

Penn State ILL Lending - ARTICLE

48p. - ~~5223~~ - 10/20

ILLiad TN: 478307



Journal Title: Memoirs of the New York Botanical Garden.

Call #: QK1 .N52  
Location: Paterno-4

Volume: 67

ILL# 13092264

Issue:

Month/Year: 1993

Pages:

Ariel: 138.234.152.5

Article Author:

Patron ;dept; ;type; Amith, Jonathan

Article Title: Pedro Acevedo; Systematics of Serjania (Sapindaceae); part 1. A revision of Serjania sect. Platycoccus

GDC

PA Academic

Notes: Borrowing Notes; ariel.cc.gettysburg.edu or 138.234.152.5

MAXCOST:\$25IFM

From:  
Penn State Interlibrary Loan Lending  
127 Paterno Library, Curtin Road  
University Park, PA 16802

Ship To:  
Musselman Library, ILL  
Gettysburg College IDS#132  
300 N Washington St  
PO Box 420  
Gettysburg, PA 17325

Fax: 814-863-2653  
Ariel: 128.118.152.188

Fax: 717-337-7001  
Email: illform@gettysburg.edu

10/11/2005

Request in processing: 20051010

A.B.

#9

10/24

Cover: *Serjania lamarckiana*. Fruiting branch with alternate leaf (Acevedo & Badini 1518) and fruit with three mericarps (Acevedo, Ridge, & G.L. Follis 3690).  
Illustration by Alice Tangerini.

Copyright © 1993

The New York Botanical Garden



Published by

The New York Botanical Garden  
Bronx, New York 10458

International Standard Serial Number 0071-5794



The paper used in this publication meets the minimum requirements of American National Standard for Information Sciences—Permanence of Paper for Printed Library Materials, ANSI Z39.48-1984.



Printed in the United States of America on recycled paper

Composition by Carol Johnson

### Library of Congress Cataloging in Publication Data

Acevedo-Rodríguez, Pedro.  
Systematics of *Serjania* (Sapindaceae) /  
Pedro Acevedo-Rodríguez.  
p. cm.—(Memoirs of the New York Botanical Garden,  
ISSN 0071-5794, v. 67)

Includes bibliographical references and indexes.  
Contents: pt. 1. A revision of *Serjania* sect. *Platycooccus*  
ISBN 0-89327-377-5  
1. *Serjania*—Classification.

I. Title.

II. Series.

[OK495.S19]

581 s—dc20

[583'.28]

92-18033

CIP

## Systematics of *Serjania* (Sapindaceae). Part 1: A Revision of *Serjania* Sect. *Platycooccus*

PEDRO ACEVEDO-RODRÍGUEZ

### Contents

Abstract	2
Resumen	2
Introduction	3
Taxonomic History	3
Morphology and Anatomy	5
Habit	5
Stems	5
Wood Anatomy	9
Macroscopic Characteristics	13
Microscopic Characteristics	13
Bark	13
Indument	13
Stipules	16
Leaves	16
Leaf axes	16
Leaflets	16
Inflorescences	18
Flowers	25
Pedicels	25
Sepals	27
Petals	27
Nectary disk	27
Androecium	27
Gynoecium	29
Fruits	29
Seeds	29
Cytology	31
Generic Relationships	31
Cladistic Analysis	33
Materials and Methods	33
Results	37
Phylogeny	39
Infrageneric Classification	40
Distribution and Ecology	41
Reproductive Biology	46
Economic Botany	48
Taxonomic Treatment	48
Excluded Taxon	48
Synoptic key to the genera of Paulliniaceae	48
Synoptic key to the sections of <i>Serjania</i>	49
Key to the species of <i>S.</i> sect. <i>Platycooccus</i>	50
Excluded Taxa	84
Acknowledgments	85
Literature Cited	86
Numerical List of Taxa	88
Index to Exsiccatae	88
Index to Vernacular Names	91
Index to Scientific Names	91

### Abstract

Acevedo-Rodríguez, Pedro (Smithsonian Institution, Dept. of Botany, National Museum of Natural History, NHB-166, Washington, D. C. 20560, U.S.A.). Systematics of *Serjania* (Sapindaceae). Part 1: A revision of *Serjania* sect. *Platycoocus*. Mem. New York Bot. Gard. 67: 1-93, 1993. — *Serjania* sect. *Platycoocus* is characterized by its membranous samaroid mericarps with flat locules. As previously delimited by Radlkofler, s. sect. *Platycoocus* contained 24 species. In this revision, five of the species recognized by Radlkofler are reduced to synonymy, and ten are transferred to other sections. *Serjania* sect. *Platycoocus* as herein recognized contains 13 species, three of which have been recently described and one that has been transferred from another section.

The infragenetic classification of *Serjania* as proposed by Radlkofler in 1874 is modified, and only five of his twelve sections are recognized in this work. The creation of a new section (*Serjania* sect. *Coniferiflora*) is proposed in order to accommodate a group of species previously included in s. sect. *Platycoocus*, but distinctive from species of other sections of *Serjania*.

### Resumen

*Serjania* sección *Platycoocus* se caracteriza por tener mericarpos samaroides con loculos semimembranosos y achatados. *Serjania* sección *Platycoocus*, como fuera delimitada por Radlkofler contiene 24 especies. En la presente revisión, 5 de estas especies han sido reducidas a sinonimia y otras 10 han sido transferidas a otras secciones de *Serjania*. Como resultado de esta revisión, 5 secciones *Platycoocus* contiene solamente 13 especies, 3 de las cuales han sido recientemente descritas y una proveniente de otra sección de *Serjania*.

La clasificación infragenética de *Serjania* propuesta por Radlkofler en 1874 ha sido también modificada. En el presente trabajo, el género *Serjania* ha sido dividido en seis secciones, donde solamente cinco de las doce secciones de Radlkofler son reconocidas. Una nueva sección (*Serjania* sección *Coniferiflora*) ha sido creada para agrupar algunas especies previamente incluidas en s. sección *Platycoocus*, pero claramente distintas del resto de las especies de *Serjania*.

### Introduction

*Serjania* Miller is a large genus of approximately 226 species of more or less woody vines, native to tropical and subtropical areas of the New World. Its essentially climbing habit, the presence of stipules, peduncles modified as tendrils, and nectary disk modified into four protruding glands, places *Serjania*, with five other genera, into the tribe Paullinieae Kunth.

A comprehensive revision of the genus was done by Radlkofler in 1875, which he expanded in his treatments of Sapindaceae for Martius' *Flora Brasiliensis* (1892-1900) and Engler's *Das Pflanzenreich* (1931-1934). The latter was the culmination of nearly a half century of work in the Sapindaceae. A total of 200 species were recognized in this posthumous work, 147 of which were described by him, and nine transferred from closely related genera. In his monograph of *Serjania* (1875), he divided the genus into 12 sections based chiefly on fruit morphology. His system is rather difficult to use because there are no qualitative characters defining some of his sections, which results in some intergradation. The sectional place-

ment of many species of *Serjania* is open to question, principally because many of them are known only from one or few collections bearing inadequate fruiting material.

Identification of *Serjania* species is particularly difficult because many of them are vegetatively very similar, not only to other *Serjania* but also to species in other genera of the Paullinieae. The presence of fruits is essential to establish the identity of the genera, especially for those taxonomists not familiar with the group.

*Serjania* sect. *Platycoocus*, as previously delimited by Radlkofler, contained 24 species, of these, five are here reduced to synonymy, and ten are transferred to other sections. *Serjania* sect. *Platycoocus* as herein recognized thus contains 13 species, three of which have been recently described and one which has been transferred from another section. A new section is created here to accommodate a group of species previously included in s. sect. *Platycoocus*, but which are distinct from species of other sections of *Serjania*, including *Platycoocus*.

The systematics of *Serjania* is still in a rather chaotic stage, and a complete revision of the genus

is needed. There is also need for more field work, which should increase knowledge of the poorly known species, as well as the biology of this interesting group of lianas.

### Taxonomic History

The first published description of *Serjania* was provided by Plumier in 1703. It consisted of a Latin diagnosis and a dedication to Rev. Father Philippe Segrant, a physician and French botanist. The genus is considered to be validly published in Miller's *Gardener's Dictionary* (1754), because this is the first published description after the nomenclatural starting point (Linnaeus, 1753), however, Miller did not include any specific names. Although the name *Serjania* was originally published with this orthography by Plumier and Miller, some variations of its spelling have been recorded. Burmann (1757), Willdenow (1799), Sprengel (1825), Schott (1825) and Schlechtendal and Chamisso (1830) published various species under the name *Serjania*. Schumacher (1794) and Kunth (1821) used the name *Serjania*. Another variation is recorded from Martius (1837) as *Serjania*.

*Serjania* was not consistently distinguished from Paullinia by early workers. Neither Linnaeus (1753), Jusseu (1789) nor Jacquin (1797) recognized *Serjania* as different from the closely related Paullinia.

In 1794, Schumacher emended Paullinia L., distinguishing it from *Serjania*, and published *S. divaricata*, *S. lucida*, *S. lupulina*, *S. racemosa*, *S. sinuata*, and *S. spectabilis* as the first binomials for the genus. This fact led many workers to consider the genus. This is the author for the genus: *Serjania sinuata*, collected from the island of Hispaniola, was the species illustrated by Plumier as *Serjania scandens triphylla* & *racemosa* (Burmann, 1757). Therefore, this species represents the original concept of the genus, and it has been designated as the type by Croat (1976).

In 1799, Willdenow transferred some species of Paullinia into *Serjania*, in this way contributing to a better understanding of the generic delimitation of these two taxa. He also published two more species in *Serjania*.

The first infragenetic classification for *Serjania* was provided by De Candolle in 1824. He treated all the species of *Serjania* known at that time and published three new names. The 21 species treated by him were placed into four categories according

to foliar characters, namely, ternate, bitermate, tritermate, or imparipinnate leaves (Table I).

During the next 50 years, 61 new names were added to *Serjania* by many different authors, without placing them into a classification system. After De Candolle (1824), no other infragenetic treatment for *Serjania* was proposed until 1874, when Radlkofler published his *Conspectus Sectionum Specterumque Generis Serjaniae*, which appeared prior to his *Monographie der Sapindaceen-Gattung Serjania* (1875). In this summary, he divided the genus into 12 sections, based mostly on fruit characters. Therein, 145 species of *Serjania* were treated, including the 89 new species to be published a few months later (1875), and six species were transferred from closely related genera. In 1878, he published *S. californica* and *S. decemstrata*. A few years later, Radlkofler (1886) published a supplement to his monograph, in which he described seven new species. Radlkofler described an additional 43 species in a series of papers (1891, 1892-1900, 1893, 1895a-d, 1898, 1899, 1901, 1903a,b, 1905, 1909, 1910, 1913a,b, 1914a,b, 1916, 1921). A total of 147 species were described by him, most of which were placed in the sections he had established in 1874, while a few remained in uncertain positions.

From Radlkofler's 1921 paper to the present, 56 new names have been proposed. A total of 296 names have been validly published under *Serjania*; of these I tentatively accept 226 as biological entities. The authors and number of species described by them in *Serjania* are provided in Table II.

A total of 63 infraspecific names have been published for *Serjania* without consistency in application of the infraspecific categories. These names were designated as forms, varieties, subforms, or subvarieties without an explanation for selecting a particular category. Of these, 49 were published by Radlkofler and the remaining by different authors.

The genus *Serjania* was placed by Kunth (1821), in the "section" Paullinieae within the Sapindaceae. This group was defined by the presence of climbing habit, tendrils, and nectary disks modified into four protruding glands. It included the genera *Cardiospermum*, *Urvillea*, *Serjania*, and *Paullinia*. A few years later, De Candolle (1824) designated the group as a tribe, with the termination *-ieae*. In this work, he recognized the same genera as Kunth and provided descriptions of all the species known in these genera at that time. It is interesting to note that other early workers did not recognize the valid-

Table I

Treatment of *Serjania* by A. P. de Candolle

Folius ternatis	
<i>S. sinuata</i> Schum.	<i>S. spectabilis</i> Schum.
<i>S. mollis</i> Kunth	<i>S. caracasana</i> (Jacq.) Willd.
<i>S. acapulcensis</i> Kunth	<i>S. angustifolia</i> Willd.
<i>S. emarginata</i> Kunth	<i>S. glabrata</i> Kunth
	<i>S. racemosa</i> Schum.
	<i>S. lupulina</i> Schum.
	<i>S. paniculata</i> Kunth
Folius bitematis	
<i>S. diversiana</i> Schum.	<i>S. speciosa</i> Schum.
<i>S. mexicana</i> (L.) Willd.	<i>S. caracasana</i> (Jacq.) Willd.
<i>S. paucidentata</i> DC.	<i>S. angustifolia</i> Willd.
<i>S. oxypetala</i> Kunth	<i>S. glabrata</i> Kunth
<i>S. osseana</i> DC.	<i>S. racemosa</i> Schum.
<i>S. pubescens</i> Kunth	<i>S. lupulina</i> Schum.
<i>S. fusca</i> Schum.	<i>S. paniculata</i> Kunth
Folius (tri-)ternatis	
<i>S. tritermata</i> Willd.	<i>S. heterophylla</i> DC.
Folius imparipinnatis	
<i>S. parvifolia</i> Kunth	

Table II

Number of names of *Serjania* proposed by different authors.

Radlkofe, L.	147	Hoehne, F.C.	2
Cambesies, J.	15	Martius, C.F.P.	2
Standley, P.	10	Schlegel & Chamisso	2
Kunth, G.S.	8	Britton, N.L.	2
Schlegel, D.F.L.	8	Casariego, G.	1
Schumacher, C.F.	6	Diels, F.L.E.	1
Trana & Planchon	6	Gardner, G.	1
Acevedo-Rdgz., P.	6	Johnston, I.M.	1
Croat, T.B.	5	Jones, M.E.	1
Griselbach, A.H.R.	5	Jussieu, A.L.	1
Sommer, G.V.	5	Macfadyen, J.	1
Bardley, F.A.	5	Musey, J.H.	1
Bentham, G.	4	Saint-Hilaire, A.	1
Fernex, M.S.	4	Schott, H.W.	1
Lippold, H.	4	Seemann, B.	1
Willdenow, C.L.	4	Smith, J.E.	1
De Candolle, A.P.	3	Spiliger, F.L.	1
Macbride, F.	3	Standley & Williams	1
Poeppig & Endlicher	3	Torrey, J.	1
Sprengel, K.	3	Urban, I.	1
Standley & Steyermark	3	Velhoza, J.M.	1
Turczanow, N.S.	3	Watson, S.	1
Charcasas, J.	2	Wright, W.	1

ity of the Pauliniaceae in the Sapindaceae. Spach (1834), Meisner (1837), and Lindley (1846) placed the genera *Paullinia*, *Cardiospermum*, *Urvillea*, and *Serjania*, along with other genera, into the tribe Sapindaceae. Bentham and Hooker (1862) included them in the subfamily (subordo) Sapindoidae along with many other genera.

In 1888, Radlkofe adopted the Kunth and De

tribe was not emended until 1931, when Radlkofe characterized the two subtribes. According to Radlkofe, the Eupauliniaceae includes the genera with zygomorphic flowers with a unilateral nectary disk modified into four prominent glands (*Serjania*, *Paullinia*, *Cardiospermum*, *Urvillea*, and *Lophostigma*, the latter added by Radlkofe in 1897). The monotypic Thimouneae possesses actinomorphic flowers with an annular nectary disk.

In 1978, Hunziker created the genus *Horszanyanthus* and placed it in the Pauliniaceae, bringing to seven the total number of genera in the tribe.

### Morphology and Anatomy

#### HABIT

Species of *Serjania* are mostly perennial, woody climbers with tendrils. However, in the absence of support, they may become arching shrubs or trailing vines. There are a few species with a shrubby habit (e.g., *S. erecta* Radlk. and *S. trichomiscia* Radlk.). The most weedy species are usually small and essentially herbaceous. A number of species branch from the base, producing many principal stems, while others present a single main stem with lateral branches throughout their extension.

There are no published reports on the architecture of *Serjania*. I have cultivated two species (*S. cuspidata* Camb. and *S. caracasana* (Jacq.) Willd.) and found them to have monopodial growth with the first 9-10 leaves developing proleptically. The first developed leaves in both species are opposite and ternately compound, while subsequent leaves are alternate and trifoliate in *S. cuspidata* or 5-foliate pinnate in *S. caracasana*. Internodes became progressively longer, and a short axillary branch carrying two tendrils is produced sylleptically with the main axis after the 10th leaf in *S. cuspidata*. I have observed a similar pattern in other members of the Pauliniaceae, such as *Paullinia pinnata* L. (see also Cremers, 1974) and *Cardiospermum halicacabum* L. Both have monopodial growth, with first leaves opposite and simple in *P. pinnata* and opposite and ternately compound in *C. halicacabum*. Subsequent leaves are alternate and the stem has long internodes. In *C. halicacabum*, five consecutive leaves are produced on an orthotropic stem which lacks tendrils. At this stage of development the stem is still erect but somewhat arched. After the sixth leaf is produced, tendrils start developing precociously and sylleptically. Supernumerary buds

are present in the leaf axils. These will later develop into lateral branches, which usually terminate in an inflorescence.

#### STEMS

Although most species of *Serjania* are shorter than 10 m, some species may have stems that reach 30 m in length and ca. 6 cm in diam. In many species, a watery or milky exudate (resin) is produced when the stem is cut. Adventitious roots are produced at the internodes of some species with creeping stems (*S. polyphylla* (L.) Radlk. and *S. reticulata* Camb.), or on plants growing in areas subject to flooding (*S. inscripta* Radlk.). The general appearance of the stem may vary from smooth or rough to densely lenticellate and from terete to angled and furrowed. Some species, such as *S. meizocoma* (L.) Willd., *S. rubicaulis* Radlk., *S. aculeata* Radlk., *S. lanuligera* Radlk., and *S. hatschbachii* Fernex, possess aciculate projections.

Cross sections of young stems show an epidermis with waxy anticlinal walls (Figs. 1c, 13f). The cortex consists of a parenchymatous zone approximately ten cells wide in cross section. Parenchyma containing druses or prismatic crystals were common in all examined species. Tannin idiosyncrasts (Figs. 1d, 2a) and secretory canals (Figs. 1d, 2a, 2b) are very common in the cortex. These canals seem to originate schizogenously and are surrounded by epithelial cells. Their contents appear cloudy in sectioned material (Fig. 2a). Exudates from freshly cut stems are frequently milky; however, they usually dry crystal clear with an amber color. This fact, along with the structure (a canal surrounded by epithelial cells) of the secretory tissue, suggests that they are resin canals. A *sclerenchyma* ring, usually seven to ten cells wide, encloses the steles. This layer occurs in the inner zone of the cortex and in many species, consists of pure fibers (Figs. 1a, 2b, 3c). The steles are ecotrophic *siphonosteles*. The outer layers of cells of the pith consist of collenchyma in many species (Fig. 3c). Species in *Serjania* sect. *Platyrococcus* possess all these characters.

#### WOOD ANATOMY

The wood anatomy of the Pauliniaceae, particularly of *Serjania*, has attracted the attention of many workers because of the anomalies present in many of its species. Gaudichaud (1841) was the first to

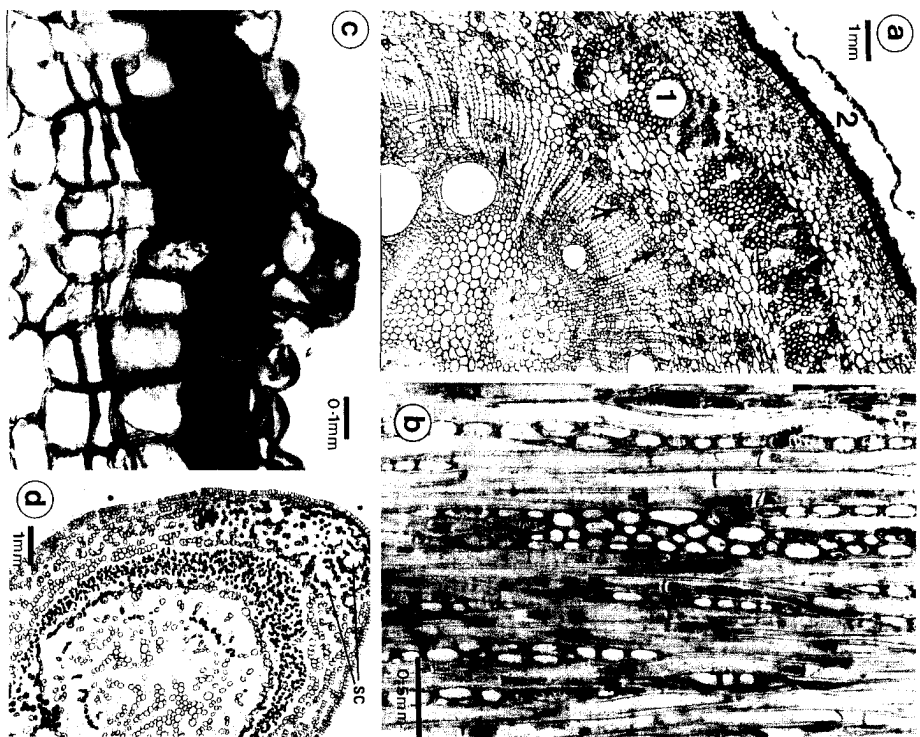


Fig. 1. Anatomical features of *Serjania*. a. Cross section of *Serjania undianzana* stem, showing ring of cortical fibers disrupted by secondary growth (1), differentiation of fibers at outer layer of phloem (black arrows), and phellum (2) (Acevedo-Rdgz. *et al.* 1970). b. Tangential section of *S. polyphylla* stem showing multiseriate rays and ray cells containing tannins (Acevedo-Rdgz. 1979). c. Cross section of *S. damicola* stem showing insertion of phellogen at outer cortex and epidermal cells with anticlinal wavy walls (Acevedo-Rdgz. & Vargas 1959). d. Cross section of a peripheral stiele in *S. polyphylla* showing high concentration of tannin idioblasts in cortex, secretory canals (SC), and inner zone of cortex not yet differentiated into fibers (Acevedo-Rdgz. 1979).

describe a type of anomaly unique to the stems of *Serjania*. In this type, the stem is made up of five to seven radially disposed stiles and there is no central stele. Nägeli (1868) studied the anatomy of various species of *Serjania* and *Paullinia* with respect to the

ontogenetic development of the anomalous structures. Radlkofler (1874, 1876, 1886, 1931) investigated these anomalies with regard to their systematic value and used them in the construction of keys and as supplementary characters in sectional

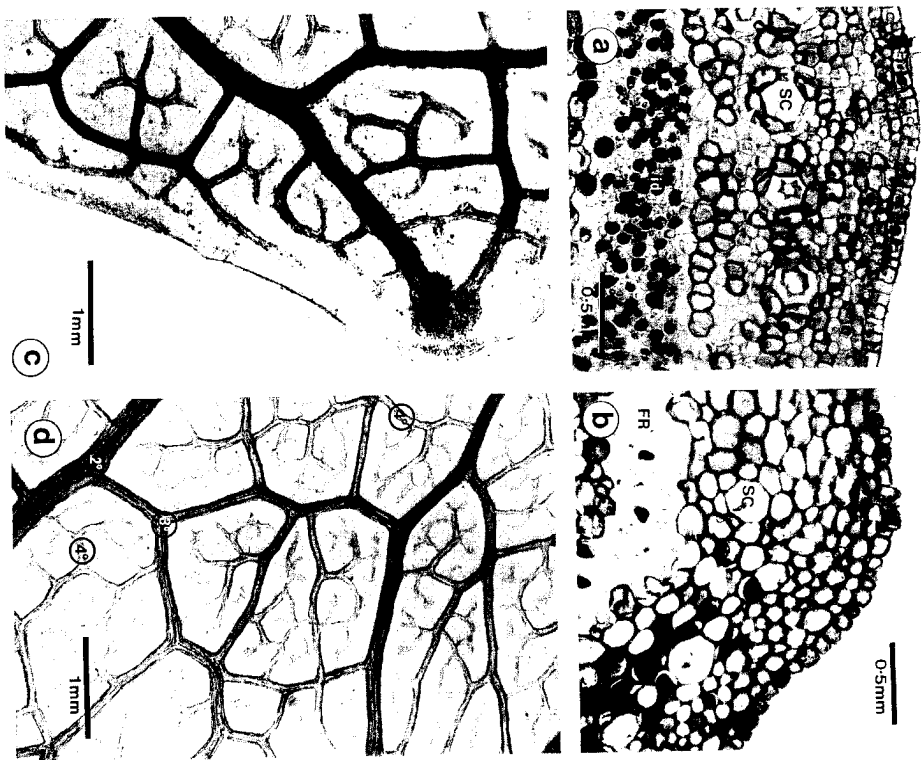


Fig. 2. Stem and leaf features of *Serjania*. a. Cross section of *S. polyphylla* in early stage of development. Tannin idioblasts (id) and secretory canals (SC) with epithelial cells (white arrow) are common (Acevedo-Rdgz. 1979). b. Cross section of the stem cortex of *S. polyphylla* in later stage of development, showing inner zone of cortex with a ring of fibers (FR), secretory canal (SC), and less tannins in cortex (Acevedo-Rdgz. 1979). c. Glandular tooth of cleared leaflet of *S. undianzana* (Acevedo-Rdgz. *et al.* 1970). d. Cleared leaflet of *S. larumoreana* showing different orders of venation (2, 3 & 4), areoles, and free veinlets (Acevedo-Rdgz. & Badini 1978).

and specific delimitation. In 1884, Haberlandt discussed some of the anomalies present in *Serjania* in relation to their adaptive significance to the climbing habit. Schenck (1893), in his classical work on the biology and anatomy of lianas, discussed the different wood anomalies present in Sapindaceae.

Pfeiffer (1926) presented a key for the species of *Serjania* based on wood anatomy. He also classified the anomalies present in the stems of the Paullinieae under seven different types, six of them occurring in *Serjania*. Meijer (1932) studied the stem and leaf anatomy of *S. curassavica* (L.) Radlk. Solereder

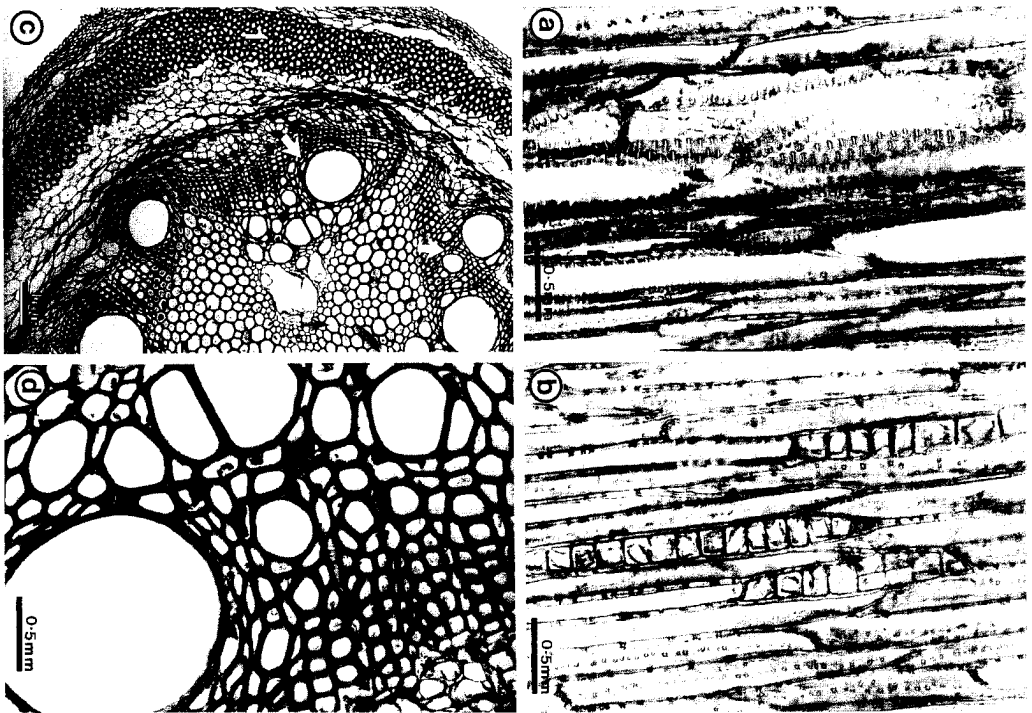


Fig. 3. Wood anatomy of *Serjania leptocarpa* (Breitler 3495). a. Radial section showing perpendicular endings in wide vessel element, overlapping ending in narrow vessel elements, and alternate pitting. b. Tangential section showing uniseriate rays containing prismatic crystals. c. Cross-section showing cortical fibers (1), vessel dimorphism (white arrows), collenchyma at outer region of medulla (black arrow), and solitary and aggregated vessels. d. Detail showing vessel dimorphism.

(1908) and Metcalfe and Chalk (1957, 1983) presented general peculiarities of the wood anatomy of *Serjania*. Johnson and Truscott (1956) studied the path of the bundles in *S.*

1993]

ACEVEDO-RODRIGUEZ: SERJANIA

9

#### Macroscopic Characteristics

In cross section, the stems of different species of *Serjania* present one to many steles separated by ground tissue. This is a feature easily observed without the aid of a microscope or even a hand lens. For this reason, the anomalous patterns shown by the species of *Serjania* are considered macroscopic characters. They have been classified by Radlkofler (1875, 1876, 1886, 1931) under the terms *simple*, *compound*, *divided*, *corded*, and *cleft xylem masses*. This character is very important in the description of species because of its diagnostic value.

A simple stele (undivided and cylindrical xylem) is the normal condition present in many families of dicotyledons as well as in most Sapindaceae. This condition is present in 96 species of *Serjania* (ca. 42% of the species), in 90% of *Paulinia*, and in all species of *Cardiospermum* and *Urvillea*. The stems may be terete (Fig. 4d) or lobed (Fig. 4e) due to the unequal production of secondary xylem. Another type of anomaly present in some species of *Serjania* and *Thimouia* with a single stele is the production of vascular bundles within the cortex or bark. This is the *corded* type of Radlkofler (Fig. 4f). These vascular bundles are produced after a few years of normal growth and are stated (Radlkofler, 1876; Solleder, 1908; Metcalfe & Chalk, 1957, 1983) to be connected to each other, but not with the central stele. Another anomaly found in some species of *Serjania* with a single stele is what Pfeiffer (1926) termed a *parted xylem mass* (Figs. 5a, 5f). The xylem becomes fractured into various complexes or islands which are the consequence of the delayed development of parenchymatous tissue within the xylem (Pfeiffer, 1926). The *cleft xylem*, described by Gaudichaud (1841) and Radlkofler (1876) for *Urvillea ulmacea* H.B.K. and *Serjania piscatoria* Radlk., is also produced within the secondary body. A transverse section of the mature stem shows the xylem radially fractured in three parts. This anomaly results from the unequal production of xylem in three areas of the stem. The stem at first becomes lobed, but later breaks through the areas where less xylem is produced. Carlquist (1988) considered this anomaly as equivalent to the divided xylem mass, however they differ ontogenetically, and therefore are different and not equivalent phylogenetically.

The condition in which numerous steles are present is known as the *multistelar stem* (*compound xylem* of Radlkofler). In this type of anomaly, a central stele is surrounded by three, five or more

steles (*peripheral steles*) that are separated by ground tissue. Nägeli (1868) studied the ontogenetic development of this anomaly in *Serjania cuspidata* (= *Urvillea ferruginea* Lindl.), *S. caracasana* (Jacq.) Willd., and *Paulinia atata* G. Don. Most recently, Obaton (1960) and Van der Walt et al. (1973) studied the ontogeny of this anomaly in *Paulinia pinnata* and concluded, as did Nägeli, that it originates within the primary body of the plant. In *S. cuspidata* and *P. pinnata*, three of the primary vascular bundles (occupying three different angles of the stem) differentiate into three peripheral steles. These are independent from the central bundles, which will give rise to a central stele by the activity of an interfascicular cambium. The peripheral steles are produced by anomalous differentiation of the intrafascicular cambium in these peripheral bundles. Each stele continues to grow in a normal way, producing xylem toward the inside and phloem toward the outside. The peripheral steles are usually three (Figs. 4a, 4c) or five (Fig. 4b) and are arranged in a triangular or, less frequently, in a pentagonal way. The presence of three peripheral steles occurs in 79 species of *Serjania* (34% of the species), in a few species of the closely related *Paulinia* (ca. 10% of the species), and in all three species of *Houssouvantus*. The presence of five peripheral steles occurs in 21 species of *Serjania* (ca. 9% of the species). Of these, 14 species show a variable number of peripherals, ranging from three to five. This character occurs only in 2-3% of the species of *Paulinia*. The presence of eight to ten peripheral steles, arranged in a circle around the central stele is unique to *Serjania* (Fig. 5d), occurring in 25 species (ca. 10% of the species). A few species with this type of anomaly are more variable, having four to ten peripheral steles (Fig. 5c). The shape of the peripherals varies from species to species. They are usually terete, but they may be also cuneiform, or compressed radially or peripherally (Figs. 4a-c, 5b-d).

This type of anomalous growth (peripheral steles around a central stele) was regarded as unique (with the doubtful exception of its occurrence in the Fabaceae) to the Pauliniaceae, by Metcalfe and Chalk (1957). In 1983, Metcalfe and Chalk, quoting Leandri (1931), also considered this anomaly to occur in the rhizomes of *Gnathia* (Thymelaeaceae). However this is a different kind of anomaly, consisting of concentric additions of xylem and phloem.

Six species of *Serjania* present a stele radially

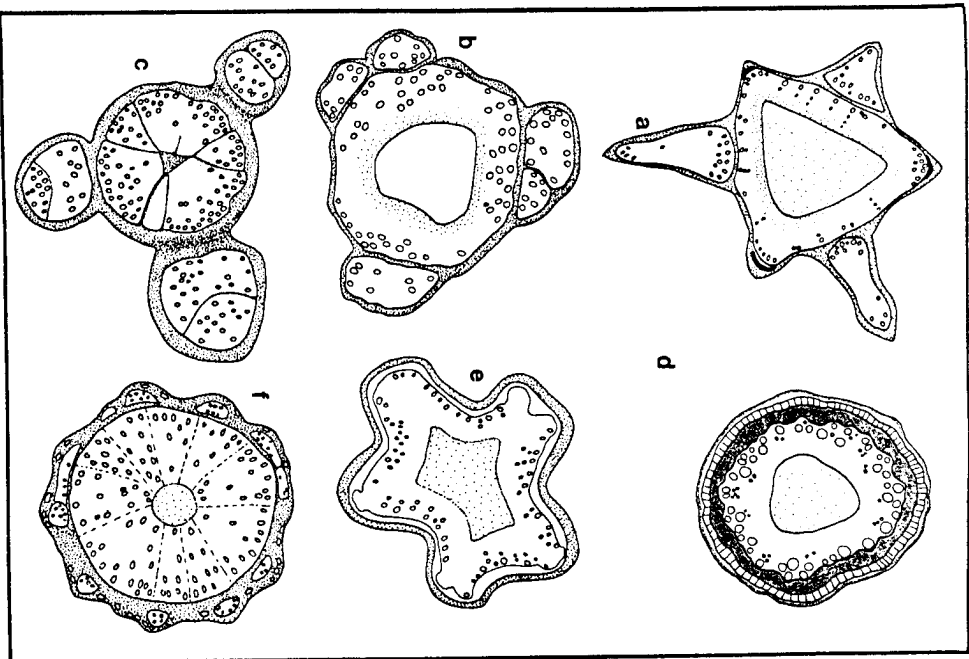


Fig. 4. Cross sections of stems of *Serjania* showing multistelar stems (a-c), simple (d-e), and corded (f) vascularization. a. With three peripheral steles, *Serjania nutans* Radlk. (Acevedo-Rdgz. & Vargas 1744). b. With five peripheral steles, *S. glabrata* Kunth (Baker 6284). c. With three peripheral steles, *S. paucisternata* DC. (Wendt 4093). d. Simple, lobed stele, *S. ampelopis* (Acevedo-Rdgz. & Vargas 1781). e. Simple, lobed stele, *S. meridionalis* (L.) Willd. (Acevedo-Rdgz. 5099). f. Corded, vascular cylinder, *S. meridionalis* Camb. (Acevedo-Rdgz. et al. 1467).

divided into four or five parts by parenchymatous tissue (divided xylem of Radlköfer). In this type, each part possesses a central medulla (Fig. 5e). This feature is unique to *Serjania*, but is present only in the "*S. paradoxa* complex" of *S.* sect. *Entyrococcus*.

The presence of one vs. many steles, as well as the number of steles and their shape, are good taxonomic characters. It has been argued by Radlköfer (1869, 1883) that in order to obtain comparable results a cross section should be made at the

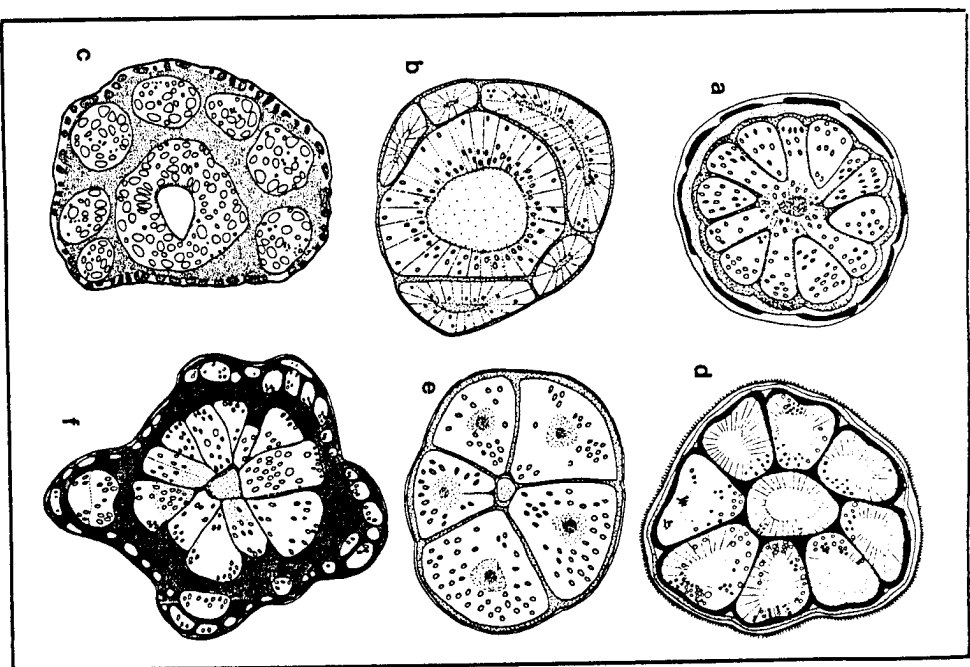


Fig. 5. Cross sections of stems of *Serjania* showing parted (a, f), multistelar (b-d), and divided (e) vascularization. a. Parted stele, *Serjania laxiflora* Radlk. (Acevedo-Rdgz. et al. 1464). b. Multistelar stem with seven peripheral steles, *S. perulacea* Radlk. (Acevedo-Rdgz. et al. 1482). c. Multistelar stem with eight peripheral steles, *S. fluminensis* Acevedo-Rdgz. (Acevedo-Rdgz. & Farney 1424). d. Multistelar stem with eight peripheral steles, *S. paradoxa* Radlk. (Acevedo-Rdgz. et al. 1502). e. Divided stele, *S. paradoxa* Radlk. (Acevedo-Rdgz. & Daly 7619). f. Parted vascular cylinder, *S. grandifolia* Sagot. (Acevedo-Rdgz. & Daly 7619).

middle of the internode. This is due to the fact that the peripheral steles are interconnected with the central stele in a very complex way at the nodes (Johnson & Truscott, 1956). A certain degree of variation is recorded in species having four or five peripheral steles. In the former, all species vary, and produce also three peripheral steles. In the latter, two-thirds of the species also have three peripheral steles. Two of the most variable species with respect to this character are *S. caracasana* (Figs. 6a, 6b),

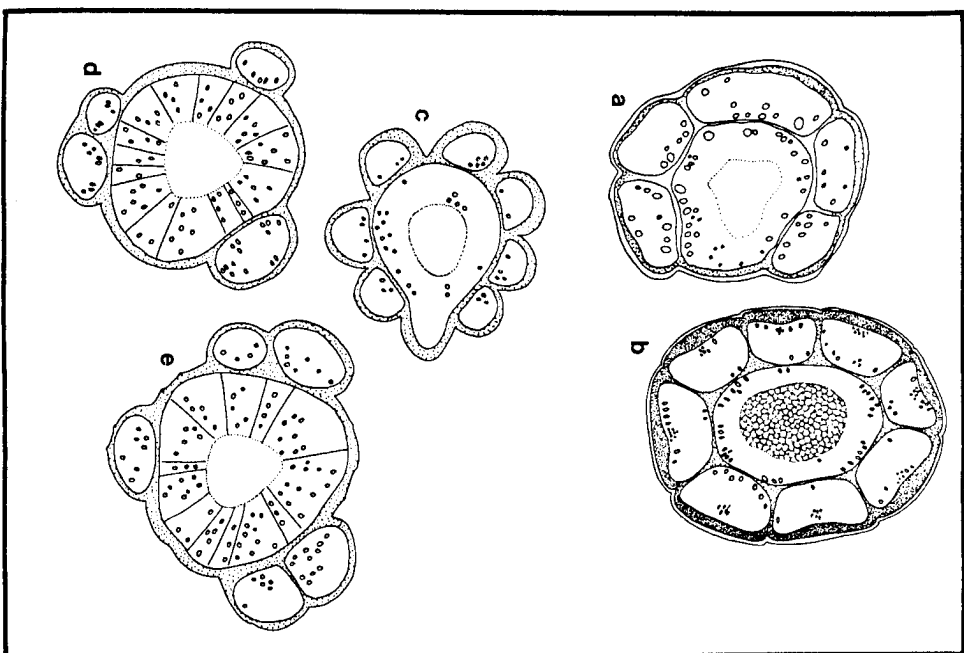


Fig. 6. Cross sections of stems of *Serjania* showing intraspecific variation of anomalous growth pattern. a-b, *Serjania caracasana* (Jacq.) Willd. (Pereira et al. 4092). c-e, *S. polyphylla* (L.) Radlk. (Zamorri et al. 19739)

and *S. polyphylla* (Figs. 6c-e) both having from four to ten peripheral steles.

The presence of wide vessels and rays as well as a hollow medulla are some of the features which can easily be seen without the aid of a microscope.

The species of *Serjania* sect. *Platycoctus* have stems with either a simple stele or with a central plus a few to many peripheral steles. They also

have wide vessels which are easily observed with the naked eye.

Anomalous growth has been considered an adaptation to the climbing habit because it increases the mechanical flexibility of stems (Flabertandt, 1884; Schenck, 1893). In the Paullinieae, the anomalous stems have wide areas of parenchymatous tissue between the steles, conferring flexibility to the

Table III

Wood characteristics of selected species of *Serjania*.

Species	Pore diam.	Vessel length	Perfor.	Inter-vas pitting	Rays
<i>communis</i>	0.7-11.7 $\mu$ m	6.5-37.7 $\mu$ m	simple	alternate	7
<i>damnicola</i>	0.7-16.5 $\mu$ m	8.5-71.5 $\mu$ m	simple	alternate	unif/multi
<i>polyphylla</i>	1.0-28.6 $\mu$ m	7.8-35.7 $\mu$ m	simple	alternate	unif/multi

stems, which in turn prevents their breakage when they are twisted or bent. The rope-like construction of stems in some species of Paullinieae may confer strength for withstanding the tensile forces resulting from the continuous movement of their supports (branches and trunks of trees). The presence of phloem between vascular cylinders in the anomalous Paullinieae may constitute a reservoir tissue from which regeneration can take place when the stems (often subject to damage from friction with supporting trees) are injured (Dobbins & Fisher, 1986).

#### Microscopic Characteristics

The wood in *Serjania* is *diffuse-porous*, and the vessels occur in two modes, wide or narrow, without intermediates (Figs. 3c, 3d, Table III). This feature has been referred to by Carquist (1985a) as *vessel dimorphism*. The wide vessels allow a much higher conductivity rate and the narrow ones carry out mechanical as well as conductivity functions. In cross section, the vessels are rounded, elliptic or slightly angular in outline, and occur solitary or in groups (Figs. 3c, 3d). The perforation plates are simple. The large elements have perpendicular ends and the small elements have oblique overlapping endwalls (Fig. 3a). Intervessel pitting is alternate in all species examined (Fig. 3a). Vasicentric tracheids may be widely distributed in the genus. Carquist (1985b) has reported them for *S. glabrata* Kunth, and I have observed them in *S. damnicola* Radlk. The ray parenchyma is heterogeneous, uniseriate (Fig. 3b), or multiseriate (to four cells wide, Fig. 1b), and contains prismatic crystals (Fig. 3b) or accumulates tannins (Fig. 1b). All these features are found in species of *Serjania* sect. *Platycoctus*.

*Serjania* has many features in common with climbing plants in other families. One of them is the presence of narrow stems with much higher water conductivity than stems in shrubs with equivalent diameters (Putts, 1984). The stems, which rely on external support, are specialized for water conduction at the expense of mechanical elements.

The high conductivity in liana stems is the result of the unusually wide vessels present in their stems, but this makes them susceptible to air embolism. Carquist (1985a, 1985b) has suggested that the occurrence of liform vessels and tracheids associated with large vessels constitutes a subsidiary conducting system which operates in case of failure in conduction caused by embolism.

#### BARK

The *phellogen* consists of a dark layer of narrow cells, which develops from the hypoderm (Fig. 1c). The phellem is formed in small plates. The phellogen contains many layers of densely staining parenchyma which, in some species, contains secretory canals. A fiber sheath is developed at the outer portion of the phloem all around the vascular cylinders (Fig. 1a). This layer, which becomes disrupted as a consequence of secondary growth, is continuously repaired by the sclerification of surrounding parenchyma (Fig. 1a). The development of the bark observed in some species of *Serjania* sect. *Platycoctus* corresponds with that described for species of other sections of the genus.

#### INDUMENT

The indument of *Serjania* is made up of trichomes that are either glandular or non-glandular. The trichomes present in a particular species may be all the same kind or a mixture of different types. It is not rare to find plants with glandular and non-glandular hairs on the same organ. Both types of hair are unbranched and sometimes the basal cell is swollen and surrounded by a ring of epidermal cells (Figs. 11d, 12d). The non-glandular hairs are by far more common and are more diverse and larger than the glandular hairs. They are usually ferruginous or whitish. The different hairs can be classified into nine types as follows:

- 1) erect, bristle-like, unicellular (Fig. 7a);
- 2) erect, bristle-like, multicellular;



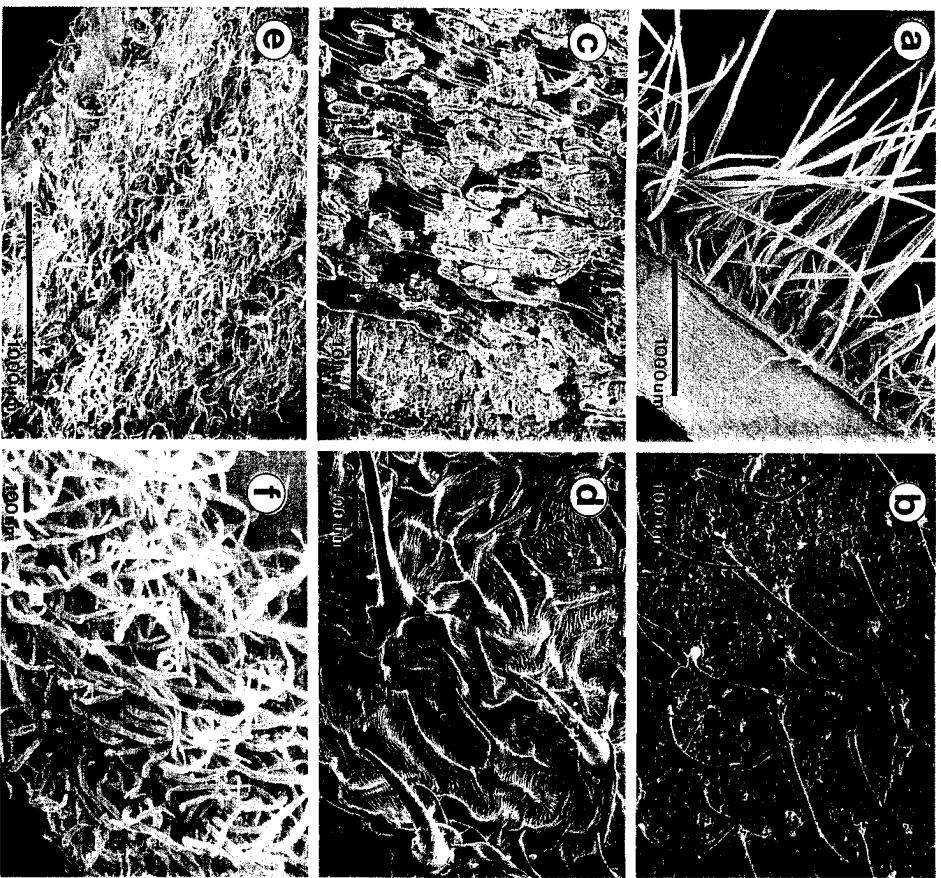


Fig. 7. Hair types in *Serjania*. a. Unbranched, erect, bristle-like, uniccular on *S. cuspidata* stems (Hakoy 1310). b. Unbranched, uniccular, short curly hairs on *S. suffrutiginosa* Radlk. leaf surface (Acevedo-Rdgz. & Vargas 1726). c. Scale-like, appressed hairs on *S. insignis* Radlk. stem (Killip 14324). d. Uniccular, short curly hairs on *S. cardospermioides* leaf surface (Purpus 6063). e. Minute, curly, uniccular hairs with woolly appearance on *S. fascifolia* Radlk. stem (Gentry 51973). f. Appressed multicellular hair on *S. columbiana* Radlk. stem (Gentry 34787a).

- 3) short, curved, uniccular (Figs. 7b, 7d);
- 4) short, curved, multicellular;
- 5) minute, scale-like, uniccular (Fig. 7c);
- 6) minute, curly, uniccular, with woolly appearance (Fig. 7e);
- 7) appressed; multicellular (sericeous) (Fig. 7f);
- 8) glandular, globose, with four apical cells (Fig. 8a);
- 9) glandular, elliptic, with one apical cell (Fig. 8b).

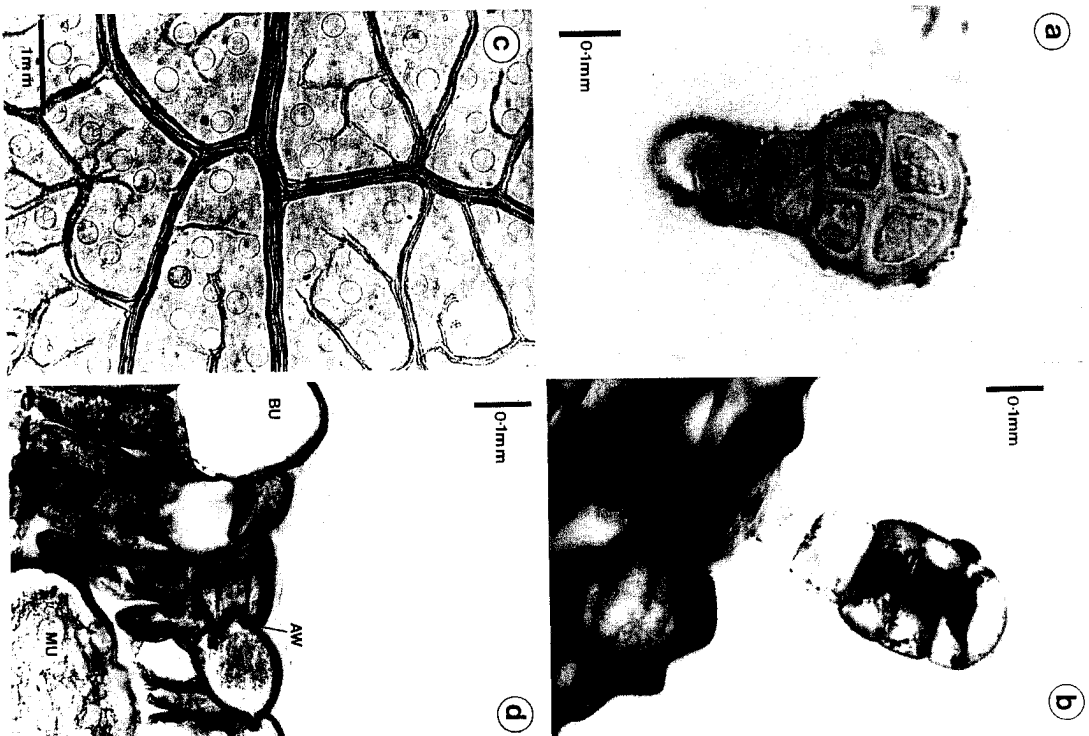


Fig. 8. Leaflet features of *Serjania*. a. Glandular, spherical hair on leaflet surface of *S. confertiflora* (Acevedo-Rdgz. et al. 1730). b. Glandular, elliptical hair on leaflet surface of *S. cuspidata* (Acevedo-Rdgz. et al. 1458). c. Cleared leaflet of *S. albomya* showing oil cells in mesophyll (Acevedo-Rdgz. & Vargas 1748). d. Cross section of *S. polyphylla* leaflet showing wavy antichlinal walls of epidermis (AW), bulliform cell (BU), and mucilaginous cell (MU) (Acevedo-Rdgz. 719).

## STIPULES

The stipules of *Serjania* are usually deltoid or subulate, ca. 5 mm long and early deciduous. Only *S. longistipula* Radlk., *S. hispida* Standl. & Sneyers, *S. magnistipulata* Acevedo-Rdgz. and *S. lancistipula* Acevedo-Rdgz. are known to have stipules longer than 1 cm. The large, foliaceous stipules of *S. magnistipulata* are unique in *Serjania*. The stipules of *Serjania* contrast with those of *Paullinia* which are often more than 1 cm long and persistent and variable in shape. The species of *S. sect. Platycoccus*, as do the majority of most species of *Serjania* in other sections, possess small, deciduous stipules.

## LEAVES

The leaves of *Serjania* are alternate and pinnately compound with a distal leaflet. The leaves are commonly ternately compound (Fig. 9a) or multiples of ternate, i.e., biernate (Fig. 9c) or triernate (Fig. 9d). Five-foliolate pinnately compound leaves (Fig. 9b) as well as leaves with intermediate forms (between biernate and ternate) are also found. Ternate leaves occur in all genera of Paullinieae. The occurrence of ternate leaves as an ontogenetic pathway in species with more complex leaves (e.g., *Cardiospermum* and *Paullinia*) suggests that ternate leaves have been one of the steps in their leaf evolution. Ternate leaves are also very common in the sister tribe Thoumiaceae and occur in other genera of Sapindaceae. Therefore, it seems that ternate leaves are a basic type from which other types have been derived. Ternate leaves occur in 41 species (18%) of *Serjania*.

The 5-foliolate, pinnate leaf (Fig. 9b) can be derived from a ternate ancestor by the subdivision of the distal leaflets into three. This condition is not very common in *Serjania*, occurring only in 21 (9%) of the species, however, it is very common in *Paullinia*.

The biernate (Fig. 9c) form is by far the most common leaf type in *Serjania*, occurring in 145 (63%) species. This condition can be derived from ternate leaves by the subdivision of all leaflets in three, or from 5-pinnately compound leaves by the subdivision of the two proximal leaflets in three. Other forms result from the subdivision of different leaflets. The triernate (Fig. 9d) occurs in eight species of *Serjania* and the 3-to 4-jugate, imparipinnate and bipinnate forms, occur in less than 10% of the species. The

term decomposed was utilized by Radlkofer to describe the last two forms mentioned, which are further compound than the biernate form. Most of the species in *S. sect. Platycoccus* have ternate or biernate leaves except for *S. squarrosa* Radlk. which has decomposed leaves.

Leaf types are usually stable in species of *Serjania*, however, variation exists within species or even within individuals. The variation is usually associated with physiological changes brought about by flowering or with ecological variations.

## Leaf Axes

The petioles and leaf rachis of *Serjania* are either winged, margined, or unwinged. They are terete and usually adaxially furrowed. The petioles, when present, are swollen or may possess a decurrent blade base. Although these characters are usually stable and show little variation within a species, some species show considerable variation of wing width. All species in *Serjania* sect. *Platycoccus* have unwinged or narrow margined petioles and rachises, and possess petioles.

## Leaflets

Most species of *Serjania* have elliptic or ovate leaflet blades. However, a smaller number of species have obovate, lanceolate, linear, rhombic, or deltoid leaflets. The size of the leaflet varies from species to species and within individuals, ranging from one to twenty cm in length. The apices are usually acute or obtuse, less frequently acuminate, rounded, or mucronate. The base of the leaflet is usually decurrent or obtuse and leaf texture ranges from membranous to coriaceous. The species of *S. sect. Platycoccus* are variable with respect to these characters.

The margins of the leaflets of *Serjania* display considerable variation. They may be entire, serrate, dentate, or sinuate. The serrations are either glandular (Fig. 2c) or non-glandular. Glandular serrations in many species produce a sweet exudate which is often collected by ants. Observation of ant aggressiveness and the absence of damage in young leaf tissue frequented by ants, suggests that nectar production might be part of a reward-protection interaction.

The use of venation patterns in the systematics of the Paullinieae has played a major role only in *Paullinia* where conspicuous variation is found.

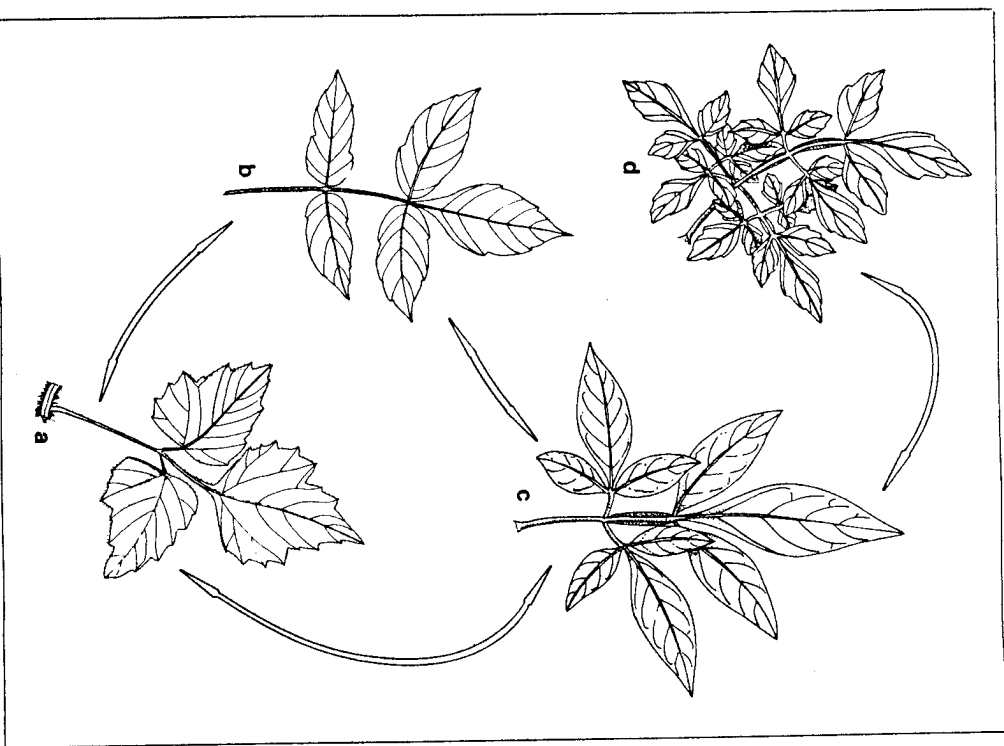


Fig. 9. Type of leaves in *Serjania*. a. Ternate in *S. cuspidata*, (Brade 29). b. 5-pinnately compound in *S. magnistipulata* (Santos et al. 3472). c. Biernate in *S. gracilis* (Acevedo-Rdgz. & Badini 1516). d. Triernate in *S. polyphylla* (Acevedo-Rdgz. & China 2200). Arrows indicate direction of transformation.

Radlkofer (1931), who recognized reticulate, transverse, and cleftate types, incorporated them into his keys and species descriptions of *Paullinia*. In *Serjania*, and the other genera of Paullinieae, the use of venation has been neglected, perhaps because of the less conspicuous variation present. The venation

patterns of *Serjania*, *Paullinia*, and *Thouinia*, as found in the state of Rio de Janeiro, Brazil, has been studied by Valente et al. (1984a, 1984b). In their survey, they found *Serjania* to have brochidodromous, craspedodromous, actinodromous, and craspedobrochidodromous (mixed) venation pat-

terns. In applying Hickey's (1979) terminology for leaf classification, mixed craspedodromus equals the craspedobrochidodromus of Valente et al. and their designation of *S. cuspidata* as actinodromus is better referred to as craspedodromus.

The types of venation found in *Serjania* can be classified into:

- 1) *craspedodromus* (Fig. 10b);
  - 2) *mixed craspedodromus* (Fig. 10d);
  - 3) *semicraspedodromus* (Fig. 10a);
  - 4) *cladodromus* (Fig. 10e);
  - 5) *brochidodromus* (Fig. 10c).
- Of these, the first two are by far the most common in *Serjania*.

Variation of Hickey's types can be found in species which have leaves with both entire and serrate margins. This is the case of *S. ampelopsis* Triana & Planch. whose entire leaflets are brochidodromus while the serrate ones are mixed craspedodromus.

Primary veins are usually moderate or stout, or less frequently thin. They are unbranched and travel straight into the terminal leaflets, whereas they are usually curved in the lateral leaflets. The secondary veins are alternate or opposite, uniformly curved, or straight and form a diverging angle of from 40° to 50° (rarely of 70°) from the primary vein. They also form a marginal loop angle of close to 90° (Fig. 11a). The tertiary vein angles between the secondary abmedial and exmedial are usually not discernible because of reticulation (Fig. 2d). Less often the AR, RR and the AA types of Hickey (1979) are found (Fig. 11c). Tertiary or higher order veins are dark in some species of *Serjania* (e.g., *S. arcolinata* Sauv. & Wright, *S. marginata* Casar., and *S. pyramidata* Radlk.) and produce a punctate or punctate-linear design on the abaxial leaflet surface. The areoles are formed by quaternary veins, which contain five veinlets divided twice, three, or four times (Figs. 2d, 11b, 11e).

The stomatal types present in species of *Serjania* in the state of Rio de Janeiro were also studied by Valente et al. (1984b). They report two types, the *anomocytic* (Fig. 12b) and the *anisocytic*, both being equally common. In addition, I have found the *encyclocytic* type in *S. brachyptera* Radlk. (Fig. 12a). Stomata may occur on both surfaces of the blade, although they are more common on the abaxial surface. In *S. brachyptera*, stomata are found on the upper surface closely dispersed along the veins (Fig. 12c).

Hairs found on leaves are non-glandular (Fig. 11d) or glandular (Figs. 8a, 8b) and are similar to

those found on stems. Basal cells of the hairs are sometimes surrounded by swollen epidermal cells (Figs. 11d, 12d). Hair domatia are found at the secondary vein axis of many species. Epidermal glands have been found in *S. confertiflora* Radlk. on the adaxial surface of the leaflet (Fig. 12d).

As viewed in cross section, the cuticle of a *Serjania* leaflet is thin. The epidermis is not sclerotized, and contains elliptic (smaller) and bulliform cells, which sometimes have wavy anticlinal cell walls (Fig. 8d). The bifacial mesophyll has densely packed uniseriate or biseriate palisade tissue (Meijer, 1932) which is sometimes interrupted by isodiametric or bottle-shaped mucilaginous idioblasts (3.5–4.4 μm tall) that are also in contact with the spongy mesophyll (Fig. 13d). Where the mucilaginous cells contact the epidermal cells there is a visible cloudy substance or mucilaginous secretion over the epidermis. The mesophyll parenchyma sometimes contain druses (Fig. 13c). The spongy mesophyll is as thick or twice as thick as the palisade. It is loose or compact and sometimes contains laticifer cells (Fig. 13a), oil cells (Figs. 8c, 11c) or druses (Fig. 13e). The contents of the secretory cells is not known. However, they may contain saponins because these compounds have been reported as abundant in the leaf and stem tissue of species of *Serjania* (Hegnauer, 1963). The vascular bundles are normally associated with a cluster of fibers on both surfaces (Fig. 13b). Laticifers are associated with the vascular bundles in *S. dumiicola* (Fig. 13c). The lower epidermis is made up of uniseriate, isodiametric cells (Figs. 13c, 13d).

#### INFLORESCENCES

The terminology developed by Briggs and Johnson (1979) for the Myrtaceae is used in the following description. The terms blastotelic and anthotetic refer to axes of the inflorescence. A blastotelic inflorescence has indeterminate growth, which either grows seasonally or ends in an aborted meristem. On the other hand, the anthotetic inflorescence has determinate growth with an axis that ends in a flower. The term thyrse refers to a blastotelic inflorescence whose secondary units (branches) are cincinni or drepania. A cincinnus and a drepanium are both gymose (anthotetic) inflorescences, but in cincinnati the flowers are produced toward alternate sides resulting in a spiral arrangement, and in drepania the flowers are produced toward the same side resulting in a scorpioid shape.

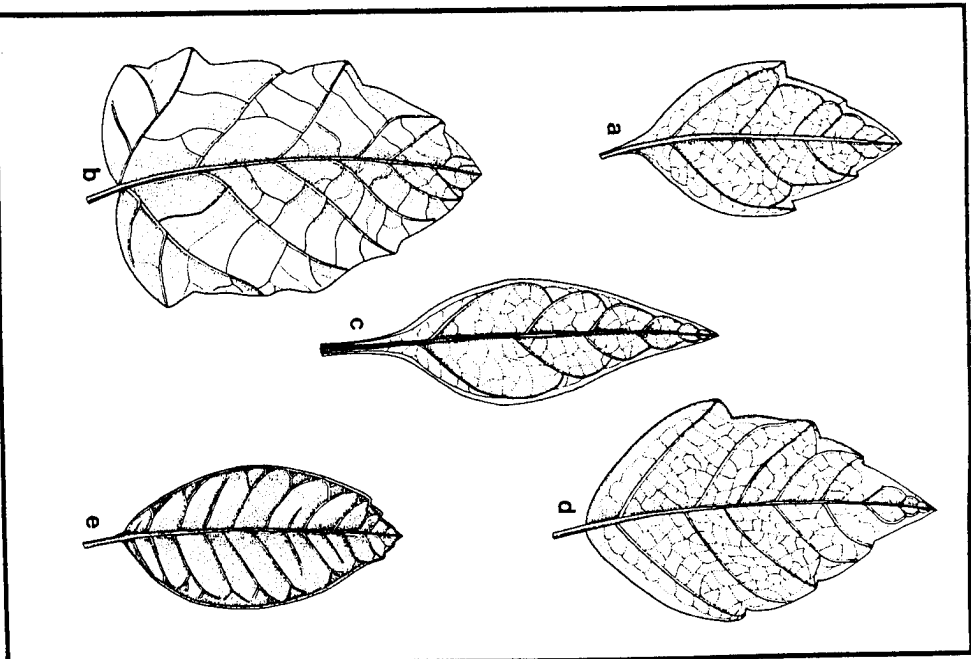


Fig. 10. Leaflet architecture in *Serjania* (venation type). a. Semicraspedodromus in *S. dumiicola* (Acevedo-Rodríguez & Vargas 1759). b. Craspedodromus in *S. cuspidata* (Acevedo-Rodríguez et al. 1458). c. Brochidodromus in *S. hatschbachii* (Hatschbach 2957). d. Mixed craspedodromus in *S. communis* (Acevedo-Rodríguez et al. 1456). e. Cladodromus in *S. acutidentata* Radlk. (Acevedo-Rodríguez et al. 1503).

However, their distinction may be difficult because the occurrence of intermediate forms.

The inflorescences of *Serjania* are blastotelic, axillary thyrses with the main axis ending in an aborted meristem (Fig. 14a). They are produced axillarily with the main stem. Cauliflory or

ramiflory is not reported for *Serjania*, which contrasts with *Paulinia* in which cauliflorous or fasciculate inflorescences occur.

Within each thyrse, two oppositely coiled tendrils (homologous to secondary branches) are precociously developed from the propyl's axillary

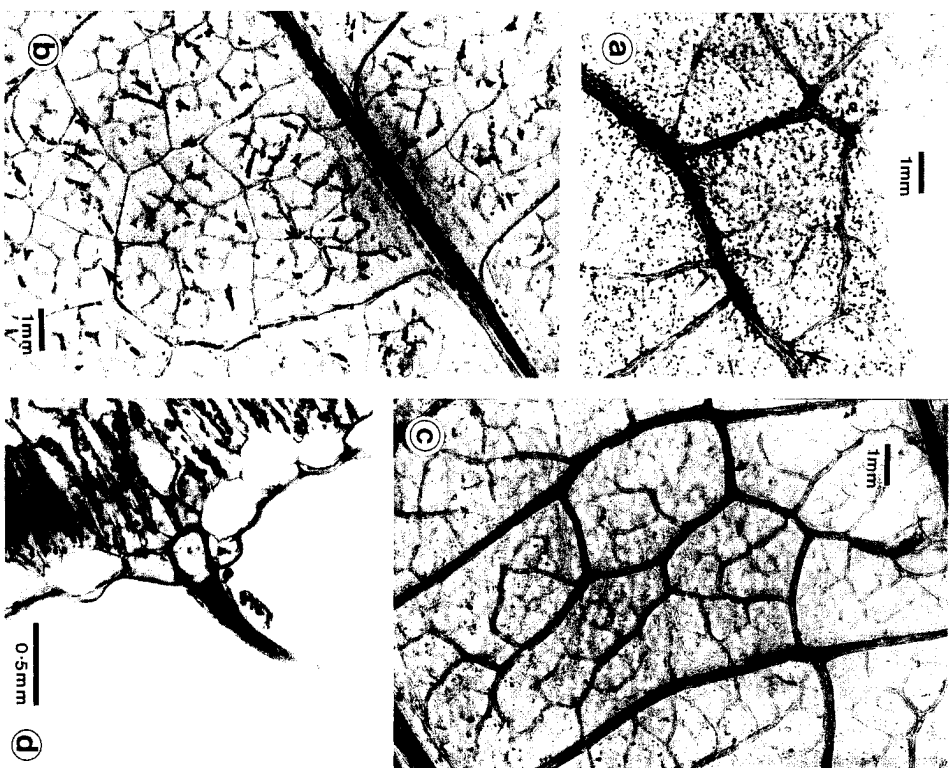


Fig. 11. Leaflet features of *Serjania*. a. Cleared leaflet of *S. inscripta* Radlk. showing marginal loop connection of secondary veins (black arrow) at 90° angle (Acevedo-Rodríguez *et al.* 1990). b. Cleared leaflet of *S. brachyptera* Radlk. showing small arcoleles and free veinlets (black arrow) (Lojanić 14995). c. Cleared leaflet of *S. alboriza* Poepp. & Endlich, showing tertiary veins of type AA and oil cells in mesophyll (Acevedo-Rodríguez & Vargas 1739). d. Cross section of *S. denticulata* leaflet showing hair embedded in swollen base (Acevedo-Rodríguez & Vargas 1739).

buds. In young plants or branches, the first inflorescences produced about the apex after the tendrils are produced. The resulting structure is an axillary short branch with two tendrils at its distal end and an abortive apex (Fig. 14h). In older plants, the main apical meristem of a thyrse is not aborted, instead it develops an axis (beyond the tendrils) which carries secondary antipetalic branches commonly known as cincinni or drepania (Figs. 14a, 14c-e). These may be alternate (Fig. 14a), opposite, or whorled (Fig. 14f).

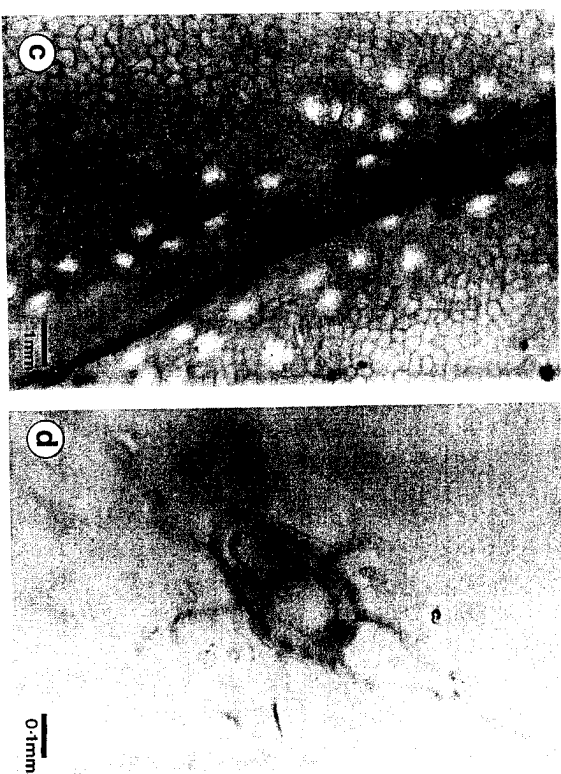
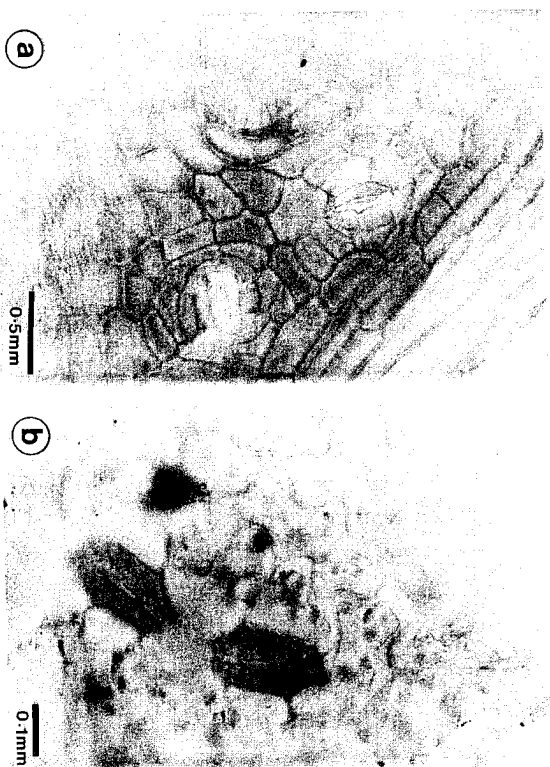


Fig. 12. Epidermal features in *Serjania*. a. Stomata, encydocytic type in *S. brachyptera* (Lojanić 14995). b. Stomata, anomocytic type in *S. confertiflora* Radlk. (Acevedo-Rodríguez & Vargas 1730). c. Stomata distributed along vein on abaxial surface in *S. brachyptera* (Lojanić 14995). d. Remaining basal cell of severed glandular hair in *S. confertiflora* (Acevedo-Rodríguez *et al.* 1457).

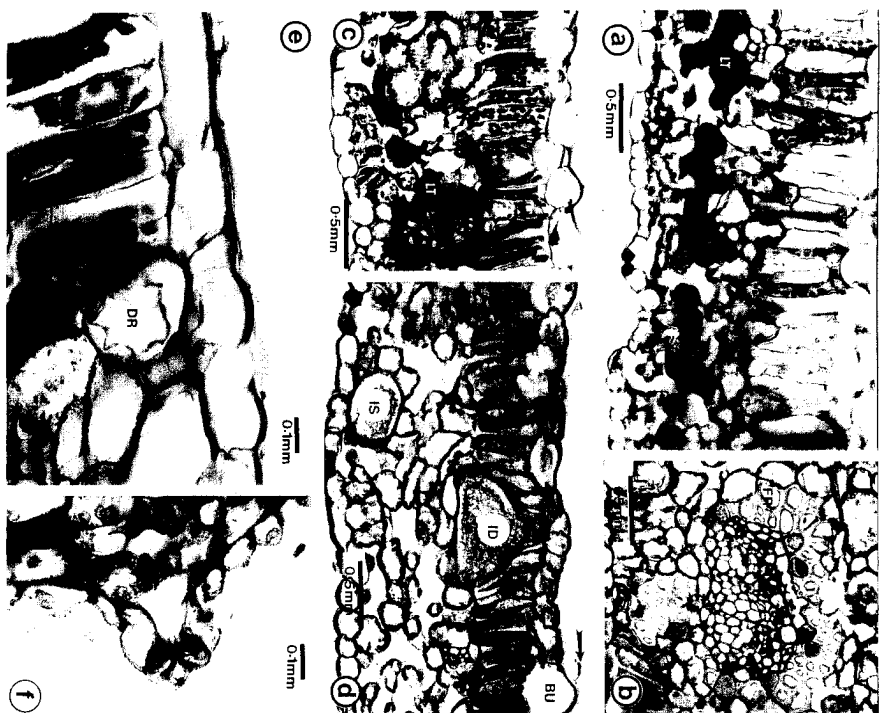


Fig. 13. Cross sections of *Serjania* leaflets, adaxial surface at upper part of pictures (a-e) and stem (f). a. *S. dumicola* showing latexifers (LT). (*Acevedo-Rdgz. & Vargas 1759*). b. *S. polyphylla* showing fiber sheath around vascular bundles (FB) (*Acevedo-Rdgz. 719*). c. *S. dumicola* showing fiber sheath around vascular bundles (FB) (*Acevedo-Rdgz. & Vargas 1759*). d. *S. polyphylla* showing bottle-shaped mucilaginous idioblasts in palisade (ID), isodiametric mucilaginous idioblasts in spongy tissue (IS), bulliform epidermal cell (BU), and mucilaginous secretion (arrow). (*Acevedo-Rdgz. 719*). e. *S. polyphylla* showing druse (DR). (*Acevedo-Rdgz. 719*). f. Cross section of *S. communis* stem, showing stomata and wavy anticlinal walls of epidermis (*Acevedo-Rdgz. 1496*).

A distinction is made here for the areas of the inflorescence axis below and above the tendrils. The area below is called the inflorescence axis (Fig. 14a) and the area above is called the rachis (Fig. 14a). The axis is voluble in most species of *S. sect. Platycoccus*. The stipe of the cinctus or drepanium is called the peduncle (Figs. 14c, d). Bracts (at

the base of thyrses), secondary bracts (at the base of peduncles), and bracteoles (at the base of pedicels) are usually very similar, having little taxonomic importance. However, in some species they are very distinctive because of their glandular margins (Fig. 14g).

Short internodes are produced at the end of the

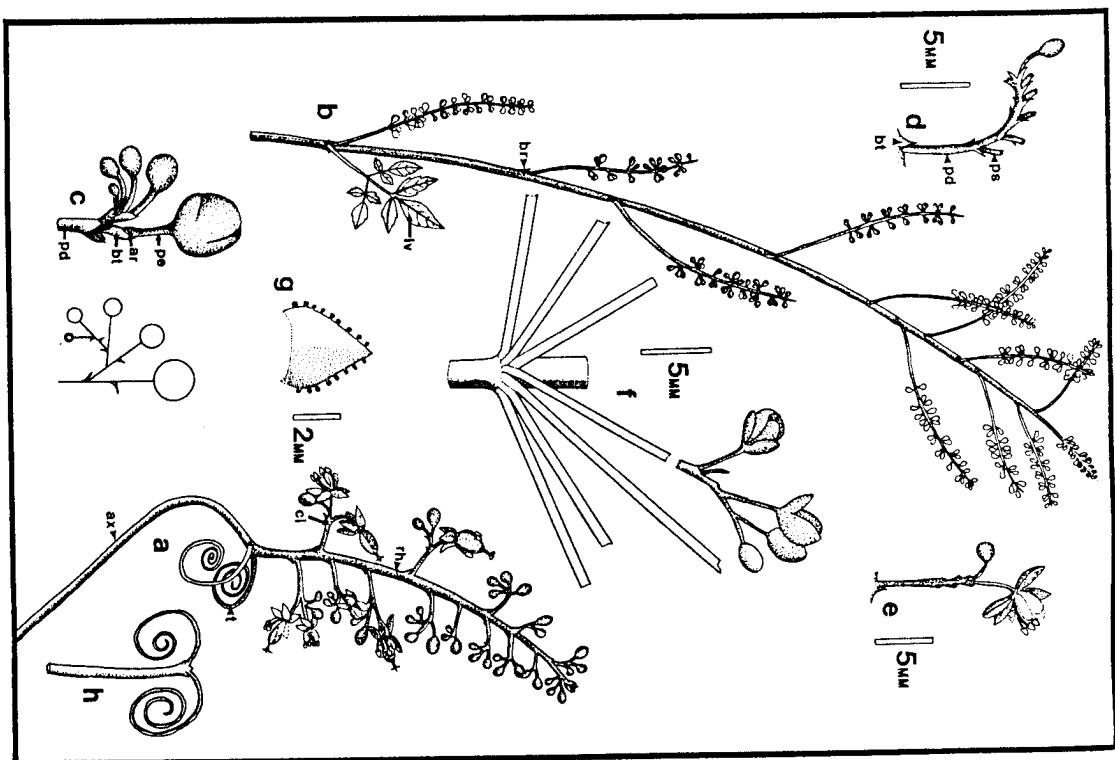


Fig. 14. Inflorescences of *Serjania*. a. Thyrsis with tendrils (t), lateral cinctus (ct), axis (ax), and rachis (rh) (*S. caracasana*, from Pohl 88). b. Frondobracteate, thyrsis, terminal inflorescence showing leaf (lv) and bracts (br) (*S. clematidea* Camb., from H. H. Smith 1272). c. Drepanium with bracteole (br), pedicel (pe), peduncle (pd), and articulation (ar). d. Drepanium with remaining long pedicel bases (ps). e. Cinctus without pedicel bases (*S. inscripta*, from Hausskn. 1854). f. Rachis with whorled cinctus (*S. sagittifolia*, from *Acevedo-Rdgz. & Vargas 1726*). g. Secondary bract with marginal glands (*S. dipymadenta* Radlk., from *Rusby 517*). h. Axillary branch carrying only tendrils (aborted inflorescence meristem) (*S. polyphylla*, from *Acevedo-Rdgz. 719*).

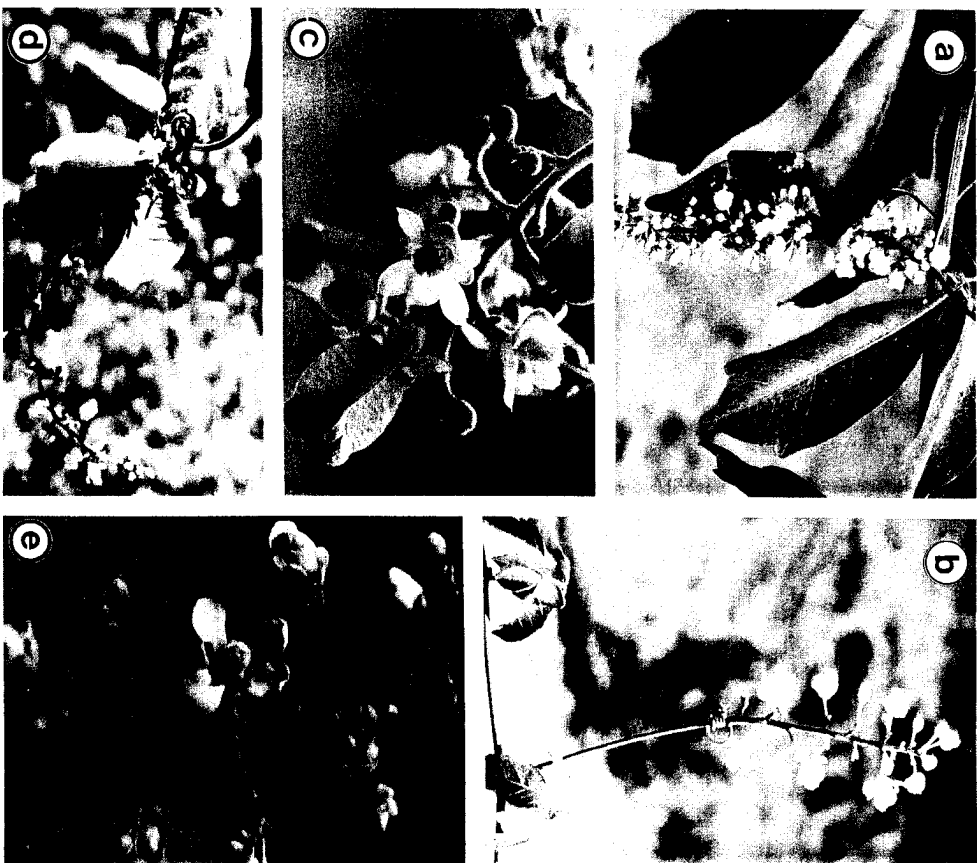


Fig. 15. Presentation of inflorescences in *Serjania*. a. Pendant inflorescence in *S. lethalis*, St. Hill. (Acevedo-Rodríguez *et al.* 1468). b. Erect inflorescence in *S. caracasana* (Acevedo-Rodríguez *et al.* 1499). c. Horizontal inflorescence in *S. polyphylla* (Acevedo-Rodríguez 719). d. Semierect inflorescence in *S. nimans* (Acevedo-Rodríguez & Vargas 1744). e. Detail of pendant inflorescence in *S. ampelopsis*, showing receptive and senescent flowers. (Acevedo-Rodríguez & Vargas 1731).

branches, which results in the aggregation of thyrses to form a thyrsoid synflorescence. This thyrsoid synflorescence ends in a thyrsis unit and shows an abrupt transition from regular leaves to bracts (Fig. 14b).

The inflorescences are presented either in upward (Fig. 15b), horizontal (Figs. 15c, d), or pendant (Figs. 15a, e) positions. Inflorescences in the majority of *S.* sect. *Platycoctus* species are pendant.

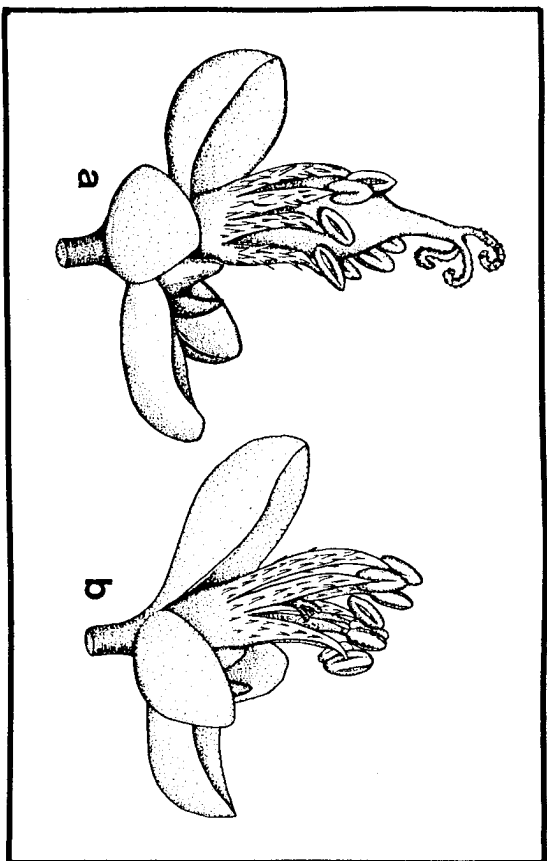


Fig. 16. Morphology of pistillate and staminate flowers of *S. grandifolia* (Acevedo-Rodríguez & Daly 1619). a. Pistillate flower with indehiscent anthers. b. Staminate flower with reduced gynoeceum.

#### FLOWERS

Radlkofer (1931) considered the flowers of *Serjania* "hemaphrodites" (structurally perfect) which were either physiologically female or male. Cruz and Melhem (1984) reported the occurrence of monoecious flowers in *Serjania* inflorescences without discussing their distribution within the species or individuals. Instead, the female flower resembles a bisexual flower with anthers that do not dehisce (Fig. 16a) and the male flower possesses a reduced pistil (Fig. 16b). In *S. grandifolia*, herbarium specimens of the male and female flowers have slightly different petal coloration. In living material, the anthers of male and female flowers are differently colored.

*Serjania* flowers are zygomorphic (Figs. 15c, e). The petals have an appendage adnate to their adaxial basal surface (Figs. 172a-e). The appendages are appressed against the anthers in a way that seems to restrict access to the disk glands (Fig. 171c). The flowers of *Serjania* show some variation in numbers of parts (viz. sepals), as well as in size, indument,

structure, and color. They are never longer than 1 cm, and typically their size range between 4 and 6 mm long. Typically, the petals, appendages, and disk glands present considerable variation in shape and size.

The flowers are of limited value in defining the genus, especially from *Paulinia* whose floral morphology is very similar. However, the flowers of *Cardiospermum* are easily distinguished from those of *Serjania* by the presence of reduced outer sepals and by the reduction of the disk glands to two. Most species of *Urvillea* are distinguished from the other genera by the presence of an apical gland at the anther apex. The flowers of *Serjania* have been of little use in the infragenetic classification, but detailed observations are now providing new insights into their systematic value. Some of the variations include the presence of anther appendages.

#### Pedicels

The pedicel is the internode(s) between the flower and the node of the axis (Fig. 14c). It is more or less

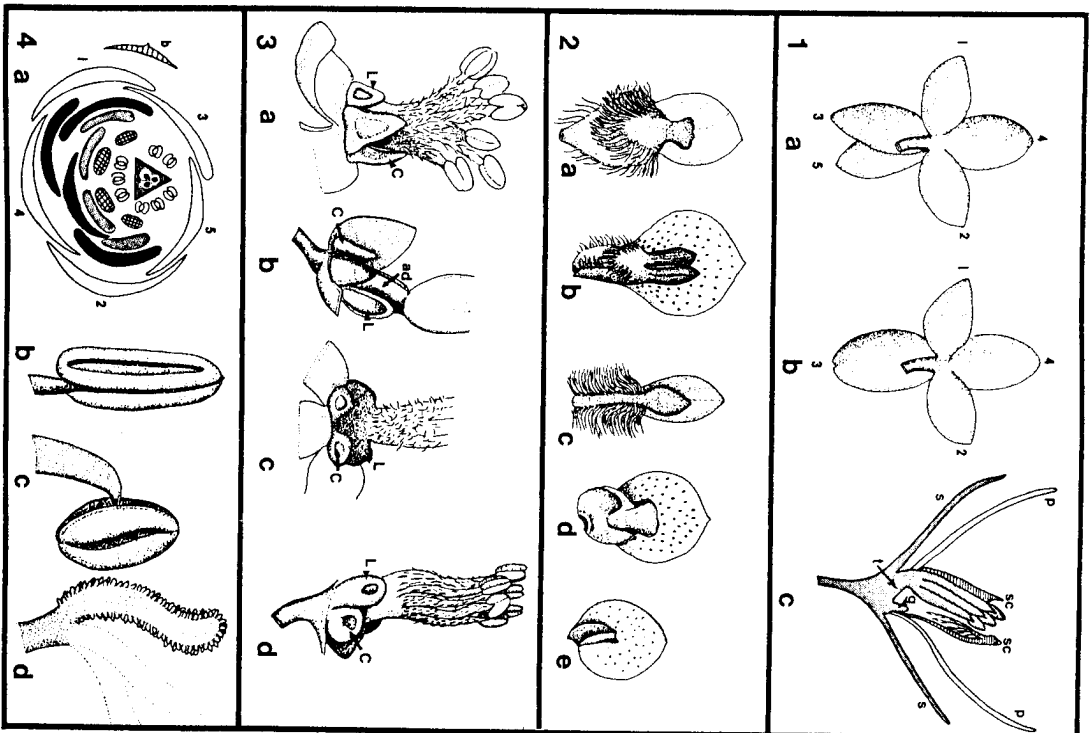


Fig. 17. Diagram of floral structures of *Serjania*.

1. Calyx: a, with 5 sepals, outer sepals overlapping (1 & 2), inner sepals (3, 4 & 5), *S. hebecarpa* Benth. (Acevedo-Rdgz. & Vargas 1773); b, with 4 sepals (3 & 5 connate), *S. communis* (Heiner 482); c, Longitudinal section through a flower (g = gland, p = petal, se = sepal, sc = appendage, t = torus), *S. communis* (Heiner 482).
2. Petals with adnate appendages: a-d, central petals: a, *S. subrotundifolia* Radlk. (Lechtler 2332); b, *S. paludosa* Camb. (Mori 13281); c, *S. confertiflora* (Schumk. s.n.); d, *S. leptocarpa* (Weir 501); e, lateral petals, *S. leptocarpa* (Weir 501).
3. Nectary disk with protruding glands: a, deltoid shape with central glands (C) larger than lateral glands (L), *S. pyramidalis* (Acevedo-Rdgz. et al. 1495); b, central glands (C) with deltoid shape, lateral glands (L) adnate to androgynephore (ad), *S.*

elongated, with a bracteole (prophyll)(Fig. 14c) inserted somewhere between the base and its middle. Above the bracteole, there is an articulation whose distance from the bracteole varies from species to species (Fig. 14c). The segment between the articulation and the bracteole is noticeable in inflorescences after the fruits have been dispersed (Fig. 14d).

#### Sepals

The number of sepals present in the calyx is either four or five (Figs. 17.1a, b). Species with four sepals have a much wider third sepal (Fig. 17.1b) instead of a third and a fifth sepal (Fig. 17.1a). In other words, the four sepale condition results from the connation of the third and fifth sepals into a wider one. Some species possess flowers with five sepals, in which the third and the fifth sepals are connate to different degrees. Aestivation of sepals in the flower bud is *quinquecordial* (Fig. 17.4a) for those species with five sepals and *imbricate* for those with four sepals. The two outer sepals (Figs. 17.1a, b) are smaller than the inner ones and usually ovate. The inner sepals are ovate or oblong with an obtuse apex (Figs. 17.1a, b). The indument on the sepals is composed of non-glandular and glandular hairs similar to those occurring on leaves. The number of sepals has been an important character in Radlkofe's classification and was used by him at different taxonomic levels. He used this character to define some species and a subsection of *S. sect. Planycoccus*. This character might be diagnostic at the species level, but has been overemphasized as an indicator of phylogenetic affinity.

#### Petals

The corolla contains four free petals which are most commonly spatulate, and less frequently obovate or oblanceolate. The vast majority of species have white petals, but the petals of *S. undemata* Acevedo-Rdgz., *S. cardiospermoides* Schlechtend.,

and *S. tenuis* Radlk. are light yellow while those of *S. velutina* Radlk. are red. Their adaxial surface is sparsely covered with small papillae (Figs. 17.2b, d, e) and has a petaloid appendage at its base (Figs. 17.1c, 17.2a-e). The petals are borne at the abaxial base of the disk gland (Fig. 17.1c). The appendages are dimorphic; those in the central position (Figs. 17.2a-d) are larger, bilaterally symmetrical, and hood-shaped while those in peripheral (lateral) position are smaller, asymmetric, and semi-hood-shaped (Fig. 17.2e). The hood-shaped area of the appendage covers the glands which are situated adaxially to the insertion of the petals (Fig. 17.1c). The appendage apex is fleshy (perhaps glandular as suggested by Simpson, 1976) and presents great variation in size and shape (Figs. 17.2a-e). The central appendages are very characteristic, usually with a yellow crown-shaped apex which sticks out against the anthers (Figs. 15c, 17.1c). Little importance was attached to the variation present in the petals and appendages by Radlkofe in the classification of *Serjania*. Variations in these structures need further examination to explore the possibilities of a major role in the classification of *Serjania*.

#### Nectary Disk

There is a unilateral nectary disk with four protruding glands inserted at the base of the androecium in *Serjania*. Less commonly, the disk has only two glands or may be semianular with four lobes. The glands are variable in size and shape, but they are usually rounded or ovate (Figs. 17.3a-d). Those in the central position are usually larger than those at the periphery, which may even be obsolete (Fig. 17.3b). The glands are fleshy and secrete nectar.

#### Androecium

In *Serjania* as well as in the many members of the Pauliniaceae, the number of stamens per flower is

1. *Serjania* (Schumk. s.n.); c, semianular disk with reduced central (C) and lateral (L) glands, *S. longipes* Radlk. (Thien 131); d, round central glands (C), oblong and larger lateral glands (L), *S. undemata* (Acevedo-Rdgz. et al. 1570).

4. Floral diagram, anthers and stigma features: a, Quintonaria aestivation (p = bracteole, numbers, dark gray, light gray, cross hatch represent sepals, petals, appendages and disk glands respectively), *S. hebecarpa* (Acevedo-Rdgz. & Vargas 1773); b, Anther from pistillate flower, appearing as basifixed, *S. hebecarpa* (Acevedo-Rdgz. & Vargas 1773); c, Anther from staminate flower, clearly dorsifixed, *S. demata* (Vell.) Radlk. (Rosa 47); d, Papillose stigmatic surface, *S. hebecarpa* (Acevedo-Rdgz. & Vargas 1773).

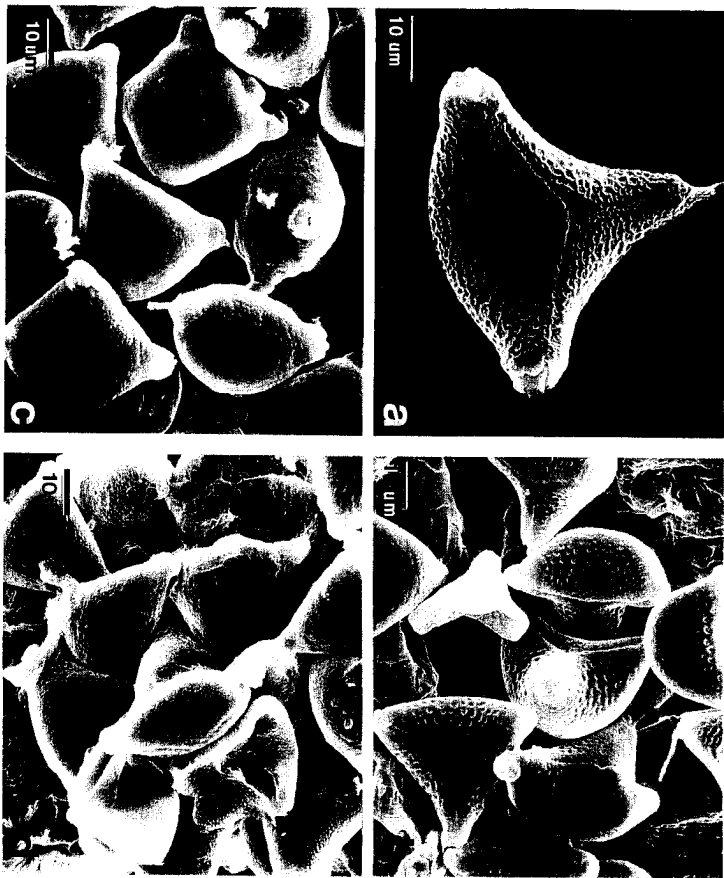


Fig. 18. SEM micrographs of *Serjania* and *Houssayanthus* pollen. a. *S. velutina* Radlk. (Mori et al. 1983), b. *S. hastachabii* (Hastachab 2957), c. *S. ampelopsis* (Acevedo-Rodr. & Vargas 1731), d. *H. incanus* (Radlk.) Fernucci (Hasler 7445).

eight. The filaments are flattened, united at the base, and of unequal length (those toward the central glands shorter). They are usually densely covered with white inflexed hairs (Figs. 17.3a, c, d). The anthers are small (0.4–0.6 mm), ellipsoid, dorsifixed, introrse, and open by longitudinal slits (Figs. 17.4b, c). Anthers of female flowers may appear basifixed because the thecae (which do not delhisce) hide the point of attachment. In some species (e.g., *S. caracasana*), a fleshy appendage is present at the apex of the anthers. Most species have yellow anthers, however, in *S. grandifolia* the anthers of the male flowers are light purple while those of the female flowers are whitish. In the field, some individuals of *S. membranacea* Splig. and *S. hebecarpa*

Benth. are reported to have lilac and orange anthers, respectively.

The pollen of Sapindaceae has been studied by Muller and Leenhouts (1976) and by Cruz and Melhem (1984). Their studies show that *Serjania* has *heteropolar, hemitricolporate* pollen with a triangular equatorial outline (Figs. 18a–c). One of the poles is convex and the other, where the colpi unite, is flatter (Fig. 18a). Exceptionally, *Serjania* pollen is isopolar and triporate, e.g., *S. caracasana* (Cruz & Melhem, 1984), or have a 4-angular equatorial outline (Fig. 18c) or an oblate equatorial outline, e.g., *S. ichthyotona* Radlk.

*Houssayanthus* (Fig. 18d), *Cardiospermum*, and *Urvillea* have the same type of pollen grains as

*Serjania* (Muller & Leenhouts, 1976). However, those of *Paulinia* differ by being isopolar and triporate. Muller and Leenhouts (1976) considered the triporate pollen to be derived from the hemitricolporate type by the reduction of the colpi.

Cruz and Melhem (1984) found the polar diameter of *Serjania* pollen to vary from 23.6 to 27.8 µm and the equatorial diameter to vary from 41.1 to 47.3 µm in the nine species they studied. I have found slightly smaller pollen grains in *S. ampelopsis* and *S. communis* Camb. In these species the equatorial diameter varies from 30 to 35 µm. Cruz and Melhem (1984) also found the size of pollen to vary between staminate and bisexual (pistillate?) flowers in some species of *Serjania*.

Exine sculpturing is reticulate, foveolate (Figs. 18a, b) or rarely psilate (Fig. 18c). The reticulate loops are larger at the flat pole. The exine consists of a columned sexine which is thicker than the nexine in all species except in *S. communis*, *S. elegans* Camb., and *S. reticulata* Camb. in which the nexine is made of two layers (Cruz & Melhem, 1984).

#### Gynoecium

The syncarpic gynoecium of *Serjania* consists of three fused carpels. The ovules are solitary, apotropous, and the placentation is axial. The ovary is glabrous or pubescent and prominently trilobate with an elliptic or oblong outline. The style is usually longer than the stigmata (three in number) which are papillose (Fig. 17.4d).

#### FRUITS

The schizocarpic fruits in *Serjania* separate into three samaroid mericarps leaving a common thin carphophore (Fig. 19a). The size of the mericarps varies from 1 cm in some species to 7 cm in other species. Each mericarp is dispersed as a single unit and contains a proximal wing (sometimes very reduced) and a distal locule where the seed is located (Fig. 19a). Young and full grown fruits are often reddish or greenish, the latter turn straw-colored when mature.

Within the Paulliniaceae, fruits are either schizocarpic or septifragal (Figs. 20a, 20b, 22a–d), *Lophostigma* and *Houssayanthus* share with *Serjania* the presence of schizocarpic fruits (Fig. 20a). Those of *Lophostigma* are of the same kind as *Serjania*, having mericarps with a distal locule and

a proximal wing. On the other hand, those of *Houssayanthus* have a central locule surrounded by a marginal wing. The remaining genera of Paulliniaceae (*Cardiospermum*, *Urvillea* and *Paulinia*) have marginicidal, septifragal fruits, with valves that open away from the sepalae (Fig. 20b).

Much weight was given to fruit variation by Radlkoter (1875, 1886, 1931) in his classification of Sapindaceae. In *Serjania*, characters such as the width of the partitioning wall (dissepimentum) (Fig. 19a), the texture and shape of the locule (Figs. 21a–d), and the presence of a crest or wing around the locule (Fig. 19b) were utilized in the delimitation of his sections. Of the twelve sections that he recognized, some are distinctive and easily recognized, but the majority are poorly delimited because of intergradation of characters. I recognize only six sections which are also based on fruit types. One of these sections, *S. sect. Confertiflora*, was not recognized before (Figs. 21a–f; see section on infrageneric classification).

The fruits of *Serjania* lack a cuticle. The epidermis is comprised of uniform cells (1.25 × 2.5–3.7 µm) with wavy anticlinal walls (Fig. 23d). The exocarp consists of approximately ten layers of parenchyma with included vascular bundles (Fig. 23a). The corner in contact with the dissepimentum contains a shield of sclereids (Fig. 23a). The exocarp becomes heavily subertized, collapses and sometimes separates from the mesocarp (Fig. 23b). The mesocarp is composed of a middle, uniseriate layer of small, isodiametric parenchyma which contains prismatic crystals and stains heavily with safranin (Figs. 23d, 23e). The endocarp is a four to eight layered zone of sclereids with overlapping oblique ends. The inner layer of the endocarp is subertized (Fig. 23e). The endocarp is organized into a mesh in which erect and transverse sclereids are found. The partitioning wall consists of short transverse sclereids.

*Serjania* sect. *Platycoocus* is characterized by having fruits with flat, membranous locules. These two characters do not occur together in any other species of *Serjania*. The fruit anatomy of *Serjania* sect. *Platycoocus* does not differ from that of other sections of the genus.

#### SEEDS

Seeds of *Serjania* are commonly lenticular, spheric, tear-shaped or rarely oblong with a triangu-



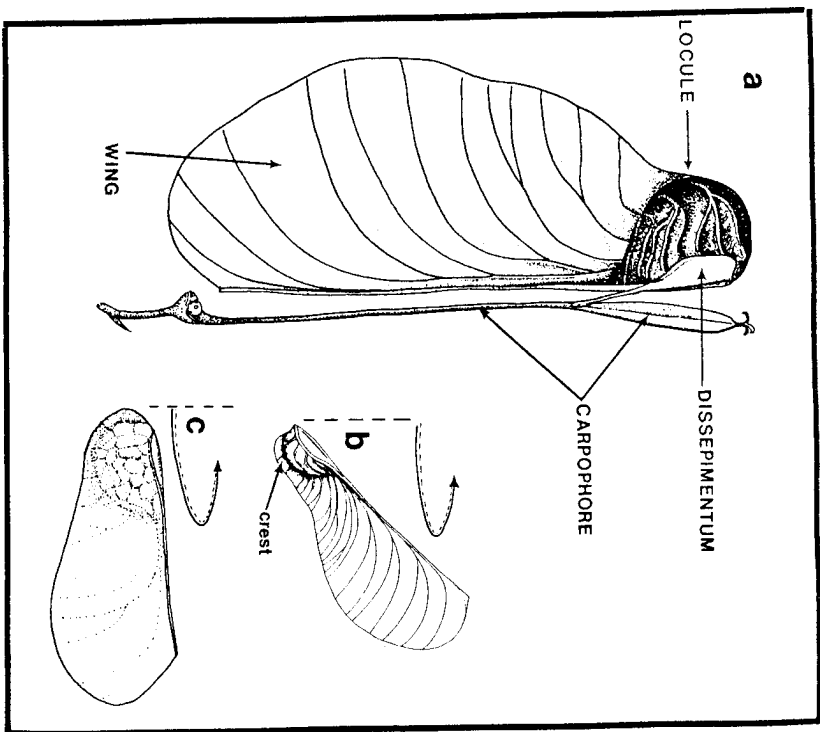


Fig. 19. Diagram of fruit mericarps in *Serjania*. a. Mericarp which is still attached to the carpopophore, showing different parts. b. Crested mericarp showing angle of spinning in free fall of ca. 45°. c. Non-crested mericarp showing angle of spinning in free fall of ca. 90°. This type of mericarp is found in all species of *S. sect. Platycoccus*.

lar outline in transverse section. They are usually dark or light brown and the size varies from 3 to 7 mm in length. The seed coat surface is strongly rugulate to weakly rugulate or sub-rugulate (Fig. 24A-F). There is an exotesta below the cuticle which consists of an uniseriate layer of uniform sclereids and a thick tissue of approximately ten cell layers of isodiametric parenchyma cells and vascular bundles (Fig. 23c). The parenchyma in this zone heavily accumulates ergastic substances. The endotesta is a two-celled tissue of larger and darker cells (Fig. 23c). The endosperm is absent in mature seeds.

Different types of cotyledon configurations occur in *Serjania*. The abaxial cotyledon refers to the cotyledon which is farther away from the fruit axis while the adaxial cotyledon is closest to the axis. The following four types of cotyledon configuration have been found in the embryos of *Serjania*: 1) both cotyledons straight and parallel to fruit axis (Figs. 25a-c), 2) the abaxial cotyledon larger and curved over the adaxial which is biplicate (Figs. 25d-h, 25j), 3) the abaxial cotyledon straight and smaller, and adaxial cotyledon biplicate (Figs. 25i, 25k, 25l), 4) both cotyledons straight and perpendicular to fruit axis (Fig. 25p). The third type may be a variation of the second type because some species show both types. Besides these four types, some anomalous embryos (Figs. 25m-o) have been

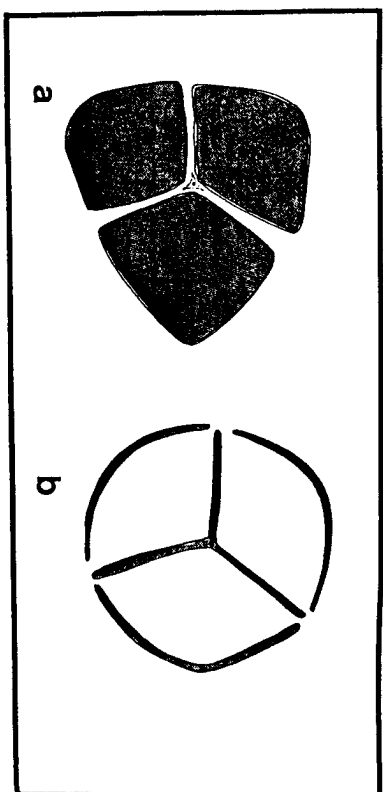


Fig. 20. Diagram showing the different dehiscence mechanisms in the Pauliniaceae. a. Schizocarpic fruit separates in three mericarpic units. The seeds are not exposed (present in *Serjania*, *Lophostigma* and *Houssayanthus*). b. Marginal and septidigital fruits, valves open away from the septae. The seeds are exposed (present in *Paulinia*, *Cardiospermum*, and *Urvillea*).

found in species having the second type. The cotyledons are entire and may be either flattened or swollen.

The type of embryo has no systematic value at the sectional level because it does not correlate with other characters. However, this character provides systematic information at the species level.

The seeds of *Serjania* sect. *Platycoccus* are lens-ticular and their seed coat surface varies from rugulate to weak rugulate. The embryos are either type 1, 2, or 4.

### Cytology

Reports on chromosome numbers have been published for 13 species of *Serjania*. All reported numbers are  $n=12$  (Table IV). I also have obtained the same count for *Serjania cuspidata* Camb., a species in *S. sect. Platycoccus*. Chromosome numbers in the woody genera *Paulinia* and *Houssayanthus* are  $n=12$  while in the herbaceous genus *Cardiospermum* they are either  $n=11$  or 10, and in *Urvillea* they are  $n=11$  (Ferrucci, 1981). The herbaceous members of the Pauliniaceae seem to be more derived, a suggestion which is supported by their shorter life cycles and reduced chromosome numbers. A similar trend has been observed in other groups in which a reduction of nuclear DNA correlates with shorter life cycles and adaptation to dis-

turbed or rapidly changing environments (Bennett, 1972).

### Generic Relationships

The genus *Serjania* is very similar to five other genera in the Sapindaceae: *Paulinia* L., *Cardiospermum* L., *Urvillea* Kunth, *Houssayanthus* Hunz., and *Lophostigma* Radlk.

Distinction of the different genera, based on vegetative characters, is very difficult and usually requires previous experience with the group. However, they are easily distinguished from each other by the type of fruit. These six genera certainly constitute a natural group within the Sapindaceae, being distinctive enough to be placed in their own tribe, the Pauliniaceae. The Pauliniaceae sensu Kunth (1821) are characterized by climbing habit, presence of stipules, and zygomorphic flowers with modified disks into 4 (or 2) glands.

The Pauliniaceae seem to be closely related to the Thoinaceae with which they share some characters, such as zygomorphic flowers with unilateral disks, hood-shaped petal appendages, and a fully developed terminal leaflet.

*Thinnoua* (placed by Radlköfer in the Pauliniaceae) should not be considered a member of the Pauliniaceae, in spite of its climbing habit and associated traits. The presence of actinomorphic flow-

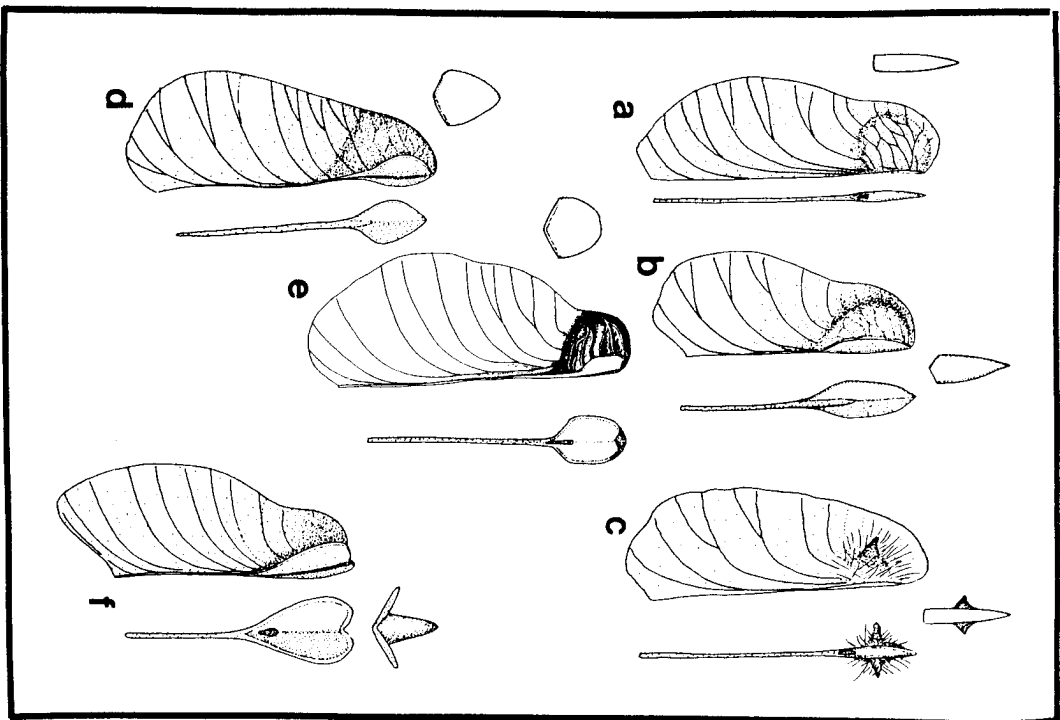


Fig. 21. Diagrammatic representation of fruit mericarps found in *Serjania* which correspond to the six sections of the genus herein recognized. a. *Serjania* sect. *Platyococcus*; locule flat and membranous, dissepimentum narrow, cross section of locule on left (*S. caspidata*, from W. Hoehne s.n. SPF 16098). b. *Serjania* sect. *Eryococcus*; locule sub-spheric and woody, dissepimentum wide, cross section of locule at top (*S. satzmanniana* Schlectend., from Acevedo-Rdgz. et al. 1522). c. *Serjania* sect. *Ceratococcus*; locule woody with a horn-like projection, dissepimentum narrow, cross section of locule on top (*S. corrigera* Turcz., from Pitler 2568). d. *Serjania* sect. *Physococcus*; locule membranous and inflated, dissepimentum wide, cross section of locule on left (*S. inflata* Poepp. & Endlich). e. *Serjania* sect. *Serjania*; locule woody and globose, dissepimentum wide, cross section of locule on left (*S. fluminensis*, from Acevedo-Rdgz. & Farney 1424). f. *Serjania* sect. *Conyrtiflora*; locule woody and flattened, dissepimentum wide, projecting beyond the locule, cross section of locule at top (*S. inscripita*, from Acevedo-Rdgz. et al. 1590).



Fig. 22. Type of fruits in the Paullinieae. a. *Septifragal*, thick, woody capsular fruits in *Paullinia alata* G.Don (Acevedo-Rdgz. et al. 1581). b. *Septifragal*, thin, inflated capsular fruits in *Cardioospermum halicacabum* L. (Acevedo-Rdgz. 2501). c. Schizocarpic fruits with samaroid mericarps in *Serjania fluminensis* Acevedo-Rdgz. (Acevedo-Rdgz. & Farney 1424). d. *Septifragal*, thin, semi-winged capsules in *Urvillea villosa* Kaulth. (Acevedo-Rdgz. et al. 1481).

ers, annular-nectary disk and spherical pollen grains in *Thinnouia*, suggest that it is better placed in the Cupaniteae.

#### Cladistic Analysis

#### MATERIALS AND METHODS

The phylogenetic relationships among the genera of the tribes Paullinieae and the Thinnouiteae were

analyzed cladistically using the computer program PAUP (Phylogenetic Analysis Using Parsimony, ver. 3.0q; Swofford, 1991). Twenty-one characters were selected for this analysis (Tables V, VI) and character state polarities were established using the method of outgroup comparison (Donoghue & Canino, 1984; Watrous & Wheeler, 1981). The tribe Sapindaceae, which is believed to be closely related to both tribes due to their similar floral and vegetative characters, was used as the immediate outgroup.

A discussion of the characters and their polariza-

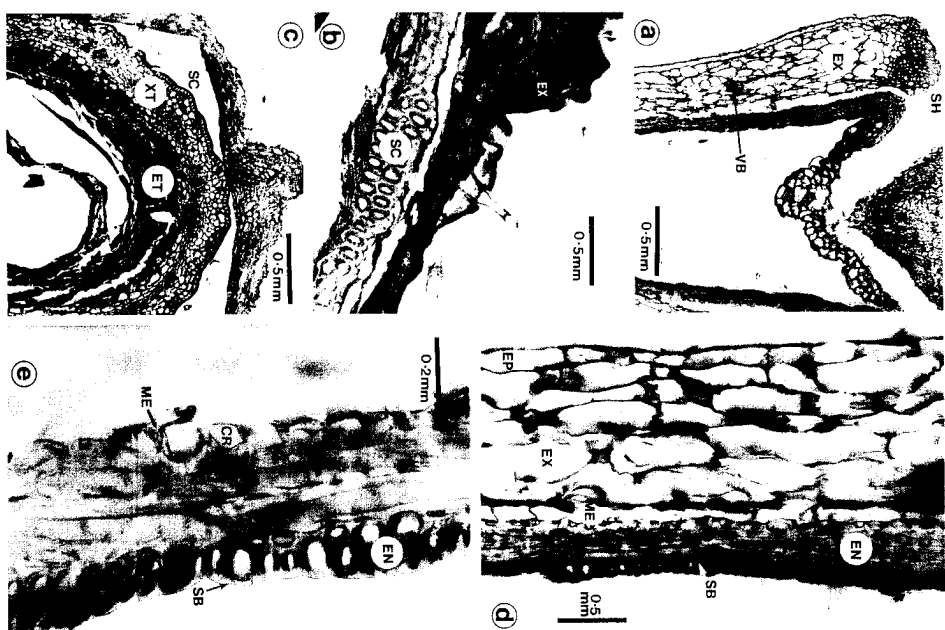


Fig. 23. Anatomical sections of the fruits and seeds of *Serjania* (all from *S. communis*; Acevedo-Rodríguez, *et al.*, 1990). a. Cross section of fruit wall with sclereid shield at corner (SH), exocarp not yet subtetized (EX) and vascular bundle (VB). b. Detail of cross section of fruit wall showing subtetized exocarp (EX) and sclereids in endocarp (SC). c. Seed cross section showing sclereids in seed coat (SC), exotesta (XT), and endotesta (ET). d. Cross section of fruit wall showing epidermis (EP), exocarp (EX), mesocarp (ME), and endocarp (EN) with inner subtetized layer (SB). e. Same, in detail showing crystals in mesocarp cells (CR).

tion follows (Tables V, VI). Numerous characters are considered plesiomorphic for the tribe Paullinieae because they are found throughout the sistergroup (Thouiniceae) and the more distant outgroup, the Sapindaceae. Derived characters are not

present in the sistergroup, and their distribution is restricted to a few genera in the ingroup. Characters 1 to 9 and 17 to 21 present a simple transformation pattern, where 0 and 1 represent plesiomorphic and apomorphic characters respectively.

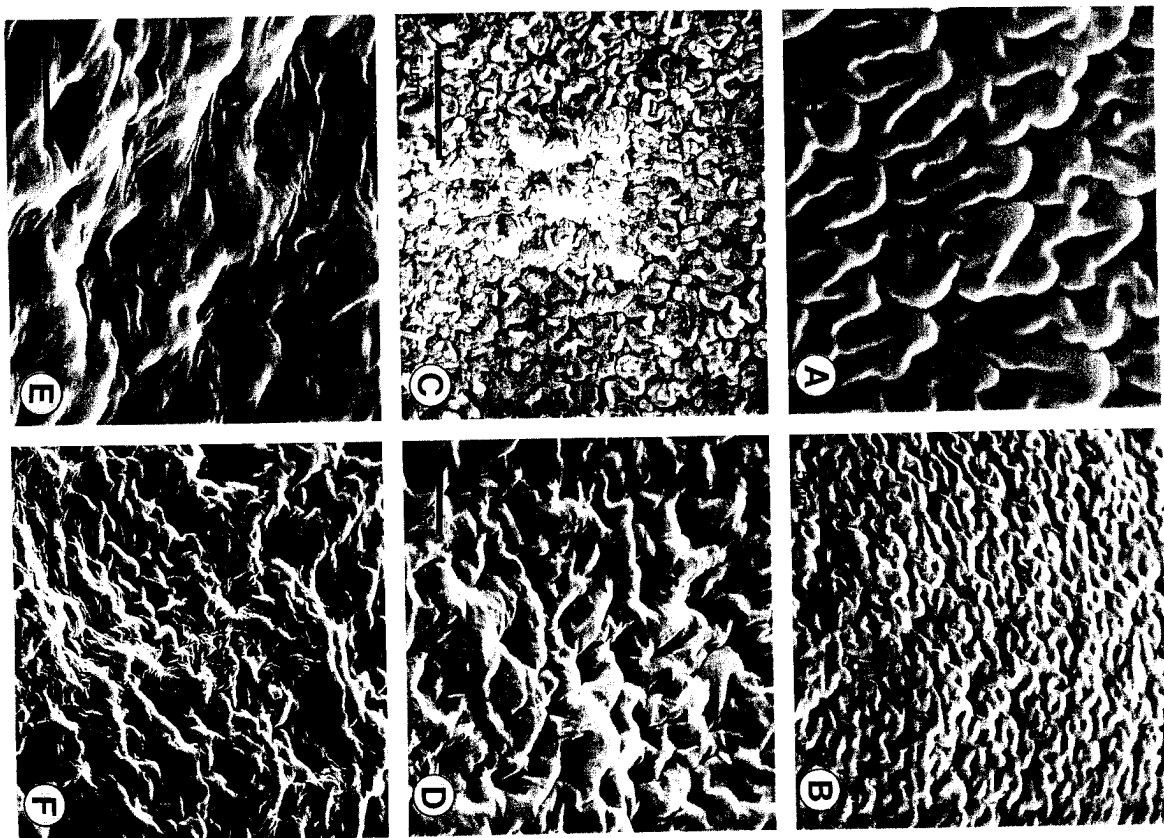


Fig. 24. Seed coat surfaces in *Serjania*. A-C. Rugulate pattern, A. *S. clematidea* Triana & Planch., B. *S. gracilis*, C. *S. clematidifolia*. D-F. Sub-rugulate pattern, D. *S. ritchomiscia* Radlk., E. *S. confertiflora*, F. *S. acutidentata*.

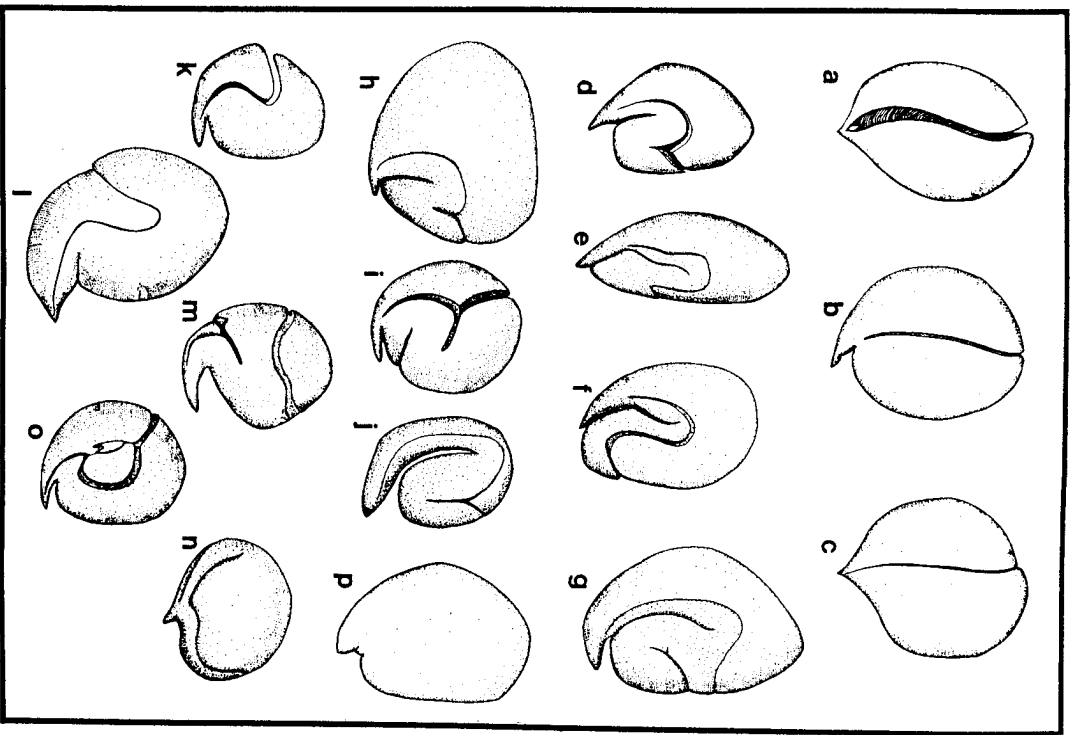


Fig. 25. Diagrammatic representation of embryo configuration in *Serjania*. a-c. Embryo with straight cotyledons, and parallel to fruit axis; d-j. Embryo with curved abaxial cotyledon and biplicate adaxial cotyledon. k-l. Embryo with small straight abaxial cotyledon and large biplicate adaxial cotyledon. m-o. Embryo with abnormal configuration (variable). P. Embryo with straight cotyledons, perpendicular to the fruit axis. a. *S. undeniata* (Acevedo-Rdgz. et al. 1570). b. *S. cardiospermoides* (Cabrada 4247). c. *S. cuspidata* (SPF 16098). d. *S. regnellii* (Acevedo-Rdgz. & Laca 1512). e. *S. confertiflora* (Acevedo-Rdgz. et al. 1449). f. *S. paludosa* (Mez 5682). g. *S. paradoxa* (Acevedo-Rdgz. et al. 1502). h. *S. mutans* Poepp. & Endlich (Klillip 27573). i. *S. lehalis* (Ehren 5524). j. *S. fluminensis* (Acevedo-Rdgz. & Tarney 1424). k. *S. marginata* Casar. (Kunth 92). l. *S. gracilis* (Acevedo-Rdgz. et al. 1514). m. *S. sinuata* Schum. (Leonard 8014). n. *S. paniculata* Kunth (Camp 545). o. *S. aboortya* (Acevedo-Rdgz. & Vargas 1748). p. *S. brachyptera* (Macbride 2291).

Table IV

Chromosome numbers reported in *Serjania*

Species	Number	Reference
<i>caracasana</i>	n=12	Fernici, 1981
<i>classoides</i>	n=12	Fernici, 1981
<i>confertiflora</i>	n=12	Fdz. Casas et al. 1982
<i>cuspidata</i>	2n=24	Acevedo-Rdgz. this paper
<i>erecta</i>	n=12	Fernici, 1981
<i>extrata</i>	n=12	Guerrin, 1961
<i>glabrata</i>	n=12	Fernici, 1985
<i>glabrata</i> f. <i>molitor</i>	n=12	Fernici, 1981
<i>hebecarpa</i>	n=12	Guerrin, 1961
<i>lucida</i>	n=12	Fernici, 1985
<i>mansiana</i>	n=12	Fernici, 1985
<i>marginata</i>	n=12	Fernici, 1985
<i>meridionalis</i>	n=12	Fernici, 1985
<i>perulacea</i>	n=12	Fernici, 1985
<i>tripleurta</i>	2n=24	Fernici, 1985

Other characters have multiple stages, varying in a linear fashion. These are polarized using the out-group comparison method and by using developmental information (see morphology section). Pleistomorphic characters are represented by 0, while apomorphic characters are indicated by higher numbers. The following characters present this ordered pattern.

10. Seed coat. Hard seed coat (0); sarcolesta (1); subsequent loss of sarcolesta (2), as shown by the presence of a "tegment" aril-like structure.
  14. Pollen aperture. Colporate (0); hemicolporate (1); porate (2).
  16. Nectary disk. Annular disk (0); semi-annular, unilateral disk (1); four-lobed, unilateral disk (2); unilateral disks modified into four glands (3); unilateral disk with two glands (4) (represents a reduction in number of glands).
- A few characters have more than two stages, but their transformations are not well understood or do not necessarily follow a linear sequence. These characters (listed below) were treated as unordered in the cladistic analysis.
11. Leaf. Pinnately compound (0); ternately compound (1); simple (2). Polarization of character responds to observations on ontogenetic development in some members of the Paullinieae and Thouiniae.
  12. Pollen equatorial shape. Spherical (0); triangular (1); ellipsoid (2).
  13. Pollen polar symmetry. Isopolar (1); heteropolar (2).
  15. Embryo. Biplicate embryo (0) (a condition in which the embryo's adaxial cotyledon is bent

over the biplicate abaxial one); straight embryo (1) (where both cotyledons are erect); incurved embryo (2) (where both cotyledons are bent toward the fruit axis, and where the adaxial cotyledon is larger and covers the abaxial one).

The following PAUP options were used for the performance of the cladistic analysis: 1) simple addition sequence; 2) one tree held at each step during stepwise addition; 3) "mulpars" was used to search for equally parsimonious trees; 4) trees were rooted to a designated outgroup (Sapindaceae); and 5) deltan optimization.

In the analyses all characters were equally weighted and ordered, except for characters 11 to 13 and 15 which were unordered.

## RESULTS

The analysis produced a single, most parsimonious tree (Fig. 26), with 44 steps and a consistency index of 0.818. The Paullinieae is monophyletic with two major clades. The first clade contains *Paullinia*, *Cardiospermum* and *Urvillea* with *Cardiospermum* and *Urvillea* being more closely related to one another. The second major clade contains *Hovassyanthus*, *Serjania* and *Lophostigma*, with *Serjania* and *Lophostigma* being more closely related.

The "*Paullinia* group" clade is well defined by the presence of capsular fruits, fleshy seed coat (or its subsequent loss) and wide fruit partitioning walls. The *Cardiospermum-Urvillea* clade differs from *Paullinia* by the presence of many derived characters, such as enlarged ions, herbaceous habit, reduced chromosome number, reduced sarcolesta, and papery fruit walls.

Table V

Characters used in the cladistic analysis of the genera of Pauliniaceae and Thouiniaceae.

Code	Character <sup>a</sup>	Plesiomorphic	Apomorphic
1.	fruit:	schizocarp(0)	capsule(1)
2.	life form:	climber, shrubs(0)	climber(1)
3.	appendages:	bilid(0)	reflexed(1)
4.	ovary:	three carpels(0)	two carpels(1)
5.	calyx:	5-merous(0)	4-merous(1)
6.	limbs:	absent(0)	developed(1)
7.	habit:	woody(0)	herbaceous(1)
8.	stipules:	absent(0)	present(1)
9.	fruit locale:	central(0)	distal(1)
10.	seed coat:	hard(0)	sarcotestal(1)
11.	leaf:	pinnae(0)	temate(1)
12.	pollen shape:	spherical(0)	simplex(2)
13.	pollen symmetry:	isopolar(0)	triangular(1)
14.	pollen aperture:	colporate(0)	ellipsoidal(1)
15.	embryo:	biplicate(0)	hemicolporate(1)
16.	nectary disk:	annular(0)	porate(2)
17.	fruit texture:	woody or leathery(0)	straight(1)
18.	partitioning wall:	narrow(0)	incurved(2)
19.	seeds:	globose(0)	4-globed(2)
20.	testis:	absent(0)	2-globed(4)
21.	resin ducts:	absent(0)	papery(1)
			widely(1)
			flattened(1)
			present(1)
			present(1)

<sup>a</sup>Refer to morphology section for discussion of characters.

Table VI

Data matrix for the cladistic analysis of the genera of Pauliniaceae and Thouiniaceae.

Taxa	Characters <sup>a</sup>																					
Oungroup	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
<i>Bridgesia</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Guindilia</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Diatenopteryx</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Athyana</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Thouinia</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Allophylus</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Serjania</i>	0	1	1	0	0	0	0	0	0	1	0	1	1	a	b	a	3	0	0	0	a	1
<i>Houssayanthus</i>	0	1	1	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1
<i>Cardiospermum</i>	0	1	1	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1
<i>Urvillea</i>	0	1	1	0	0	0	0	0	0	2	1	1	1	1	1	1	1	1	1	1	1	1
<i>Lophostigma</i>	1	1	1	0	0	0	0	0	0	2	1	1	1	1	1	1	1	1	1	1	1	1
<i>Paullinia</i>	1	1	1	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1

<sup>a</sup>For characters see Table IV. Polymorphic characters represented by: a(= 0 & 1) and b(= 1 & 2).

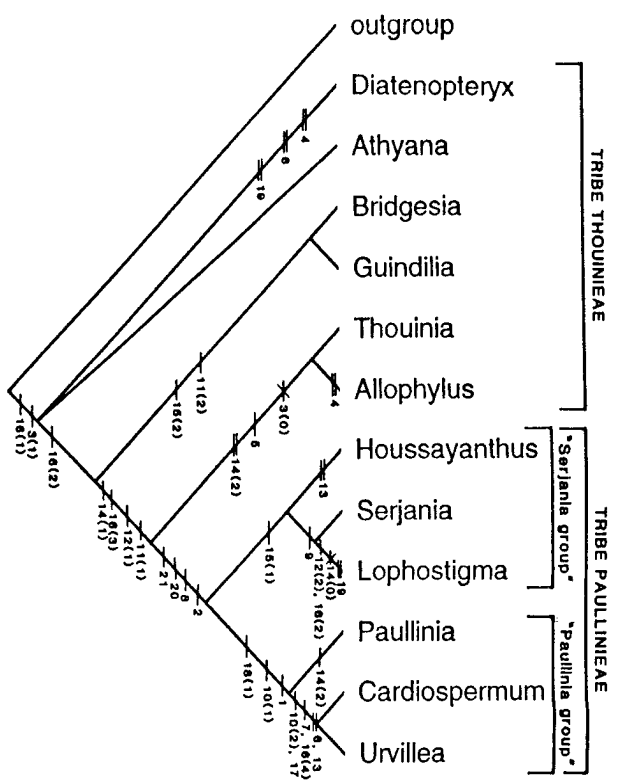


Fig. 26. Cladogram of genera traditionally included in the tribes Pauliniaceae (*Serjania*, *Paullinia*, *Cardiospermum*, *Urvillea*, *Lophostigma*, and *Houssayanthus*) and Thouiniaceae (*Athyana*, *Diatenopteryx*, *Bridgesia*, *Guindilia*, *Thouinia*, and *Allophylus*). Two monophyletic units are contained within the tribe Pauliniaceae. The "Paulinia group" with *Paullinia*, *Urvillea* and *Cardiospermum*, and the "Serjania group" with *Houssayanthus*, *Serjania* and *Lophostigma*. The cladogram has 44 steps and a consistency index of 0.818. Generated by PAUP from the data matrix in Table V and drawn directly from the computer output. The lengths of the branches have no significance. Numbers correspond to characters; numbers in parentheses correspond to states "0," "1," "2," "3," and "4" respectively in the data matrix; "-"=apomorphic, "="=parallelism and "x"=reversal.

The "Serjania group" clade is defined by the presence of an embryo with straight cotyledons. This character is interpreted as being independently derived in the *Houssayanthus* (*Serjania-Lophostigma*) clade and in *Paullinia*, because it produces a more parsimonious cladogram. The *Serjania-Lophostigma* clade is characterized by the presence of distal fruit locules, a common derived character. The *Paullinia* and the *Serjania* group make up the previously described tribe Pauliniaceae.

The tribe Thouiniaceae (*Diatenopteryx*, *Athyana*, *Bridgesia*, *Guindilia*, *Thouinia* and *Allophylus*) is paraphyletic, with *Thouinia* and *Allophylus* forming one clade, and with *Bridgesia* and *Guindilia* forming another. *Athyana* and *Diatenopteryx* are basal to the group, and their relationship to the other genera is still not clear.

If the Pauliniaceae are recognized as a tribe, then the Thouiniaceae would have to split into three or four

tribes. Alternatively, the Thouiniaceae and the Pauliniaceae may be combined into one tribe with four to six sub-groups. A proposal for a new classification scheme is deferred until the relationship of *Athyana* and *Diatenopteryx* is resolved.

Phylogeny

Apparently *Serjania* evolved in the Americas because of its absence from other continents, both as living plants and fossils. The oldest known fossil for *Serjania* and the closely related genera, *Paullinia* and *Cardiospermum*, are from the Gatuncillo Formation of Panama, which dates from the middle to the upper Eocene (Graham, 1985). The pollen fossil flora of the Gatuncillo Formation suggests the prevalence of a tropical climate during the Eocene because it is composed of elements

believed to be closely related to modern tropical taxa. If this assumption is correct, then the Paulliniaceae have had a long evolutionary history under tropical regimes.

If the evolution of *Serjania* has occurred primarily in the tropics, its most likely center of origin is South America. This hypothesis is supported by the fact that the Eocene floras of southern North America are regarded as subtropical (Dilcher, 1973), while those of northern South America contain many tropical elements (González Guzmán, 1967). The greater diversity of *Serjania* in South America might be indicative of a more ancient history for the genus in that region. It is quite possible that *Serjania* has been present in South America since the Eocene. Cerrado, a savanna-like type of vegetation from central Brazil, where a great number of species of *Serjania* are found, is also known to date from the Eocene (Ehler, 1972).

However, Mexico is another major center of diversity of *Serjania* and has a high percentage of endemics. Moreover, there are no fossil records for the group in South America (perhaps because of inadequate preservation), whereas both *Serjania* and *Paullinia* are known from as early as the Miocene in Mexico (Graham, 1979). In any case, the existing high diversity of *Serjania* in both Mexico and South America (particularly central Brazil) might have to be explained by dispersal from one region to the other through the pluvial volcanic island arc formed in the late Cretaceous (Raven & Axelrod, 1981). There are two fossil records assigned to the closely related genera *Thouinia* and *Cardiospermum* from the Eocene in the U.S.A., which might indicate an ancient history of the group in North America. However, both records lack documentation, and are therefore not reliable (Muller, 1981).

Fossil records for *Serjania* are known for only a few species. Unfortunately, there are no fossil records for species of *S. sect. Platyococcus*. However, judging from its present distribution, it seems most likely that *S. sect. Platyococcus* had its origin in South America.

The phylogeny of the species of *S. sect. Platyococcus* is at present unresolved. A cladistic analysis of its species (with PAUP) utilizing 15 characters, produced 123 equally parsimonious trees at 39 steps. These trees suggest completely different relationships which range from highly unlikely to plausible. A consensus tree produced with the output data of the analysis revealed, as in most of the trees, that *S. squarrosa* is at

the very base of *S. sect. Platyococcus* and therefore may not even belong in the section. The unresolved nature of this cladogram might be due to difficulties in polarizing the characters utilized, as well as to the lack of knowledge of characters in some of the taxa.

At this moment, a cladistic analysis is not particularly useful in resolving the phylogeny of *S. sect. Platyococcus* and it seems preferable to group the species based on overall similarity.

*Serjania communis* might represent the ancestral species because it has the widest distribution as well as marked subspecific differentiation. *Serjania leptocarpa* and *S. danicola* are very similar to *S. communis*, especially when vegetative characters are considered. Judging from overall similarity and by the distributional ranges of these species, it seems that *S. leptocarpa* and *S. danicola* (both with a distribution restricted to the Andes) constitute two vicariant species that might have arisen from populations of *S. communis* isolated by the uplift of the Andes.

*Serjania cardiospermioides*, *S. caspidata*, *S. morii*, and *S. reginelli* are phenetically very similar, which suggests a close relationship. The distribution of *S. cardiospermioides* is disjunct from the other three species.

*Serjania caspidata* resembles *S. communis* var. *communis*, indicating a possible relationship of the two taxa. *Serjania caspidata* is endemic to the restinga vegetation (a savanna-like vegetation on sandy substrate) on the southeastern Brazilian coast, where *S. communis* constitutes a rare element. It is possible that *S. caspidata* evolved from peripheral populations of *S. communis* and became adapted to the drier regimes present in the restingas. Gene flow might have been prevented by the depressed fitness of intermediate populations.

*Serjania tenuis*, restricted to the restingas of southeastern Brazil, seems to be close to *S. communis*, at least phenetically. The younger substrate where *S. tenuis* occurs, along with its restricted distribution, might indicate that *S. tenuis* is in fact a more recent species, perhaps derived from *S. communis* or from a common ancestor.

#### Infrageneric Classification

*Serjania*, as treated by Radlkotter (1875), consisted of 12 sections based chiefly on fruit morphology (Table VII). The characters considered most important were shape and texture of the locule, width of the partitioning wall, and the presence of a crest or wing around the locule. His system is difficult to use, how-

Comparison of the classification of *Serjania* proposed herein with that of Radlkotter.

Radlkotter's classification (1875)	New classification, proposed here
<i>S. sect. Platyococcus</i>	<i>S. sect. Platyococcus</i> <i>S. sect. Coniferiflora</i>
<i>S. sect. Ceratococcus</i>	<i>S. sect. Ceratococcus</i>
<i>S. sect. Eurycoccus</i>	<i>S. sect. Eurycoccus</i>
<i>S. sect. Eurycoccus</i>	<i>S. sect. Serjania</i>
<i>S. sect. Platyococcus</i>	
<i>S. sect. Holoococcus</i>	
<i>S. sect. Dicyococcus</i>	
<i>S. sect. Simoococcus</i>	
<i>S. sect. Ooococcus</i>	
<i>S. sect. Phacococcus</i>	
<i>S. sect. Symococcus</i>	
<i>S. sect. Physococcus</i>	<i>S. sect. Physococcus</i>

ever, because there are no qualitative characters defining some of the sections. This results in some intergradation. Moreover, the position of some species treated by Radlkotter was provisional because no fruiting material was known for them.

The suggested interspecific relationships in Radlkotter's classification of *Serjania* do not stand when modern collections are taken into consideration. As a result, to account for the variation present in *Serjania*, it is necessary to redefine the original sectional concepts. Consequently, fewer sections are recognized by me as discrete units within *Serjania*.

I have combined eight of Radlkotter's sections into one and have created a new section, for a total of six sections (Table VII). In Figure 21, I have illustrated the fruit features defining my concept of the sections of *Serjania*.

#### Distribution and Ecology

*Serjania* is a New World genus with approximately 226 species, distributed from southwestern United States to northern Argentina, including the West Indies (Fig. 27). A few species are grown as ornamentals in the Old World and in the Pacific. At the present stage of knowledge of *Serjania*, it seems that the majority (60%) of species occupy a medium geographical range (i.e., a quarter to a third of the area of the continent), followed by species (35%) which occupy a restricted range (endemic, usually known from a few collections) and by species (5%) with a wide geographical range (i.e., throughout the

continent). This pattern agrees with that found by Gates (1982) for *Banisteriopsis* (Malpighiaceae) which has winged diaspores similar to those of *Serjania*. However, it clearly differs from that found by Gentry (1979) for most of the wind dispersed Bignonaceae lianas, which occupy wide geographical ranges.

There are three major centers of distribution for *Serjania*, one in southern Mexico with 48 species, another in the central Brazilian plateau, and a third along the Brazilian Atlantic coast, both with 35 species. A fourth center, containing 24 species, is found along both sides of the Andes at middle elevations.

The great majority of *Serjania* species occur in thickets or in open and relatively dry vegetation (50%) such as cerrado, campo rupestre (a savanna-like vegetation with rocky outcrops) (Fig. 28A), and restinga (Fig. 28B). Many of the species (35%) occur along margins of gallery forests, and a small percentage (8%) are found usually associated with disturbed areas or gaps in dense tall humid forests (Table VIII). Few species occur in areas above 1500 m elevation, and no species have been collected above 3000 m. The importance of *Serjania* seems to decrease from wetter to drier vegetation types. Goodland (1969) showed how the abundance of *S. grandiflora* Camb. (= *S. caracasana* (Jacq.) Willd.) and *S. erecta* Radlk. decreases along vegetations with increasing drier regimes and fewer arboreal elements, i.e., there are fewer species of *Serjania* in the continuum from cerrado-cerrado-campo cerrado to campo sujo (forested areas to grassy fields).

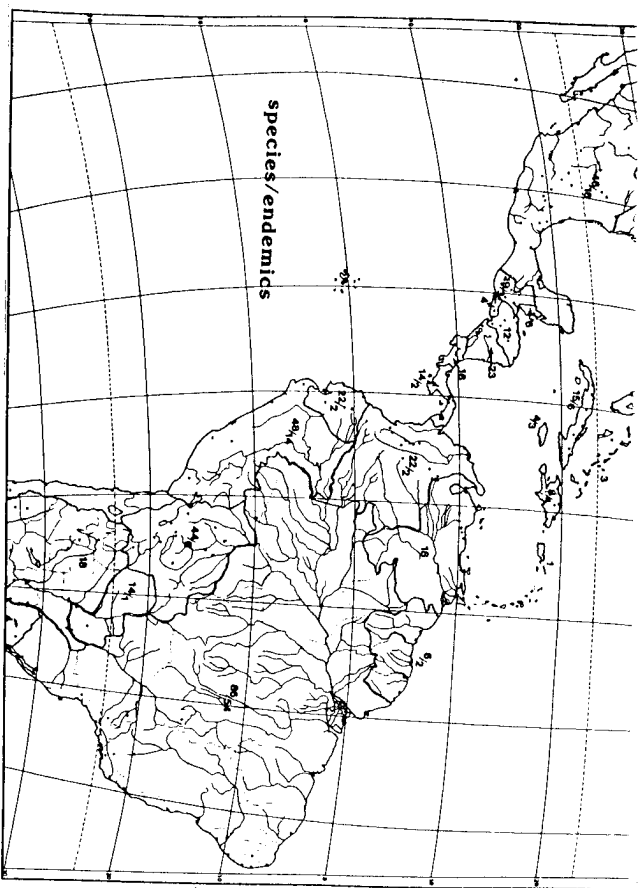


Fig. 27. Distribution of *Serjania* by countries in the Americas. Number above line equals total number of species while number below line equals number of endemic species in a given country.

It is possible that *Serjania*, in spite of being very diverse in the cerrado, does not constitute a very important ecological element for the flora of the area. This conclusion has been reached through different studies of cerrado vegetation. Goodland (1970), in his ecological studies of the Triângulo Mineiro (southern Minas Gerais), did not mention Sapindaceae, and Rizzini (1971) only cited three species of *Serjania* in his survey on woody cerrado plants. It seems that many herbarium collections of *Serjania* marked as from cerrado, actually come from the gallery forests which dissect much of the cerrado region.

The distribution of *Serjania* contrasts with that of the closely related *Paullinia* because of its preference for drier and more open environments. Although there is some overlap in the distribution of species of the two genera, the vast majority of species of *Paullinia* occupy humid dense forests, especially in the Amazon area. This pattern is understandable in light of the fact that

the major mode of dispersal in *Paullinia* is zoochory.

All species of *S.* sect. *Platyococcus* occur in South America (except for *S. curdiospermioides*, which has a middle to northern Central America distribution). Most have a rather restricted distribution. However, *S. communis* is widely distributed and three others (*S. ampelopsis*, *S. lepicarapa* Radlk., and *S. squarrosa*) have moderately wide distributions. Two species, *S. cuspidata* and *S. tenuis*, occur along the coastal scrubby vegetation (restinga) of southeastern Brazil. *Serjania cuspidata* ranges from Bahia to São Paulo and is sympatric with *S. tenuis* in Rio de Janeiro where the latter occurs. Other endemics are found in Brazil: *S. regnellii* Schlechtend. in the central planalto in Minas Gerais, *S. morii* Acevedo-Rodr. in the Atlantic forest in Bahia, and *S. haschickii* in the Atlantic forest in São Paulo. The rest of the species are distributed along middle elevations in the Andes. *Serjania ampelopsis* ranges from Colombia to Bolivia. *S.*



Fig. 28. Typical habitats of *Serjania*. A. Campo rupestre (Serra do Cipó, Minas Gerais, Brazil). B. Restinga de Massambaba (Rio de Janeiro, Brazil).

Table VIII

Occurrence of *Serjania* in major vegetation types as determined from exsiccatae.

Caatinga (Brazil)		Campo Rupestre (Brazil)	
<i>bahiana</i>	(BA) <sup>a</sup>	<i>plabrata</i>	(BA)
<i>clematidifolia</i>	(BA)	<i>pernambucensis</i>	(BA)
<i>foveolata</i>	(BA)	<i>pinnatifolia</i>	(BA)
<i>fasciifolia</i>	(BA)		
Cerrado (Brazil)			
<i>acoma</i>	(GO, MG)	<i>hebecarpa</i>	(MT)
<i>acutidenata</i>	(MG)	<i>lethalis</i>	(MG)
<i>caracasana</i>	(MG)	<i>meridionalis</i>	(GO)
<i>clematidifolia</i>	(RJ)	<i>multiflora</i>	(MG)
<i>elegans</i>	(MG, BA)	<i>noxia</i>	(MG)
<i>erecta</i>	(GO, MG)	<i>paradoxa</i>	(MG)
<i>glutinosa</i>	(MT)	<i>regnelli</i>	(MG)
<i>gracilis</i>	(BA)	<i>reticulata</i>	(MG, GO)
Gallery Forest (in many countries)			
<i>acoma</i>	(GO, MG, MT, PR, SP)	<i>manisiana</i>	(MG)
<i>acutidenata</i>	(BA, MG)	<i>marginata</i>	(BA, GO)
<i>bahiana</i>	(BA)	<i>membranacea</i>	(PA)
<i>caracasana</i>	(GO, SP)	<i>meridionalis</i>	(GO)
<i>cissoides</i>	(GO, SP)	<i>multiflora</i>	(GO)
<i>comata</i>	(GO, MT, PR)	<i>obusidenata</i>	(DE, MG, MT)
<i>corrugata</i>	(BA, MG)	<i>ovalifolia</i>	(DE, GO, MG, MT)
<i>crassifolia</i>	(MT)	<i>paradoxa</i>	(BA, DF, MG)
<i>elegans</i>	(MG)	<i>perulacea</i>	(GO)
<i>erecta</i>	(BA, GO, MG, MT, PR, SP)	<i>pinnatifolia</i>	(MG)
<i>fasciifolia</i>	(MG)	<i>pisicaria</i>	(GO)
<i>glutinosa</i>	(MT, DF)	<i>pyramidalata</i>	(MG)
<i>hebecarpa</i>	(MT, DF, GO, MG, MT, SP)	<i>reticulata</i>	(GO)
<i>lethalis</i>		<i>velutina</i>	(GO)

Table VIII (continued)

Restingas (southeastern Brazil)			
<i>caracasana</i>	(RJ)	<i>dura</i>	(SP)
<i>ichthyocarpa</i>	(BA, RJ)	<i>clematidifolia</i>	(BA, RJ)
<i>elegans</i>	(RJ)	<i>salzmanniana</i>	(BA, RJ)
<i>cuspidata</i>	(RJ)	<i>eucardida</i>	(RJ)
<i>scopulifera</i>	(BA)	<i>denata</i>	(BA, RJ)
<i>fluminensis</i>	(RJ)	<i>tenuis</i>	(RJ)
<i>francaia</i>	(RJ)		
Savannas			
<i>acoma</i>	Brazil (DF)	<i>mexicana</i>	Venezuela
<i>arrolinnea</i>	Venezuela, Mexico	<i>orbicularis</i>	Brazil (PA)
<i>caracasana</i>	Paraguay	<i>ovalifolia</i>	Brazil (MA)
<i>communis</i>	Venezuela	<i>paucidenata</i>	Venezuela
<i>inflata</i>	Peru	<i>reticulata</i>	Bolivia
Terra Firme Forest (Amazon basin)			
<i>caracasana</i>	<i>granatifolia</i>	<i>pyramidalata</i>	<i>lethalis</i>
<i>circumvallata</i>	<i>membranacea</i>	<i>salzmanniana</i>	<i>noxia</i>
<i>clematidifolia</i>	<i>tenatifolia</i>	<i>elongata</i>	<i>glutinosa</i>
<i>paucidenata</i>			
Varzea Forest (Amazon basin)			
<i>diborhya</i>	<i>leptocarpa</i>	<i>purpurascens</i>	
<i>exarata</i>	<i>membranacea</i>	<i>pyramidalata</i>	
<i>inscripia</i>	<i>paucidenata</i>		
Disturbed Vegetation (in many countries)			
<i>acutidenata</i>	<i>diborhya</i>	<i>inscripia</i>	<i>paradoxa</i>
<i>adiantoides</i>	<i>diplomadenia</i>	<i>laevigata</i>	<i>paucidenata</i>
<i>altissima</i>	<i>diffusa</i>	<i>laruoriana</i>	<i>perulacea</i>
<i>albigera</i>	<i>diversifolia</i>	<i>laterita</i>	<i>peruviana</i>
<i>ampelopsis</i>	<i>damicola</i>	<i>leptocarpa</i>	<i>pinnatifolia</i>
<i>arrolinnea</i>	<i>dura</i>	<i>lethalis</i>	<i>plicata</i>
<i>brevipes</i>	<i>elongata</i>	<i>lobulata</i>	<i>polyphylla</i>
<i>caligera</i>	<i>erecta</i>	<i>membranacea</i>	<i>purcata</i>
<i>caracasana</i>	<i>exarata</i>	<i>meridionalis</i>	<i>regnelli</i>
<i>cardiospermoides</i>	<i>foveata</i>	<i>mexicana</i>	<i>rekoii</i>
<i>chacatoarpa</i>	<i>fasciifolia</i>	<i>micronulata</i>	<i>reticulata</i>
<i>circumvallata</i>	<i>jascostrata</i>	<i>multiflora</i>	<i>rhombea</i>
<i>clematidifolia</i>	<i>glabrata</i>	<i>nigricans</i>	<i>rugla</i>
<i>clematidifolia</i>	<i>glutinosa</i>	<i>noxia</i>	<i>salzmanniana</i>
<i>columbiana</i>	<i>goniocarpa</i>	<i>nutans</i>	<i>setigera</i>
<i>comata</i>	<i>granatifolia</i>	<i>oblongifolia</i>	<i>sphaerococca</i>
<i>communis</i>	<i>granatifolia</i>	<i>obusidenata</i>	<i>squarrosa</i>
<i>corrugata</i>	<i>granitis</i>	<i>ovalifolia</i>	<i>sufferruginea</i>
<i>crassifolia</i>	<i>grossi</i>	<i>orbicularis</i>	<i>tenatifolia</i>
<i>crassihervis</i>	<i>hebecarpa</i>	<i>oxyphylla</i>	<i>tenuis</i>
<i>cuspidata</i>	<i>hispidula</i>	<i>paucidenata</i>	<i>trijobolata</i>
<i>dasycladus</i>	<i>ichthyocarpa</i>	<i>purpurascens</i>	<i>triquetra</i>
<i>deflexa</i>	<i>impressa</i>	<i>pyramidalata</i>	<i>trivostri</i>
<i>deltoides</i>	<i>longipes</i>	<i>racemosa</i>	<i>velutina</i>
<i>eucardida</i>	<i>mansiana</i>		

<sup>a</sup> Abbreviations in parentheses stand for the Brazilian states.<sup>b</sup> Reported by Araújo de D. S. D. & R. P. B. Henriques, 1984.



*leptocarpa* is found from Venezuela to Bolivia. *S. squarrosa* is endemic to central Peru, and *S. dimiticola* is endemic to central Bolivia.

### Reproductive Biology

The examination of numerous herbarium specimens of *Serjania* suggests that the species are obligately xenogamous. Although the species are monocious (because pistillate and staminate flowers may be encountered in the same inflorescence), a close examination of the flowers reveals them not to be contemporary. This is corroborated by my field observations of individuals of *S. caracasana* and *S. grandifolia* Sagot, which bore only one kind of flower at a given time.

In spite of the interesting floral morphology, which has drawn the attention of many taxonomists, no studies have been published on the pollination biology of *Serjania*. The only mention of reproductive biology in *Serjania* is that of Miller (1873), in which the flowers of *S. cuspidata* are said to be protandrous.

There are only a few publications which treat the pollination biology of other genera of Pauliniaceae. Simpson (1976) suggested that the petal appendages of *Paullinia* accumulate nectar in their hoods. He also speculated that insects would necessarily approach the flowers from above and that pollination is nototribic. While my observations confirm that nectar is accumulated in the appendages, pollination of *Serjania* was observed to be sternotribic.

The flowers of *Serjania* are upwardly to laterally oriented in the inflorescence. I have observed the flowers of *S. caracasana* to open early in the morning, producing a strong sweet smell which seems to attract many different kinds of insects. The petals then are expanded or become slightly reflexed while the appendages stay erect and pressed against the anthers (Fig. 15c). The appendages have a bright yellow color in freshly opened flowers, but become white as the flower ages.

The particular orientation of the petal appendages in newly opened flowers (pressed together against the stamens) seems to restrict the entrance to the nectary disk by the visiting insects. The visitors must approach the flowers from above in order to enter the tube-like arrangement of petal appendages and stamens (Figs. 15c, 17 1c).

Among the most prominent visitors are small to medium-sized bees (see Table IX). Equal numbers of

wasps and flies, as well as a small number of moths, have also been collected while visiting the flowers.

On many occasions, medium-sized hummingbirds have been observed visiting large-flowered species of *Serjania* (pers. observations). Bees are the most likely pollinators of *Serjania* because, when examined, they had pollen grains all over their ventral surface. Most of them also had massive amounts of pollen accumulated in their rear leg coxaltracheae. The pollen from the corbiculae turned out to be almost exclusively from the species of *Serjania* upon which the bee was collected. This shows a high fidelity of these insects toward the same source species, at least on a given foraging flight. One of the bees collected had three other kinds of grains, but *Serjania* pollen was by far the most abundant. Flies are also potential pollinators because they had pollen grains dusted over their ventral surfaces. Flies also had abundant grains on their mouth parts which indicates that they utilize *Serjania* pollen as a food source. Different species of medium- to large-sized wasps were also collected while visiting the flowers of *Serjania*. They had large amounts of *Serjania* pollen on their mouth parts, which suggests that they also consume *Serjania* pollen. No pollen grains were observed elsewhere on their bodies, except for one large wasp, which was carrying *Serjania* pollen on its neck. It is possible that this wasp is also an effective pollinator. The moths collected did not carry pollen on their bodies.

Although nectar seems to be a major reward for pollinators of *Serjania*, pollen grains may play a large attracting role. The presence of indelible stamens in pistillate flowers might constitute an attractive feature for pollen foragers. The studies of Bawa (1976) and Subba Reddi et al. (1983), upon other members of Sapindaceae (*Capania guatemalensis* Radlk. and *Seppindus emarginatus* Vahl) that have a floral biology similar to *Serjania*, have shown that pollen is the major reward for their pollinators.

No account on temporal activity of flower visitors has been published. My observations indicate that more insects visit plants of *Serjania* during the early morning and late afternoon than at mid-day and evening.

The fruits of *Serjania*, as already mentioned (Fig. 19), split into three mericarpic units which are either dispersed by wind or water currents. In dry, open areas, wind is the predominant dispersal vector, whereas in gallery or seasonally flooded forests water currents are the principal mode of dispersal.

Once the fruits reach maturity, the mericarps are

Table IX

List of insects visiting *Serjania* flowers collected during field work

<i>Serjania ampelopsis</i> Planch. & Linden. Bee ( <i>Apis mellifera</i> L.) carrying no pollen, except for a few grains on corbiculae. Fly ( <i>Copsepylum</i> sp.) carrying no pollen.	
<i>Serjania confertiflora</i> Radlk. Bees ( <i>Trigona bipunctata</i> Lep.) with abundant <i>Serjania</i> pollen on leg corbiculae; <i>Trigona dorsalis</i> Sm., no pollen seen; <i>Trigona jary</i> Sm., <i>Serjania</i> pollen on middle legs.	
<i>Serjania crassifolia</i> Radlk. Bees ( <i>Apis mellifera</i> L.) carrying <i>Serjania</i> and other type of pollen; <i>Melipona interrupa</i> Latr., carrying a few <i>Serjania</i> pollen on mouth parts and on leg corbiculae; <i>Trigona testaceicornis</i> var. <i>punctata</i> Sm., carrying <i>Serjania</i> pollen on abdomen and rear legs; Wasp ( <i>Brachygastra augusti</i> Saussure), carrying no pollen.	
<i>Serjania deltoidea</i> Radlk. Bee ( <i>Neocorymbura</i> sp.) carrying no pollen. Flies ( <i>Xanthocephalus</i> sp.), carrying <i>Serjania</i> pollen on mouth parts; <i>Trichopoda</i> sp., carrying <i>Serjania</i> -type pollen on lower abdomen, head and mouth parts; <i>Oritida obesa</i> , carrying <i>Serjania</i> -type pollen on lower part of body and mouth parts; <i>Tachinidae</i> , carrying no pollen. Moth (unidentifiable), carrying no pollen. Wasps ( <i>Polybia dimititata</i> Oliver), carrying no pollen; <i>Polybia occidentalis</i> Oliver, carrying <i>Serjania</i> pollen on mouth parts.	
<i>Serjania dimiticola</i> Radlk. Bees ( <i>Augochlora</i> sp. and <i>Colletes</i> sp.), carrying no pollen. Wasp ( <i>Polistes</i> sp.), carrying no pollen.	
<i>Serjania grandifolia</i> Sagot ex Radlk. Bees ( <i>Trigona hypogaea</i> Silvestri), pollen grains all over abdomen, those on leg corbiculae exclusively <i>Serjania</i> type; <i>Colletes</i> sp. carrying non- <i>Serjania</i> pollen type. Various butterflies in the Hesperiidae, carrying no pollen. Wasps ( <i>Camsomeris servillii</i> Guerin), carrying no pollen; <i>Mischocyttarus</i> sp., carrying no pollen; <i>Monezuma dimititata</i> Saussure, carrying <i>Serjania</i> pollen on mouth parts; <i>Pegasis</i> sp., carrying <i>Serjania</i> pollen on mouth parts; <i>Synecoides</i> sp., carrying <i>Serjania</i> pollen on neck.	
<i>Serjania</i> cf. <i>leucosepala</i> Radlk. Bee ( <i>Neocorymbura</i> sp.), carrying no pollen.	
<i>Serjania sphearococca</i> Radlk. Bee ( <i>Paratetrapedia</i> sp.) carrying very few <i>Serjania</i> pollen over lower part of abdomen.	
<i>Serjania sufferruginea</i> Radlk. Bees ( <i>Apis mellifera</i> L.), carrying <i>Serjania</i> pollen on leg corbiculae. Fly ( <i>Allogopa exotica</i> ), carrying no pollen.	
<i>Serjania tenuifolia</i> Radlk. Bees ( <i>Apis mellifera</i> L.), carrying no pollen; <i>Trigona bipunctata</i> Lep., carrying no pollen; <i>Trigona fulvohirta</i> Fr., carrying no pollen; <i>Trigona postica</i> Latr., carrying mostly <i>Serjania</i> pollen on posterior part of abdomen, on legs and rear leg corbiculae; <i>Trigona tatarica</i> var. <i>mellicolor</i> Paek., carrying few <i>Serjania</i> pollen over lower part of body.	
<i>Serjania</i> sp. Bees ( <i>Trigona compressa</i> Latr. and <i>Neocorymbura</i> sp.), carrying no pollen. Beetle ( <i>Polymeris</i> sp.), carrying no pollen.	

aided in abscission by the wind. The wind speed required for fruit abscission may vary from species to species, depending on weight, shape, and size of the mericarp. These three factors may have an effect on the dispersal potential of mericarp as well. Smaller or lighter mericarps are expected to travel longer distances than larger or heavier ones under the same wind conditions.

After abscission, the mericarp spins in the air around the locule with the wing oriented at ca. 45° (Fig. 19b) from the axis of spin. A slight variation is found in the species of *S.* sect. *Platyococcus* in which the angle

of wing orientation is ca. 90° (Fig. 19c). Consequently, the mericarps in this section tend to glide rather than spin. According to Augspurger (1986), gliding diaspores of tropical trees have a smaller dispersal potential than autogyro diaspores (spinning) under the same wind conditions. This difference in dispersal behavior might account for the more restricted distribution of species of *S.* sect. *Platyococcus* compared to species of other sections of *Serjania*. It seems that subsequent dispersal of mericarps by water is also common in *Serjania* because many of the species occur along rivers and streams.

Economic Botany

Serjania is well known for its ichthyotoxic activity. In a worldwide survey of ichthyotoxic plants, Serjania has the greatest number of species utilized for this purpose (Acevedo-Rodriguez, 1990). A total of 57 species ranging from Central to South America and into the West Indies, have been reported to be used as fish poisons. The main compounds responsible for the ichthyotoxin seem to be saponins, which kill fish by asphyxiation.

The stems of various species of Serjania (S. polyphylla, S. mexicana, and S. subdentata) are utilized in the manufacture of baskets and as binding material in the construction of small houses or huts in Cuba and Puerto Rico (Véliz, 1950; Morton, 1981). In the Dominican Republic, the bark of various species of Serjania is used for making ropes. Various other species have been utilized in folk medicine for the treatment of toothache, rheumatism, and venereal diseases (Morton, 1981).

In Minas Gerais (Brazil), thin cross sections of various species of Serjania (along with other species of lianas) are used to decorate small souvenir boxes.

Taxonomic Treatment

SAPINDACEAE Jussieu, Gen. pl. 246. 1789. Type: Sapindus limnaeus

- 1. Petals not projecting beyond the calyx; stamens with filaments of equal length; anthers basifixed; stigma capitate; pollen grains cylindrical-ellipsoid, 4-porate (two species, one from Bolivia, the other from Peru and Ecuador)
2. Petals projecting beyond the calyx; stamens with filaments of unequal length; anthers dorsifixed; stigma 3-branched; pollen grains triangular, hemitricolporate or triporate.
3. Mericarps with distal locale and a proximal wing (about 226 species, from tropical and subtropical America).
3. Mericarps with short wing all around locale (three species from tropical America).
4. Fruits septifragal capsules, not separating into mericarps, seeds exposed.
4. Fruits papery and inflated, seeds with white rufiform or cordiform hilum, plants herbaceous or slightly woody.
5. Fruits not completely inflated, with marginal wing; stamens of same length, spreading; anthers with apical appendage; disk glands four; plants producing milky exudate (about 15 species from tropical and subtropical America).
5. Fruits completely inflated, without marginal wings; stamens of unequal length, connivent; anthers without apical appendage; disk glands two; plants not producing milky exudate (about 14 species from tropical and subtropical America).
4. Fruits woody; seeds usually with sarcolemma, but without white hilum; plants woody (about 150 species from tropical and subtropical America).

SYNOPTIC KEY TO GENERA OF PAULLINEAE

Tribe Paullinieae Kunth in H.B.K., Nova gen. sp. pl. 5: 77. 1821. Type: Paullinia Limaensis subtribe Eupaulinieae Radlkof. in A. Engler, Pflanzenz. 4 (Heft 98a): 165: 19. 1931.
Woody climbers. Leaves ternately, bilaterately, or pinnately compound (less often further divided) with a terminal leaflet; stipules present, although in many species early deciduous. Inflorescences thyrses, the axillary ones bearing a pair of opposite tendrils at lower node, the terminal without tendrils. Flowers zygomorphic; calyx 4-5-merous; corolla of four distinct petals, with adnate hood-shape; appendage at adaxial surface; nectary disk unilateral, modified into (2-)4 protruding glands; stamens 8, unequal or equal, the anthers dorsifixed or less frequently basifixed, introrse; pollen grains triangular (hemitricolporate, triporate) or ellipsoid-cylindrical (4-colporate); ovary trilocellar, each carpel with a single ovule.
EXCLUDED TAXON
Thimouia Triana & Planchon, Ann. Sci. Nat. Bot. IV, 18: 368. 1862. Type: Thimouia myriantha Triana & Planchon.
A cladistic analysis has shown that Thimouia belongs to neither the tribe Paullinieae nor to the Thoumiaceae (see chapter on Generic Relationships). Thimouia should better be placed in the tribe Cupanieae.

SEPLANIA Plumier ex Miller, Gard. dict. abr. ed. 4. 1754. Type: Paullinia seriana Linnaeus (Serjania seriana (L.) Drnce) = Serjania sinuata Schumacher (lectotype designated by Croat, 1976).
Woody climbers. Functionally monoecious with functionally male and female flowers. Plants usually

SYNOPTIC KEY TO SECTIONS OF SERJANIA

- 1. Fruit wing not or hardly distinct from locale (not or slightly constricted below locale); locale flattened, elliptic in cross section.
2. Seeds spherical or nearly so
3. Locule woody with a horn-like projection on lateral wall
4. Locule membranous or chartaceous, without a horn-like projection
1. Fruit wing strongly differentiated from locale (strongly constricted below locale); locale globose, triangular, or rounded in cross section.
4. Locule membranous, inflated
5. Partioning wall with a nb (all around) projecting beyond the locale walls; locale triangular in cross section
5. Partioning wall not projecting beyond locale walls; locale spherical or triangular in cross section
5. sect. Eurycoccus
5. sect. Ceratococcus
5. sect. Platyococcus
5. sect. Physococcus
5. sect. Conteriflora

Serjania sect. Conteriflora Acevedo-Rdz., sect. nov. Loculi transsecti triangulares; dissepimentum ultra coccos excurrentia; cinctium ventrilatit.
Fruit locale triangular in cross section; dissepiment projecting beyond locale, forming a nb-like structure. Inflorescence with whorled, long-peduncled cinctium.
Type: Serjania conteriflora Radlkof.
ally long and pendant, with coiling axis. Nectary disk with two or four glands, the torus enlarged. Samaras with flat locale not differentiated from wing; locale not crested or winged; wing straight or slightly constricted below locale, the partioning wall oblong or narrowly elliptic. Seeds lenticular, or asymmetrically lenticular, flattened.

Distribution. Most of the species in S. sect. Platyococcus have restricted distributions. Of the thirteen species here recognized, nine are endemic to small areas (Figs. 36, 41), one (Serjania communis) has a very wide distribution (Fig. 30), and three have relatively wide distributions (Figs. 32, 39). As pointed out before, it seems that the restricted distribution of the species of S. sect. Platyococcus is related to the dispersal capability of their fruits.
Within S. sect. Platyococcus, Radlkof. recognized two subsections and 24 species. In this revision, no subsections are recognized and only nine of the species included by Radlkof. in the section are recognized (Table X). Of the species Radlkof. recognized, ten (known by him only from inadequate fruiting material) belong to other sections of

Table X

Comparison of the species placed by Radlkofler in *S. sect. Platycoccus* with the classification proposed here  
Radlkofler's classification (1931)

Classification here proposed	
<i>S. sect. PLATYCOCCUS</i>	<i>S. sect. PLATYCOCCUS</i>
1. <i>S. communis</i>	1. <i>S. communis</i>
2. <i>S. hirsuta</i>	<i>S. hirsuta</i>
3. <i>S. stenoperygia</i>	<i>S. stenoperygia</i>
4. <i>S. leptocarpa</i>	2. <i>S. leptocarpa</i>
5. <i>S. viridissima</i>	<i>S. viridissima</i>
6. <i>S. daniicola</i>	3. <i>S. daniicola</i>
7. <i>S. cuspidata</i>	4. <i>S. cuspidata</i>
8. <i>S. regnellii</i>	5. <i>S. morii</i>
9. <i>S. cardiospermoides</i>	6. <i>S. regnellii</i>
10. <i>S. tenuis</i>	7. <i>S. cardiospermoides</i>
	8. <i>S. tenuis</i>
	9. <i>S. undulata</i>
11. <i>S. ampelopsis</i>	10. <i>S. harschbachii</i>
12. <i>S. areolata</i>	11. <i>S. tarroana</i>
13. <i>S. squarrosa</i>	12. <i>S. ampelopsis</i>
14. <i>S. plaspipedia</i>	<i>S. areolata</i>
	13. <i>S. squarrosa</i>
15. <i>S. grandiflora</i>	<i>S. plaspipedia</i>
16. <i>S. pubidosa</i>	<i>S. sect. CONFERTIFLORA</i>
17. <i>S. charneca</i>	<i>S. grandiflora</i>
18. <i>S. congeriflora</i>	<i>S. pubidosa</i>
19. <i>S. hirsutiflora</i>	<i>S. charneca</i>
20. <i>S. minutiflora</i>	<i>S. congeriflora</i>
21. <i>S. decemstrata</i>	<i>S. inscripta</i>
	<i>S. minutiflora</i>
22. <i>S. trichomania</i>	<i>S. decemstrata</i>
	<i>S. sect. EURYCOCCUS</i>
23. <i>S. brachyptera</i>	<i>S. trichomania</i>
	<i>S. sect. PHTSOCCOCUS</i>
	<i>S. brachyptera</i>
24. <i>S. joveana</i>	<i>S. sect. SERMANIA</i>
	<i>S. joveana</i>

*Serjania* and another five are here treated as synonyms of species within *S. sect. Platycoccus* (Table X). Three recently described species and one placed by Radlkofler into a different section belong to *S. sect. Platycoccus*, thereby bringing the total number of species I recognize in the section to thirteen.

KEY TO THE SPECIES OF *S. SECT. PLATYCOCCUS*

1. Cross section of stem with multiple stoles, stems obtusely or sharply angled.
  2. Leaves ternate or biternate.
    3. Cross section of stem with 3 peripheral stoles.
      4. Leaves biternate.
        5. Calyx with third and fifth sepals connate 3/4 to entire length; stems obtusely to sharply angular, variously pubescent. . . . . 1. *S. communis*.
        5. Calyx with third and fifth sepals free; stems usually obtusely angled, glabrescent.
          6. Flowers 5-7 mm long; fruit pyriform in outline, 5-6 cm long. . . . . 2. *S. leptocarpa*.
          6. Flowers 3-4 mm long; fruit oblong in outline, ca. 2 cm long. . . . . 3. *S. daniicola*.
        4. Leaves ternate.
          7. Stems sharply triangular.
            8. Stem with long (1.5-3 mm), hispid, ferruginous hairs only along ridges.
              9. Leaflets ovate to trilobate, densely hispid on both surfaces. . . . . 4. *S. cuspidata*.
              9. Leaflets wide-elliptic, glabrous on both surfaces. . . . . 5. *S. morii*.

7. Stems sparsely covered with short, (0.5-0.8 mm long), yellowish hairs. . . . . 6. *S. regnellii*.
8. Terminal leaflets ovate, widely ovate, or trilobate, with lower surface densely to sparsely covered with yellowish appressed hairs. . . . . 7. *S. cardiospermoides*.
9. Terminal leaflets ovate, elliptic, oblong, or lanceolate, with lower surface glabrous. . . . . 8. *S. tenuis*.
10. Cross section of stem with 5 to 8 peripheral stoles.
  11. Leaves ternate. . . . . 9. *S. undulata*.
  11. Leaves biternate.
    12. Stems lobed, with 5-6 furrows, with senescent (2-3 mm long) hairs, often with short thorny projections. . . . . 10. *S. harschbachii*.
    12. Stems terete or obtusely angular, tomentose, without thorny projections. . . . . 11. *S. tarroana*.
11. Leaves decompound (3-5-jugate, lower jugae further divided). . . . . 13. *S. squarrosa*.
12. Cross section of stem with single stoles; stems terete. . . . . 12. *S. ampelopsis*.

1. *Serjania communis* Cambessedes in St. Hilare, Fl. Bras. Mer. 1: 362, 1828. Type: Brazil, Rio de Janeiro, s.d. (fl. fr), St. Hilare cat. D 810 (holotype, P; isotype, MPU, n.v.; photo NY from MPU).  
Figs. 10d, 13f; 23a-c; 29a-k.

Semi-woody climber to 15 m long. Stems slender (less than 1 cm in diameter); obtusely or sharply 3 or 5-angulate, with three major ribs, stems ferruginous-tomentose, especially on main ribs, or glabrescent; cross section with large, central, subterete or obtusely 5-angled stiele and three smaller, subterete, elliptic or laterally compressed, peripheral stoles. *Stipules* deltid or subulate, 0.5-1.5 mm long, with same indument as stem. *Leaves* biternate; petioles not winged, sub-terete or angular, adaxially furrowed, 1.7-4.5 cm long, densely to sparsely tomentose; main rachis sub-terete, margined, or narrowly winged, adaxially furrowed, 1-4 cm long, densely to sparsely tomentose; secondary rachises sub-terete, adaxially furrowed, 1-3.3 cm long, densely to sparsely tomentose; leaflets charnaceous, acute or long acuminate (less often obtuse) and mucronate at apex, the terminal leaflet larger, 3-7.5 (-11) x 1.7-3(-5) cm, elliptic, narrow elliptic, ovate, lanceolate, rhombic, or less often trilobate, with attenuate or truncate base, sometimes tapering into more or less prolonged petiolate, the lateral leaflets 2.5 x (0.5-1) x 1.4-2.7 cm, oblong, elliptic, or lanceolate, with obtuse (or rarely obtusate) and oblique base, sessile or petiolulate, the upper surface glabrous or sparsely covered with 0.7-1.5 mm long, yellowish, inflexed or erect hairs with swollen bases and glanular hairs, especially on veins, the lower surface lighter, sparsely covered with same indument as upper surface, especially on veins, or glabrescent, the margins ciliate, acutely or obtusely serrate, the teeth clear glanular, the veins mixed craspedotromous, the primary vein

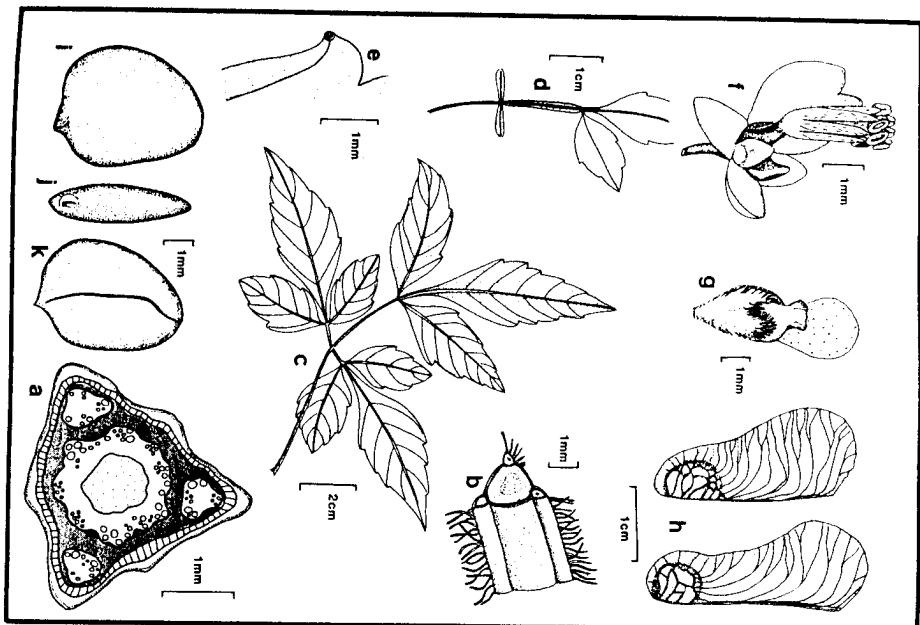


Fig. 29. *Serjania communis* var. *communis* showing a central and three peripheral steles (Aevedo-Ridge, 1431). b. Cross section of stem of *S. communis* var. *glabra* showing indument (Lourin 465). c. Bitemate leaf of *S. communis* var. *communis* (Krapovickas & Yanni 37000). d. Winged rachis. *S. communis* var. *alsmithii* (Wojtkowski 5757). e. Recurved lower glandular tooth on leaflet margin. *S. communis* var. *alsmithii* (Kling 2357). f. Staminate flower with petals removed. *S. communis* var. *communis* (Heiner 452). g. Central petal with adaxial appendage, adaxial surface sparsely papillose. *S. communis* var. *communis* (Heiner 452). h. Fruits mesocarp. *S. communis* var. *communis*. Right side from Krapovickas & Yanni 37000, left side from Belém 1598. i. Seed, lateral side. *S. communis* var. *communis*. Right side from 2830J. j. Seed, ventral side (same as i). k. Embryo with straight cotyledons (same as j).

not constricted below locule; the partitioning walls to 2 mm wide. Seeds lenticular, light brown, ca. 5 mm long; embryo with straight cotyledons.

#### Distribution and Phenology. *Serjania commu-*

nis is the most polymorphic and widely distributed of all species of *S. sect. Platycoctes*. It occurs in Colombia, Venezuela, Ecuador, Peru, Brazil, and Bolivia and has been collected in savannas, restingas, dense humid forests, dry scrublands, gallery forests, and in open

1993]

ACEVEDO-RODRIGUEZ: SERJANIA

53

areas such as forest margins, road margins, and from secondary vegetation. It is found from sea level to 1500 m elevation (Fig. 30). It flowers and fruits year-round.

Local Name. Brazil, São Paulo: *Timbó miúdo*.

Field observations. The stems of *S. communis* produce a watery exudate (not milky) when cut and the inflorescences are pendulous. The name *communis* refers to the common occurrence or wide distribution of this species.

#### KEY TO VARIETIES OF *S. COMMUNIS*.

1. Teeth of leaflet margins straight; inflorescence to two times longer than subtending leaf.
  2. Upper leaflet surface smooth; stems obtusely three to five angular, variously pubescent. . . . . 1a. *S. communis* var. *communis*.
  2. Upper leaflet surface foveolate; stems sharply triangular, commonly tomentose at angles. . . . . 1b. *S. communis* var. *glabra*.
1. Teeth of leaflet margin recurved; inflorescences ca. three times longer than subtending leaf. . . . . 1c. *S. communis* var. *alsmithii*.

#### 1a. *Serjania communis* Cambessedes var. *communis*.

Figs. 29a, c, f, g.

*Serjania hirsuta* Cambessedes in St. Hilare, Fl. Bras. Mer.: 1: 367. 1828. Type, Brazil, Minas Gerais: Ocaia, in pasture, s.d. (U). *Larriote* s.n. (holotype, P; isotype, MPU, n.v.; photo NY from MPU).  
*Serjania communis* var. *mollis* Radlkof. Monogr. *Serjania* 110. 1875. Type, Brazil, Minas Gerais: Caldas, 24 May 1868 (U). *Regnell* 138\* (lectotype, MO, here designated).  
*Serjania communis* var. *pilosula* Radlkof. Monogr. *Serjania* 110. 1875. Type, Same as typical variety.  
*Serjania stenopterygia* Radlkof. Monogr. *Serjania* 110. 1875. Type, Brazil, Bahia: s.d. (U). *Blanchet* 3747 (holotype, G; isotypes, F-2 sheets, G, GH, NY).

*Stems* 3-5-angular, with 3-5 major ribs. Plant densely pubescent to glabrescent, hairs minute and glandular or not-glandular, yellowish or whitish, erect or prostrate, with swollen base. *Leaflets* lanceolate, elliptic, narrowly elliptic, rhombic, or trilobate, the margins acutely or obtusely serrate.

*Distribution.* *Serjania communis* var. *communis* has the widest distribution of the varieties of *S. communis* (Fig. 30). It has been collected in Venezuela, Colombia, Ecuador, Peru, Brazil, Bolivia and Paraguay from a wide array of ecosystems such as humid forest, gallery forest, open disturbed areas, scrublands, savannas, and the sandy restingas of southeastern Brazil. It ranges from sea level to 1500 m elevation.

Recognition of vars. *mollis* and *pilosula* is not warranted, because these taxa are based on insignificant differences. Moreover, Radlkof. cited the same collection under different varietal names. The recognition of *S. hirsuta* is not accepted here either because it represents an extreme in variation in indument character. Likewise, *S. stenopterygia* differs from the remaining specimens of *S. communis* var. *communis* only in its winged leaf rachis.

**Specimens examined. VENEZUELA. AMAZONAS:** Raudal de los Guanaribos, 2°16'N, 64°38'W, at water's edge, 24 Jul 1951 (U). *Croizat* 294 (NY). Raudal Monserrat, by river side, 19 Sep 1951 (U). *Croizat* 658 (NY). **AMAZONAS:** Fretles, trail between San Durital and Los Pajaritos, 10°03'N, 64°06'W, 1200-1400 m, mountain savanna, along creek, 1 Dec 1981 (U). *Daviz* & *González* 19783 (NY, MO). **AMAZONAS:** Colonia Tovar, 10°25'N, 67°17'W, 1854-1855 (U). *Fandler* 203 (GH, K, US). Turiamo, 500 m, s.d. (U). *Williams* 10420 (F-2 sheets, US). **DISTRITO FEDERAL:** Caracas, Oct 1846 (U). *Landstam* 166 (S); lower Coiza, vic. Caracas, in savanna, 1200 m, 23 Sep 1917 (U). *Pitler* 7420 p.p. (US); lower Coiza, in savanna, 800-1200 m, 14 Oct 1917 (U). *Pitler* 7484 (US). **MIRANDA:** Los Teques, Parque de los Barbaos, 1100-1500 m, 21 Dec 1917 (U). *Pitler* 7410 (G, US). **TACHIRA:** Lobatera, La Cazadora, 7°55'N, 72°18'W, dry distributed evergreen scrub, 21 Jul 1983 (U). *Welff* & *Ortiz* 5405 (MO). **ZULIA:** Bolívar, El Pensando-Las Ties Marianas, 10°25'N, 70°55'W, evergreen forest, 7 Feb 1980 (U). *Banning* 8724 (NY).  
**COLOMBIA.** Tolima: La Trinidad, along ravine, 1100-1300 m, 21-25 Dec 1917 (U). *Peruval* 3313 (GH, MO, US).  
**ECUADOR. SANTIAGO-MORONA:** El Pandero, ridge between Hues Pañe and Negro, 730-1180 m, 14 Dec 1944 (U). *Camp* 1521 (NY).

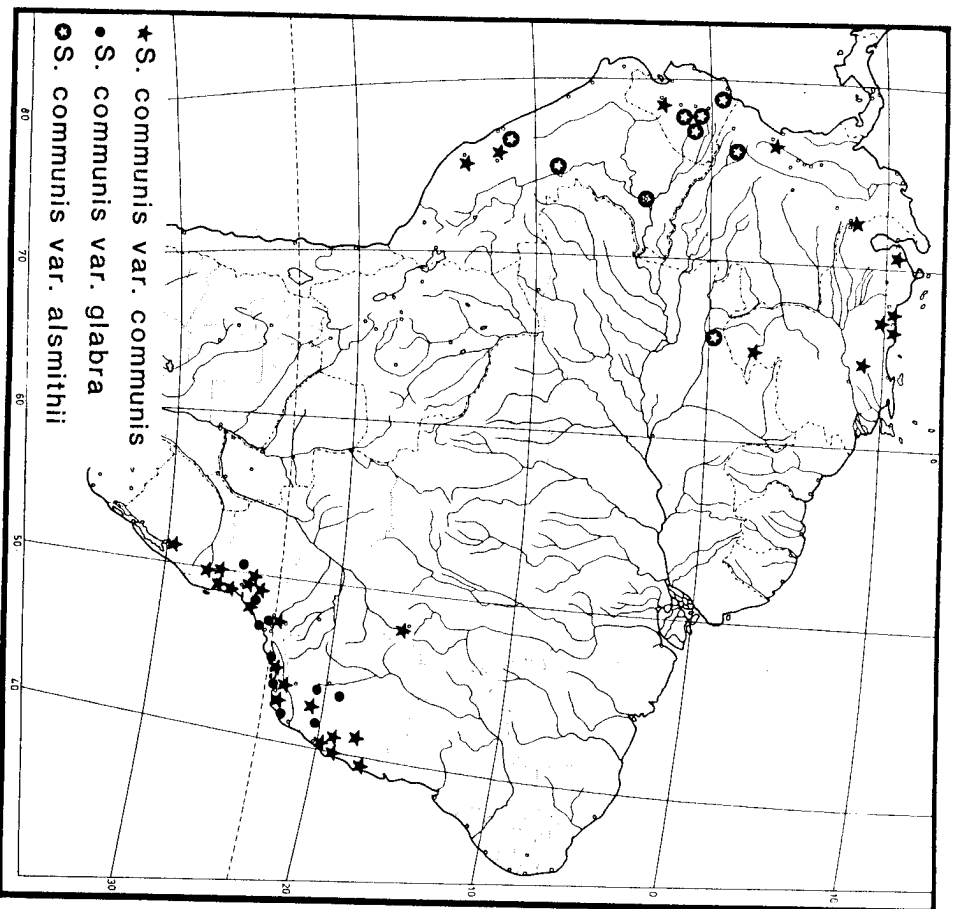


Fig. 30. Distribution of *Serjania communis* varieties. Each symbol represents a single collection.

**PERU.** HUANCAYELICA, Taycajca, above Virgen-Pampa, SE of Tarma, low, evergreen forest, 1000 m, 11 Apr 1964 (fl), *Tovar* 4602 (US). JUNIN: La Merced, dense forest, 700 m, 29 May-4 Jun 1929 (fl), *Killip & Smith* 25408 (F, NY, US).

**BRAZIL.** BAHIA, Prado, 6 km S of Prado, near sea level, 4 Sep 1986 (fl), *Acevedo-Rdgz. et al.* 1542 (CEPEC, MO, NY, US). DISTRITO FEDERAL: without specific locality, 14 Apr 1959 (fl), *Pereira* 4563 (US). ESPÍRITO SANTO: Aldetramento dos Índios, along Paracás river, 9 Jul 1942 (fl).

*Bueno & Emygdio* 199 (R), Aracruz, Estação de Biologia Marinha Mallo Leão, 9 Jan 1986 (fl), *Araújo & Peixoto* 296 (NY); Fundão, Três Barras, 1 Aug 1984 (fl) *Pizzolo* 207 (MBML, US); Jaguassú, Alto Limoeiro, 22 May 1946 (fl), *Brade et al.* 13348 (RB-3 sheets); Santa Teresa, Vargem Alta, 7 May 1985 (fl), *Bouquet Fernandes* 1119 (MBML, US); São Mateus, Reserva Socotama, 30 m, 15 May 1977 (fl), *Martinehl et al.* 2246 (RB-3 sheets). MINAS GERAIS: Teófilo Otoni, roadside, 14 Aug 1965 (fl), *Belém* 1598

1993]

ACEVEDO-RODRIGUEZ: SERJANIA

55

(CEPEC, NY); Vicosia, road to São Miguel, córrego Sipo, 600 m, 28 Jul 1930 (fl, fr), *Mezita* 4909 (F, GB, MO, NY, US). PARANÁ: Morretes, Graciosa-Serra Paranapiacaba, 23 Jan 1953 (fl), *Strelitz* s.n. (US); Ypiranga, forest manager, 4 Jan 1909 (fl), *Dusen* 7490 (GH, US). RIO DE JANEIRO: Alto de Teresópolis, 850 m, s.d. (st), *RB* 69656 (RB-2 sheets); Ararama, Rio Bacaxá, 16 Jun 1976 (fl), *Araújo et al.* 1183 (GU A); Casimiro de Abreu, roadside, 13 Aug 1986 (fl, fr), *Acevedo-Rdgz. et al.* 1439 (MO, NY, RB); Itapêba in restinga, 22 May 1963 (fl), *Martins* 315 (GU A); Jacarepagua, along road to Represa Camorim, 25 Aug 1980 (fl) *Leão* 1323 (GU A); Mangaratiba, Ilha de Marambá, 14 Jul 1983 (fl), *Pace & Ribeiro* 14 (NY, UFRJ); Majé, Mar-Apr 1823 (fl), *Riedel* s.n. (NY); Maricá, secondary forest, low elevation, 15 Aug 1986 (fl, fr), *Acevedo-Rdgz. et al.* 1455, 1456 (MO, NY, RB); Novo Friburgo, May 1935 (fl), *Alston-Lutz*, 890 (R); Novo Iguaçu, Tingüá, Serra do Maeco, roadside, 26 Sep 1983 (fl), *Sommer et al.* 390 (GU A); Parati-Mirim, 29 Jun 1977 (fl), *Almeida et al.* 255 (RB-2 sheets); Petrópolis, montane forest, 700-1044 m, 10-16 Jul 1882 (fl), *Bull* s.n. (NY); Pirai, Ribeirão das Lajes, 5 Jul 1983 (fl), *Peixoto & Peixoto* 1874 (NY); Rio Bonito, Barçana, Aug 1974 (fl, fr), *Laclette* 168 (R), *Faz. Cachoeiras*, secondary vegetation, 13 Aug 1986 (fl, fr), *Acevedo-Rdgz. et al.* 1431 (MO, NY, RB); Rio de Janeiro, Barra da Tijuca, restinga, 11 Jul 1964 (fl), *W. Hoehne* 5738 (RB); Jardim Botânico, 19 Aug 1945 (fl), *Kuhnmann* 6262 (NY, RB-7 sheets); Morro da Urua, 9 Jun 1957 (fl), *Emmerich* 20 (R); Pico de Anicã, 9 Jun 1957 (fl), *Travassos* 260 (R); Recreio dos Bandeirantes, Lagoa das Taxas, 20 Jun 1965 (fl), *Santos* 5876 (R); Tijuca, 22 May 1963 (fl), *Martins* 315 (MO); Tijuca, Sete Cachibas, 22 Jun 1979 (fl), *dos Santos* 43 (GU A); Vista Chinesa, roadside, 10 Aug 1979 (fl), *Angeli* 473 (GU A), Aug 1877 (fl), *Glaziou* 8592, 8593, 8598 (K), 1839 (fl), *Guillemin* 782 (F-2 sheets), 8 Jun 1960 (fl), *Martins* 129 (GU A), 5 Aug 1983 (fl), *Sommer* s.n. (GU A); vic. Toca dos Pereiras, 2 Jun 1982 (fl), *Sommer* 198 (GU A); Serra dos Orgãos 12 May 1877 (fl), *Glaziou* 8598 (R); Silva Jardim, Rio Capivari, 16 Jun 1976 (fl), *Araújo et al.* 1178 (GU A); Teresopolis, 11 Aug 1942 (fl), *Emygdio* s.n. (R); Vargem Grande, on Boca do Maio road, 25 Aug 1980 (fl), *Reitz & Klein* 3710 (NY, US); do Sacarau, 24 Jul 1983 (fl), *Reitz & Klein* 3710 (NY, US). GRANDE DO SUL: Vic. São Leopoldo, Oct 1941 (fl), *Leite* 570 (NY). SANTA CATARINA: Alto Maiaador, Rio do Sul, forest, 700 m, 17 Oct 1958 (fl), *Reitz & Klein* 3720 (NY, US); Brusque, secondary vegetation, 10 Oct 1949 (fl), *Reitz* 3088 (F, US); Azambuja, secondary vegetation, 50 m, 18 Nov 1953 (fl), *Klein* 742 (US); Itarama, riverside, 100 m, 20 Sep 1956 (fl), *Reitz & Klein* 3710 (NY, US); Ilhota, secondary vegetation, 100 m, 21 Oct 1960 (fl), *Reitz & Klein* 10256 (NY, US); Itajaí, s.d. (fl, fr), *Müller* 294 (R). MORRO DA RASSEADA, secondary vegetation, 50 m, 14 Oct 1955 (fl), *Klein* 7706 (NY, US); Sanga da Arca, roadside, 27 Nov 1980 (fl), *Kropovickas & Vanni* 37000 (CITES); Unibon, disturbed vegetation, 11 Nov 1964 (fl, fr), *Martins* 12029 (SP-2 sheets). SÃO PAULO: Campinas, Chacra Prouca, 24 May 1905 (fl), *Heimer* 452 (MO); Ilha do Cananeira, edge of rainforest, sea level, 9 Sep 1976 (fl), *Davis et al.* 6073 (SP); Jardim Botânico, 10 Sep 1968 (fl), *Schubsky* 975 (SP-2 sheets); Reserva Biológica Parque Estadual Fontes de Piratanga, forest, 28 Feb 1989

(fl), *Barron* 1595 (SP-2 sheets), 28 Aug 1977 (fl), *Silvestre* 78 (SP-2 sheets); Reserva do Instituto de Biologia SP, disturbed terra firme forest, 15 Nov 1980 (fl), *Rosa & Pires* 3741 (SP); Santa Ana, Nov 1912 (fl, fr), *Brade* 6412 (SP); Sítio Tangará, 3 Feb 1987, (fl), *de Mello* 5242 (R).

**BOLÍVIA.** La Paz: Nor Yungas, ca. Corico on road from Camarvito Yoloosa, 1000 m, 31 May 1987 (fl), *Acevedo-Rdgz. & Vargas* 1742 (LPR, MO, NY, US).

**1b. *Serjania* communis Cambessedes var. *glabra* Radlkof. Monogr. *Serjania* 110. 1875. Type: Brazil. Without locality, s.d. (fl), *Sellow* s.n. lectotype, F, fragment of B, here designated.** Fig. 29b.

*Serjania cuspidata* Cambessedes f. *dissecta* Radlkof. Monogr. *Serjania* 107. 1875. Type: Brazil. Without specific locality, *Pohl* s.n. (type, n.v.).

Stems sharply triangular, tomentose ferruginous, especially at angles; Upper leaflet surface foveolate. Plants variously pubescent or glabrescent.

**Distribution.** *Serjania communis* var. *glabra* is restricted to the southeastern states of Brazil (Fig. 30). It has been collected in moist forest as well as in open areas at elevations from sea level to 1000 m.

Specimens examined. **BRAZIL.** ESPÍRITO SANTO: Ilhota, margin of forest, 21 Jun 1982 (fl), *Hantschke & Guimarães* 43160 (F); MINAS GERAIS: Ouro Preto, 7 Jan 1894 (fl, fr), *Magalhães Gomes* 33 (R); Santa Bárbara, 13 Apr 1933 (fl), *Barron* 38292 (SP); Serra, on road MG 010, from Diamantina to Conceição de Mato Dentro, 1000 m, 20 Aug 1986 (fl), *Acevedo-Rdgz. et al.* 1490 (EPAMIG, MO, NY); FAKAMA: Guaratuba, Boa Vista, margin of forest, 6 Mar 1980 (fl, fr), *Ohlvera* 252 (GB, MO); Rio de Janeiro: Ilhota, Lago Azul, 24 Jan 1936 (fl), *Campo Porto* 2867 (B); Ilhota forest, 900-1000 m, 20 Oct 1927 (fl, fr), *Zerry* s.n. (W); Macaé, Pico do Frade de Macaé, 900-1000 m, 22 Oct 1985 (fl), *Leymann et al.* 14 (NY); Teresopolis, Granja Matra, 28 May 1977 (fl), *Carnelio* 540 (NY); SÃO PAULO: Butantã, 29 Sep 1917 (fl, fr), *F. C. Hoehne* 556 (NY); Cubatão, 24 May 1894 (fl), *Loeferer* 10409 (SP); Ribeirão Preto, 19 Feb 1922 (fl, fr), *Halweg & Halweg* 1565 (US); São Paulo, Glade Jardim, Nov 1940 (fl, fr), *W. Hoehne* 13426 (NY); São Paulo, in woods, 20 Nov 1941 (fl, fr), *Pickett* 5513 (US); Instituto Botânico, 860 m, forest, 21 Feb 1976 (fl), *Davidse* 10499 (MO, SP), Jan 1977 (fl, fr), *Kirizawa* 91 (SP); Serra da Bocaina, Jan 1925 (fl), *Alston-Lutz* s.n. (R); Ubatuba, Mirim River, gallery forest, 10-40 m, 17 Jul 1979 (fl), *Jovan* 465 (RB).

**I. c. *Serjania communis* Camboesedes var. *alsmithii***  
(Machbride) Acevedo-Rodr. comb. nov.

Fig. 29d, e, ik.

*Serjania alsmithii* Machbride, Publ. Field Mus. Nat. Hist., Bot. Ser. 8, 3A: 298, 1956. Type: Peru. Loreto: Yurimagas, lower Huallaga river, 135 m, woods, 22 Aug-9 Sep 1929 (fr). Killip & Smith 28301 (holotype, F.; isotypes, NY, US).

*Stems* 3-5 angular, glabrescent. *Leaflet margins* with recurved teeth (at least the lower ones). *Inflorescences* to three times longer than subtending leaves.

**Distribution.** *Serjania communis* var. *alsmithii* is restricted to the southern part of Colombia, Ecuador, Peru and eastward into central Brazil (Fig. 30). It has been collected from 100 to 1300 m elevation, from moist forest and disturbed areas.

**Specimens examined.** **COLOMBIA.** CAQUETA: San José de Fragua, disturbed forest along river, 320 m, 11 Jan 1974 (fr). Genry et al. 9140 (MO).

**ECUADOR.** ESMERALDAS: Lita, Barma-San Lorenzo railroad, wet montane forest, 550-650 m, 11 Jun 1978 (fl, fr). Madison et al. 5220 (AAU, F, NY). Napo: Rio Conejo, rainforest and roadside, 340 m, 1 Apr 1972 (st). Dwyer & MacBryde 9807 (MO). Hac, Cotacachi, 500 m, 19-20 Feb 1968 (fr). *Harling et al.* 7052 (GB, MO); Rio Holín, ca. 10 km E of Archidona, dense forest, 650 m, 19-25 Apr 1935 (fr). *Mexia* 7244 (US); Tena, dense forest, 400 m, 2-11 Apr 1935 (fr). *Mexia* 7183 (F-2 sheets, NY, US). PASTAZA: Quichillo Uro, ca. 8 km N of Puerto Sarayacu, 6 Oct 1974 (fr). *Lago* 3963 (GB, MO); Mera, Colonia Jauva, 1100 m, 17 Jan 1977 (fr). *Harling et al.* 14729 (GB, MO); Sarayacuquillo, ca. 10 km E of Puerto Sarayacu, 8 Oct 1974 (fr). *Lago* 3995 (GB, MO).

**PERU.** Junin: San Ramón, dry woods, 900-1300 m, 9-12 Jun 1929 (fr). Killip & Smith 24756 (F, NY, US). Loreto: Mishuayacu, ca. Iquitos, 100 m, forest, Feb 1932 (fr). *Klug* 2557 (F, NY). Ucayali: Pucallpa, in open place, 200 m, 4 Jun 1960 (fr). *Wojtkowski* 5767 (MO, US).

**BRAZIL.** AMAZONAS: Upper Rio Negro basin, along Rio Casainho, 100-140 m, 16-24 Feb 1946 (fr). *Cardona* 1420 (F, NY, US).

**2. *Serjania leptocarpa* Radlkofet, Monogr. Serjania** 112, 1875. Type: Brazil. Amazonas: Margin of Rio Negro as far as confluence with Solimoes river, May 1851 (fl). *Spruce* 1561 (lecto-type, K, here designated; isotypes, CGE, NY).

Figs. 3, 17, 2d, e, 31.

*Serjania vitidissima* Radlkofet, Ergänz. Monogr. Serjania 81, 1886. Type: Brazil. Rio de Janeiro-São Paulo: Without specific locality, 1861-1862 (fr). *Weir* 501 (holotype, K). *Serjania schubertii* Chatterass, Revista Acad. Colomb. Ci. Exact. 7: 479, 1952. Type: Colombia. Norte de Santander:

La Cabuya, Hoya del rio Chingá, 1300 m, 25 Nov 1941 (fl, fr). *Chatterass* 13444 (holotype, F.; isotype, US).

Semi-woody climber, to 4 m long. *Stems* slender (to 1 cm in diam.), obtusely 5-angular, three-ribbed, glabrescent and smooth, the young stems densely covered with yellowish, straight and curved hairs, 0.3-0.5 mm long; cross section of stem with large, central, obtusely angled stiel with hollow medulla and three, smaller, subtetretic, peripheral stiles slightly included in central one. *Stipules* deltoid, narrowly deltoid, orbiculate, ca. 1 mm long. *Leaves* binate; all axes glabrous to densely covered with minute, to 0.2 mm long, curly, yellowish hairs; petioles not winged, terete, furrowed at adaxial surface, (2.5-4-6(-7) cm long; main rachis terete, not winged or slightly margined, adaxially furrowed, (1.5-2.5-5 cm long; secondary rachis terete, 1-2.5 cm long; leaflets chartaceous, short to long acuminate, often glandular and mucronate at apex, the terminal leaflet larger, 5.5-9(-17.5) x 2-4(-8) cm, ovate, elliptic or lanceolate, with attenuate or abruptly attenuate base, the lateral leaflets 4.5-8 x (1.2-2-3.2 cm, oblong or lanceolate, with attenuate or obtuse base, sparsely to densely covered with minute (0.2 mm long), yellowish, inflexed hairs along both surfaces; the lower surface lighter, with dark network of tertiary and quaternary veins, the margins ciliate, remotely and obtusely serrate, the lower serrations glandular, the veins mixed craspedodromous, the primary and secondary veins prominent. *Inflorescence* often longer than subtending leaves, all parts densely covered with small, yellowish, curly hairs; axis 3-9(-19) cm long, glabrescent, almost terete; rachis 1-8(-19) cm long, slightly angular and striate; bracts and bracteoles subulate, ca. 1 mm long; cincinni alternate, the peduncle 1-2.5 cm long, 4-7-flowered, the lower peduncles longer; pedicel 4-5 mm long, slightly flattened, articulate at 1-2.5 mm from base, bracteoles at base or close to articulation. *Flowers* with sepals 5, the outer sepals 2.5-3 mm long, ovate, obtuse at apex, glabrescent, minutely ciliate at margins, the inner sepals 4.5-5.5 mm long, elliptic or obovate, with minute, woolly, yellowish hairs, the third and fifth free; petals white, obovate to spatulate, clawed, (5-) 6-7 mm long, papillose on adaxial surface; appendages 3.5-4.5 mm long, with densely hairy margins, the central ones hood-shaped, with fleshy crown-shaped apex, the lateral ones not fleshy, asymmetric, with outer side bent over disk glands; disk glands two (the

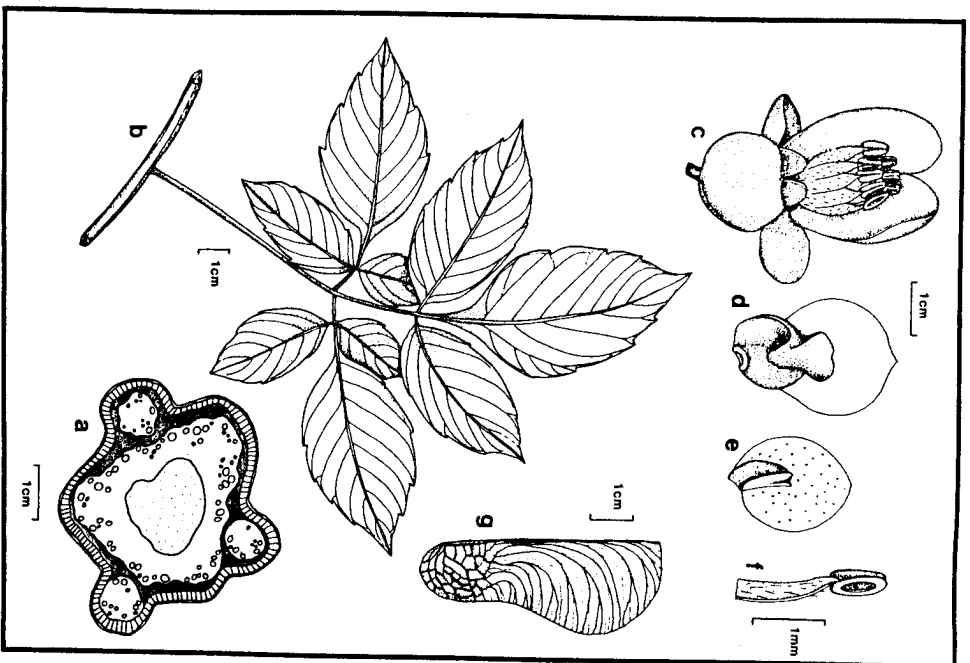


Fig. 31. *Serjania leptocarpa*. a, cross section of stem showing a central and three peripheral steles (*Bratler* 3495). b, Binate leaf and fragment of stem (*Chatterass* et al. 12101). c, Staminate flower with petals removed (*Weir* 501). d, Central petal with adnate appendage (same as c). e, Lateral petal with adnate appendage (same as c). f, Stamen (same as c). g, Fruit mericarp (from *Zamory* 3878).

laterals obsolete) ovate in outline, periclinally flattened, 1-1.2 mm long; tons slightly enlarged; filaments sparsely covered with minute, 0.2 mm long, whitish, inflexed hairs, the anthers ca. 0.75 mm long; ovary spatulate in outline, papillose, with minute, yellowish hairs along edges, the style with same pubescence as ovary, the stigma papillose. *Fruit* 5-6 cm long, pyriform in outline; locule flat, chartaceous, with reticulate, dark, non-prominent network of veins; wings membranous, outline not constricted below locule, truncate at base. *Seeds* not known.

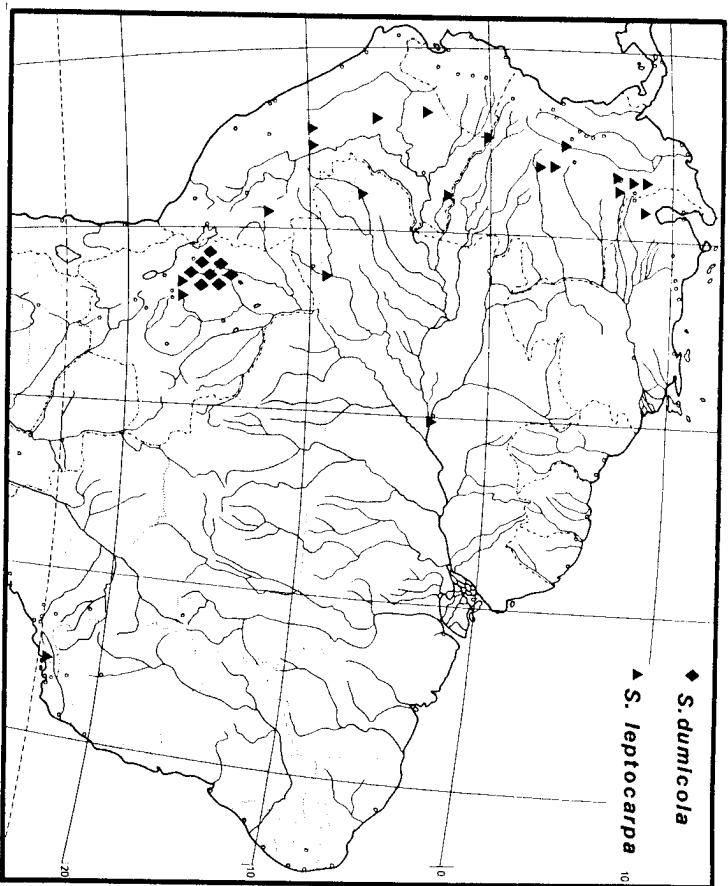


Fig. 32. Distributions of *S. leptocarpa* and *S. dumicola*. Each symbol represents a single collection.

**Distribution and Phenology.** *Serjania leptocarpa* is known from Colombia, Venezuela, Ecuador, Peru, Brazil, and Bolivia (Fig. 32). It has been collected in moist, gallery, and secondary forests, as well as in thickets, from 100 to 1600 m elevation. It probably flowers year-round and fruits from August to November.

**Specimens examined.** **COLOMBIA.** MAGDALENA: Fundación to Salamanca, 100 m, 30 Nov 1943 (fl), *Haight 3917* (F, US); Magdalena valley, Poponté, 2 Nov 1924 (fl), *Allen 788* (MO). META: Sierra de La Macarena, along Guapaya river, in dense humid forest, 450 m, 2 Dec 1949 (fl, fr), *Philipson et al. 1690* (F, US), dense forest on river bank, 450 m, 29 Nov 1949 (fl), *Philipson et al. 1596* (F, US). NORTE DE SANTANDER: Región del Sarre, La Cahuya, 1300 m, 12 Oct 1941 (fl), *Carreras et al. 12101* (F, GH, US); *Carreras et al. 12829* (BM, F, GH). PUTUMAYO: Putumayo river, opposite mouth of Guappi river, on border

between Ecuador and Peru, 200 m, 19 May 1978 (fl), *Gentry et al. 22116* (MO). TOLIMA: Líbano, La Trinidad, by ravine, 1100-1300 m, 26-29 Dec 1917 (fl), *Pennell 33134* (GH, NY).

**VENEZUELA.** LARA: Guárico, secondary vegetation, Dec 1951 (fl, fr), *Tamayo 3818* (VEN). MERIDA: Mesa Bolívar, along road to El Vigma, secondary forest, 1000 m, 16 Jan 1964 (fl), *Breteler 3495* (G-2 sheets, MO, NY-2 sheets, US).

**ECUADOR.** PASTAZA: Curaray river, vic. Laguna Garzayacu, humid, tropical primary forest, 250 m, 20-26 Aug 1985 (fl, fr), *Palacios & Neill 676* (NY).

**PERU.** AMAZONAS: Mirina, in forest, 250 m, 7 Apr 1960 (fl), *Wojtkowski 5652* (MO, US); JONIN: Puerto Yessup, in thicket along river, 400 m, 10-12 Jul 1929 (fl), *Killip & Smith 26313* (F, NY). LORETO: Cachimpueto, Rio Cachimpueto, 250 m, in forest, Jul 1933 (fl), *Klug 3125* (NY). FLORIDA: Putumayo river, at mouth of Zabinda river, in forest, 200 m, Mar-Apr 1931 (fl), *Klug 2080* (F, NY, US); Alto Amazonas, border of Pastaza river between Rimachi and Wiyowan river, 31 Jul 1979 (fl), *Díaz et al. 1296* (MO). MADRE DE DIOS: Mamu, Mamu river, beach 16 km above the mouth, in forest near river,

15 Aug 1976 (fl), *Foster & Augspurger 3093* (F, K, MO, NY, US); SAN MARTÍN: Tarapoto, 27 Aug 1967 (st), *Martin & Piquemán 1846* (ECON).

**BRAZIL.** AMAZONAS: Semang Aunstiela, May 1911 (fl), *Ule 9538* (K); along Tarauaca river, várzea forest, s.d. (fl), *Krakoff s.n.* (MO).

**BOLIVIA.** COCHABAMBA: Anahuacama, Espiritu Santo, 750 m, Jun 1909 (fl), *Buchneri 2208* (GH, NY, -3 sheets, US); Totos, Los Santos, ca. 120 km from Cochabamba, 600 m, 20 Nov 1956 (fl), *Cardenas s.n.* (US 2320677); Espiritu Santo, 1891 (fl), *Bang 1262* (F, GH, K, NY-2 sheets, MO, R, U, WIS).

**Local Name:** Peru: *Mazore*.

**Field observations.** The fresh fruits of *S. leptocarpa* are red-orange and the inflorescences are pendulous.

Radlkofler's concept of *S. leptocarpa* was based on the densely hairy specimens available to him. *Serjania viridissima* was separated from *S. leptocarpa* by Radlkofler as a closely related but glabrous species. Recent collections show wider variation in pubescence, which range from densely pubescent to almost completely glabrous. As a consequence, the separation of *S. viridissima* from *S. leptocarpa* is not maintained. Typical material of *S. schultzei* matches perfectly that of *S. leptocarpa*.

The vegetative morphology of *Serjania leptocarpa* is similar to that of *S. communis*. However, *S. leptocarpa* has more robust leaves, flowers, and fruits. *Serjania leptocarpa* differs qualitatively from *S. communis* in having its third and fifth sepals completely free (vs. connate 3/4 to 4/5 of their length) and by its oblong (vs. ovate) fruits with the wing outline not constricted (vs. slightly constricted) below the locale. These species also differ in their altitudinal distributions. *Serjania leptocarpa* is mostly found at middle elevations while *S. communis* occurs at lower elevations.

*Serjania leptocarpa* also resembles *S. dumicola*, but differs from it by being more robust (i.e., larger leaves, flowers and fruits) and by having yellowish, inflexed (vs. whitish, erect) hairs.

The name *leptocarpa* refers to the slender fruits of this species.

3. *Serjania dumicola* Radlkofler, Monogr. Serjania 111: 1875. Type: BOLIVIA. Larceala: Close to Sorata at Mansamani stream, in thicket, 2650 m, Feb-Mar 1860 (fl, fr), *Mendon 775* (lectotype, F, here designated; isotypes, F, G, GH, K, MPU-2 sheets, NY-4 sheets, PD).

Figs. 1c; 10a, 11d; 13a, c; 33a-1.

Semi-woody climber to 3 m long. Stems slender (less than 1 cm in diam.), glabrescent, reddish brown or gray; obtusely triangular, with three major ribs, the young stems sharply angular, with five ribs, the sulcus densely covered with minute (0.5 mm), whitish, erect hairs; cross section of stem with large central, obtusely 5-angled steele and three smaller, elliptic peripheral steles slightly included in the central one. *Stipules* deltoid or subulate, 1-1.5 mm long, with same indument as stem. *Leaves* biennate, all axes densely to sparsely covered with minute (0.5 mm), erect, whitish or yellowish hairs; petioles not winged, sub-terete, adaxially furrowed, (1-)-3-5 cm long; main rachis marginated, sub-terete, adaxially furrowed, 2-3.2(-)4 cm long; secondary rachises sub-terete, adaxially furrowed, 1-1.5 cm long; leaflets chartaceous, obtuse, acute or acuminate, mucronate at apex, the terminal leaflet larger, 3-9 × 1.5-4(-5) cm, ovate or lanceolate, with attenuate, abruptly attenuate or truncate base, the lateral leaflets 2.5-6 × (0.8-)-1.7-3.5 cm, oblong or lanceolate, with rounded and oblique base, sessile, the upper surface glabrous to sparsely covered with minute (0.3-0.5 mm), whitish or yellowish, inflexed hairs, the veins sparsely or densely covered with same indument, the lower surface lighter (whitish), sparsely covered with whitish, erect hairs 0.5 mm long, especially on veins, the margins ciliate, revolute, remotely and acutely serrate, the teeth glandular-mucronate (glands acute), the veins semicraspedodromous, the primary vein slightly prominent underneath. *Inflorescence* usually longer than subtending leaves, densely covered with same indument as stem; axis 3.5-10 cm long, twining, 4-angular; rachis 1-9(-14) cm long, slightly flattened and angular; bracts and bracteoles subulate, 1.2-1.5 mm long; drepania(-cincinid) alternate, the peduncle 0.5-2.6 cm long, 3-8-flowered; pedicels 1.7-3(-4) cm long, slightly flattened, articulate at middle, with a bracteole at base. *Flowers* with sepals 5, minutely ciliate at margins, woolly, sometimes with white, inflexed, 0.1 mm long hairs, obtuse at apex, the outer sepals 1.5-2.2 mm long, ovate, the inner sepals 2.5-3.5 mm long, elliptic or ovate, the third and fifth free; petals white, spatulate or obovate, clawed, rounded at apex, 3-4 mm long, with minute papillae on adaxial surface; appendages ca. 3 mm long, with densely hairy margins, the central ones hood-shaped, with fleshy crown-shaped apex, the lateral ones not fleshy, asymmetric, with outer side bent over in outline, perichinially flattened, ca. 1 mm long, the lateral glands elliptic and smaller, adnate to the slightly enlarged torus; filaments flattened, sparsely covered

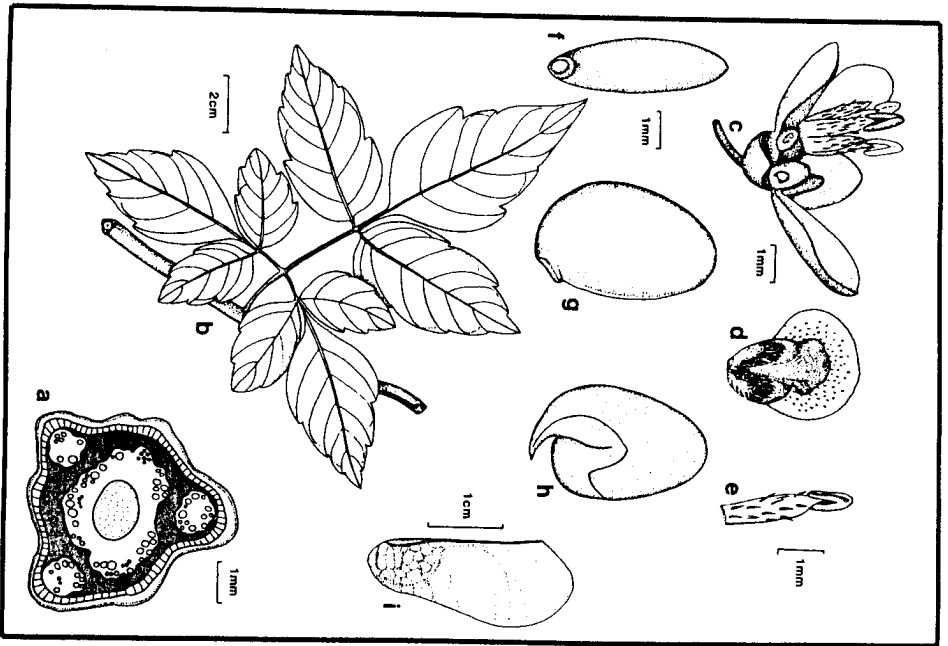


Fig. 33. *Serjania dumicola*. a. Cross section of stem, showing a central stele and three pericarpel ones. b. Bifurcate leaf and fragment of stem. c. Staminate flower with petals removed. d. Central petal with adnate appendage. e. Stamens, filament with inflexed hairs. f. Seed, ventral side. g. Seed, lateral side. h. Embryo, showing cotyledons configuration. i. Ferti mericarp. All drawn from Acevedo-Rdgz. & Vargas 1759 except for the seeds and embryo which are from Buchten 710).

with inflexed, white, 0.2 mm long hairs, the anthers 0.7 mm long; ovary spatulate in outline, densely covered with yellowish, inflexed hairs 0.2 mm long, the style with same indument as ovary, the stigma papillose. Fruits oblong in outline or slightly wider at base, 2.2-2.7 cm long, notched at apex, subcordate at base; locale flat, not winged, with dark, slightly prom-

inent, reticulate network of veins; wing glabrous, with outline slightly constricted below locale; partitioning walls to 2 mm wide. Seeds lenticular, dark brown, 4-5 mm long; embryo with adaxial cotyledon biplicate and the abaxial cotyledon bent over.

**Distribution and Phenology.** *Serjania dumicola*

1993]

ACEVEDO-RODRIGUEZ: SERJANIA

61

is known by a few collections from the Bolivian department of La Paz (Fig. 32). It has been collected in thickets or open areas with shrubby vegetation from 2400 to 2700 m elevation. It flowers from December to June and fruits from February to June.

Specimens examined. **BOLIVIA.** La Paz: Inquisivi, shady ravine woods, 2450 m, 16°55'S, 67°10'W, 18 Jan 1989 (Hd). Lewis 35129 (MO, US), forest, 2200 m, 16°53'S, 67°09'W, 30 Mar 1989 (Hd), Lewis 35435 (MO, US), Larecchia, Between Guanay and Tipuan, Apr-Jun 1892 (Hd), Bong 1450 (F); Laaya: vic. of Pizazuela, 16°28'S, 67°22'W, thorn scrub, 1200-1790 m, 30 Dec 1989 (Hd), Dorr et al. 6918 (NY, US); Nor Yungas, vic. of Champisapa, along road to Yalosa, 2060-2760 m, 16°16'S, 67°48'W, 7 May 1990 (Hd), Lareyn & Dorr 13522 (NY, US), Milliguayra, 1300 m, Dec 1917 (Hd, F), Buchten 710 (GH-3 sheets, NY, US), without locality, 1890 (Hd, F), Beang 421 (F, GH-2 sheets, K, MO, NY-5 sheets, US-2 sheets); Sorata, vic. of Sorata, shrubby forest along stream, 2800 m, 4 Dec 1983 (st), Beck 8632 (CTES); 2.9 km from San Pedro along road to La Gruta de San Pedro, 2450 m, 3 Jun 1987 (Hd, F), Acevedo-Rdgz. & Vargas 1759 (F, LPB, MO, NY-2 sheets, US); 4.4 km from San Pedro to Consta, rocky hillside with shrubs, 2700 m, 5 Dec 1983 (Hd, F), Beck 8666, 8667 (LPB, NY), rocky entrance to the gorge, 2780 m, 12 Jun 1980 (Hd), Brooke 6493 (F), without specific locality, 2440 m, Feb 1886 (Hd), Rasky 5718 (F, GH-2 sheets, NY-3 sheets).

**Field observations.** The stems of *S. dumicola* produce a watery (not milky) exudate when cut and the inflorescences are pendulous.

*Serjania dumicola* resembles *S. leptocarpa* but differs from it by its smaller flowers and fruits, whitish erect (vs. inflexed and yellowish) pubescence, acute glandular-mucronate (vs. obtusely glandular) teeth, mucronate apex, and obtusely triangular mature stem (vs. sharply ribbed). In overall morphology, *S. dumicola* is very similar to *S. communis*. However, *S. dumicola* has wider fruits with an oblong outline (vs. slightly constricted below the locale), the third and fifth sepals are distinct (vs. connate along most of their length), and the cotyledons are biplicate (vs. straight). *Serjania dumicola* might represent a vicariant species that evolved from populations of *S. communis* after the uprise of the Andean highlands.

The name *dumicola* means "dweller in thickets" and refers to the habitat of the species.

4. *Serjania cuspidata* Cambessés in St. Hilaire, Fl. Bras. Mérid. 1: 356, 1828. Type Brazil, Rio de Janeiro: Rio de Janeiro on fence and primary forest, 1816 (Hd), St. Hilaire Catal. A 732 (holotype, P, isotype, MPU, n.v.; photo NY from MPU).

Figs. 7a, 8b, 10b, 21a, 25c; 34a-i.

*Paulinia guaruniana* Vellozo, Fl. Num. 160, 1825 [1829]; Vellozo, Fl. Num. Icon. 4: 1, 35, 1827 [1831]. Type Brazil, Rio de Janeiro: Exact locality unknown (lectotype, Tabula 35 in Vellozo, here designated).  
*Paulinia meyeniana* Walpers, Nov. Actum Acad. Caes. Leop.-Carol. Nat. Cur. 19: 312, 1843. Type: Brazil, Rio de Janeiro, Meyen s.n. (n.v.).  
*Urvillea ferruginea* Lindley, Bot. Register 13: 1077, 1827. Type: Brazil. Exact locality unknown (lectotype, Figure 1077 in Lindley, here designated).  
*Serjania cuspidata* f. *genuina* Radlkofert, Monogr. Serjania 107, 1875. Type: Base on same specimen as *S. cuspidata* Camb.

Woody vine to 3 m long. Stems slender (less than 1 cm wide), sharply triangular, six-ridged with three very much more prominent, the corners covered with stiff, coarse, 2-3 mm long, ferruginous hairs, the sides glabrescent, the young stems with an extra row of hairs on each side; cross section of stems with central, rounded, large stele with hollow pith and three peripheral, smaller, rounded steles. *Stipules* linear, 5 × 0.8 mm, acute, with hispid margins. *Leaves* ternate, or sub-binate (file Radlkofert); petioles not winged, shorter than leaflets, adaxially flattened, densely covered with rusty, curly, 0.2 mm long hairs; leaflets characeous, with acute or cuspidate apex, the terminal leaflet larger, ovate, widely ovate, deltoide, trilobate or 5-lobate, (4.7-6.8(-10.7) × (4-5.5-7.6(-10.5) cm, with truncate, attenuate, abruptly attenuate or subcordate base, decurrent onto more or less prolonged (1-4 cm long) petiole, the lateral leaflets oblong-ovate, (3.6-) 4.5-7(-9.1) × (2.5-3.2-5.1(-6.9) cm, with oblique or subcordate base, shortly petiolulate (1-2 cm long), the upper surface densely to sparsely covered with rusty appressed hairs, especially on veins, sometimes glabrescent, the lower surface densely covered with rusty, stiff, erect hairs, especially on veins, the margins serrate and covered with rusty, stiff, erect hairs, the teeth clear glandular, acuminate, obtuse or rounded, the veins conspicuously prominent on lower surface. *Inflorescence* axillary, two to three times longer than subtending leaf; axis 3- to 4-angular, usually twining, hispid (hairs to 0.3 mm long); rachis subterete or slightly flattened, with minute (0.2 mm long), whitish or yellowish curly hairs; bracts and bracteoles narrowly oblong, with ciliate margins and acuminate apex; primary bracts 3-3.5 mm long, the secondary bracts ca. 1 mm long, clinchm alternate, 0.4-0.7(-2) cm long, densely covered with minute, rusty, curly hairs, usually 5-flowered; pedicels 2.5-3.5(-5) mm





*S. cardiospermoides* in general morphology. However, *S. cuspidata* differs by the presence of stiff, erect hairs on the stem angles and leaf margins. *Serjania cardiospermoides* var. *sibubiana* has similar hairs on the main stem angles but not as long or as abundant. Moreover, the leaflets of *S. cardiospermoides* are chartaceous and almost glabrous.

The name *cuspidata* probably refers to the abruptly acuminate or cuspidate apex of the leaflets of this species.

5. *Serjania morii* Acevedo-Rodriguez, Brittonia 40: 285, fig. 2. 1988. Type: Brazil, Bahia: Santa Cruz de Cabrália, 4-6 km E of ecological station Pau-Brasili (ESPAB), ca. 17 km W of Porto Seguro, on old road to Santa Cruz de Cabrália, disturbed Southern-Bahian moist forest, 16°23'S, 39°08'W, 40 m, 19 Oct 1978 (fl), Mori et al. 10855 (holotype, CEPPEC, isotypes, NY, US). Fig. 35a-g.

Woody vine. Stems slender (less than 1 cm wide), sharply triangular, the angles covered with stiff, coarse, 1.5-2 mm long, rusty hairs; cross section of stem with central, rounded, large stiele with hollow medulla and three peripheral, smaller, rounded sties. Stipules oblong, 0.2-0.7 cm long, acute, ciliate at margin. Leaves ternate, 15-20 × 20-21 cm; petioles not winged, much shorter than leaflets, cylindrical, slightly swollen at base, adaxially furrowed and covered with minute (0.5 mm), curled, ferruginous hairs; leaflets chartaceous, glabrous except for a few hairs on margins and adaxial surface of veins, abruptly acuminate at apex, with repand-denticulate margins, terminal leaflet oval, 11-13 × 7-8.3 cm, the base rounded or obtuse, decurrent into a more or less prolonged (1-2 cm) petiolule, lateral leaflets oval-oblong to obovate, sometimes oblique, base rounded, shortly petiolulate. Inflorescence axillary, three times longer than subtending leaf, the axis sparsely covered with erect, 1 mm long, rusty hairs; bracts narrowly oblong, 5.2 × 1 mm, with ciliate margins and acuminate apex; cincinni alternate, 1-1.5 cm long, densely covered with minute, rusty, curled hairs, usually 5-flowered; bracteoles lanceolate, ca. 3 mm long; pedicel ca. 4 mm long, articulate near base, densely covered with minute (0.15 mm), yellowish, inflexed hairs. Flowers with sepals with same indument as pedicel, especially on adaxial surface, the outer sepals ca. 4 mm long, ovate, with obtuse apex, the inner sepals 5-5.5 mm long, ovate-elliptic, with obtuse apex, third and fifth sepals connate from 1/4 to 2/5 of their length; petals

white, 6.5-7.5 mm long, broadly spatulate, adaxially minutely papillose, the apex rounded; the appendages of central petals 5 mm long, hood-shaped, with fleshy, crown-shaped apex and ciliate margins, the appendages of lateral petals 4 mm long, with slightly fleshy apex and ciliate margins; disk glands 4, the central glands 1.5 mm long, broadly ovate in outline, and obtuse at apex, the lateral glands reduced, ca. 0.7 mm long, annular; filaments puberulent, the anthers ellipsoid, ca. 1 mm long; ovary not seen. Fruit and seeds not seen.

Distribution. *Serjania morii* is known only from the type (Fig. 36).

*Serjania morii* is placed in *S. sect. Platyococcus* even without knowledge of its fruits, because it is very similar to *S. cuspidata*. These species share similar stem indument and general flower morphology. However, *S. morii* differs by its wide elliptic to oblong-oval (vs. ovate to subtriobovate) leaflets; repand denticulate (vs. dentate) margin, essentially glabrous (vs. tomentose) leaflets, and third and fifth sepals connate 1/4 to 2/5 (not 2/3 to 3/4) of their length.

The name of this species honors Dr. Scott A. Mori, collector of the type and specialist in neotropical Lecythidaceae, who has done extensive work in eastern and central Brazil.

6. *Serjania regnellii* Schlechtendal, Linnaea 18: 57. 1844. Type: Brazil, Minas Gerais: Caldas, s.d. (fl, fr), Regnell 138 (holotype, HAL 064975). Figs. 25d, 37a-h.

Woody vine to 5 m long. Stems slender (less than 1 cm in diam.), sharply to obtusely triangular at maturity, sides two-furrowed near angles, sparsely covered with yellowish, erect, 0.5-0.8 mm long hairs; cross section of stem with central, terete, large stiele and three peripheral, smaller, elliptic sties; these slightly included in central stiele in old stems. Stipules subulate, 1.5-2 mm long, with same indument as stems. Leaves ternate; petioles not winged, shorter than leaflets, adaxially and abaxially furrowed, densely covered with erect, rusty, 0.5 mm long hairs; leaflets chartaceous, covered with erect, whitish, or yellowish hairs with swollen bases, ca. 0.2 mm long (longer on veins), with acuminate apex, the terminal leaflet larger, ovate, 6.4-9.2(-15) × 3.6-6.5 cm, with attenuate, usually sessile or less often decurrent into more or less prolonged (1-2.7 cm long) petiolule, the lateral leaflets oblong-ovate or lanceolate, 6-9(-11.6) × 3.4-6.4 cm,

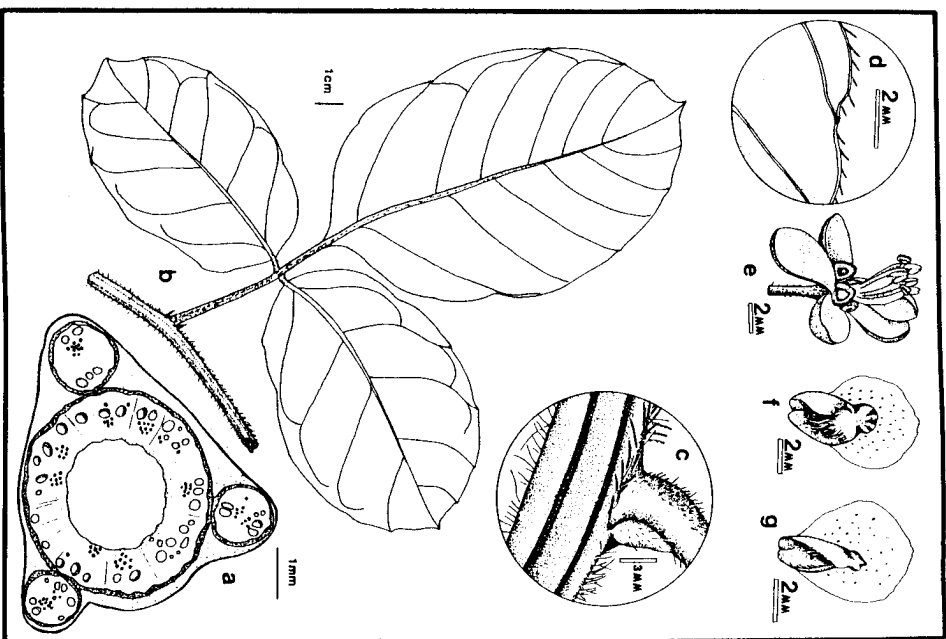


Fig. 35. *Serjania morii*: a. Cross section of stem showing a central and three peripheral sties. b. Ternate leaf and fragment of stem. c. Detail of stem showing stipule. d. Ciliate margin of leaflet with glandular tooth. e. Sammarinate flower with petals removed. f. Central petal with adnate appendage. g. Lateral petal with adnate appendage. All drawn from Mori et al. 10855.

with oblique, rounded base, sessile or shortly petiolulate (2-6 mm long), the epidermis often with rod-shaped oxalate crystals, the margins remotely and obtusely serrate and covered with whitish, appressed, 0.5 mm long hairs, the teeth glandular, the veins mixed craspedotromus, the lower pair of secondary veins often opposite, primary and secondary

veins slightly prominent on both surfaces. Inflorescence axillary, 1.5 times longer than subtending leaf-axis 4-angular, usually twining, all parts sparsely covered with yellowish, erect hairs; rachis subterete or slightly flattened, striate; bracteoles narrowly subulate, with glandular hairs along margins, the primary bracts 1.5 mm long, the secondary bracts ca. 0.7 mm

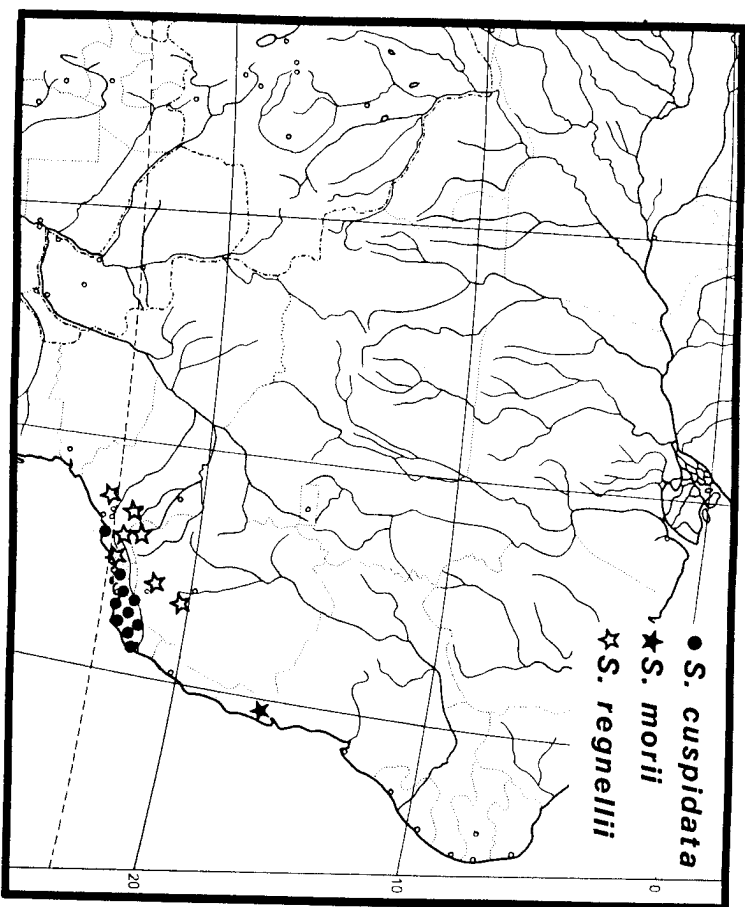


Fig. 36. Distribution of three endemic species of *Serjania* sect. *Platycoecus*: *S. cuspidata*, *S. morii* and *S. regnellii*. Each symbol represents a single collection.

long; cincinni alternate or subopposite, 0.4–1 cm long; 4–6-flowered; pedicels ca. 1.5 mm long, articulate at base. *Flowers* with sepals obtuse at apex, ciliate, with same indument as pedicel, the outer sepals 1.2–2.5 mm long, ovate, the inner sepals 2–3 mm long, obovate or wide ovate, third and fifth sepals connate from 2/3 of their length; petals white, 2.5–3.2 mm long, spatulate, adaxially minutely papillose, the apex rounded; appendages of central petals 1.5–2 mm long, hood-shaped, with fleshy, crown-shaped apex and ciliate margins, the appendages of lateral petals 1.5 mm long, with slightly fleshy apex and ciliate margins; disk glands four, the central glands ca. 0.5 mm long, widely oblong in outline, with obtuse apex,

the lateral glands narrower; torus reduced; filaments sparsely covered with white, inflexed hairs, the anthers ellipsoid, ca. 0.4 mm long. *Fruits* 2.7–3.3 cm long, outline oblong or elliptic, sparsely covered with minute, erect, yellowish hairs with swollen bases, the base subcordate, the apex retuse; locule flattened, with slightly prominent veins; outline of wing not constricted below locule. *Seeds* lenticular, light brown, 0.5–0.6 mm long; *embryo* with biplicate, smaller, adaxial cotyledon and curved, larger abaxial cotyledon.

**Distribution and Phenology.** *Serjania regnellii* is known only from the states of Minas Gerais and São

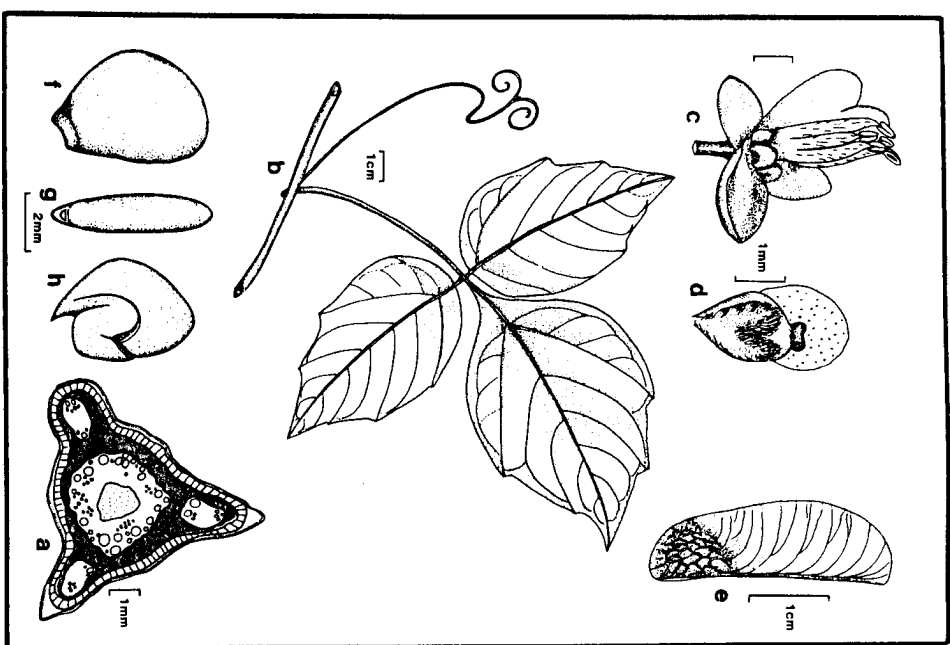


Fig. 37. *Serjania regnellii*: a, cross section of stem with a central and three peripheral stoles; b, Ternate leaf and fragment of branch; c, Staminate flower with petals removed; d, Central petal with adnate appendage; e, Fruit, mericarp; f, Seed, lateral view; g, Seed, ventral view; h, Embryo showing cotyledons configuration. All drawn from Acevedo-Rodríguez & Laca 1512.

Paulo, Brazil (Fig. 36). It has been collected in campo rupestre as well as in open disturbed areas. It flowers from April to May and fruits in August.

**Specimens examined.** BRAZIL, MINAS GERAIS: Belo Horizonte, Apr 1898 (fl), Silveira 2891 (R), Serra do Curral, s.d. (fr), Melo Barreto 6134 (F), Caldas, 28 Mar 1847 (fl, fr), Regnell 138 (S), 10 May 1847 (fl), Regnell 138 (NY), 18 May

1866 (fl), Regnell 138 (MO), 28 May 1866 (fl), Regnell 138 (S), 10 Apr 1877 (fl), Regnell 138 (F); Ouro Preto, Rod. MG-BR 356, 5 km W of Cachoeira do Campo, 22 Aug 1986 (fl), Acevedo-Rodríguez & Laca 1512 (EPAMIG, MO, NY-2 sheets, US); Santo Antonio do Leite, campos vegetation, 9 Apr 1976 (fr), Badini 23379 (NY-3 sheets); Serra do Lemeiro, vic. of São João, 28 Feb 1881 (fl), Glaziov 12508a (R), SÃO PAULO: Without specific locality, s.d. (fl, fr), Damazio s.n. (RB 8373); Cunha, Serra do Monjolo, 14 Apr

1930 (D). *Vegas et al.* 3860 (US), Serra da Cantareira, 16 Apr 1944 (D), W. Hoehne s.n. (SP-11028), 11 May 1979 (D), *Nikolaeva* 5785 (F), 25 Jun 1907 (F), *Usteri* 10408 (SF), Ribeiro Pires, Apr 1937 (D), *Vidal* s.n. (R-36537).

**Field observations.** The stems of *S. regnellii* produce a watery (not milky) exudate when cut, and the fruits are reddish at maturity.

*Serjania regnellii* is morphologically similar to *S. cuspidata*. *Serjania regnellii* and *S. cuspidata* both have sharply triangular stems (although variable in *S. regnellii*) but the latter has long stiff erect hairs on the main angles while the first does not. These species also differ in the shape of their leaflets: those of *S. regnellii* are narrower (oblong or lanceolate) while those of *S. cuspidata* are wider (ovate or sub-trioblate).

This species honors Dr. Anders Fredrik Regnell (1807-1884), a Swedish physician and botanist, collector of the type, who lived for more than forty years in Caldas, Minas Gerais, Brazil.

**7. *Serjania cardiospermioides*** Schlechtendal & Chamisso, *Linnaea* 6: 418, n. 1290, 1831. Type: Mexico. Veracruz: Papantla, Dec 1828 (fr). *Schiede* s.n. (lectotype, HAL, here designated; isotype, HAL).

Figs. 7d, 38a-i.

**Woody vine** to 3 m long. *Stems* slender (less than 1 cm in diam.), obtusely 3-5-angular, with five ribs, three of which are more prominent; cross section of stem with central, subterete to angular, large stiele and three smaller, elliptic, peripheral stiales, these not included in the central one which becomes terete when old. *Stipules* deltoïd, 1 mm long, with ciliate margins. *Leaves* ternate; petioles shorter than leaflets, not winged, sub-terete, adaxially flattened, sparsely to densely covered with light yellow, curly, 0.1-0.3 mm long hairs, these swollen at base; leaflets chartaceous, with long acuminate or cuspidate apex, the terminal leaflet wider, ovate, widely ovate, or trilobate, (4.6-6.9(-12) × 3.5-7(-11) cm, with rounded or abruptly and short-attenuate base, decurrent onto petiole 1.5-3(-4) cm long, the lateral leaflets lanceolate, (3.5-5.7(-10) × 2.5-5(-7) cm, with oblique truncate base, shortly petiolulate (1-1.5 cm long), the upper surface densely to sparsely covered with yellowish, appressed hairs, especially on veins, sometimes glabrescent, the lower surface densely to sparsely covered with yellowish, prostrate or erect hairs, especially on veins, the margins remotely serrate,

ciliate and scarious, the teeth clear glandular, acute, obtuse or rounded, the veins mixed craspedotomous, the primary and secondary veins slightly prominent on lower surface. *Inflorescence* axillary, as long as or three times longer than subtending leaf; axis 4-angular, usually twining, with yellowish, 0.5-1 mm long hairs; rachis angular, furrowed, with similar indument as axis, but the hairs shorter (0.3 mm long); bracts and bracteoles subulate or lanceolate, 1.5 mm long, with ciliate, glandular margins, the secondary bracteoles shorter; cinchimi (-drepania) alternate or opposite, 0.3-0.7(-0.9) cm long, with same indument as rachis, usually 5-flowered; pedicels 2.5-5 mm long, articulate at 1-2 mm from base, with same indument as peduncle, but finer. *Flowers* with sepals densely covered with whitish, slender hairs, the outer sepals (1.5-)2-3 mm long, ovate and obtuse at apex, the inner sepals (2.5-)3-4 mm long, obovate, with obtuse apex, third and fifth sepals connate 2/3 of their length; petals white, 4-5 mm long, broadly spatulate or obovate, adaxially densely and minutely papillose, the apex rounded; appendages of central petals ca. 3.5 mm long, hood-shaped, with fleshy, crown-shaped apex and ciliate margins, the appendages of lateral petals 3 mm long, with slightly fleshy apex and ciliate margins; disk glands four, the central glands 0.8-1 mm long, ovate in outline, and obtuse at apex, the lateral glands smaller or reduced, elliptic; lobes more or less enlarged; filaments densely to sparsely covered with white, inflexed hairs, the anthers ellipsoid, 0.6-0.7 mm long; ovary with obovate outline, sparsely covered with whitish, short, inflexed hairs. *Fruits* 2.4-4(-4.7) cm long, outline oblong or ovate, glabrous, the base truncate, subcordate or rounded, the apex reuse; locules flattened, with slightly prominent, reticulate network of veins; outline of wing not constricted below locule; partitioning wall narrowly elliptic, 0.7-0.8 × 0.2 cm. *Seeds* lenticular, light brown, ca. 0.6 mm long; *embryo* with erect cotyledons.

**Distribution and Phenology.** *Serjania cardiospermioides* occurs in the lowlands of Mexico, Guatemala, Honduras, El Salvador, Nicaragua, and Costa Rica (Fig. 39). It has been collected in primary tropical rainforest, deciduous forest, pine forest, gallery forest, thickets, and in distributed areas such as secondary forest and roadsides at elevations from 30 to 1600 m. It flowers year-round and usually fruits from September to March.

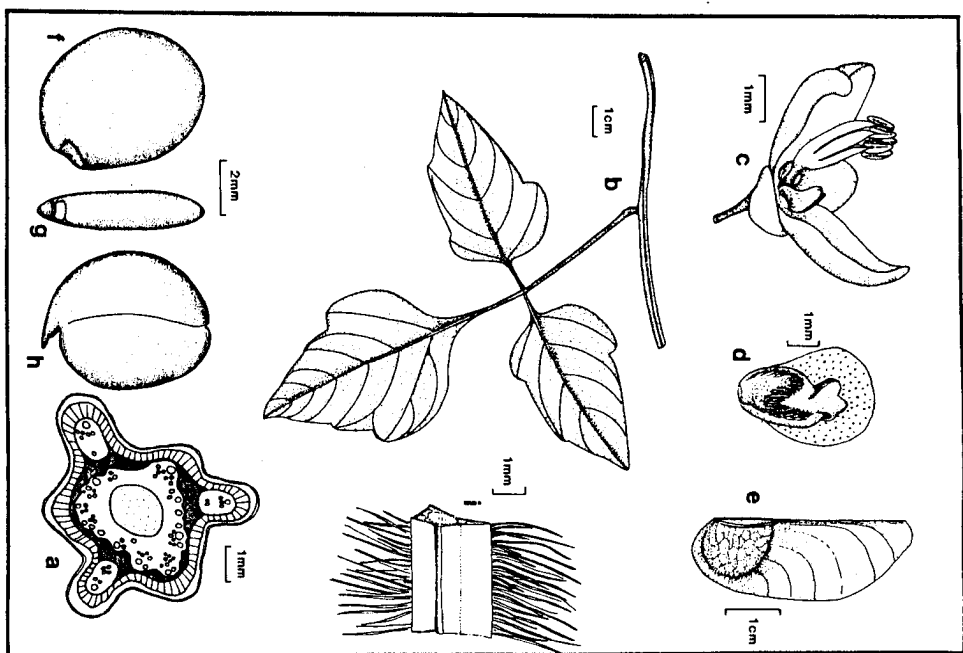


Fig. 38. *Serjania cardiospermioides* var. *cardiospermioides*. a. Cross section of stem showing central stiele and three peripheral stiales (Purpus 8681). b. Ternate leaf and fragment of stem (Purpus 2063). c. Staminate flower with petals removed (Nee 23640). d. Central petal with adnate appendage, petal densely papillose (Nee 23640). e. Staminate flower with petals removed (Nee 23640). f. Seed ventral side (Catalan 4247). g. Seed ventral side (Catalan 4247). h. Embryo with straight cotyledons (Catalan 4247). i. Seed ventral side (Catalan 4247). g. Seed ventral side (Catalan 4247). h. Embryo with straight cotyledons (Catalan 4247). i. Seed ventral side (Catalan 4247).

*Serjania cardiospermioides* is distinct from the remaining species of *S. sect. Platycoccus*. It is morphologically similar to *S. cuspidata* or *S. regnellii*, but differs by its obtusely 3-angled stems (vs. sharply triangular). The name *cardiospermioides* refers to the vegetative similarity of this species with some species of *Cardiospermum*.



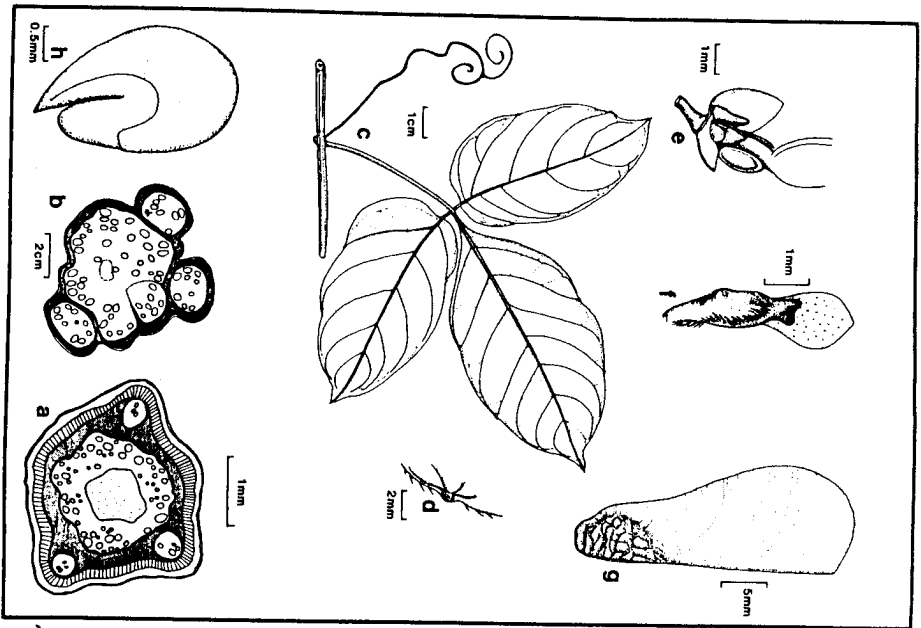


Fig. 40. *Serjania tenuis*: a. Cross section of young stem with a central and three peripheral steles (Eiten & Eiten 6258). b. Cross section of mature stem (Riedel & Luechmann 505). c. Ternate leaf with branch fragment (Eiten & Eiten 6258). d. Glandular tooth on leaflet margin (Eiten & Eiten 6258). e. Pistillate flower with sepals and petals removed (Schlich s.n.). f. Central petal with adaxial appendage (Duarte 5824). g. Fruit mericarp (Duarte 5824). h. Embryo showing cotyledons configuration (Duarte 5824).

five-angular, with three to five prominent ribs, glabrous and smooth; cross section of stem with a central, obtusely triangular, large stele and three peripheral, smaller, terete or subterete steles, these not included in central one. *Stipules* deltoïd, 0.9–1.5 mm long, glabrous. *Leaves* ternate; petioles not

winged, terete, as long or shorter than leaflets, axially furrowed, glabrous except for few erect or inflexed hairs, 0.5 mm long, on adaxial surface; leaflets membranous to chartaceous, with acuminate or mucronate apex, the terminal leaflet larger, ovate, elliptic or oblong-lanceolate, (3)–6–11 ×

1993]

ACEVEDO-RODRIGUEZ: SERJANIA

73

2.1–5.2 cm, with attenuate base, the laterals oblong or lanceolate, (3)–4.2–7.5(–9) × 1.6–3.5(–4.2) cm, with oblique, rounded base, sessile or shortly petioled (1–1.5 mm long), the upper surface glabrous, except for a few erect or inflexed hairs, 0.3–0.5 mm long on midvein, the lower surface glabrous, the margins entire, scarious, crenate or remotely and obtusely serrate, ciliate and slightly revolute, the teeth glandular, the veins mixed craspedotromus, the primary and secondary veins slightly prominent on both surfaces. *Inflorescence* axillary, 1.5 times longer than subtending leaf; axis 4-angular, striate, sparsely covered with minute, ca. 0.2 mm long, yellowish or whitish, curly hairs; bracts and bracteoles subulate, ca. 1 mm long, margins with glandular hairs; cincinni alternate, 0.5–3 mm long, with same indument as rachis, 3–6-flowered, pedicels 2–4 mm long, articulate close to base, sparsely covered with minute whitish hairs. *Flowers* with sepals obtuse at apex, the outer sepals 1.2–2.5 mm long, ovate, the inner sepals (2.5)–3–4.6 mm long, oblong or wide ovate, third and fifth sepals connate 7/8 of their length; petals white or light yellow, 4–5.5 mm long, spatulate or oblanceolate, sparsely covered with minute papillae on adaxial surface, the apex rounded; appendages of central petals 3–4 mm long, basally connate with petals to 2 mm, hood-shaped, with fleshy, crown-shaped apex and ciliate margins, the appendages of lateral petals 3 mm long, with slightly fleshy apex and ciliate margins; disk with two or four glands, the central glands ca. 0.8 mm long, ovate in outline, with obtuse apex, the lateral glands obsolete or less often slightly developed; ions enlarged; filaments densely covered with white, inflexed hairs, the anthers ellipsoid, ca. 0.5 mm long; ovary oblong or ellipsoid, densely covered with white, inflexed, minute hairs. *Fruits* 2.1–3.2 cm long, outline ovate, sparsely covered with minute, erect, whitish hairs with swollen bases, the base cordate, the apex retuse; locules flattened, with slightly prominent veins; outline of wing not constricted below; locule endocarp densely covered with whitish, floccose hairs. *Seeds* flattened, with oblong outline, dark brown, ca. 3 mm long (immature); *embryo* with biplicate, smaller, adaxial cotyledon and curved, larger, abaxial cotyledon.

**Distribution and Phenology.** *Serjania tenuis* is endemic to the state of Rio de Janeiro, Brazil (Fig. 41). It is naturally distributed along coastal, open areas from where it invades secondary formations. It has been collected from sea level to 950 m eleva-

tion. *Serjania tenuis* flowers mostly from January to July and fruits in May.

**Specimens examined.** BRAZIL. Without specific locality, s.d. (fl). *Burchell* 2781 (K). RIO DE JANEIRO: Without specific locality, Faz. Bocinha, Feb 1937 (fl). *Freire* 782 (R); Laguna, Baía de Sepetiba, Ilha Furada, along coast, 30 Mar 1968 (fl). *Marrinelli* 1543 (NY, RB-2 sheets), coastal area, 30 Mar 1968 (fl). *Sacre & Braga* 2594 (NY, RB-9 sheets), 30 Mar 1968 (fl). *Sacre & Braga* 2626 (NY, RB-2 sheets). Niterói, Saco de São Francisco, 21 Apr 1942 (fl). *Pereira* s.n. (R-35012). Paraná, Paraní, sea level, roadside, 21 Apr 1965 (fl). *Eiten & Eiten* 6258 (MO, NY, US). Resende, Jaituba, Oct 1872 (fl). *Glazio* 5772 (R), Rio de Janeiro, without specific locality, May–Jun 1822 (fl, fr). *Forbes* s.n. (BM), 1852 (fl). *Riedel & Luechmann* 505 (A, NY-2 sheets), s.d. (fl). *Schott* 713 (F, K, NY), Apr 1883 (fl, fr). *Glazio* 13694 (K); Corcovado, 12 Apr 1931 (fl). *Bridle* 10719 (R-4 sheets); Gávea, close to the sea, 4 May 1872 (fl, fr). *Glazio* 5772 (R), 6 Apr 1943 (fl). *Silva* s.n. (RB-48002); Gramari, restinga, 8 Mar 1935 (fl). *Freire* 591 (R), in secondary formations, 8 May 1969 (fl). *Sacre* 4980 (MO, NY-2 sheets, RB-2 sheets), 8 May 1969 (fl, fr). *Sacre* 4968 (RB-2 sheets), 80–100 m, 23 Mar 1972 (fl). *Sacre* 8744 (MO, NY-2 sheets, RB); Laguna Rodórgo de Freitas, 16 May 1961 (fl, fr). *Duarte* 5824 (F, NY, R, U, US); Guaratiba, roadside s.d. (fl). *Almeida & Larroche* 1349 (RB-2 sheets), s.d. (fl). *Gaudichaud* 834 (F-2 sheets), Teresopolis, Serra dos Orgãos, ex Miers herbarium, collector unknown 2129 (BM-2 sheets).

**Field observations.** The inflorescences of *S. tenuis* are pendant.

*Serjania tenuis* is morphologically similar to *S. communis* and *S. undulata*. However, it differs from the former by its ternate leaves (vs. bilternate), essentially glabrous parts (vs. variously pubescent), and embryo with biplicate cotyledons (vs. straight). From *S. undulata* it differs by its stems with a central and three peripheral steles (vs. a central surrounded by 6–7 peripheral steles), and embryo with biplicate cotyledons (vs. straight).

The name *tenuis* (thin or slender) probably refers to the slender fruits of this species.

9. *Serjania unidentata* Acevedo-Rodriguez, Brittonia 39: 350, fig. 2, 1987. Type: Brazil, Santa Catarina: Município de Mafra, on side of highway 116 at Km 9 (3 km from Mafra), on rocky soil, 900 m, 11 Sep 1966 (fl, fr). *Acevedo-Rdzg., Hasebach & Souza* 1570 (holotype, BM; isotypes, CTES, F, MO, NY, RB, US). Fig. 42a–h.

Woody vine to 10 m long. *Stems* to 1 cm in diam., terete, slightly 8-sulate; cross section of stem with

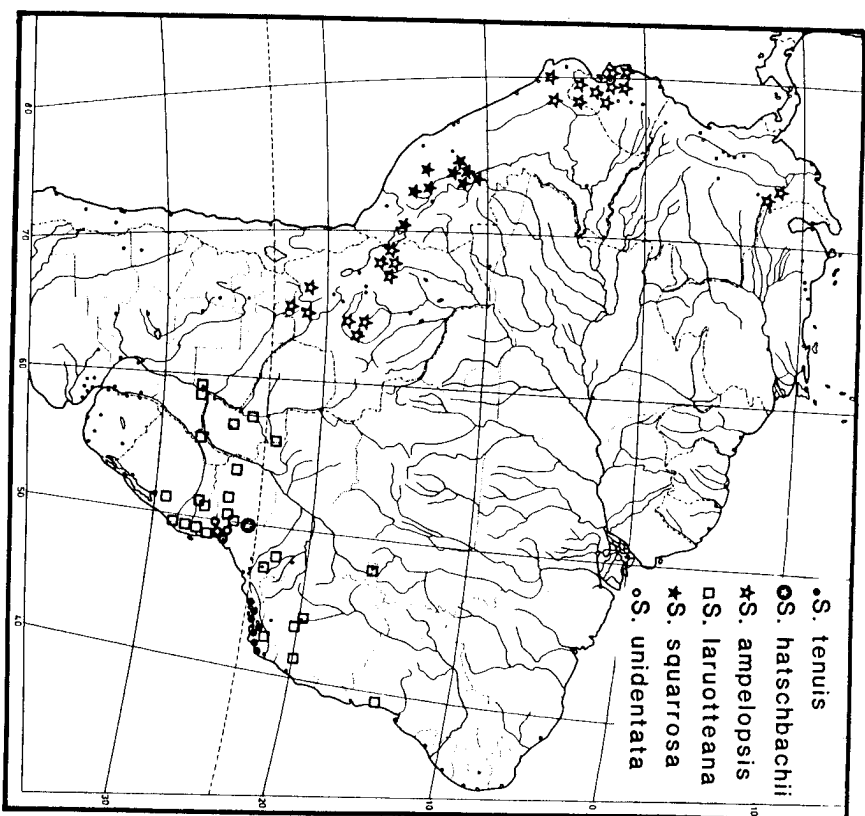


Fig. 41. Distributions of *S. tenuis*, *S. hatschbachii*, *S. ampelopsis*, *S. laruotteana*, *S. squarrosa* and *S. unidentata*. Each symbol represents a single collection.

central, terete stipe surrounded by (6-)7 terete, smaller stipes; *Stipules* subulate, 2 mm long; *Leaves* ternate; petioles not winged, shorter than leaflets, adaxially plose; leaflets 4-15 x 1.5-5 cm, chartaceous, dull green, glabrous, acuminate or acute at apex, the terminal leaflet slightly larger, elliptic, with attenuate base, the lateral lanceolate, with oblique, obtuse base, and shortly petiolulate, the margins revolute, pale, remotely denate, and ciliate, the teeth somewhat glandular and rounded, the veins semicretaspedodromous, the primary and secondary veins prominent on lower surface; *Inflorescence* axillary, longer than subtending leaf, axis subterete or angular, usually coiling, gla-

brous; rachis terete, sparsely covered with minute, ca. 0.2 mm long, whitish, curly hairs; bracts and bracteoles subulate, 1 mm long, with glandular hairs along margins; *cinconi* alternate, 0.1-4 mm long, with same indument as rachis, 3-6-flowered; pedicels 3 mm long, articulate at base; *Flowers* with sepals 4, ciliate, adaxially tomentose, the external two 3.5 mm long, ovate, obtuse, the connate internal one (consisting of third and fifth) 6 mm long, the fourth 4 mm long; petals pale yellow, spatulate, 6 mm long, adaxially papillose; appendages of central petals 4 mm long, crown-shaped and fleshy at apex, the appendages of lateral petals 3 mm long; torus well developed;

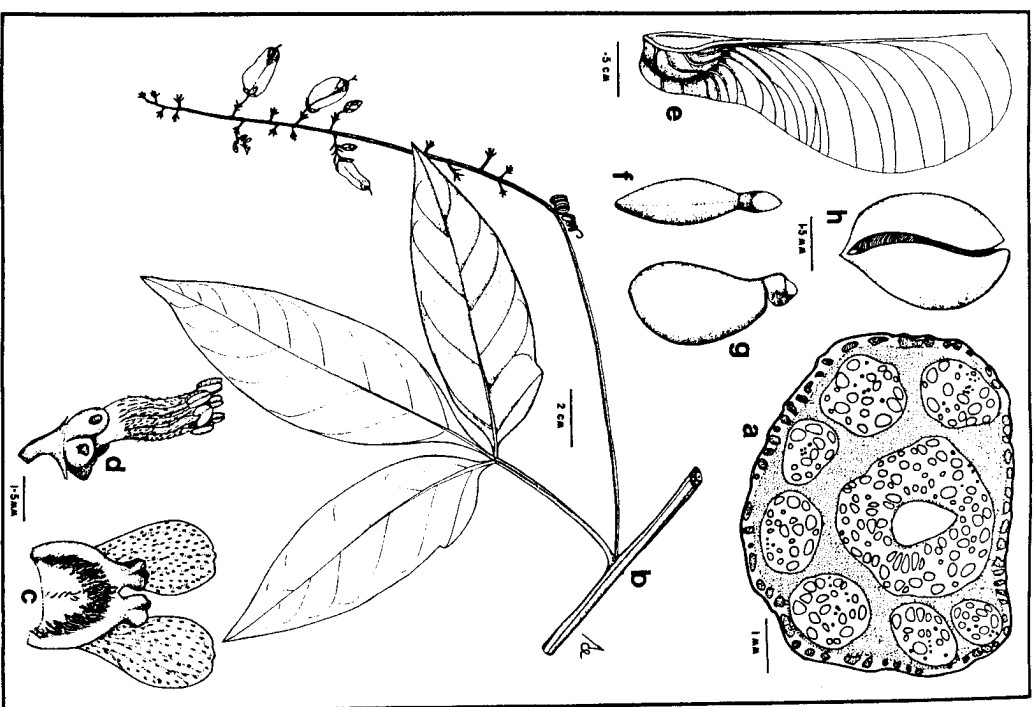


Figure 42. *Serjania unidentata*. a. Cross section of stem showing a central and seven peripheral steles. b. Fruiting branch with ternate leaf. c. Petals with appendage. d. Staminate flower with sepals and petals removed, showing nectary glands and stamens. e. Mericarp. f. Seed, ventral view. g. Seed, lateral view. h. Embryo showing configuration. (All from Acevedo-Rodríguez *et al.* 1970).

filaments with woolly, white hairs, the anthers elongate (1.3-1.4 cm wide); locules lentiform, 7 x 4 mm, dorsal side with a decurrent wing; partioning straw-colored, chartaceous, wings wider close to base (1.3-1.4 cm wide);

pliose. Seeds asymmetrically lentiform, 5-7 mm long, reddish brown, attached near to base of locule; embryo with straight cotyledons.

**Distribution and Phenology.** *Serjania unidentata* is endemic to the southern states of Paraná and Santa Catarina, Brazil (Fig. 41). It has been collected along disturbed patches of vegetation. It flowers from July to September and fruits from September to October.

**Specimens examined.** BRAZIL, PARANÁ: São José dos Pinhais, Cachoeira, 31 Jul 1986 (fl), *Cordeiro & Silva* 329 (CTES); Campina Grande do Sul, Serra Capivari Grande, 14 Jul 1986 (fl), *Silva & Cordeiro* 126 (CM, CTES); Piranguara, Borba do Campo, 30 Oct 1986 (fr), *Hanschbach & Souza* 50684 (CM, CTES); SANTA CATARINA: Matriz, 5 km S of Matriz, along road BR-116, 5 Oct 1988 (fr), *Hanschbach & Kummrow* 52390 (MBM, US).

**Field observations.** The stems of *S. unidentata* produce a watery sap (not milky) when cut, inflorescences are pendant with twining axes, and the fruits turn from green to straw-colored.

*Serjania unidentata* seems to be closely related to *S. tenuis*, because of their similar leaves and flowers. However it differs from this species by its stems with a central stiele surrounded by 6-7 peripheral stieles (vs. a central one with 3 peripheral ones), and embryo with straight cotyledons (vs. biplicate).

The epithet *unidentata* refers to the striking tooth on the lower outer margins of the lateral leaflets; in the type material.

10. *Serjania hatschbachii* Ferrucci, Bonplandia 5: 243. 1983. Type. Brazil. Paraná: Adrianópolis, barra Rio Pardo, margin of forest, 4 Apr 1976 (fl, fr), *Hanschbach* 38822 (holotype, MBM, isotype, CTES).

Figs. 10c; 18b; 43a-i.

Semi-woody vine. Stems ca. 0.6 cm in diam., subterete, with 6 prominent ribs, sparsely covered with 2-3 mm long, setulose yellowish hairs, glabrescent, spiny projections often present; cross section of stem with central, subterete, large stiele and (3-4)-5 peripheral, smaller, terete or subterete stieles, these not included in central one. *Stipules* deltid to subulate, ca. 1 mm long, with setulose and glandular hairs on margin. *Leaves* biternate; petioles and rachis not winged, sub-

terete, adaxially furrowed, densely to sparsely covered with same indument as stems, petioles shorter than primary rachis; leaflets chartaceous, with acuminate and mucronate apex, the terminal leaflet larger, lanceolate or elliptic, (3)-6-11 x 2.1-5.2 cm, with long attenuate base, the lateral leaflets lanceolate or elliptic, (3)-4.2-7.5(-9) x 1.6-3.5(-4.2) cm, with rounded base, sessile, both surfaces glabrous, except for a few hairs on midvein of upper surface, the margins revolute, scarious, remotely and acutely serrate, ciliate when young, the teeth glandular, the veins semi-crispedodromous, the primary and secondary veins slightly prominent on lower surfaces. *Inflorescence* axillary, longer than subtending leaf, axis 4-angular, glabrous, usually twining; rachis subterete, glabrous and striate; bracts and bracteoles subulate, ca. 1 mm long, margins with glandular hairs; cinchinal whorled, 0.8-1.2 cm long, glabrous, 5- to 7-flowered; pedicels 2-4 mm long, articulate close to base, sparsely covered with minute, whitish hairs. *Flowers* with sepals 5, obtuse at apex, the outer sepals 1.7 mm long, ovate, the inner sepals 2.5 mm long, oblong or widely ovate, third and fifth sepals free; petals 3-3.5 mm long, spatulate, sparsely covered with minute papillae on adaxial surface, the apex rounded; appendages of central petals cream color, ca. 2.5 mm long, hood-shaped, with fleshy, crown-shaped apex and ciliate margins, the appendages of lateral petals 3 mm long, with slightly fleshy apex and ciliate margins; disk with four glands, ca. 0.7 mm long, ovate in outline, with obtuse apex; torus reduced; filaments sparsely covered with white, inflexed hairs, the anthers ellipsoid, ca. 0.4 mm long, *Fruits* 2.2-2.5 cm long, heart-shaped in outline, glabrous, the base obtuse, the apex venose; locules flattened, with slightly prominent veins; wings reduced toward the base. *Seeds* flattened, lenticular, light brown, 7 mm long; embryo with biplicate, smaller, adaxial cotyledon and curved, larger abaxial cotyledon.

**Distribution and Phenology.** *Serjania hatschbachii* is known from three collections from Adrianópolis-Ribeira at the border of Paraná and São Paulo (Fig. 41). It has been collected in flower and fruit in January and April.

**Specimens examined.** BRAZIL, PARANÁ: Adrianópolis, road to Ribeirão do Rocha, 27 Jul 1987 (sn), *Hanschbach & Silva* 51291 (US). SÃO PAULO: Ribeira, on effr., 15 Jan 1993 (fl, fr), *Hanschbach* 2957 (US).

*Serjania hatschbachii* is morphologically similar

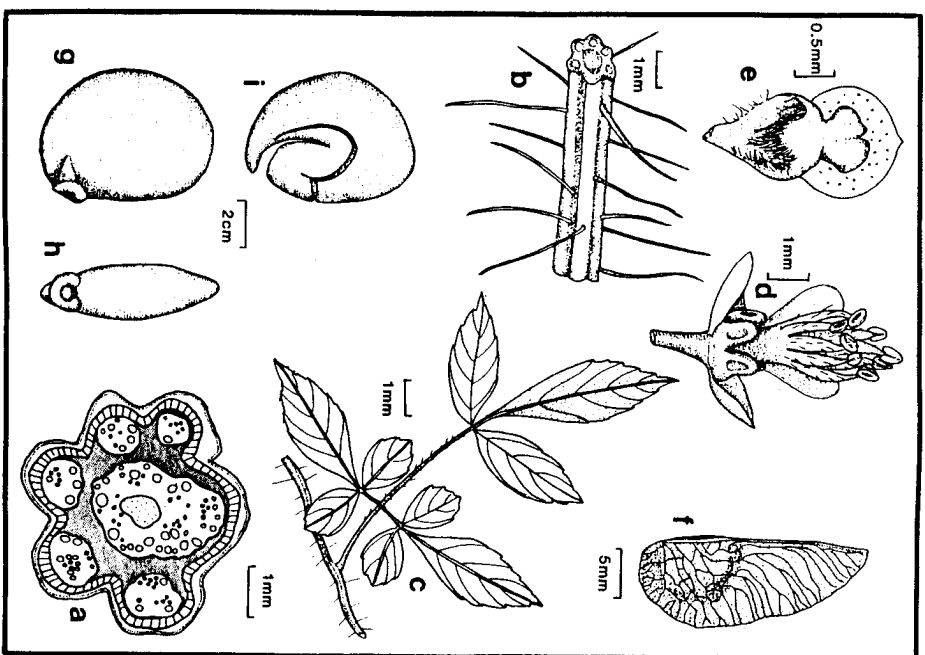


Fig. 43. *Serjania hatschbachii*: a. Cross section of stem showing a central and five peripheral stieles. b. Section of stem with hisute indument. c. Biternate leaf and fragment of branch. d. Staminate flower with petals removed. e. Central petal with adnate appendage. f. Fruit mericarp with reduced wing. g. Seed, lateral view. h. Seed, ventral view. i. Embryo showing configuration. All drawn from *Hanschbach* 2957.

to *S. tenuis*. However, it differs from this species by its biternate (vs. ternate) leaves, sparsely hisute stems (vs. glabrous), cross section of stem with five to seven peripheral stieles (vs. three) and fruits with a very reduced wing.

This species honors Gert Hanschbach, who made the only collections of this species as well as of many

other interesting plants from southeastern Brazil.

11. *Serjania larroiteana* Cambessedes in St. Hilaire, Fl. Bras. Mém. 1: 368. 1828. Type. Brazil. Minas Gerais: Villa de Pati, s.d. (fr), *Larrouite s.n.* (holotype, P).

Fig. 44.



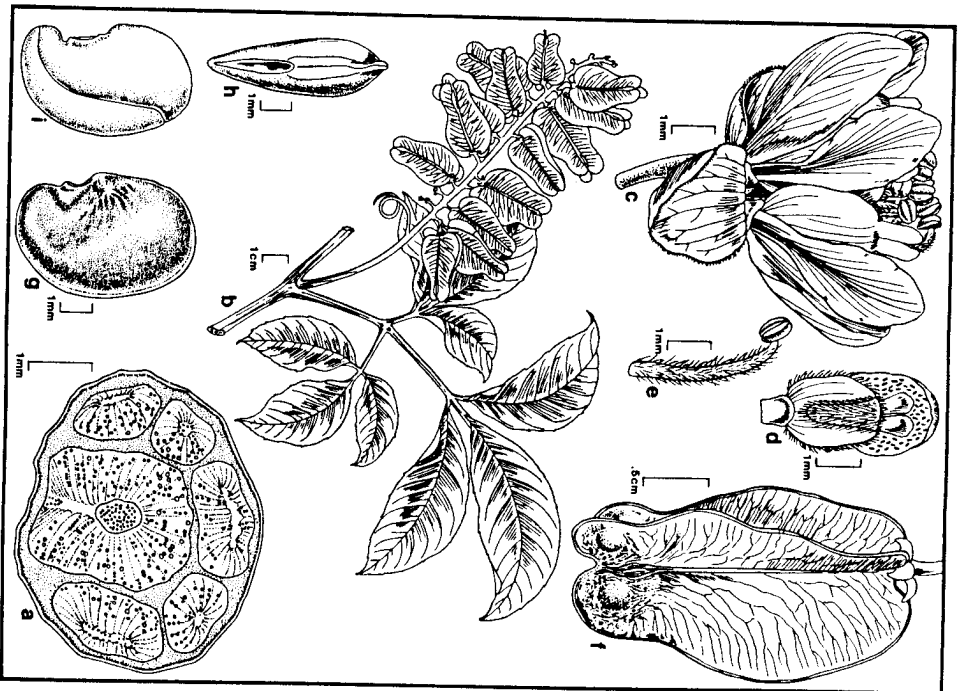


Fig. 44. *Serjania larreae*. a. Cross section of stem showing a central and five peripheral steles (Acevedo-Rdgz. & G. L. Follis 3690). b. Fruiting branch with bierrate leaf (Acevedo & Badini 1518). c. Staminate flower (Dusen 8050). d. Central petal with adaxial appendage (Dusen 8050). e. Anther filament with inflated hairs (Dusen 8050). f. Fruit with three mericarps (Acevedo-Rdgz. & G. L. Follis 3690). g. Seed, lateral view (Acevedo-Rdgz. & Badini 1518). h. Seed, ventral view (Acevedo-Rdgz. & Badini 1518). i. Embryo showing configuration (Acevedo-Rdgz. & Badini 1518).

*Paulinia belangerioides* Gardner, London J. Bot. 2: 338. 1843. Type, Brazil, Rio de Janeiro, Serra dos Orgaos, Mar 1838 (f), Gardner 341 (holotype, BM, n.v.; isotype, NY).

*Serjania selowiana* Klotzsch & Trevisanus, Bot. Zeitung (Berlin) 5: 393. 1847, nomen nudum.

Woody climber to 15 m long. Stems to 4 cm in diam., terete or angular, usually with whitish striae, young stems terete, densely covered with straw-colored or whitish, curly hairs, ca. 0.4 mm long; cross section of stem with a central, angular stele, sur-

1993]

ACEVEDO-RODRIGUEZ: SERJANIA

79

rounded by 4 to 8 peripheral ones, the peripheral steles terete to flattened, of different sizes. *Stipules* deltoid, 1.3 mm long, early deciduous. *Leaves* bierrate, 11–28 × 10–28 cm, all axes densely covered with straw-colored or whitish, curly hairs, ca. 0.4 mm long, petioles not winged, terete and striate, 2.5–7 cm long, with darkened pulvinus; main rachis furrowed or margined, 2.5–5.5 cm long, the secondary rachises 0.5–2 cm long; leaflets chartaceous, lanceolate, elliptic, or oblong, 4.5–14 × 1.8–4.5 cm, the terminal leaflets larger, the apex acuminate or abruptly acuminate, often mucronate, the base attenuate in terminal leaflets, obtuse and oblique in lateral leaflets, the upper surface glabrous, the lower surface with dark network of tertiary veins, glabrous with tuft of hairs at vein's angle, the margins revolute, and finely serrate, veins semicraepodromous, the primary vein raised on both surfaces. *Inflorescence* axillary or terminal, 10–20(–35) cm long, longer than subtending leaves, with same indument as stems; axis 3–12 cm long, terete or nearly so; rachis terete or slightly angular, striate; bracts and bracteoles deltoid to subulate, 1.2–3 mm long, glabrous with serrulate or glandular margins; drepania (-cincinnid) alternate, the peduncle 0.5–3.5 mm long, 3- to 6-flowered; pedicels 2–3.5 mm long; articulate near the base. *Flowers* with sepals 5, the outer sepals 2–2.5 mm long, ovate, obtuse at apex, glabrous, ciliate at margins, the inner sepals 3–3.5 mm long, oblong-ovate, densely covered with minute (to 0.1 mm long), whitish, woolly hairs, the third and fifth sepals free; petals white, spatulate, ca. 4 mm long, sparsely papillose on adaxial surface; appendages 3 mm long, the central appendages hood-shaped, with fleshy, crown-shaped apex, the lateral appendages asymmetric, slightly fleshy at apex; disk glands four, 1–1.2 mm long, ovate to sub-rounded; torus enlarged into a short androgynophore; filaments sparsely to densely covered with minute (0.1–0.2 mm long), whitish, woolly hairs, the anthers 0.6–0.7 mm long; ovary obovoid-trigonus, 2–2.5 mm long, glabrous or whitish, floccose; style 1–2 mm long. *Fruits* 2–4 × 1.7–2 cm, with nearly oblong outline, but constricted below the locule, or obpanurate, chartaceous, glabrous or sparsely pubescent, the apex notched, the base cordate; locule lenticular, flat, with network of slightly raised, dark veins, not crested. *Seeds* light brown, nearly lenticular, 5.5–6.5 × 4.6–5 mm; embryo symmetrical in frontal plane, the cotyledons straight, the adaxial cotyledon slightly smaller.

**Distribution and Phenology.** *Serjania larreae* is a common species from southeastern Brazil, Paraguay and Argentina (Fig. 42). It occurs in semi-dry forests as well as open or disturbed areas from sea level to ca. 1000 m elevation. It flowers from February to June and fruits from June to January.

**Specimens examined.** BRAZIL. Bahia: Rio Ilha, Aug 1821 (D). *Riedel* 256 (NY, 3 sheets, US); Rio Una, 1 Aug 1821 (Dd). *Riedel* 285 (NY). Distrito Federal: Baçhi do Rio Bartolomeu, along gallery forest, 5 Jun 1979 (Dd), Mendonça & Silva 54 (NY, US). Espírito Santo: Itabora, Corrego São João, in open area, 11 Jun 1985 (f), *Hutchbach* 49396 (MBM, NY, US). MINAS GERAIS: Belo Horizonte, along roadside, 800 m, 19 Aug 1986 (f), *Acevedo-Rdgz. et al.* 1463 (EPAMIG, NY, US), (st). *Acevedo-Rdgz. et al.* 1465 (EPAMIG, NY, US). Ouro Preto, along roadside, 27 Aug 1986 (f), *Acevedo-Rdgz. & Badini* 1518 (NY, US), 550 m, 20 Aug 1986 (f), *Acevedo-Rdgz. et al.* 1501 (EPAMIG, NY, US); Viçosa, São Miguel, disturbed vegetation, 900 m, 26 Jan 1930 (f), *Mexia* 4799 (GB, NY, US), along Chaçala Valley Road, 2 km from Agriculture College, in cut-over thickety woods, 675 m, 21 May 1930 (f), *Mexia* 4776 (NY, US). PARANA: without exact locality, along Iguaçu river, 12 Dec 1908 (st), *Dusen* 7353 (US); Campo Largo, secondary vegetation, 25 Apr 1964 (D), *Dombois* 213 (US); Guarapuava, São Judas Tadeu, in disturbed vegetation, 15 May 1986 (f), *Hutchbach & Manso* 50373 (US); Lapa, Rio Passa Dois, along roadside in secondary forest, 900 m, 10 Sep 1986 (f), *Acevedo-Rdgz. et al.* 1562 (MBM, NY, US); Matelândia, margin of rainforest, 18 Jun 1967 (f), *Hutchbach* 16573 (MO, NY, US); Rio Branco, Cate, along forest margin, 17 Jul 1964 (f), *Hutchbach* 48080 (MBM, NY, US); São Mateus do Sul, along road toward Irate, in degraded vegetation, 10 Sep 1986 (f), *Acevedo-Rdgz. et al.* 1564 (NY); Villa Velha, in forest, 27 Apr 1909 (f), *Dusen* 8050 (NY, US). RIO DE JANEIRO: Mandioca, Jan 1823 (D), *Riedel* s.n. (NY, 2 sheets, US); RIO GRANDE DO SUL: Pai, vic. of Caxias, 21 Jun 1950 (f), *Rambo* 47159 (CM); Reuterberg, in primary forest, 6 Jun 1949 (f), *Rambo* 41849 (NY, US). SANTA CATARINA: Antipólis, Palhoça, along secondary vegetation, 500 m, 4 Apr 1953 (Dd), *Klein* 488 (NY, US-2 sheets); Guatambu, Campos Novos, margin of forest, 700 m, 10 Jul 1963 (f), *Reitz & Klein* 15197 (US). Major Vitoria, in disturbed vegetation, 750 m, 10 Jul 1962 (f), *Reitz & Klein* 13083 (US); Rio do Meio, along secondary vegetation, 15 Jan 1959 (f), *Reitz & Klein* 8227 (NY); Sanga de Arica, Jacinto Machado, margin of disturbed vegetation, 200 m, 13 May 1960 (f), *Reitz & Klein* 9068 (US); Serra do Espigão, Monte Castelo, 1000 m, 20 Apr 1962 (f), *Reitz & Klein* 12643 (US). SÃO PAULO: Banianus, 11 May 1920 (f), *F. C. Hoehne* 3964 p. p. (NY); Campinas, s.d. (D), *Campos Novas* 454 (US), 27 Apr 1968 (Dd), *Correa de Melo* s.n. (NY); São Carlos, Santa Eudoxia, in secondary forest, 500 m, 21-29 S., 47°51' W., 20 Jun 1961 (f), *Ehren* et al. 3077 (MO, US).

PARAGUAY: AMAMBAY (?): Sierra de Amambay, May 1907-08 (f), *Rojas* 10448 (NY). PARAGUARI: vic. of Sapanai, May 1913 (f), *Hassler* 11730 (NY, US), SAN

PERU: Primavera, wet area along wood edge, 20 Jul 1956 (Fr.), *Woolston 638* (NY).

ARGENTINA, CORRIENTES: Harí, Tynait, 19 Aug 1956 (Fr.), *Pedersen 396* (NY, US); Santa Ana, 8 Sep 1910 (D), *Rodríguez 351* (US); Misiones: San Ignacio, Yabebey, 20 May 1944 (D), *Berteri 74* (A, NY).

**Field observations.** The stems of *S. larnottiana* usually produce an abundant milky exudate when cut. Fruits are either green or red at maturity.

*Serjania larnottiana* was placed by Radlkoter in his *S. sect. Eucoceus* (my sect. *Serjania*), in spite of its mericarps with flattened locules. He considered *S. larnottiana* to be closely related to *S. sphaerococca*, even though the latter has globose fruit locules. Moreover, there is no discussion as to why *S. larnottiana* was included within this section. *Serjania larnottiana* certainly should be included in *S. sect. Platycoccus* because of its flattened and membranous mericarp locules with lenticular seed. *Serjania larnottiana* differs from other species in *S. sect. Platycoccus* by the production of a white exudate, a character which is not always present, however.

12. *Serjania ampelopsis*: Planchon & Linden in Triana & Planchon, Ann. Sci. Nat. Bot. IV, 18: 350, 1862. Type: Colombia, Norte de Santander, Prov. de Ocaña, vic. Ocaña, 1390 m, Oct 1850 (D), *Schlim 153* (lectotype, BR, here designated; isotype, BR, F, K). Figs. 15e, 18g, 45.

*Serjania areolata* Radlkoter, Ergänz. Monogr. Serjania 87, 1886. Type: Bolivia, La Paz; Nor Yungas, vic. Coroico, 5000-7000 ft, May 1866 (D), *Pearce s.n.* (holotype, K).

Semi-woody climber to 5(-8) m long. Stems slender (ca. 5 mm in diam.), nearly terete, or 5- to 6-costate, glabrous; the young stems angular; cross section of stem with single stele, the medulla hollow. *Stipules* deltoïd, ca. 1 mm long, usually covered with minute (to 0.3 mm long) whitish hairs. *Leaves* biternate, 11-20 × 12-19 cm, all axes sparsely to densely covered with minute (to 0.35 mm long) whitish hairs; petioles not winged, terete and ridged at adaxial surface, (1.5-2.6(-7) cm long; main rachis terete, marginated, or narrowly winged, (1.5-1.7-3.2(-4.2) cm long, the secondary rachises 0.5-2.5 cm long; leaflets chartaceous to membranous, lanceolate, elliptic, oval or ovate, 2.9(-12.5) × 1-3.5(-7) cm, the terminal leaflet larger, the apex acuminate or abruptly acuminate, the base attenuate, obtuse or rounded in terminal leaflet, oblique and shortly petiolulate in lateral leaf-

lets, the upper surface glabrous except for few hairs on veins, covered with whitish, mucilaginous dots, the lower surface lighter (because of whitish glandular projections), with dark network of tertiary veins, glabrous or sparsely covered with minute (0.3-0.5 mm long), whitish hairs, the margins revolute, ciliate, entire or remotely dentate to sub-serrate, the veins brochidodromous or mixed craspedodromous, the primary and secondary veins slightly raised on both surfaces. *Inflorescence* 10-20(-35) cm long, usually longer than subtending leaves; axis 4-12 cm long, glabrous, almost terete; rachis angular, striate, densely or sparsely covered with minute (to 0.15 mm long), whitish, inflexed hairs; bracts and bracteoles lanceolate, 1-2.5 mm long, with same indument as rachis; cincinni opposite, subopposite or alternate, the peduncle 0.5-1.4(-2.5) cm long, glabrous or densely covered with minute (to 0.15 mm long), white hairs, 4- to 5(9)-flowered, the lower peduncles longer, pedicels 2-5 mm long, slightly flattened, with same indument as peduncle, articulate at 1-2.5 mm from base; bracteoles narrowly deltoïd, 0.5 mm long, close to pedicel articulation. *Flowers* with sepals 5, the outer sepals 2-3.5 mm long, ovate, obtuse at apex, sparsely covered on abaxial surface with minute (to 0.1 mm long), whitish hairs, ciliate at margins, the inner sepals 3-5 mm long, oblong-ovate, densely covered with minute (to 0.1 mm long), whitish hairs, the third and fifth sepals free or connate to half their length; petals white, obovate, clawed, 4-5.5(-7) mm long, with minute papillae on adaxial surface; appendages 3-5 mm long, with densely hairy margins, the central appendages hood-shaped, with fleshy crown-shaped apex, the lateral appendages not fleshy, asymmetric, with outer side bent over disk glands; disk glands four, the central glands 1-1.2 mm long, ovate to oblong-ovate and obtuse at apex, the lateral glands 1 mm long, oblong to rounded, laterally adnate to enlarged torus; filaments sparsely to densely covered with minute (0.2-0.3 mm long), whitish, inflexed hairs, the anthers 0.75 mm long; ovary elliptic to oblong in outline, sparsely to densely covered with minute, whitish hairs; style 0.5-0.8 mm long, the stigma papillose. *Fruits* 3-4.2 × 3 cm, ovate to oblong, chartaceous, glabrous, the apex notched, the base cordate; locules lenticular, flat, with network of slightly raised, dark veins, not-crossed or slightly crested; wings glabrous, with slightly constricted outline below locule. *Seeds* dark brown, lenticular, 6-7 × 5.0-5.6 mm; embryo symmetrical in frontal plane, the adaxial cotyledon smaller and bifurcate, the abaxial cotyledon larger and curved.

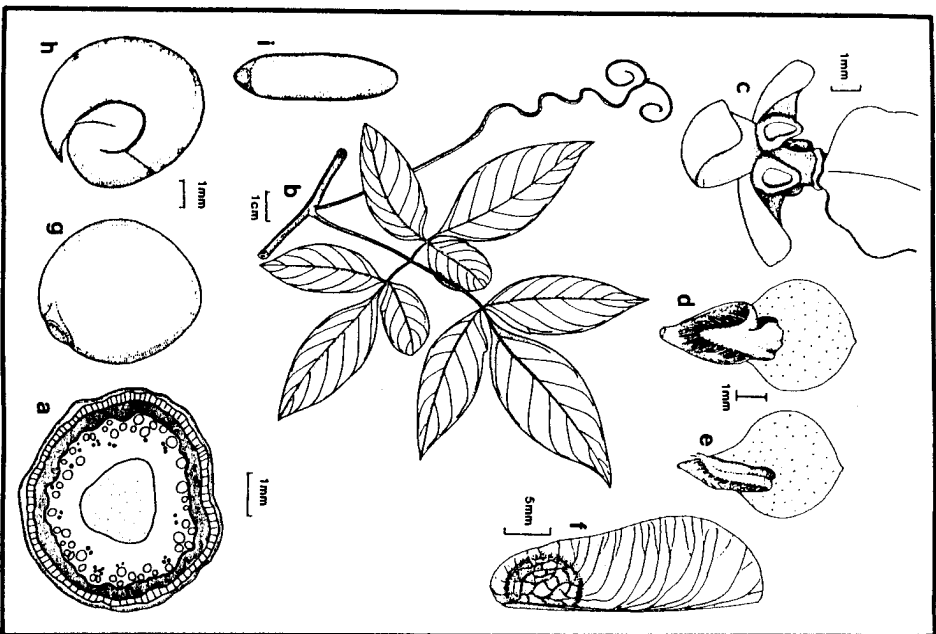


Fig. 45. *Serjania ampelopsis*. a. Cross section of stem with single stele. b. Biternate leaf with branch fragment. c. Pistillate flower with petals removed. d. Central petal with adnate appendage. e. Lateral petal with adnate appendage. f. Fruit mericarp. g. Seed, lateral view. h. Embryo showing cotyledons configuration. i. Seed, ventral view. All drawn from Acevedo-Rodríguez & Vargas 1781.

**Distribution and Phenology.** *Serjania ampelopsis* has been collected in Colombia, Ecuador, Peru, Bolivia and Argentina (Fig. 41). It occurs in humid to semi-dry forests as well as open or disturbed areas from sea level to 2130 m elevation. It flowers from April to January and fruits from May to December.

Specimens examined. **COLOMBIA.** NORTE DE SANTANDER: Prov. de Ocaña, Ocaña to Pamplona, Santa Bárbara, open area on fence, 3800 ft, 7 Nov 1878 (D, Fr.), Kalbreyer 800 (K). **ECUADOR.** AZUAY: Machalati, Santa Isabel road, near bridge over San Francisco river, shrubby thicket, 730 m, 11 Jun 1971 (Fr.), Macbride 435 (US). **BOLIVIA:** Between road to Buena and Haeda, Roca Mercedes, lower spurs of Contil-

len Central, 600 m, 12 Sep 1943 (f). *Acacia Solis*, 5180 (f). CHIMBORAZO: Canyon of Chanchan river, from Naranjapata to below Huagra, 600-900 m, 19 Jun 1945 (f, fr). *Camp* E3364 (NY). GUAYAS: Capera, 23.5 km N of Guayaquil on road to Daule, 150 m, 21 May 1981 (fl, fr). *Dodson & Clendenin* 11037 (MO). Guayaquil, 0-50 m, 18-20 Jun 1923 (fl). *Hitchcock* 20148 (GH, NY), 30 Aug-2 Sep 1918 (fl, fr). *Rose & Rose* 22455 (F, GH, NY, US); 3 km N of Juble Moreno, deciduous forest, 200-300 m, 11 May 1985 (fl, fr). *Harting & Andersson* 25039 (GB); vic. del Oro, jet. of rivers Amboas & Lajas, 10 km S of Portovelo, 670-760 m, 6 Oct 1944 (fl, fr). *Camp* E5366 (NY); jet. of Guayas, Cañar, Chimborazo & Bolívar, near Baeza, 300-380 m, 8-15 Jun 1945 (fl). *Camp* E3711 (F, GH, NY, US). LOJA: Alamor-Cazaderos road, 5 km W of El Limó, secondary growth, 800 m, 3 Apr 1980 (fl). *Harting & Andersson* 17829 (GB, MO); Alamor-Puyango road, semi-deciduous forest, 600-700 m, 7 Apr 1980 (fl). *Harting & Andersson* 17970 (GB). MANABÍ: Naranja, N of Paján, 550 m, 16 Jul 1942 (fl). *Haught* 3405 (F, NY, US).

PERU. LAMBAYEQUE: Lambayque, vic. "El Salvador" restaurant, Mesones Muño Hwy., 28 km E of Olmos, 1150-1200 m, 8 Jan 1964 (fl). *Hutchinson & Wright* 3467 (F, NY). CAJAMARCA: Cutervo, Icazo, in hedgerow, dry region, 1300 m, 18 Dec 1938 (fr). *Stork & Hinton* 10210 (f).

BOLIVIA. La Paz: Nor Yungas, Coroico, ca. 20 km S of Coroico along roadside, 1660 m, 29 May 1987 (fl, fr). *Acavedo-Ridge & Vargas* 1727 (F, LPB, MO, NY, US), ca. 4 km S of Coroico along roadside, 1600 m, 30 May 1987 (fl). *Acavedo-Ridge & Vargas* 1731 (F, LPB, MO, NY, US), Sep 1894 (fl). *Bang* 2444 (GH, MO, NY-2 sheets, US, WIS); Conqulla, Hacienda el Choro, 1700 m, 28 Jun 1930 (fl). *Buchtien* 8124 (NY). SANTA CRUZ: Florida, Bernège river, after bridge Agua Blanca, 1 Jun 1963 (fl). *Legramante & Caezo* 4020 (CTES); Yeta Buena, stream side, 1300 m, 14 Jun 1966 (fl). *Siebach* 291 (NY); 63 km W of Santa Cruz de la Sierra along road to Samnappa, humid, open roadside, 1200 m, 13 Jun 1987 (fl). *Acavedo-Ridge & Vargas* 1778, 1719 (F, LPB, MO, NY, US); 35 km E of Samnappa along road to Santa Cruz de la Sierra, 1500 m, 13 Jun 1987 (fl). *Acavedo-Ridge & Vargas* 1781 (F, LPB, MO, NY, US). TARIJA: Ipa, 30 km N of Villa Montes, Thaingate stream, 3 Jun 1971 (fl). *Krapowichas et al.* 19476 (NY); Arce, 29.2 km S of Emboroza-Sidras road, on road to Bernège, 12.7 km S of Naranjo Agrio, disturbed moist subtropical forest, 600 m, 21-23 April 1983 (fl). *Solomon* 10017 (MO, NY). O'Connor, 6.8 km NW of Entre Rios, disturbed moist tropical forest, 1400 m, 3 May 1983 (fl). *Solomon* 10435 (MO, NY).

ARGENTINA. SALTA: 28 Jul 1944 (fl). *Schultz & Vozda* 5386 (CTES); Orta, along road to Rio Peseado, ca. 12 km from international bridge over Bernège river, 30 May 1974 (fr). *Caezo et al.* 10238 (LL).

**Field observations.** The stems of *S. ampelopsis* produce a watery (not milky) exudate when cut, and the inflorescences are pendulous.

*Serjania areolata* was separated from *S. ampelopsis* by Radlkofler because of its larger flowers with the third and fifth sepals free from one another, and its glabrescent parts. These differences break down when

additional material is studied. *Serjania areolata* represents the extreme in variation in these characters and, therefore, I consider it a synonym of *S. ampelopsis*.

*Serjania ampelopsis* does not seem to be clearly related to any member of *S. sect. Platycoccus* except for *S. communis*, with which it shares many vegetative characters. *Serjania ampelopsis* might represent a vicariant species which evolved from isolated populations of *S. communis* after the geologically recent uplift of the Andes.

The name *ampelopsis* means grapevine-like and refers to the climbing habit of this species.

13. *Serjania squarrosa* Radlkofler, Monogr. Serjania 115. 1875. Type: Peru. Locality unknown, 1839-1840 (fl, fr). *Gay* s.n. (lectotype, P, here designated; isotype P, M; photos at B, GH, M, MO, NY from P). Fig. 46a-h.

*Serjania platypetala* Radlkofler, Bot. Jahrb., Syst. 54: 42. 1916. Type: Peru. Ayacucho, rocky slopes between shrubs, 3000-3200 m, May 1910 (fl, fr). *Weberbauer* 5506 (holotype, B, destroyed; lectotype, US, here designated; isotypes, F, GH, NY).

Woody vine 2 m long. Stems slender (to 1 cm in diam.), subterete or angular, with 5 prominent ribs, glabrescent. Young stems densely ferruginous; cross section of stem with central subterete, large stiele and (1)-2-3 peripheral, smaller, subterete stiles, these slightly included in central stiele. *Stipules* oblong, ovate, ca. 2 mm long. Leaves 4-5-jugate, lower jugae compound, or bipinnate; petiole margined, adaxially tomentose, 1-2.5(-4) cm long; rachises winged, adaxially tomentose, the main rachis 4-6.5 cm long; leaflets chartaceous to coriaceous, with acute, mucronate apex, the terminal leaflets subrhombic, deltoid, lanceolate, oblong-lanceolate, or trilobate, (0.7-) 1-3.5(-5.5) × 0.6-2(-3) cm, long attenuate or concave at base, the lateral leaflets ovate, oblong or lanceolate 1-2(-4) × 0.5-1.5 cm, obtuse and oblique at base, sessile or shortly petiolulate, both surfaces glabrous or sparsely covered with minute (0.1-0.6 mm long), whitish hairs with swollen bases, the margins remotely serrate above middle, the teeth obtuse and glandular, the veins mixed craspedodromous, the primary and secondary veins slightly prominent on lower surface, higher order of veins dark, forming a conspicuous network. *Inflorescence* axillary, longer than subtending leaf, axis angular, sparsely covered with minute (0.2 mm long), whitish hairs; rachis angular and slightly striate, densely covered with same indument as axis; bracts and bracteoles subulate, with glandular

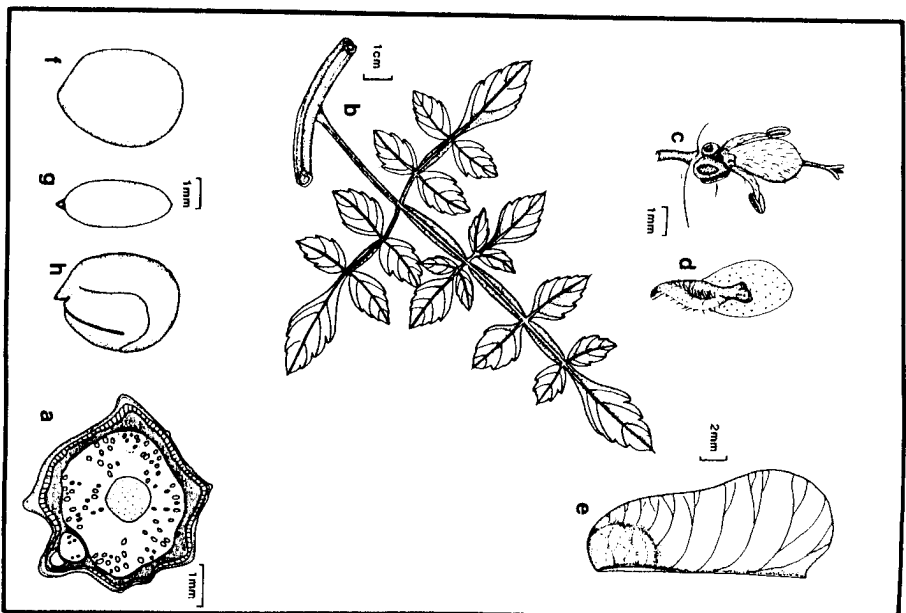


Fig. 46. *Serjania squarrosa*. a. Cross section of stem with a central and a peripheral stiele. b. 4-jugate leaf, with lower pinnae removed, and fragment of stem. c. Pistillate flower with sepals and petals removed. d. Central petal with adaxial appendage. e. Fruit mericarp. f. Seed, lateral view. g. Embryo, ventral view. h. Embryo, lateral view. All drawn from *Gentry et al.*, 23317.

hairs on margins, the bracts ca. 2.5 mm long, the bracteoles 0.7 mm long; cincinni alternate, 0.2-2.5 cm long, with same indument as rachis, 5-7-flowered; pedicels 4-5 mm long, articulate close to middle, with same indument as cincinnus or glabrous. *Flowers* with sepals obtuse at apex, lanceolate on abaxial surface, glabrous or densely covered with woolly, yellowish hairs, the outer sepals 2-3.2 mm

long, oblong-ovate, the inner sepals 3-5 mm long, obovate, third and fifth sepals free; petals 4-5.5 mm long, spatulate or obovate, sparsely or densely covered with minute papillae on abaxial surface; lanceolate on abaxial surface, the apex rounded, appendages of central petals ca. 4 mm long, hood-shaped, with fleshy, crown-shaped apex and ciliate margins, the appendages of lateral petals 3 mm long, with slightly fleshy, elon-

gated apex and ciliate margins; disk with two central glands, ca. 1 mm long, ovate in outline, with obtuse apex, the lateral glands usually reduced; torus reduced; filaments sparsely covered with white, inflexed hairs, the anthers ellipsoid, ca. 0.4 mm long; ovary obovate in outline, glabrous to densely tomentose, the hairs yellowish or whitish, the style longer than stigma. *Fruits* 1.7-2.1 cm long, ovate in outline, glabrous or sparsely covered with yellowish or whitish hairs, the base subcordate, the apex slightly retuse; locules flattened, with slightly prominent veins; wings slightly constricted below the locale. *Seeds* flattened, lenticular, light brown, 5 mm long, embryo with duplicate adaxial and curved abaxial cotyledons.

**Distribution and Phenology.** *Serjania squarrosa* is a high elevation (1200-3200 m) species endemic to Peru (Fig. 41). It has been collected in the departments of Apurímac, Ayacucho, Cuzco, and Puno, from gallery forests and open areas such as rocky hillsides, dry slopes, and roadsides. It flowers from December to May and fruits from January to June.

**Specimens examined.** PERU. Without specific locality, Paríchar, river-bank, 2900 m, 26 Apr 1925 (fl.), Pennell 13688 (f, GH-2 sheets, NY). APURÍMAC: Abancay, vic. of Abancay, 2400 m, Apr 1938 (fl.), Vargas 943 (A, F, MO); Chalhuanca, vic. Palayoa, dry slopes, 2650-2800 m, 24 Jun 1978 (fl.), Gentry et al. 23317 (MO). AYACUCHO: Between rivers Huayana and Octros, 21 Feb 1968 (fl.), Sotelo 5660 (US). Cuzco: Huiscranchi, Arcepa, Huasá, 3200 m, May 1925 (fl, fr), Herrera 687 (A, US). Quilabamba, Quinalpana, roadside, 1210-1435 m, 29-30 Dec 1986 (fl), Núñez 6767 (MO); Umbamba, Ollantaytambo, 3000 m, 27 Apr 1915 (fl, fr), Cook & Gilbert 389 (US-2 sheets), Jan 1926 (fl), Ferrera 889a (US), bank of Umbamba river, 2850 m, 26 Apr 1925 (fl), Pennell 13685 (f-2 sheets); Pucallanca, rocky hillside, 2900 m, 18 Jan 1949 (fl), Vargas 7603 (MO), illegible vic. Teneac, roadside, 2770 m, 5 Jun 1964 (fl), Gade s.n. (MIS), Puno: Ollachea, 2725 m, Jan 1937 (fl, fr), Sotelo 560 (f).

*Serjania squarrosa* is a very distinct species not obviously related to any other species of *S. sect. Platycoccus*. The cladistic analysis for the species of *S. sect. Platycoccus* suggests that *S. squarrosa* may not belong to it. However, *S. squarrosa* is better kept in *S. sect. Platycoccus* until more is known about other sections of *Serjania*.

#### Excluded Taxa

*Serjania brachynera* Radlkof., Bot. Jahrb. Syst. 37: 145, 1905. Type: Peru. Huancoc: Huamaltes, between Panchau and Chiquibamba along valley of Marañón

river, 3200 m, Jul 1903 (fl, fr), Weyerhauser 3304 (holotype, B, destroyed; lectotype, USM, here designated; isotype, F, fragment of B). Based on recent collections of fruits, this species belongs to *S. sect. Physococcus*.

*Serjania charitacea* Radlkof., Monogr. Serjania 114, 1875. Type: French Guiana. Without specific locality, 1833 (fl), Leprieux 331 (lectotype, G, here designated; isotypes, F-2 sheets, G, MO photos from G).

Fruiting material is not known for this species. However, it is morphologically similar in other features to the *S. confertiflora* complex and therefore, should be placed in *S. sect. Conertiflora*.

*Serjania confertiflora* Radlkof., Monogr. Serjania 117, 1875. Type: Brazil. Rio de Janeiro, s.d. (fl), Schott 712 (lectotype, K, here designated).

Mature fruits of this species have woody locules with partitioning walls that project beyond the locale. These features place *S. confertiflora* in its own section.

*Serjania decemstriata* Radlkof., Sitzb. Mat. Phys. Akad. München 8: 223, 1878. Type: Argentina. Buenos Aires: Close to Buenos Aires, s.d. (fl), *Didrichsen* s.n. (holotype, C).

Although no fruiting material is known for this species, I tentatively place it in *S. sect. Conertiflora* because of its similar morphology to *S. confertiflora*, with which it may be synonymous.

*Serjania foveata* Grisebach, *Plantae Lorentzianae* 60, 1874. Type: Argentina. Tucumán: Close to Siabón, in subtropical forest, Mar 1872 (fl), Lorenz 288 (holotype, GOETD).

This species has woody fruits with globose locules and wide dissepimentum. Therefore, I consider this species to be a member of *S. sect. Serjania*.

*Serjania grandiflora* Radlkof., Bot. Jahrb. Syst. 37: 144, 1905. Type: Colombia. Santa Marta, along open dry water course, 5 miles N of Bondas, 100 ft, Oct 1898 (fl), H.H. Smith 1538 (lectotype, NY, here designated; isotypes, BR, CM, GH).

Recent collection of this taxon reveals that its fruits are woody, with a marginal rib along the partitioning

wall. These features differ from those of *S. sect. Platycoccus*. Therefore, this species should be transferred to *S. sect. Conertiflora*.

*Serjania inscripta* Radlkof., Bot. Jahrb. Syst. 37: 145, 1905. Type: Brazil. Amazonas: Lago de Esperança, Jurua Mirim, Aug 1904 (fl, fr), *Ule* 5644 (holotype, B, destroyed; lectotype, K, here designated).

*Serjania inscripta* is clearly a member of *S. sect. Conertiflora* because of its woody fruits with a marginal rib along the partitioning wall.

*Serjania minutiflora* Radlkof., Repert. Spec. Nov. Regni Veg. 17: 355, 1921. Type: Paraguay. Central: vic. of Ypacaray lake, Dec 1913 (fl), *Haskler* 12414 (holotype, B, destroyed; lectotype, NY, here designated; isotypes, A, GH, K, US).

Although fruiting material for *S. minutiflora* is not yet known, it is morphologically similar in other features to *S. confertiflora*. Therefore, *S. minutiflora* should be transferred to *S. sect. Conertiflora*.

*Serjania pulchra* Cambessedes in St. Hilaire, Fl. Bras. Mer. 1: 369, 1828. Type: Brazil. Minas Gerais: vic. Ohm d'Agua and Contendas, marshy area, Oct 1816-21 (fl), *Sr. Hilaire* 17 (holotype, P).

The fruits of this species are triangular in outline, with the partitioning wall projecting beyond the locale, a character which defines *S. sect. Conertiflora*.

*Serjania schunkei* Acevedo-Rodríguez, Brittonia 40: 287-288, fig. 3, 1988. Type: Peru. San Martín: Mariscal Cáceres, Tocache Nuevo, Quebrada Cañayacu de Huaguisha, in tall forest, 500-650 m, 3 Jan 1981 (fl), *J. Schunke* 176a, 12492 (holotype, NY; isotypes, F, MG, MO, US).

*Serjania schunkei* was described from a single fruiting collection and placed at that time in *S. sect. Platycoccus*, because it had fruits resembling those of section *Platycoccus*. A second collection with flowering material indicates that this taxon should be transferred to the genus *Lophostigma* (Acevedo-Rodríguez, 1993).

*Serjania trichomisca* Radlkof., Monogr. Serjania 114, 1875. Type: Brazil. Goiás: Serra São Felix do Rio Friaes, s.d. (fl, fr), *Pohl* 1934 (holotype, W).

Although only immature fruits are known from this species, they do not have flat locules, which indicates that *S. trichomisca* does not belong to *S. sect. Platycoccus*. This species is better placed in *S. sect. Euryococcus*.

#### Acknowledgments

This paper is based on my doctoral dissertation. I would like to express my deepest appreciation to Dr. Scott A. Mori for his guidance and interest in this study and his valuable contribution toward the completion of this manuscript. My appreciation is also extended to Drs. Gillian T. Prance, Dennis W. Stevenson, James L. Luteyn, and James C. French for reviewing the manuscript and for serving on my Graduate Committee.

I am indebted to the following people who gave their time, advice, and instruction in many areas encountered during my study: Dr. P. Mick Richardson for his valuable suggestions on the cladistic analysis; Dr. Rupert Barnaby for guidance on botanical Latin and typification problems; Don Black for technical assistance on plant anatomy, photography, and electron microscopy; Michael Baxter for assistance with the SEM; John Pruski for his valuable review of the manuscript; Dr. Pat Holmgren for requesting the loans from many herbaria; Steve Cristofolini for processing the loans; and LOTHIAN LYNAS and Jane Brennan for their assistance with literature references and interlibrary loans.

I am also indebted to fellow graduate students Karl Vincent and Katia Rodrigues, and to Drs. Ricardo Callejas, Douglas Daly and Vicki A. Funk for their valuable discussions on various subjects.

I am extremely grateful to The New York Botanical Garden for awarding me a Herbarium Graduate Fellowship, and to the Conoco/Lawrence Funds of the NYBG which provided partial financial support for my field work.

I thank the following institutions which provided logistical support, and assistance and warm hospitality during my travels abroad: Jardim Botânico do Rio de Janeiro, especially to Gustavo Martineili, Cyl Farney, Andrea Ferreira da Costa and Talia Fortuna Alves; Empresa de Pesquisa Agropecuária do Minas Gerais, especially to Mízi Brandão Ferreira and J. Pedro Laça Buendía; Comissão Executiva do Plano da Lavoura Cacaueira, Ilheus, Bahia, especially to Luiz A. Matos Silva; Museu Botânico Municipal, Curitiba, Paraná, especially to Gert Hatschbach; Herbario Nacional de Bolívia,







- diffusa* 44, 45  
*divaricata* 3, 4  
*diversifolia* 44, 45  
*dimorpha* 6, 13, 18, 19, 20, 22, 40, 45, 46, 47, 50, 58, 59, 60, 61  
*dura* 45  
*elegans* 29, 44, 45  
*elongata* 44, 45  
*emarginata* 4  
*equestris* 23  
*erecta* 5, 37, 44, 45  
*eucardata* 44, 45  
*exarata* 37, 44, 45  
*foveolata* 44  
*fluminensis* 1, 132, 33, 36, 45  
*foveata* 44, 45, 50, 84  
*fascifolia* 14, 44, 45  
*fascoserrata* 45  
*glabrata* 4, 10, 13, 37, 44, 45  
*glabrata f. mollis* 37  
*glutinosa* 44, 45  
*goniocarpa* 45  
*gracilis* 17, 35, 36, 44, 45  
*grammatophora* 44  
*grandidens* 50, 84  
*grandiflora* 41  
*grandifolia* 11, 25, 28, 44, 45, 46, 47  
*grandis* 44, 45  
*grossi* 44, 45  
*hamulifera* 5  
*haushubertii* 5, 19, 28, 42, 50, 51, 74, 76, 77  
*hebecarpa* 26, 27, 28, 37, 44, 45  
*heteri* 44  
*heterophylla* 4  
*hirsuta* 50, 53  
*hispidula* 16, 45  
*ichthyocarpa* 28, 45  
*impress* 45  
*inflata* 32, 44  
*inscripta* 5, 20, 23, 32, 45, 50, 84  
*laevigata* 45  
*lamprophylla* 44  
*lanicispila* 16  
*larmoniana* 7, 44, 45, 50, 51, 74, 77, 78, 79, 80  
*laterita* 45  
*laxiflora* 11, 44  
*leptocarpa* 8, 26, 40, 42, 44, 45, 46, 50, 56, 57, 58, 59, 61  
*lehnalis* 24, 36, 44, 45  
*leucosepala* 47  
*lobulata* 45  
*longipes* 27, 45  
*longisepala* 16  
*lucida* 3, 4, 37  
*lupulina* 3, 4  
*macrocarpa* 44  
*magnisepalata* 16, 17  
*mansiana* 37, 44, 45  
*marghiana* 18, 36, 37, 44  
*membranacea* 28, 44, 45  
*meridionalis* 10, 37, 44, 45  
*metciana* 4, 5, 8, 10, 44, 45, 48  
*minimiflora* 50, 84  
*mollis* 4  
*morti* 40, 42, 50, 64, 65, 66  
*macromulata* 45  
  
*multiflora* 44, 45  
*nigricans* 44, 45  
*noxia* 44, 45  
*novata* 10, 24, 36, 45  
*oblongifolia* 45  
*obtusidentata* 44, 45  
*orbiculatis* 45  
*ossana* 4  
*ovalifolia* 44, 45  
*oxyphylla* 4, 44, 5  
*paludosa* 26, 36, 50, 84  
*paniculata* 4, 36, 44  
*paradoxa* 10, 11, 36, 44, 45  
*parvifolia* 4  
*paucidentata* 4, 10, 44, 45  
*pedicellatis* 44  
*pernambucensis* 44, 45  
*perulacea* 11, 37, 44, 45  
*peruviana* 44, 45  
*phascoloides* 50, 71  
*pinarifolia* 44, 45  
*pisicatoria* 9, 44  
*planycarpa* 44  
*platanopetala* 50, 83  
*platicna* 44, 45  
*polyphylla* 5, 6, 7, 11, 12, 13, 15, 17, 22, 23, 24, 44, 45, 48  
*pubescens* 4  
*pubescens* 4  
*puncinata* 44, 45  
*puncinulata* 45  
*purpurascens* 44, 45  
*pyramidalis* 18, 26, 44, 45  
*racemosa* 3, 4, 44, 45  
*rachyptera* 44  
*regnelli* 36, 40, 42, 44, 45, 50, 51, 63, 64, 66, 67  
*rekei* 45  
*reticulata* 5, 29, 44  
*rhombea* 44, 45  
*rubicaulis* 5, 44  
*rylia* 45  
*saltzmaniana* 32, 45  
*schubertii* 56  
*schubertii* 84  
*scopolifera* 45  
*sellowiana* 78  
*seriana* 49  
*seriata* 45  
*simata* 3, 4, 36, 49  
*specabilis* 3, 4  
*sphaerocarpa* 45, 47, 80  
*squarrosa* 16, 40, 42, 44, 45, 46, 49, 50, 51, 74, 82, 83, 84  
*stenoperlygia* 50, 53  
*subidentata* 8, 48  
*subrotundifolia* 26  
*suffrutiginosa* 14, 23, 45, 47  
*tenmifolia* 44, 45  
*tenuis* 27, 40, 42, 45, 50, 51, 71, 72, 74, 76, 77  
*trichomisa* 5, 35, 50, 84  
*trifoliolata* 45  
*triplex* 37  
*triquetra* 44, 45  
*trivostis* 44, 45  
*trieriana* 4  
*truncata* 45  
*undentata* 6, 7, 11, 27, 36, 50, 51, 73, 74, 75, 76  
  
*velutina* 28, 44, 45  
*viridissima* 50, 56, 59  
*Sapindaceae* 34, 37  
*Sapindus* 48  
*emarginatus* 46  
*Subtribe Eupaulthinae* 4  
*Subtribe Thimouinae* 4  
*Thimouia* 4, 9, 17, 31, 33, 48  
  
*myriantha* 48  
*Thimouia* 38, 39, 40  
*Thymelaeaceae* 34, 37, 38, 48  
*Thymelaeaceae* 9  
*Urvillica* 3, 4, 9, 25, 28, 29, 31, 37, 38, 39, 48  
*ferruginea* 9, 61  
*ulmacea* 9  
*villosa* 33