.V.1999, fl. e fr., *R.N. Damasceno 952* (RB); Mun. Saquarema, Restinga da Massambaba, 10.VIII.1986, fr., *P. Acevedo-Rodríguez & C. Farney 1424* (R, RB); idem, Reserva Ecológica Estadual de Jacarepiá, Restinga de Ipitangas, 24.V.1988, fr., *C. Farney & L.S. Sarayba 2133* (HB, RB); idem, 14.V.1993, fl. e fr., *G.V. Somner 756* (RBR); idem, 29.X.1991, fr., *G.V. Somner et al. 704* (RBR).

***Serjania ichthyoctona* Radlk., Serj. Monogr.: 230. 1875**

Woody climbers; stem dark brown, triangular, 3-costate, ribs conspicuous, glabrous, in cross section composed of one large central vascular cylinder and three prominent smaller peripheral cylinders; stipules ca. 0.5 mm long, triangular, canaliculate; petiole unwinged,

canaliculate; rachis unwinged, bicanaliculate. Leaves biternate, leaflets 1.9–10 × 1–4.9 cm, elliptic to lanceolate, coriaceous, both surface glabrous, apex acute, margin entire, revolute, without domatia, venation brochidodromous. Thyse axillary and terminal, racemiform, 2–10.9 cm long, tomentose; bracts deltoid. Flowers zygomorphic, 5.5–7.5 mm long; sepals 5; petals 4, crest of posterior petals appendage bicorniculate; lobes 4, posterior ovoid, anterior ovoid, reduced; stamens 2.5–3.5 mm long, pubescent fillets, surrounding a pistilode, staminodes 2–2.5 mm long, surrounding a gynoeceium; ovary ca. 1.5 mm long, trigonous-obovoid, pubescent. Schizocarps 2.7–2.8 × 2.1–2.3 cm, chartaceous, pubescent; seminiferous portion of mericarp globose, without a dorsal crest, endocarp glabrous; seeds 1–3, globose; without aril; embryo with sub-straight cotyledons (Figures 9A–F).

Serjania ichthyoctona is endemic to Brazil, occurring in the states of Bahia, Espírito Santo, Pernambuco and Rio de Janeiro (Figures 2C, 3). It is found in the following plant formations: sandy coastal plain, dense ombrophilous forest, seasonal deciduous forest and seasonal semideciduous forest formations. In restinga, it occurs in non-flooded scrub, flooded scrub and ridge forests. Flowering occurs in January and April, from June to September and fruiting from July to October. The taxon has been evaluated based on the IUCN (2019) criteria as Least Concern (LC).

In this study, the species differs from other *Serjania* by the following characteristics: stem triangular, 3-costate, with conspicuous ribs, composed in cross section of one large central vascular cylinder and three prominent smaller peripheral cylinders; leaves biternate, coriaceous, leaflets with entire margins; fruits with seminiferous portion of mericarp globose, without crest.

Selected materials: **BRAZIL**. RIO DE JANEIRO: Mun. Cabo Frio, APA Bacia do Rio São João/Mico-leão-dourado, Parque Ecológico do Mico Leão Dourado, 14.VIII.2003, fl., *D. Fernandes 752* (RB); Mun. Casimiro de Abreu, estrada do Rio Dourado, hacia Rio das Ostras, 14.VIII.1986, fl., *P. Acevedo-Rodríguez et al. 1441* (RB, RBR); Mun. Macaé, Fazenda Jurubatiba, na mata de restinga, 17.IX.1986, fl., *D. Araujo & M.C.A. Pereira 7562* (GUA); Mun. Mangaratiba, Restinga da Marambaia, 31.VII.1997, fl., *G.V. Somner & M.S. Ferrucci 831* (RBR); Mun. Rio de Janeiro, Restinga da Tijuca, 22.VIII.1945, fl., *J.G. Kuhlmann 6267* (RB); Mun. Saquarema, Restinga de Ipitangas, 20.X.1988, fr., *C. Farney 2177* (HB, RB).

***Serjania littoralis* Somner & Ferrucci, Ann. Bot. Fennici 46: 479. 2009**

Semi-woody climbers; stem light brown or dark brown, cylindrical, 6-striate, puberulous when young, glabrescent when mature, not hollow, geniculate, with orange glandular trichomes; in cross section with a single vascular cylinder; stipules ca. 0.5–1 mm long, triangular; petiole unwinged, canaliculate. Leaves trifoliolate, leaflets 2.4–7.5 × 1.2–3.4 cm, elliptic, chartaceous, conduplicate, apex acuminate-mucronate, margin entire, sometimes with 1–2 glandular teeth in the basal third, subrevolute, wavy, with yellowish cartilaginous line, both surfaces glabrous, without domatia, venation brochidodromous. Thyse axillary or terminal, subspiciform, 1.3–2.8 cm long, pubescent; bracts triangular. Flowers zygomorphic, ca. 6.5 mm long; sepals 5, petals 4, crest of posterior petal appendages bicorniculate; posterior nectariferous lobes ovoid, anterior orbicular; stamens 2–3.5 mm long, puberulous fillets,

Paullinieae of the restingas of Rio de Janeiro

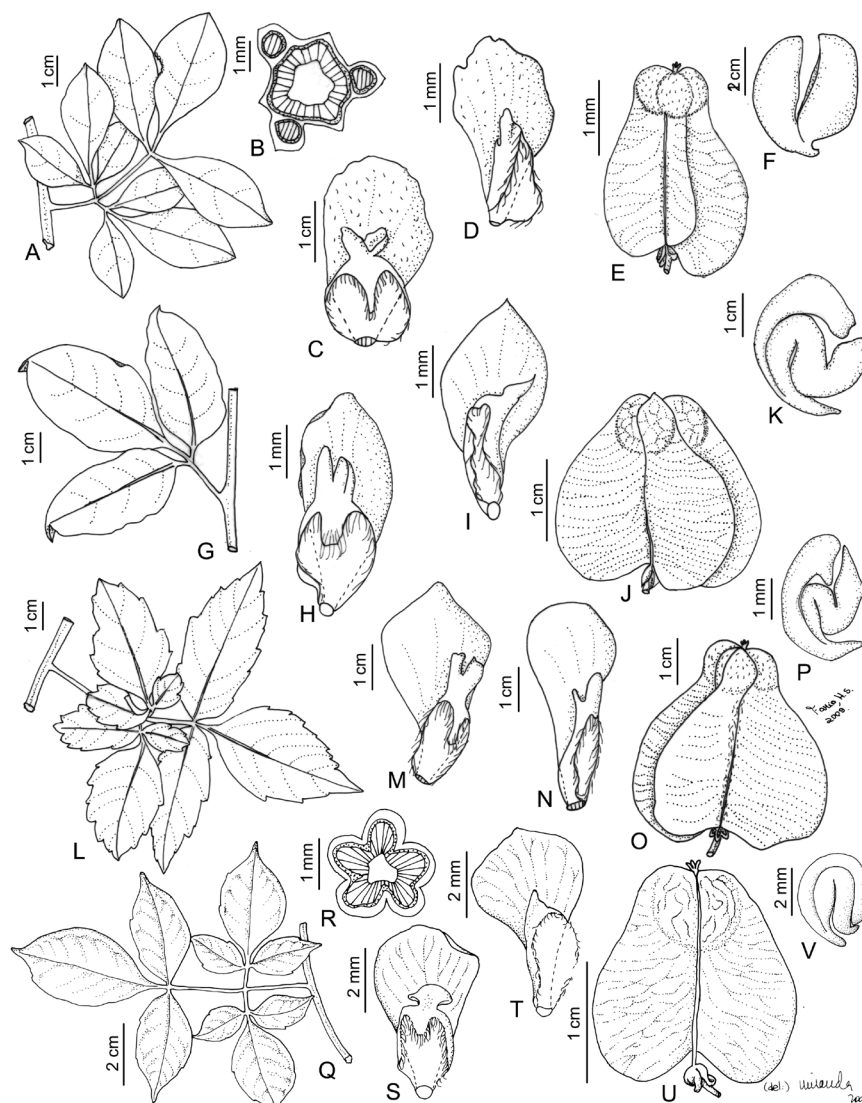


Figure 9. *Serjania ichthyoctona* – A. biternate leaf; B. cross-section of the stem; C. posterior petal; D. anterior petal; E. fruit; F. embryo. *S. littoralis* – G. trifoliolate leaf; H. posterior petal; I. anterior petal; J. fruit; K. embryo. *S. pernambucensis* – L. biternate leaf; M. posterior petal; N. anterior petal; O. fruit; P. embryo. *S. salzmanniana* – Q. biternate leaf; R. cross-section of the stem; S. posterior petal; T. anterior petal; U. fruit; V. embryo. (A–B: D. Sucre 5874; C–D: D. Fernandes 752; E–F: V.L.G. Klein, 1038; G: M. S. Faria 90; H–I: M. S. Faria 82; J–K: D. Araujo 10309; L–P: M. Vianna F. et al. 347; Q–R: M. S. Faria 123; S–T: C. Farney, U–V: M. S. Faria 124. Illustrators A–P: M. S. Faria and Q–V: C. Miranda).

surrounding a pistilode, staminodes 1.5–2.5 mm long, surrounding a gynoeceum; ovary ca. 2.5 mm long, trigonous-obovoid, with glandular trichomes. Schizocarps 1.4–2.4 × 1.3–2.5 cm, chartaceous, glabrous, seminiferous portion of mericarp inflated, dorsal crest 1–1.5 mm wide, endocarp glabrous; seeds 1–3, subglobose, without aril; embryo with outer cotyledon curved and inner biplicate (Figures 9G–K).

Serjania littoralis is endemic to the northern coast of Rio de Janeiro state, occurring in ridge forests of restinga (Figures 2C, 3). However, there are records of collections on rocky stretches of the shore, a type of habitat described by Veloso *et al.* (1991) as “*pontal rochoso*”, which influence on the origin of the restingas. Flowering occurs from May to June and fruiting from June to August. According to Somner *et al.* (2018), the conservation status of this species is evaluated as endangered (EN). In this study, we established that *S. littoralis* has an extent of occurrence (EOO) of approximately 1200 km² (B1 <5000 km²), and is

found exclusively in the restinga of Rio de Janeiro, where there are few records of its occurrence. This habitat has suffered loss of quality caused from tourism and real estate development (B2a ≤5 and b(i,ii,iii,iv)).

In this study, the species differs from other *Serjania* by the following characteristics: stem 6-striate, with orange glandular trichomes, and a single vascular cylinder in cross section; leaves trifoliolate, leaflets with margins entire, subrevolute, wavy, with a yellow cartilaginous line; crest of posterior petal appendagea bicorniculate; fruits with seminiferous portion of mericarp inflated, and dorsal crest 1–1.5 mm wide.

Selected materials: **BRAZIL.** RIO DE JANEIRO: Mun. Armação de Búzios, Praia da Gorda, 9.VI.2008, fr., *M.S. Faria 90* (RB); restinga da praia de José Gonçalves, 25.VI.1999, fr., *D. Fernández 236* (RB, RBR); Mun. Cabo Frio, APA Pau-Brasil, 9.VI.2008, fl., *M.S. Faria 82*

(RB); estrada antiga para Búzios, próximo Centrinho, 28.VI.1995, fl., *D. Araujo 10309* (GUA).

***Serjania pernambucensis* Radlk., in Martius, Fl. Bras. 13 (3): 332. 1892**

Woody climbers; stem dark brown, 5–6-sulcate, densely ferruginous-tomentose, with a single vascular cylinder in cross section; stipules 1.5–2 mm long, ovate-triangular; petiole and rachis unwinged, canaliculate. Leaves biternate, leaflets 6.5–8.5 × 4.8–5.1 cm, ovate, coriaceous, apex acute, margin serrate-dentate, ferruginous-pubescent on both sides, abaxial surface more densely pubescent, with glandular trichomes, venation craspedodromous. Thyrses axillary and terminal, racemiform, 1.2–3.1 cm long, dense ferruginous-tomentose; bracts triangular. Flowers zygomorphic, 6–7.5 mm long; sepals 5; petals 4, crest of posterior petal appendages erose or emarginate; nectariferous lobes 4, posterior orbicular, anterior ovoid; stamens 3–3.5 mm long, puberulous fillets, surrounding a pistilode, staminodes 2–2.5 mm long, surrounding a gynoecium; ovary ca. 1.5 mm long, trigonous-obovoid, densely ferruginous-tomentose. Schizocarps 2.3–2.5 × 2–2.2 cm, pubescent close to the septum, seminiferous portion of mericarp globose, ferruginous-tomentose, without dorsal crest, endocarp lanose; seeds 1–3, obovate, without aril; embryo with outer cotyledon curved and inner biplicate (Figures 9L–P).

Serjania pernambucensis is endemic to Brazil, occurring in Bahia, Minas Gerais, Pernambuco and Rio de Janeiro (Figures 2C, 3). It is found in the following plant formations: sandy coastal plain, dense ombrophilous forest, seasonal semideciduous forest and savanna formations. This species is rare in Rio de Janeiro and is found on the northern coast of the state, occurring in ridge forests of restinga. Flowering occurs in March and May, and fruiting in March and from May to June. The taxon has been evaluated based on the IUCN (2019) criteria as Least Concern (LC).

In this study, the species differs from other *Serjania* by the following characteristics: indument densely ferruginous-tomentose throughout the plant; leaves biternate, with unwinged petiole and rachis; fruits with seminiferous portion of the mericarp globose, without a dorsal crest.

Selected materials: **BRAZIL**. RIO DE JANEIRO: Mun. Armação de Búzios, Estrada do condomínio Vila Verde, 30.V.2004, fl. e fr., *M. Vianna Filho et al. 347* (GUA); Mun. Macaé, Bairro dos Cavalheiros, estrada de acesso ao vale encantado, 16.V.2009, fl., *R.D. Ribeiro 1111* (RB); Mun. Rio das Ostras, Praia Virgem, rua João Persegueiro do Amaral, paralelo à praia, 05.V. 2016, fl., *G.V. Somner et al.* (RBR).

***Serjania salzmanniana* Schldt., Linnaea 18: 46. 1844**

Woody climbers; stem dark brown, 5-costate, crenate-lobate, hollow, pubescent, with a single vascular cylinder in cross section; stipules ca. 1 mm long, triangular; petiole unwinged, canaliculate; rachis bicanaliculate or marginate. Leaves biternate, rarely 5-foliolate, bullate; leaflets 2.6–8.5 × 1.5–4.5 cm, rhomboidal to ovate or elliptic, chartaceous, apex acuminate-mucronate, margin serrate-dentate, adaxial surface puberulous on midvein, abaxial surface glabrous, without domatia, venation semicraspedodromous. Thyrses axillary and terminal, racemiform, 2.2–7 cm long, tomentose; bracts triangular. Flowers zygomorphic, ca. 9 mm long; sepals 5; petals 4, crest of posterior petal appendages erose; nectariferous lobes 4, posterior ovoid, anterior orbicular, reduced; stamens 2.5–4 mm long, puberulous fillets, surrounding a pistilode,

staminodes 2.5–4 mm long, surrounding a gynoecium; ovary ca. 3 mm long, trigonous-obovoid, pubescent and with glandular trichomes. Schizocarps 1.7–2.8 × 1.5–2 cm, ovate-cordate, chartaceous, glabrous, dorsal crest 2–4 mm wide, seminiferous portion of mericarp inflated, endocarp lanose; seeds 1–3, obovoid, without aril; embryo with outer cotyledon curved and inner biplicate (Figures 9Q–V).

Serjania salzmanniana is endemic to Brazil, occurring in the states of Alagoas, Bahia, Ceará, Espírito Santo, Goiás, Maranhão, Pará, Paraíba, Pernambuco, Rio de Janeiro, Rio Grande do Norte and Sergipe (Figures 2C, 3). It is found in the following plant formations: sandy coastal plain, dense ombrophilous forest, seasonal semideciduous forest and savanna formations. In restinga, it occurs in scrub dunes, seasonally flooded scrub, seasonally flooded swamps and ridge forests. The species is very frequent in non-flooded scrub in Carapebus restinga. Flowering occurs from February to March and in December, and fruiting from February to June, from August to September and in December. The taxon has been evaluated based on the IUCN (2019) criteria as Least Concern (LC).

In this study, the species differs from other *Serjania* by the following characteristics: stem crenate-lobate, with a single vascular cylinder in cross section; leaves biternate or 5-foliolate, bullate; fruits with seminiferous portion of mericarp inflated and dorsal crest 2–4 mm wide.

Selected materials: **BRAZIL**. RIO DE JANEIRO: Mun. Carapebus, PARNA Jurubatiba, 10.VI.2008, fr., *M.S. Faria et al. 98* (RB, RBR); Mun. Casimiro de Abreu, no loteamento Praia Ouro Verde, Restinga de “Ericaceae”, 27.VI.1983, fr., *D. Araujo 5641* (GUA); Mun. Macaé, entre a Lagoa Cabiúnas e a faixa de tubulação da Petrobras, 25.III.1998, fr., *D. Araujo 10644* (GUA); Mun. Paquetá, Praia da Moreninha, 17.V.2008, fr., *J. Figueira s.n.* (RBR 30699); Mun. Saguarema, Jacocé, 29.III.2000, fl., *C. Farney 4015* (RB).

***Serjania tenuis* Radlk., Consp. Sect. Sp. Serjan. 98. 1874**

Woody vine; stem brown or greenish brown, 3–5-costate, obtusely-triangular, with three prominent ribs, puberulous when young, glabrous when mature, in cross section composed of a single central vascular cylinder and three smaller peripheral cylinders; stipules ca. 1 mm long, deltoid; petiole unwinged, canaliculate. Leaves trifoliolate; leaflets 4.9–9.5 × 1.9–4.1 cm, lanceolate to ovate, sub-chartaceous, apex acuminate, mucronate, margin with four small teeth, or rarely entire, adaxial surface glabrous and abaxial surface pilose on the midvein, without domatia, venation mixed craspedodromous. Thyrses axillary, racemiform, 3.5–16.5 cm long, pubescent; bracts triangular. Flowers zygomorphic, 7–9 mm long; sepals 4; petals 4, crest of posterior petal appendages emarginate; nectariferous lobes 4, posterior lobes ovoid, anterior ovoid, reduced; stamens 2.5–4 mm long, puberulous fillets, surrounding a pistilode, staminodes 2–3.5 mm long, surrounding a gynoecium; ovary ca. 3.5 mm long, trigonous-obovoid, pubescent. Schizocarps 2.5–2.6 × 2.3–2.4 cm, ovate-cordate, chartaceous, glabrous; seminiferous portion of mericarp laterally flattened; dorsal crest 1–2 mm long, endocarp lanose; seeds 1–3, lenticular, without aril; embryo with outer cotyledon curved and inner biplicate (Figures 10A–E).

Serjania tenuis is endemic to Rio de Janeiro, occurring in restinga (in ridge forests) and dense ombrophilous forests (Figures 2D, 3). Flowering occurs in March and from May to June and fruiting in March and May. According to Somner et al. (2018),

Paullinieae of the restingas of Rio de Janeiro

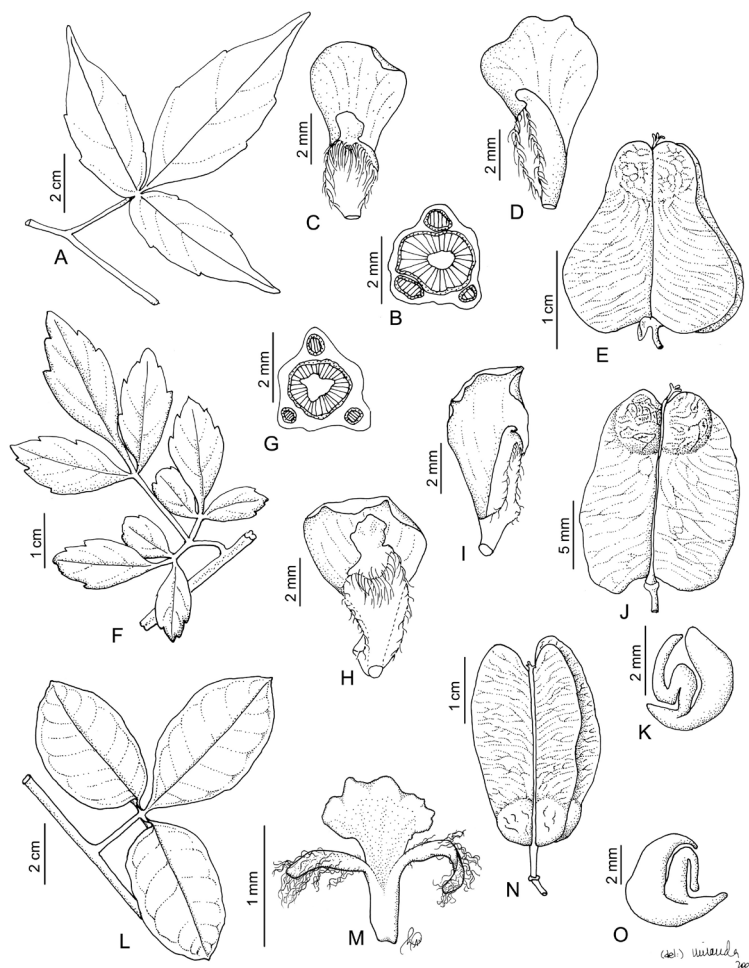


Figure 10. *Serjania tenuis* – A. trifoliolate leaf; B. cross section of the stem; C. posterior petal; D. anterior petal; E. fruit. *S. thoracoides* – F. bifoliate leaf; G. cross section of the stem; H. posterior petal; I. anterior petal; J. fruit; K. embryo. *Thinouia restingae* – L. trifoliolate leaf; M. petal; N. fruit; O. embryo. (A–B: D. Sucre 4968; C–E: M. S. Faria 74; F, G, J–K: P. Acevedo-Rodríguez et al. 1452; H–I: D. Sucre 3925; L–M: M.G. Bovini 1925; N–O: M.G. Bovini & J.M.A. Braga 170. Illustrator A–L, N–O: C. Miranda and M: L. A. Brito).

the conservation status of this species is evaluated as vulnerable (VU), and it suffers from habitat degradation due to human action in Atlantic Forest (B2b(iii)). In this study, we established that the species has an extent of occurrence (EOO) of approximately 14000 km² (B1 >20000 km²).

In this study, the species differs from other *Serjania* by the following characteristics: stem 3–5-costate, obtusely-triangular, with three prominent ribs, in cross section composed of one central vascular cylinder and three smaller peripheral cylinders; leaflet margins with four small teeth, or rarely entire; fruits with seminiferous portion of mericarp laterally flattened.

Selected materials: **BRAZIL.** RIO DE JANEIRO: Mun. Cabo Frio, Caminho para Praia do Peró, 3.III.2008, fl., *M.S. Faria et al.* 73 (RB); idem, 3.III.2008, fr., *M.S. Faria* 74 (RB); Mun. Rio de Janeiro, Restinga de Grumari, 8.III.1935, fl., *C.V. Freire* 591 (R).

***Serjania thoracoides* Radlk., Consp. Sect. Sp. Serjan. 170. 1874**

Woody climbers; stem dark brown, triangular, 3-costate, ribs conspicuous, rarely pubescent, in cross section composed of one large

central cylinder and three smaller peripheral cylinders; stipules 1–1.5 mm long, triangular; petiole unwinged, canaliculate, rachis unwinged, bicanaliculate. Leaves bifoliate; leaflets 2–3.2 × 0.8–1.5 cm, rhomboidal to elliptic; chartaceous, apex acuminate-mucronate, margin serrate-dentate, adaxial surface pubescent on midvein and abaxial surface puberulous, without domatia, venation craspedodromous. Thyse axillary and terminal, racemiform, 0.8–2.3 long, pubescent; bracts deltoid. Flowers zygomorphic, 5.5–6.5 mm long; sepals 5; petals 4, crest of posterior petal appendages erose; nectariferous lobes 4, posterior nectariferous lobes ovoid, anterior ellipsoid, reduced; stamens 2.5–3 mm long, puberulous fillets, surrounding a pistilode, staminodes 2–2.5 mm long, surrounding a gynoeceum; ovary ca. 1 mm long, trigonous-obovoid, pubescent. Schizocarps 1.5–1.7 × 1–1.6 cm, chartaceous, glabrous; seminiferous portion of mericarp globose, without crest; endocarp lanose; seeds 1–3, globose, without aril; embryo with outer cotyledon curved and inner biplicate (Figures 10F–K).

Serjania thoracoides is endemic to southeastern Brazil and occurs in Espírito Santo, Minas Gerais and Rio de Janeiro (Figures 2D, 3). It is found in restinga and dense ombrophilous forest formations. In restinga, it occurs in dune thickets. Flowering occurs in January, from May to June and from August to October and fruiting from August

to October. The taxon has been evaluated based on the IUCN (2019) criteria as Least Concern (LC).

In this study, the species differs from other *Serjania* by the following characteristics: stem triangular, 3-costate, ribs conspicuous, in cross section composed of one large central vascular cylinder and three smaller peripheral cylinders; fruits small, with seminiferous portion of mericarp globose and without a crest.

Selected materials: **BRAZIL**. RIO DE JANEIRO: Mun. Armação de Búzios, Restinga da praia do Forno, 19.VIII.1998, fl., *D. Fernandes et al.* 34 (R); Mun. Cabo Frio, restinga entre a Praia das Focas e a Praia do Forno, 14.VIII.1986, fr., *P. Acevedo-Rodríguez 1452* (RB).

***Thinouia mucronata* Radlk., Sitzungsber. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. München 8: 282. 1878**

Thinouia repanda Radlk. in Engl. & Prantl, Nat. Pflanzenfam. 3(5): 308. 1895.

Woody climbers; stem grayish brown, slightly costate when young, cylindrical when mature, glabrescent or glabrous, in cross section with a single vascular cylinder; stipules 0.5–1 mm long, triangular; petiole unwinged, canaliculate. Leaves trifoliolate; leaflets 3–8.8 × 1–5.1 cm, ovate-rhomboidal or ovate, chartaceous, apex acute or obtuse-mucronate, margin subentire, with 1–2(–3–4) teeth reduced to inconspicuous gland, glabrous or puberulous on both surfaces, domatia, venation craspedodromous. Thyse axillary, umbelliform, 0.8–1.7 cm long, pubescent; bracts ovoid. Flowers actinomorphic, 2.5–4 mm long; sepals 5; petals 5, spatulate, with divergent bifid appendages, never bifurcated; nectariferous disk annular; stamens 2.2–4 mm long, villose fillets, surrounding a pistilode, staminodes 1.5–1.7 mm long, surrounding a gynoeceum; ovary ca. 1.2 mm long, trigonous-ovoid, villose. Schizocarps 3.5–3.9 × 1.9–2.5 cm, obcordiform, chartaceous, glabrous; stipe 0.6–0.8 cm long, endocarp villose; seeds 1–3, trigonous-ellipsoid, without aril; embryo with outer cotyledon curved and inner biplicate (Figures 11A–C).

Thinouia mucronata occurs in Argentina, Brazil, Bolivia and Paraguay. In Brazil, there are records in the following states: Bahia, Espírito Santo, Mato Grosso do Sul, Minas Gerais, Paraná, Rio de Janeiro, Rio Grande do Sul, Santa Catarina and São Paulo (Figures 2D, 3). This species is uncommon in the restinga of Rio de Janeiro, with only one occurrence record. It is found in the following plant formations: sandy coastal plain, dense ombrophilous forest, seasonal semideciduous forest and gallery forest formations. In restinga, it occurs in ridge forests and dune thickets. Fruiting occurs in April and June. The taxon has been evaluated based on the IUCN (2019) criteria as Least Concern (LC).

In this study, the species differs from other *Thinouia* by the following characteristics: stem with a single vascular cylinder in cross section; leaflets chartaceous, with sub-entire margins, with one or two, rarely three to four teeth reduced to inconspicuous gland, venation craspedodromous; corolla spatulate, with divergent bifid appendages; fruits obcordiform, glabrous.

Selected materials: **BRAZIL**. RIO DE JANEIRO: Mun. Cabo Frio, Estação Radiométrica de Campos Novos, 2 Distrito, Estrada do Anel Viário, 12.VI.2009, fr., *G.V. Somner & M. Faria 1354* (RBR).

***Thinouia restingae* Ferrucci & Somner, Brittonia 60(4): 371. 2008**

Woody climbers; stem grayish brown, sub-cylindrical, 5–6 costate, glabrous, in cross section composed of one central vascular cylinder and three peripheral cylinders; stipules 1–2.5 mm long, triangular, petiole unwinged, canaliculate. Leaves trifoliolate, leaflets elliptic to lanceolate, 2.3–5.8 × 1–3 cm; sub-coriaceous, apex acute-mucronate, margin entire, both surfaces glabrous, without domatia, venation brochidodromous. Thyse axillary, umbelliform, 1–1.5 cm long, pubescent; bracts triangular. Flowers actinomorphic, 5–6 mm long; sepals 5; petals 5, petals spatulate, with divergent bifid appendages, sometimes bifurcated; nectariferous disk annular; stamens 2.5–4 mm long, villose fillets, surrounding a pistilode, staminodes ca. 1.5 mm long, surrounding a gynoeceum; ovary ca. 1.5 mm long, trigonous-ovoid, pubescent on the angles. Schizocarps 2.8–3.4 × 1.7–1.9 cm, obcordiform, chartaceous, glabrous; endocarp villose; seeds 1–3, obovoid; without aril; embryo with outer cotyledon curved and inner biplicate (Figures 10L–O).

Thinouia restingae is endemic to Brazil, occurring in the states of Bahia, Espírito Santo and Rio de Janeiro (Figures 2D, 3). It is found in the following plant formations: sandy coastal plain, dense ombrophilous forest and seasonal semideciduous forest formations. In restinga, it occurs in dune thickets and ridge forests. Flowering occurs in October and December and fruiting in January, May, July, August and October. This species is evaluated here by its conservation status as vulnerable (VU). Although its extent of occurrence (EOO) is below 20000 km² (B1) and records are still scarce and scattered, the species is concentrated especially in restinga of Rio de Janeiro State, environments that have suffered intense human degradation. A few isolated specimens were recorded in Bahia and Espírito Santo in the Atlantic Forest (B2 < 2000 km²; B2a ≤ 10 and b(i, iii, iv)).

In this study, the species differs from other *Thinouia* by the following characteristics: stem sub-cylindrical, 5–6 costate, glabrous, in cross section composed of one central vascular cylinder and three peripheral cylinders; leaflets subcoriaceous, with entire margins, both sides glabrous; venation brochidodromous, petals with divergent bifid appendages, sometimes bifurcated.

Selected materials: **BRAZIL**. RIO DE JANEIRO: Mun. Armação de Búzios, Praia da Gorda, 16.XII.1998, fl. *D. Fernandes 195* (RBR); Mun. Macaé, condomínio Mar do Norte, 18.VII.1993, fr., *M.G. Bovini & J.M.A. Braga 170* (RB); Mun. Saquarema, Restinga de Ipitangas, 30.X.1983, fl., *C. Farney 2173* (RB); Mun. Rio das Ostras, restinga do Mar do Norte, 18.12.2000, fl., *M.G. Bovini 1925* (RB).

***Urvillea glabra* Cambess., Fl. Bras. Merid. 1: 353, tab. 74. 1828**

Subwoody climbers; stem light brown, subcylindrical, 5–6-costate, inconspicuous ribs, geniculate, glabrous, with a single vascular cylinder in cross section; stipules ca. 0.5 mm long, triangular; petiole unwinged, canaliculate. Leaves trifoliolate; leaflet 1.2–7.6 × 1.3–3.4 cm, ovate, sub-chartaceous, apex acute, margin serrate-dentate, with 2 or 4 pairs of teeth close to apex, venation prominent, both sides glabrous, abaxially with laticiferous utricles, with domatia, venation mixed craspedodromous. Thyse axillary, sub-spiciform, 1–5.2 cm long,

Paullinieae of the restingas of Rio de Janeiro

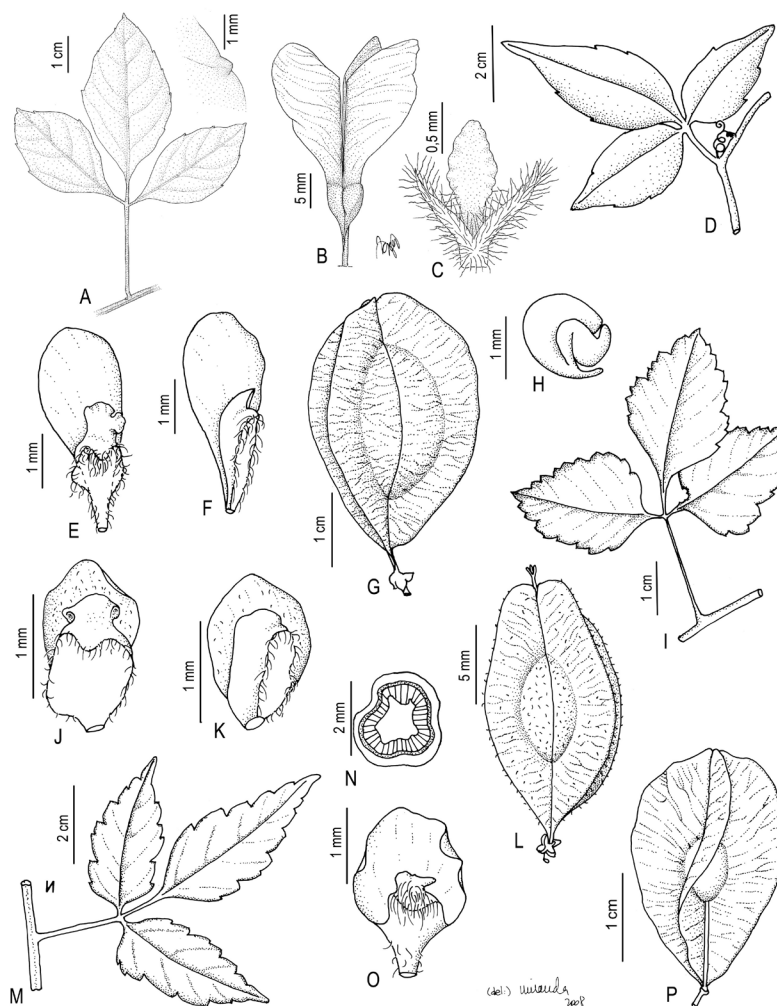


Figure 11. *Thinouia mucronata* – A. trifoliolate leaf; B. fruit; C. petal. *Urvillea glabra* – D. trifoliolate leaf; E. posterior petal; F. anterior petal; G. fruit; H. embryo. *U. rufescens* – I. trifoliolate leaf; J. posterior petal; K. anterior petal; L. fruit. *U. stipitata* – M. trifoliolate leaf; N. cross section of the stem; O. petal; P. fruit. (A, C: L. B. Salmazi s.n.; B: F. Chagas-Silva 1501; D–F: M. S. Faria et al. 41; G–H: H.P. Bautista 334; I–J: M.C. Gaglianone et al. 148; K: M. S. Faria 34; L–M: R. Andreatta et al. 668; N: R.C. Forzza et al. 2729; O: A. Oliveira & D. Fernandes 139. Illustrators A–C: I. H. F. Azevedo and D–P: C. Miranda).

puberulous; bracts triangular. Flowers zygomorphic, 4.5–6.5 mm; sepals 5; petals 4, crest of posterior petal appendages biariculiform; posterior nectariferous lobes orbicular, anterior elliptic; stamens 2.5–3 mm long, puberulous fillets, surrounding a pistilode, staminodes 1–1.5 mm long, surrounding a gynoeceium; ovary ca. 2 mm long, trigonous-ellipsoid, pubescent. Capsules 3–5.5 × 2.2–2.7 cm, three-winged, obovate or oblong, sub-chartaceous, glabrous, with inflated locules; endocarp puberulous; seeds 1–3, subglobose; aril semicircular; embryo with outer cotyledon curved and inner biplicate (Figures 11D–H).

Urvillea glabra is endemic to Brazil, occurring in Espírito Santo, Rio de Janeiro and São Paulo, in sandy coastal plain and dense ombrophilous forest formations (Figures 2D, 3). In restinga, it occurs in non-flooded scrubs and ridge forests. Flowering occurs from April to June and fruiting in May and from July to September. According to Valente et al. (2013), this species is evaluated by its conservation status as Vulnerable (VU). Although it has an extent of occurrence (EOO) of approximately 6300 km² (B1 <20000 km²), records are still scarce and scattered, the species is concentrated especially in restinga in Rio

de Janeiro State, and with a few isolated records in Espírito Santo and São Paulo, environments that have suffered intense human degradation (B2 <2000 km²; B2a ≤10 and b(i, iii,iv)).

In this study, the species differs from other *Urvillea* by the following characteristics: stem geniculate, glabrous; leaves sub-chartaceous; leaflets glabrous on both sides, abaxially with laticiferous utricles; margin serrate-dentate, with 2 or 3 pairs of teeth close to the apex; capsules obovate or oblong, measuring 3 to 5.5 cm long, glabrous.

Selected materials: **BRAZIL**. RIO DE JANEIRO: Mun. Cabo Frio, APA Pau-Brasil, 9.VI.2008, fl., *M.S. Faria 81* (RB); idem, *M.S. Faria 83* (RB); Mun. Paraty, caminho a Paratimirim, 23°15.54', 44°39,37'W, 27-IX-2005, *Urdampilleta & Obando 293* (CTES, UEC); Mun. Rio de Janeiro, Restinga de Grumari, 16.VIII.1986, fr., *P. Acevedo-Rodríguez et al. 1461* (RB); idem, 30.V.1972, fl., *J.A. Jesus 1596* (RB); Mun. Saquarema, Reserva Ecológica Estadual de Jacarepiá, 22-VII-1993, *Araujo 9870* (CTES).

Urvillea rufescens* Cambess. Cambess., Fl. Bras.*Merid. 1: 354. 1828**

Woody climbers; subcylindrical, stem reddish brown, 5-costate, not geniculate, pubescent, in cross section with a single vascular cylinder; stipules triangular, ca. 0.5 mm long; petiole unwinged, canaliculate. Leaves trifoliolate; leaflets 1–4.7 × 0.4–2.2 cm, ovate, sub-coriaceous, apex obtuse or acuminate, mucronate, margin crenate-dentate, adaxial surface dark-brown, glabrous or sub-glabrous, midvein pubescent with orange glandular trichomes, venation sunken, abaxial surface greenish-brown, pubescent, densely so on veins, without laticiferous utricles, without domatia, venation craspedodromous. Thyse axillary, sub-spiciform, 2.8–9 cm long, pubescent; bracts triangular. Flowers zygomorphic, ca. 2.5 mm; sepals 5, petals 4, crest of posterior petal appendages emarginate; posterior nectariferous lobes ovoid, anterior ovoid or elliptic; stamens 1.5–3 mm long, puberulous fillets, surrounding a pistilode, staminodes 1–1.5 mm long, surrounding a gynoeceium; ovary ca. 2 mm long, trigonous-ellipsoid, densely tomentose. Capsules 1.8–2.2 × 0.9–1.6 cm, three-winged, elliptic, sub-chartaceous, puberulous, locules inflated, pubescent only on the central portion, endocarp glabrous, puberulous at junction of septum walls; seeds 1–3, ovoid; aril cordiform; embryo with outer cotyledon curved and inner biplicate (Figures 11I–L).

Urvillea rufescens is endemic to Brazil, occurring in Bahia, Espírito Santo, Minas Gerais, Pernambuco, Rio de Janeiro and São Paulo states (Figures 2D, 3). It is found in the following plant formations: sandy coastal plain, dense ombrophilous forest and seasonal semideciduous forest formations. In restinga, it occurs in dune thickets, seasonally flooded forests and ridge forests. Flowering and fruiting occur from June to October. The taxon has been evaluated based on the IUCN (2019) criteria as Least Concern (LC).

In this study, the species differs from other *Urvillea* by the following characteristics: stem pubescent, not geniculate; leaflets sub-coriaceous, with crenate-dentate margin, adaxial surface glabrous or subglabrous, pubescent on the midvein with orange glandular trichomes, abaxial surface without utricles, pubescent; capsules elliptic, measuring 1.8 to 2.2 cm long, puberulous.

Selected materials: **BRAZIL.** RIO DE JANEIRO: Mun. Araruama, Praia do Hospício, 5.VIII.1987, fl., *A.M.S. da F. Vaz* 463 (RB); Mun. Cabo Frio, Distrito de Tamoios, Estação Rádio Marinha Campo Novos, 2.X.2003, fl., *G.S.Z., Rezende* 111 (RB); Mun. Casimiro de Abreu, Estrada de terra bacia São Pedro da Aldeia, 14.VIII.1986, fl., fr., *P. Acevedo-Rodríguez* 1443 (RB). Maricá, 2.VI.1988, fr., *A. Souza et al.* 2232 (R); Mun. Rio das Ostras, ARIE de Itapebussus, 17.X.2007, fr., *M.S. Faria* 34 (RB); Mun. Rio de Janeiro, Restinga de Grumari, 14.VIII.1968, fl., *D. Sucre* 3500 (RB); Mun. São João da Barra, Restinga de Iquipari, 5.IX.2003, fl. e fr., *M.C. Gaglianone* 148 (RB); Mun. Saquarema, Restinga de Massambaba, 10.VIII.1986, fl., *P. Acevedo-Rodríguez* 1423 (RB). Idem, Restinga de Ipitangas, Reserva Ecológica Estadual de Jacarepia, 29.X.1991, fr., *G.V. Somner et al.* 710 (CTES).

***Urvillea stipitata* Radlk., Sitzungsber. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. München 8: 264. 1878**

Woody climbers; stem reddish brown or grayish brown, subcylindrical, 5-costate, puberulous when young, glabrous when

mature, in cross section with a single vascular cylinder; stipules 2–3 mm long, falcate or subulate; petiole unwinged, canaliculate. Leaves trifoliolate; leaflets 2–11 × 1.3–4.4 cm, ovate to ovate-lanceolate, sub-chartaceous, apex acute or acuminate, mucronate, margin incise-dentate, with 1 or 2 pairs of proximal incisions not exceeding one third of semi-blade; adaxial surface dark-brown, glabrous or subglabrous, except the puberulous veins, venation prominent, abaxial surface light-brown, with laticiferous utricles, totally pubescent or with puberulous veins; venation craspedodromous; with domatia. Thyse axillary, racemiform, 1–7 cm long, tomentose; bracts falcate. Flowers zygomorphic, 5–6 mm long; sepals 5; petals 4, crest of posterior petal appendages biauriculariform; posterior nectariferous lobes suborbicular, anterior elliptic; stamens 2–3 mm long, pubescent fillets, surrounding a pistilode, staminodes 1.–2.5 mm long, surrounding a gynoeceium; ovary ca. 2 mm long, trigonous-ellipsoid, pubescent or with glandular trichomes. Capsules 2.3–2.8 × 1.4–2.8 cm, three-winged, elliptic or obovate, locules flattened laterally, sub-chartaceous, pubescent, endocarp puberulous; seeds 1, trigonous-ovoid; aril not cordiform; embryo with outer cotyledon curved and inner biplicate (Figures 11M–P).

Urvillea stipitata is endemic to Brazil, occurring in Alagoas, Bahia, Minas Gerais, Pará, Paraíba, Pernambuco, Rio de Janeiro and Rio Grande do Norte (Figures 2D, 3). It is found in the following plant formations: sandy coastal plain, dense ombrophilous forest and savanna formations. In restinga, it occurs in dune thickets and ridge forests. Flowering occurs in February and April and fruiting from April to July and in November. The taxon has been evaluated based on the IUCN (2019) criteria as Least Concern (LC).

In this study, the species differs from other *Urvillea* by the following characteristics: stem puberulous when young, glabrous when mature, not geniculate; leaflet margins incise-dentate, with 1 or 2 pairs of proximal incisions not exceeding one third of semi-blade; abaxial surface with laticiferous utricles; capsules elliptic or obovate, pubescent.

Selected materials: **BRAZIL.** RIO DE JANEIRO: Rio das Ostras, Praia da Virgem, 4.XI.2002, fr., *H. do N. Braga* 4028 (R); Mun. Rio de Janeiro, Restinga Grumari, 30.VI.1987, fr., *A.M.S. da F. Vaz* 456 (RB); idem 21.V.2000, fr., *A. Oliveira & D. Fernandes* 139 (RB); idem, 10.V.1985, fr., *Araújo et al.* 6851 (CTES).

Discussion

The genera with the highest number of species in the restinga were *Serjania* (15 spp.) and *Paullinia* (9 spp.), thus corroborating the data obtained by Araujo (2000) in her floristic and phytosociological analysis of Rio de Janeiro state's restinga. The restingas of Rio de Janeiro have a large number of Paullinieae, which comprise about 65% of the total of Sapindaceae (46) in this ecosystem (Sapindaceae in Flora e Funga do Brasil 2022).

Among the 30 species studied here, around 13% are exclusively of sandy coastal plain formations, approximately 85% are also found in dense ombrophilous forests, and almost 50% also occur in seasonal semi-deciduous forests (Table 2). The high number of restinga species occurring in dense ombrophilous forest areas corroborates studies on the origin of restinga vegetation, indicating that there was a colonization of the restingas by species from adjacent forest regions, after sea level regression events that occurred in the Pleistocene (Cerqueira 2000).

Similarly, Rizzini (1979) stated that the flora of restinga must have originated from Atlantic Forest vegetation, and because this region has such a recent holocene origin, still has much influence of the Atlantic Forest and few endemic species typical of this restinga.

The richest sandy coastal plain was Cabo Frio (19 species), which is already a region known for its concentration of a large number of endemic species (Lacerda et al. 1993, Araujo 1997). A large number of Paullinieae species were found in degraded areas, which was expected since many gaps in the ridge forest were observed, thus allowing the abundance of these climbing plants (Engel et al. 1998, Lima et al. 1997). The occurrence of endemic species of the sandy coastal plains (*P. coriacea*, *S. eucardia*, *S. fluminensis* and *S. littoralis*) should be highlighted in future management of these habitats with the aim of conserving these species.

In this study we observed a large number of species in the ridge forests (27 species), which are characterized by their sharp changes in topographic elevation and tall canopy trees. These phytophysiological characteristics are favorable for the development of plants with a climbing habit. Although vines are important elements of the biota as a source of food for the fauna, many projects for the recovery of degraded areas implement methods that remove the climber plants to favor the growth of trees and shrubs (Rozza et al. 2007, Viani et al. 2015). In our study, we present native and threatened lianas of the restingas, and this information will be important in future forest management projects in these regions.

During the field expeditions, countless buildings under construction and fires were observed in the sandy coastal plains visited, besides sand removal. Some species of *Paullinia* and *Serjania* have records of use by the population for human food, manufacture of handicrafts and medicines (Guarim Neto et al. 2000). Taking into account this information on traditional uses, the processes of degradation occurring in the ecosystem and the values of richness/endemism of the species, it is important to emphasize the need to raise awareness among local people, so that these areas can be preserved.

Among the 30 species studied, seven were classified as threatened of extinction, while the remaining species do not face a significant risk for extinction, being classified as Least Concern. We classified *P. coriacea* and *T. restingae* as Vulnerable and *S. eucardia* as Endangered, for the first time. We are currently developing a work in collaboration with the CNCFlora Group to formalize the new classification of these three species, which will soon be published. Four other species, *Serjania fluminensis*, *S. littoralis*, *S. tenuis* and *U. glabra*, were extracted from the “Livro vermelho da flora do Brasil” (Valente et al. 2013) and the “Livro vermelho da flora endêmica do Estado do Rio de Janeiro” (Somner et al. 2018). It is suggested that future conservation projects should be undertaken for these eight threatened species studied here.

Although we focused on the species found in the sandy coastal plains of Rio de Janeiro, many species have a wider distribution in South America or are widely distributed on the Atlantic coast, with few cases restricted to Rio de Janeiro. From the analysis of the total geographic distribution of the species (Figure 2) and using the ten patterns defined by Araujo (2000) for the species of Rio de Janeiro’s sandy coastal plains, their distribution was classified as: Southeastern Atlantic Coast (*P. coriacea*, *P. ferruginea*, *S. eucardia*, *S. fluminensis*, *S. littoralis*, *S. tenuis* and *U. glabra*), Neotropical (*C. corindum* and *S. caracasana*), Broad Atlantic Coast (*P. micrantha*, *P. pseudota*, *P. revoluta*, *P. ternata*, *P. trigonia*, *P. weinmanniifolia*, *S. corrugata*, *S. cuspidata*, *S. dentata*, *S. ichthyoctona* and

T. mucronata), Amazon-Atlantic Coast (*S. communis*), Eastern-Southern Brazil (*P. meliifolia*, *S. clematidifolia*, *S. confertiflora*, *S. pernambuscensis*, *S. thoracoides* and *U. rufescens*), Northern Amazon-Atlantic Coast (*S. salzmänniana* and *U. stipitata*) and Pleistocene Arch (*T. mucronata*).

The sandy coastal plains are an ecosystem that has suffered from deforestation in addition to the constant threat by human occupation and degradation by tourism (Maciel 1990). Because of this, it is important to develop floristic and phytosociological studies to obtain knowledge of the plant species that occur in these sandy coastal plains areas in order to propose public conservation policies (Chaves et al. 2013). This study has also highlighted species that need further attention in conservation projects because of their endemic status, and provides taxonomic resources to facilitate the accurate identification of these species in future studies.

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Author Contributions

Mônica dos Santos Faria: Participated in data collection, contributed with data analysis and interpretation, made critical revisions and added intellectual content and contributed to manuscript preparation.

Nilda Marquete Ferreira da Silva: Participated in data collection, made a substantial contribution to the concept and design of the study, made critical revisions and added intellectual content.

Lilian de Andrade Brito: Contributed with data analysis and interpretation, made critical revisions added intellectual content and contributed to manuscript preparation.

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Conflicts of Interest

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

Data Availability

The following online material is available for this article: Numerical list of species and list of all the studied exsiccatae (<https://data.scielo.org/dataset.xhtml?persistentId=doi:10.48331/scielodata.3ESAAB>).

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