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AN INTRODUCTORY

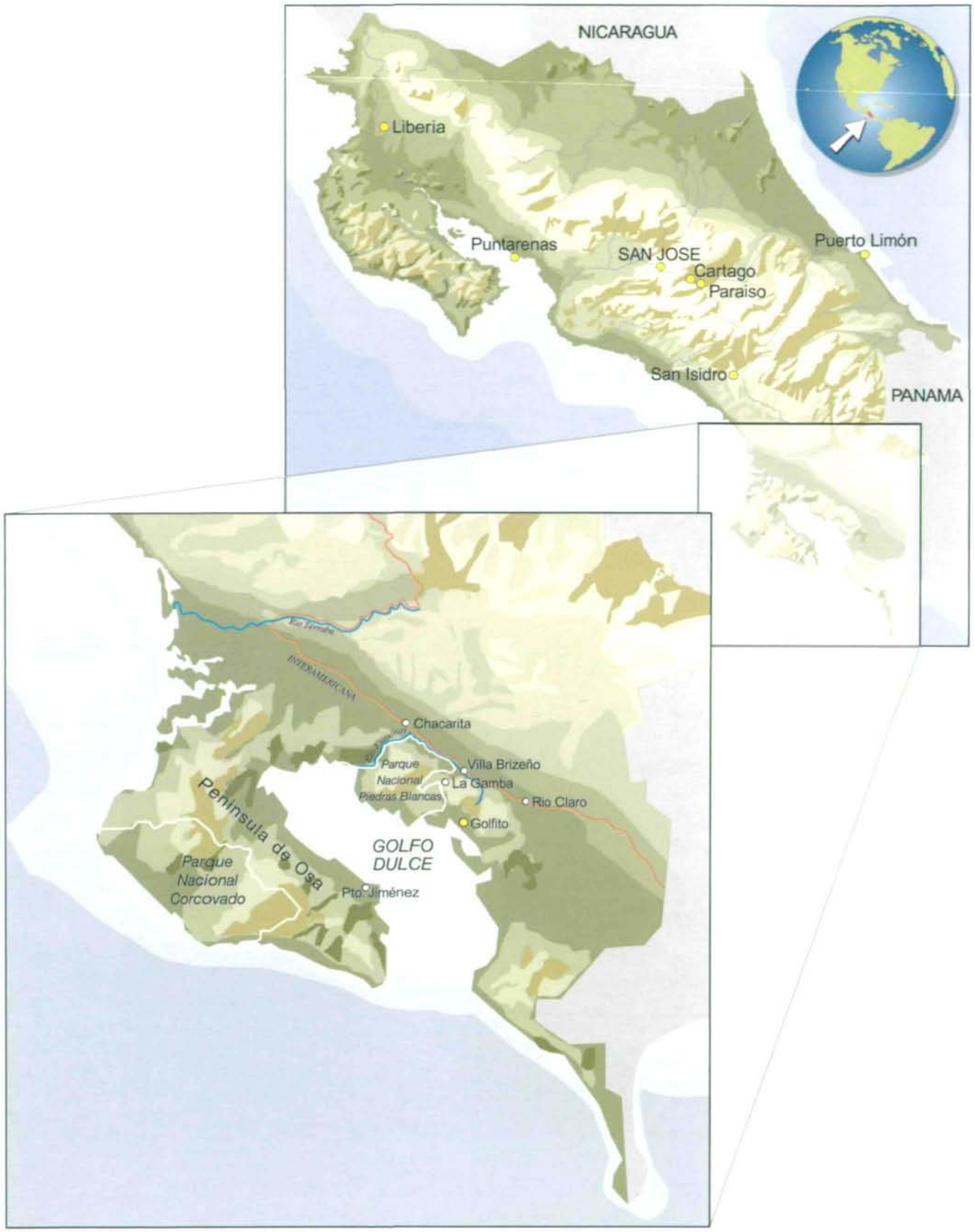
FIELD GUIDE

TO THE FLOWERING PLANTS OF THE

GOLFO DULCE RAIN FORESTS COSTA RICA

CORCOVADO NATIONAL PARK AND PIEDRAS BLANCAS NATIONAL PARK ("REGENWALD DER ÖSTERREICHER")

HRSG.: BIOLOGIEZENTRUM DES OÖ. LANDESMUSEUMS



Map 1. Geographical location of Costa Rica and the Golfo Dulce region with the Corcovado National Park (Parque Nacional Corcovado) and the Piedras Blancas National Park (Parque Nacional Piedras Blancas), the latter encompassing the "Austrian Rainforest" ("Regenwald der Österreicher"). Preparation: Bettina Berger.

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CORCOVADO NATIONAL PARK
AND
PIEDRAS BLANCAS NATIONAL PARK
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Contents

Preface

The rainforests of the Golfo Dulce region in southeast Costa Rica belong to the most interesting and species-rich forests in Central America. About fifty years ago, the American botanist Paul H. Allen (1956) carried out pioneering work in the region, and described the vegetation and plant diversity in the book *The Rain Forests of Golfo Dulce*. A proper flora covering the estimated 3000 species or more is still lacking. A first step towards such a flora was the booklet "Árboles de la Península de Osa" by QUESADA & al. (1997) which presents a brief survey on the most common trees of the Osa peninsula (with line drawings).

The present "Introductory Field Guide" is an effort to make a further step. It is not restricted to trees, but covers all the commoner flowering plants, including shrubs, lianas, epiphytes, ground herbs and aquatic plants, and it is not restricted to the Osa Peninsula, but covers the whole Golfo Dulce region. This area is now home to two National Parks: the "Corcovado National Park" (on the Osa Peninsula) and the "Piedras Blancas National Park" (formerly "Corcovado National Park sección Esquinas" or "sección Piedras Blancas", the "Esquinas Rainforest") northwest of Golfito (Map 1). For a proper flora more collecting work (especially in the more remote areas of the parks) and intensive study of special plant groups is needed.

The production of the Field Guide is intimately connected with the conservation efforts of the Esquinas Rainforest and is the result of many fortunate events. About ten years ago I became involved in the fascinating project aimed to protect a tropical rainforest. Michael Schnitzler, a distinguished musician and professor at the University of Music and Performing Arts in Vienna, had started an initiative to save the "Esquinas Rainforest" from destruction. Though the area of this forest was declared on paper as a National Park (now Piedras Blancas National Park), there was still uncontrolled logging by land owners. Prof. Schnitzler founded the association "Regenwald der Österreicher", collected over many years money in Austria and conveyed it to the Costa Rican government. With that money the government bought tracts of forest from the landowners thereby saving the forest from clearance.

Prof. Schnitzler showed remarkable far-sightedness in his vision for the "Regenwald der Österreicher". Not only did he promote forest protection, but he also encouraged scientific work in the forest. He first bought a small hut located at the edge of the Esquinas forest. This hut was the start of the Field Station La Gamba ("Tropenstation La Gamba"), which is located today in another, larger and much more comfortable, building. In Austria, Prof. Schnitzler established an advisory board consisting of Austrian scientists interested in tropical biology. I was invited to join the advisory board and so I started to search for students interested in tropical botany. Eventually I found two students who were enthusiastic and adventurous enough to tackle botanical work in the Esquinas forest: Werner Huber and Anton Weissenhofer. They used the hut as a base camp and from there they carried out studies on the floristic composition and structure of a selected plot as part of their diploma theses. In 1996 they finished their theses, but continued to work scientifically until now.

Nearby the field station the Esquinas Rain Forest Lodge was constructed for eco-tourists. Thus also student excursions into the Esquinas forest became possible. During that time, the plan to produce an identification guide for common plants of the Esquinas forest was born. Initial work for the project was funded by the Austrian National Bank (Österreichische Nationalbank). Enthusiastic students joined the project and worked out some of the major families as parts of their diploma theses: Thomas Baumgartner (palms), Eva Schembera (legumes), and Sabine Will (Rubiaceae). Another diploma thesis, by Dominik Lautsch was devoted to ferns and fern allies. The results will be published separately, as we had to restrict the Field Guide to flowering plants. Apart from these floristic theses, scientific work on many more aspects of the rainforest was performed during the years. A report on these activities, covering the years from the beginning (1993) until the end of 1999 can be obtained by the editors or consulted in the Internet (http://www.regenwald.at).

The Field Guide project could not have been successfully finished without the participation of Georg Zimmermann. He wrote the greatest portion of the family treatments. For the introductory part an essay on the geology and geological history of the Osa Peninsula was written by the geologist Dr. Otto Malzer, and a special chapter on its soils was contributed by Susanne Pamperl, another student who conducted a diploma thesis in the Esquinas Forest.

Initially, we restricted our efforts for the Field Guide to the plants in the Esquinas forest. However, Nelson Zamora, leading botanist of the "Flora of Costa Rica" project centered at INBio (Instituto Nacional de Biodiversidad, Heredia), recently joined the Field Guide project, and the decision was taken to expand the coverage of the Field Guide also to the Corcovado National Park on the Osa Peninsula. Nelson Zamora proved most helpful and active. He revised the text of many families, helped with plant identifications, made drawings, slides and maps located at INBio available, and agreed to act as a co-editor. From INBio we also received support from Reinaldo Aguilar, whose excellent plant knowledge and field experience proved indispensable, and from Maria Marta Chavarria Díaz, who helped with plant identifications. Another important Costa Rican institution that deserves acknowledgement is the Museo Nacional de Costa Rica, San José. The staff members of the herbarium, especially Joaquin Sanchez, Armando Ruiz, Alfredo Cascante, Mariela Bermúdez, Silvia Lobo, and Armando Estrada, as well as Guiselle Alvarado (Dept. of Ornithology) were most cooperative and helpful through the years. Some even agreed to act as co-authors and revised certain plant families.

Botanists from other institutions provided support as well, especially Dr. Barry Hammel (Missouri Botanical Garden, St. Louis), who helped from the beginnning with information and plant identifications and who improved of many of the family treatmens. In addition, we are grateful for the cooperation of Dr. Michael Grayum (Missouri Botanical Garden, St. Louis), Dr. Robert Dressler (Micanopy, Florida), and Dr. Günther Gerlach (Botanical Garden Munich).

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Dr. Peter Stütz and Stefán Jirka were most helpful in reading and correcting large portions of the text. For manifold technical assistance thanks go to (in alphabetical order) Dr. Ralf Buchner, Stefanie Csekits, Manfred Dworak, Dr. Michael Kiehn, Mag. Brigitte Krückl, Dr. Veronika Mayer, Matischa Orator, Monika Paschinger, Wolfgang Prader, Verena Schmelz, and Mag. Susanne Sontag.

Last but not least, I have to thank the many institutions and people who supported the project through grants and generous donations. They are listed on a foregoing page.

I would be happy if the Field Guide would prove to be a valuable contribution to the appreciation of rainforests and their plant diversity in a relatively poor and little known region of Costa Rica. May this be another stepping stone to preserve these complex and vulnerable ecosystems for future generations.

Vienna, November 2001 Anton Weber

The Golfo Dulce and its Rain Forests: Introduction

A. WEISSENHOFER

Biological diversity is intimately related to the topological, geological, and chemical diversity within a given physical environment. Therefore, an outline of the surroundings in the Golfo Dulce region seems appropriate to understand its ecology, flora and vegetation, and need for conservation. The Golfo Dulce region encompasses a wide variety of environmental conditions and harbors some of the most species-rich life zones in Costa Rica. Its forests are by far the most luxuriant in Central America, with strong floristic affinities to the Colombian Chocó-region. The vegetation comprises of a number of very distinctive plant associations whose composition and distribution depends on rainfall, slope, drainage, soil type, and other factors. Species found in one place are often completely lacking in another, even though the distance separating them may very short. Thus, superficially identical situations may support entirely different populations, and may sometimes be the result of fortuitous circumstance rather than basic ecological conditions.

It is reasonable to assume that a high number of constraints are responsible for generating a highly specialized or locally unique plant association. Normally, a single species is not dominant. The great majority of tree species is confined to one or very few major ecological associations.

The hillsides with their clay ridges and rocky slopes support a rich tree flora. The local conditions of soil, slope, drainage, exposure to wind, and past history are reflected in the type of vegetation and its floristic composition. For example, the nearly pure stands of *Vochysia ferruginea* are very conspicuous during the flowering season in May, when the forest is dotted with yellow flowers. Large colonies of *Vochysia* (e.g., Fila Gamba, Fila Cruces) probably originate from older clearings, as all species of the genus in Central America invade cleared forest.

Climatic formations are limited by rainfall distribution and edaphic formations are determined by conditions of soil or topography. Transitional formations, however, have been often shaped by human impact. Due to forest clearings for banana and oil palm plantations as well as for pastures or timber exploitation, flat forest types are no longer preserved in the Golfo Dulce region, except those in the Corcovado National Park.

The following chapters present a brief survey of the natural history of the Golfo Dulce area. The first chapter sketches the geographical location and the climatic conditions of the area. With regard to the latter, special emphasis is put on the situation in the Piedras Blancas National Park, as this is the only site where temperature and precipitation measurements are available from both outside and inside the forest. The next chapter presents a brief introduction to the flora and vegetation of the two national parks in the region. A more detailed account of the vegetation can be found in ALLEN's classic book on the Golfo Dulce rainforests (1956), as well as in HARTSHORN's general introduction to plants in the *Natural History of Costa Rica* (JANZEN 1983). Although ALLEN's pioneering book is now nearly 50 years old, it comprises a wealth of important and interesting information and is still a must for everyone who wants to learn about the scientific aspects of the Golfo Dulce forests. A brief survey on the uses and the threats to rainforest plants can be found in the chapter "Utilization and conservation of the Golfo Dulce rain forests". Another chapter deals with the soils of the Golfo Dulce area. It was written by Mrs. Susanne Pamperl, who conducted soil investigations in the Esquinas forest as part of her diploma thesis. The chapter on the geology and geological history, compiled by the geologist Dr. Otto Malzer, is more comprehensive. Not only does it deal with the geological situation in the Golfo Dulce area, but it also provides an overview of the geological history of the Middle American land bridge, which has enormous significance for the understanding of present-day flora and fauna in Central America. As the reader certainly wants to know whether and how he can visit (and eventually perform studies in) the rainforests

and national parks of the Golfo Dulce region, some basic information on tourist (and research) facilities is given in another chapter. Finally, some general remarks are made on the structure, scope, limitation and use of the *Introductory Field Guide*.

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Basic Geographical and Climatic Features of the Golfo Dulce Region

A. WEISSENHOFER and W. HUBER

Geography

The Península de Osa and the Esquinas forest are situated in the Puntarenas Province in southern Costa Rica near southwestern Panama. The geographical coordinates lie mainly between 8°27'-8°41'N and 83°15'-83°45'W. The main sector of the Corcovado National Park covers 424 km² and the Esquinas forest (Piedras Blancas Park) covers 148 km². The altitude ranges from sea level up to 745 m on the Osa península (Cerro Rincón and Cerro Mueller in the Fila Matajambre) and up to 579 m in the Esquinas forest (Cerro Nicuesa). Between the two parks the Golfo Dulce Forest Reserve (592 km²) has been established thereby forming a natural forest corridor. The regions extremely wet natural systems evolved in partial isolation from the drier parts of the Pacific Coast further north.

The whole region is still tectonically active. Up to ten tremors per day have been measured in the region, and crustal elevations have been observed.

Within the Corcovado National Park lies the drainage of the Corcovado Basin, a broad sediment-filled oceanic embayment between Punta Llorona and Punta Salsipuedes which extends inland from the Pacific Ocean 2-10 km eastward. The basin's low plain covers about 100 km² with several meandering rivers, partially rimmed by upland hills which increase in altitude and irregular relief from an undulating plateau (below 200 m) in the north-west part of the park (north of Llorona), to 745 m in the south-east on the peninsula's highest peaks. The rugged uplands produced by intensive tectonic activity and weathering (causing frequent landslides), are dominated by eroded narrow ridges and long steep slopes, with dense drainage networks (TOSI 1975, HERWITZ 1981, HARTSHORN 1983, HERRERA-MCBRYDE et al. 1997). A virtually uninterrupted sandy beach extends for 20 km, with cliffs and pocket beaches at the northern and southern park headlands; there is a marine cave near the southern point of the beach.

The Piedras Blancas Park consists mainly of narrow ridges and steep slopes covered with primary forest. The Río Esquinas, named after its conspicuous meanders (in Spanish *esquinas* means corner), forms the natural border to the north and the west side of the park. Several *quebradas* (streams) and small rivers pass through the land and flow into the Río Esquinas. Floodplains within the park along the two main rivers, the Río Esquinas and the Río Bonito, cover abandoned farm land and secondary forest at different stages of regrowth. Due to logging, almost no flat land with primary forest remains within the park, except small pockets along the coast and deep inside the park. The steep and rocky southern border, formed by the shoreline of the Golfo Dulce, is every so often interrupted by sand and gravel beaches, which give way to small plains. Near the mouth of the Río Esquinas there are extensive mangrove swamps. Some small coral reefs northwest of the Esquinas forest also belong to the park.

Climate

Rainfall. In Central America two different patterns of rainfall distribution can be distinguished. The Atlantic side has no pronounced dry season and highest rainfalls are observed during December and January. On the Pacific side there are distinct rainy (May - November) and dry seasons (December - April), with heaviest rainfalls occurring in October and November. In the Central American Isthmus and particularly in Costa Rica there is great variation within this pattern due to the presence and orientation of mountain ranges (see below).

The Golfo Dulce region is one of the most humid areas in Costa Rica. The Esquinas forest and its vicinity are influenced by the rain gradient created by the mountains of the Fila Cruces range and the adjacent Talamanca Mountains. ALLEN (1956) noted the outstandingly high rainfall in the Esquinas region many years ago.

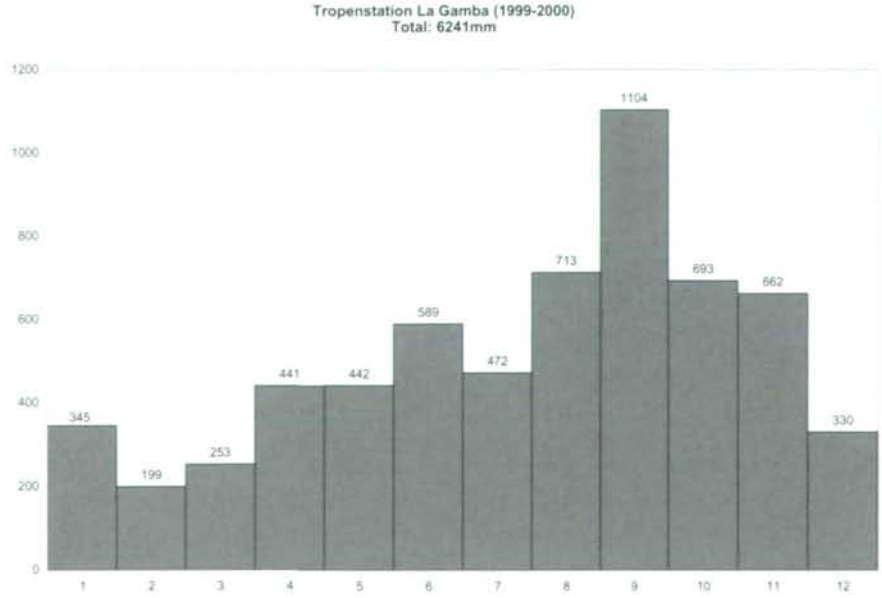
During the months with the highest precipitation (August through November) it rains nearly every day. Typically, rainfall occurs in short and heavy showers in the afternoon hours. However, sometimes it may rain for periods of up to 24 hours. Under such circumstances, solar radiation is heavily reduced, and the forest becomes very dark.

The dry season is not as pronounced in the area. February and March are the driest months and sometimes it does not rain for days at a time. However, a water deficit in the soil is rarely observed. Normally, more than 200 mm rainfall is measured per month and the humidity stays high. In the slightly drier Corcovado Park, wild fires do occasionally arise in February and March (JANZEN 1983, JONES 1990).

During the drier period of the year some trees drop their leaves completely and a considerable amount of leaf litter accumulates on the forest floor. Some of the smaller streams dry up on steep terrain, but others survive and form small pockets of water. From December 1997 to April 1998, "El Nino" heavily affected the region and there was nearly no rain for a period of three months. Many epiphytes died, but others recovered within a few months.

Windstorms also occur, but only rarely with the force of a tornado (JANZEN 1983, BOZA & MENDOZA 1981). In May 1997 a strong windstorm heavily affected the vicinity of La Gamba. Many large trees, mainly on steep ridges, were felled by the storm, forming large tree gaps.

Since 1997 meteorological data have been recorded at the Field Station La Gamba ("Tropenstation La Gamba") and for the years 1999 and 2000 complete data sets of precipitation are available (Fig. 1). The average annual precipitation at the field station was 6241 mm (6409,5 mm in 1999 and 6071,5 mm in 2000). The month with the highest precipitation was September (1104 mm), when more than 1/6 of the yearly rainfall was recorded. In September 2000, 152 mm of precipitation were measured in just a few hours. The driest month was February, but even here nearly 200 mm of precipitation was measured. The data show clearly that there is a period with lesser rain, but not a real dry season. A somewhat drier period also may occur in July and August giving rise to the so-called "veranillo" ("little summer") which is poorly defined and lasts from 7 to 10 days. The highest rainfall normally occurs in October and November. It is probable that on the highest peaks in the Esquinas forest (e.g., Cerro Nicuesa, 579 m) rainfall is higher than at the field station.



Monthly precipitation at the Field Station La Gamba (8°42'N, 83°12'W, 70 m)

The average number of rainy days is 286,5 (Fig. 2) per year. Therefore, statistically rain can be expected nearly every day. However, in the year 2000 over 60% of the yearly precipitation was measured in only 67 days. On 91 days there was no rain and on 104 days less than 10 mm rain was recorded.

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
Days with rain	18	16.5	16	21.5	27.5	26.5	25.5	27.5	29	28.5	28.5	21.5	286.5

Monthly average of rainy days during the years 1999 and 2000 at the Field Station La Gamba.

There are only few meteorological records from Corcovado National Park (HERRERA 1986, COEN 1983, HERWITZ 1981). The mean annual rainfall is estimated to range between 3000 and 3800 mm on the plains and 4000 and 5000 mm in the uplands. The nature of the vegetation suggests that the annual rainfall on the highest mountain peaks of the peninsula is perhaps 5000-6000 mm or more (BOZA 1988). In general, it is considered that climatic associations dominate the uplands' vegetation, while in the Corcovado plain edaphic and drainage conditions play a more important role (HARTSHORN 1983).

Temperature and humidity. Temperature measurements in the forest and at the Field Station La Gamba have been made sporadically since December 1993 and regularly since May 1997 (Fig. 3). Measurements inside of the forest were made about 1 km south of the field station near one of the research plots and outside of the forest were measured at Field Station La Gamba. There is a remarkable difference between atmospheric temperature inside and outside of the forest. Mean annual temperature was recorded as 25.2°C inside of the forest (WEISSENHOFER 1996) while it was 27.4°C outside at the field station. The monthly average ranged from 22.3°C to 28°C inside the forest and from 23.2 °C to 31.5 °C at the station. The minimum temperature of 20.0°C was reached both in August at the field station and in December inside the forest. The maximum temperatures measured were 32°C inside the forest (26.3.1994) and 38.5°C at the Field Station (5.4.1998).

	Field Station (altitude 70m)	Forest (altitude 300 m)
Mean annual temperature (average)	27.4	25.2
Max. temperature (average)	31.5	28.0
Max. temperature (absolute)	38.5	32.0
Min. temperature (average)	23.3	22.3
Min. temperature (absolute)	20.0	20.0

Temperature data at the Field Station La Gamba and in the interior of the Esquinas forest (in °C).

The coolest months were January, February and December with average temperatures between 26.5 and 26.7°C (Fig. 4). The months with the highest temperatures were April and May, with 28.1°C and 28.0°C, respectively.

In the dry season the range of the monthly averages of the diurnal temperatures is usually higher than during the rainy season. A constant high variation, between 10 and 13 degrees, is usually found during January, February and March, sometimes in April and May. Interestingly, the highest diurnal variation (up to 14°C) occurred in the wettest month (September) on 19.9.1999. The lowest diurnal variation is around 2.5°C and occurs during long, rainy periods in October and November, when it is cloudy day and night. The seasonal variation in the mean monthly average at the field station was not more than 1.6°C. However, the air temperature on the forest floor is almost constant, with a measured range of the average diurnal temperature of only 1.4°C. Thus the diurnal temperature variation appears to be greater than the variation between the seasons.

Month	Mean monthly minimum	Mean monthly maximum	Mean monthly average
January	22.6	30.8	26.7
February	22.6	32.0	27.3
March	23.4	32.5	27.9
April	22.8	32.6	28.1
May	23.6	32.5	28.0
June	23.0	31.6	27.3
July	23.5	31.3	27.4
August	23.9	31.5	27.7
September	23.4	32.2	27.8
October	23.6	31.1	27.4
November	23.3	30.2	26.7
December	22.9	30.2	26.5

Mean monthly minimum, maximum, and average air temperatures at the Field Station La Gamba, 1999-2000.

The relative humidity is constantly high, averaging 88.3% at the Station and 97.7% inside the forest. Mist forms daily at dawn, sometimes at dusk and after heavier rainfalls. Under these conditions air temperature is lower.

On the Osa Península the mean annual temperature is 26° to 27°C near the coast (varying daily up to 10°C) and 21° to 23°C on the higher mountain peaks. The period of March through May is warmer while the period of November through January is cooler. The daily sunshine average is 5 hours per day over the course of the year, decreasing from 8 hrs per day in February, to 6 hrs per day in January and March through May, to 3-4 hrs per day in June through November (HERRERA-MCBRYDE et al. 1997).

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A Brief Outline of the Flora and Vegetation of the Golfo Dulce Region

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Flora

The Golfo Dulce region is one of few places on earth where so much biological diversity can be found within a relatively small geographical area (VAUGHAN 1981). This is partly because of Costa Rica's role as a "corridor" for the flora and fauna from North to South America and vice versa. So far, 2369 species in 961 genera of 182 families of vascular plants (ferns, fern allies and flowering plants) have been recorded from the Golfo Dulce Area. In the whole ACOSA area (Área de conservacíon de Osa, see maps 2 and 3) 2709 species, 935 genera and 187 families of vascular plants have been recorded so far (INBio data base). It is also notable, that the region harbors over 700 tree species — the greatest tree species diversity in all of Central America — which represents one fourth of all the tree species in Costa Rica (QUESADA et al. 1997).

In the recent years 57 species from the area were described as new to science. Significant and conspicuous new species include *Costus osaensis* (Costaceae), *Ruptiliocarpon caracolito* (Lepidobotryaceae), *Justicia peninsularis* (Acanthaceae), *Pleurothyrium golfodulcensis, Aiouea obscura, Ocotea patula* (Lauraceae), *Inga golfodulcensis* (Fabaceae-Mimosoideae), and *Stemmadenia paulii* (Apocynaceae). 59 species were recorded as new for the flora of Costa Rica, including *Ziziphus chloroxylon* (Rhamnaceae), *Oecopetalum greenmanii* (Icacinaceae), *Recchia simplicifolia* (Simaroubaceae), *Micropholis venulosa* (Sapotaceae), and *Buchenavia tetraphyllla* (Combretaceae). Ironically, most of the new discoveries were along paths or near clearings.

Floristic affinities

The flora has strong affinities with the Chocó region of north-western South America (HARTSHORN 1983, HUBER 1996) as well as with the Venezuelan Amazon. Elements of the Guayanan flora that may have arrived before the formation of the Panama Isthmus are also found (GÓMEZ 1986).

South American tree species are abundant. Some reach their northern limits in the area, e.g., *Chaunochiton kappleri* (Olacaceae), *Couratari scottmorii* (Lecythidaceae) and *Paramachaerium gruberi* (Fabaceae-Faboideae) (QUESADA et al 1997). Other species are found or have been recently discovered also somewhat further north, e.g., *Anthodiscus chocoensis* (Caryocaraceae), *Newtonia suaveolens* (Fabaceae-Mimosoideae) in the Bosques de Savegre Abajo (900-1100 m), *Couratari guianensis* (Lecythidaceae), *Batocarpus costaricense* and *Brosimum utile* (Moraceae) in the Canton de Aguirre, Portalon-Quepos-Puntarenas (600 m), and *Caryocar costaricense* (Caryocaraceae), *Pterygota excelsa* (Sterculiaceae), *Tachigali versicolor* (Fabaceae-Caesalpinioideae) and *Uribea tamarindoides* (Fabaceae-Faboideae) in the Reserva Biológica Carara.

There are also distinctive affinities to (1) Costa Rica's mainland flora, where shared species are found either at higher elevations, e.g., *Oreomunnea pterocarpa* (Juglandaceae), *Ticodendron incognitum* (Ticodendraceae), or on the Atlantic slope (e.g., *Ruptiliocarpon caracolito*, a recent discovery belonging to the family Lepidobotryaceae, previously considered purely African); (2) Jamaica (*Ziziphus chloroxylon*, Rhamnaceae) and (3) several countries to the north, even including Mexico (e.g., *Recchia simplicifolia*, Simaroubaceae) (HERRERA-MCBRYDE et al. 1997).

It is generally understood that the area around the Golfo Dulce was a natural refuge cut off from the mainland during glacial periods. Under such circumstances, speciation occurred at an accelerated rate and many new species evolved in the fragmented forests. The results were so-called "hot-spots" of biodiversity containing high numbers of endemic species. For instance, 25% of the Marantaceae species are endemic to the region (HERRERA-MCBRYDE & al. 1997). In a one hectare research plot near the Field

Station La Gamba over 12% of the tree species (dbh > 10 cm) were found to be endemic: *Pleurothyrium golfodulcensis* (Lauraceae), *Copaifera camibar* (Fabaceae-Caesalpinioideae), *Acacia allenii* (Fabaceae-Mimosoideae), *Clusia peninsulae* (Clusiaceae), etc. (HUBER 1996).

Thus, the genetic and economic potential of the myriad species for timber, chemical uses, medicines, food, etc. demonstrates the clear incentive for further protection and study of the forests around the Golfo Dulce.

Vegetation

General remarks. Thirteen major ecosystems have been distinguished in the region (TOSI 1975, VAUGHAN 1981, BOZA & MENDOZA 1981). With more detailed research of the vegetation, 25-30 associations may become distinguishable (HARTSHORN 1983), including associations of the coastline, cliff and rock faces, landslips and waterfalls. In the last decades several vegetation studies have been performed in the Golfo Dulce area. Until 1981 thirteen major ecosystems had been distinguished (TOSI 1975, VAUGHAN 1981, BOZA & MENDOZA 1981), but HARTSHORN (1983) estimated the actual number as 25-30. The new Ecomaps project, founded by the government of the Netherlands and lead by the National Institute of Biodiversity (INBio) and the National Systems of Conservation Areas of Costa Rica (SINAC) aims to map all ecosystems of Costa Rica, in order to know more about the vegetation and to allow decisions on conservation and inventory efforts. In 1998 the project started in the Área de Conservación Osa (ACOSA), which includes 17 wild protected areas ranging from Dominical to Osa Península and Punta Burica. About 44.7 % of the area is covered by natural forests, which are concentrated in Corcovado and Piedras Blancas National Park. In total, 184 sample sites were studied and 38 different ecosystems could be identified. From the 28 natural and semi-natural ecosystems, 6 are secondary forest types, and 22 are different primary vegetation types such as mangrove, palm swamp and forests. Also 10 types of cultural ecosystems are distinguishable. In the present chapter 18 ecosystems (including secondary forest vegetation) are briefly described.
The ACOSA Conservation Area includes 17 wild protected areas, from Dominical down to Osa Península and Punta Burica. Now only 44.7 % of the ACOSA area is covered by forest, concentrated in Corcovado and Piedras Blancas National Park.

According to the HOLDRIDGE Life Zone System (HOLDRIDGE 1967), the main life zones in the region are the **Tropical Wet Forest**, the **Tropical Moist Forest** and the **Tropical Premontane Wet Forest**.

The **Tropical Wet Forests** around the Golfo Dulce are the only forests of this type that are still extant on the Pacific side of Central America (HARTSHORN 1983). They cover the lowlands of the Golfo Dulce. A few canopy species are deciduous, dropping their leaves during specific intervals in the dry season, e.g., *Parkia pendula* (Fabaceae-Mimosoideae), *Couratari guianensis* (Lecythidaceae), *Dussia discolor* (Fabaceae-Faboideae), *Brosimum utile* (Moraceae). But this does not change the evergreen state of the forest. The tallest trees of the multi-layered forest can reach about 50 m in height. Stilt rooted palms are very abundant and characteristic of this life zone. Dwarf palms as well as broad-leaved banana-like herbs dominate the shrub layer. The ground layer is sparse with a few ferns, including *Selaginella* species and others. Woody lianas and hemi-epiphytic shrubs are common while strangling figs are rare. The tropical wet forest is the most species-rich forest in Costa Rica and the abundant rainfall coupled with a short three-month dry season seems to be ideal for tree growth.

The **Tropical Moist forest** is the most extensive life zone in Costa Rica and comprises the mouth of the Golfo Dulce. This forest is a tall, multi-stratal, semi-deciduous or evergreen forest. The canopy trees are up to 50 m in height. Palms, especially *Iriartea deltoidea*, *Socratea exorrhiza, Attalea butyracea, Cryosophila guagara, Euterpe praecatoria* etc. sometimes can be found in abundance. The shrub layer consists of dwarf palms and giant broad-leaved herbs. The ground is generally bare except for occasional ferns. Herbaceous vines, woody lianas and epiphytes are abundant (HARTSHORN 1983).

Tropical Premontane Wet Forests are located in a substantial band stretching from the Puerto Cortés-Palmar-Sierpe area, to the Corcovado basin and to eastern and southern portions of the Osa Península. This forest is medium to tall (up to 40 m), semi-evergreen with two or three strata. A few canopy species drop their leaves during the dry season. Tree ferns and epiphytes are infrequent. The shrub layer is 2-3 m tall and often dense. The ground, however, is bare except for sporadic ferns. Climbing herbaceous vines are abundant and thick layers of mosses cover most trees.

The highest peaks such as the Cerro Rincón probably harbor **Tropical Premontane Rain Forest** (HARTSHORN 1983, HERRERA-MCBRYDE et al. 1997), an evergreen forest characterized by two or three strata, up to 40 m tall, with a very dense ground layer consisting mainly of ferns. Tree ferns abound in such life zones, as do epiphytes, which cover practically all surfaces.

In the following the most important vegetation units are briefly described:

Forest on plains
This forest type is found on well-drained alluvial flats and terraces. These floodplains are very suitable for the planting of bananas and oil palms, which have been commercially cultivated for many years. As a result, this forest type has become extremely rare in the region and probably no longer exists in the Esquinas forest. The forest comprises trees up to 45 m tall and tree density is relatively low with 250-300 trees/ha (dbh > 10 cm) (HOLDRIDGE et al 1971).

Giant *Anacardium excelsum* (Anacardiaceae) (to 50 m tall and 3 m in dbh) and other large trees such as *Caryocar costaricense* (Caryocaraceae), *Hernandia didymantha* (Hernandiaceae), *Pterygota excelsa* (Sterculiaceae), *Terminalia oblonga* (Combretaceae) and *Ceiba pentandra* (Bombacaceae) are the dominant components. One individual of *Ceiba pentandra* is probably the largest tree in Central America, between 70 m to 80 m tall and over 3 m in diameter above the 10 m high buttresses (BOZA 1988).

The fan palm, *Cryosophila guagara*, which sometimes forms pure stands, and stilt - rooted trees such as *Bravaisia integerrima* (Acanthaceae) are very conspicuous constituents of the forest.

Some species are deciduous, but the period without leaves is usually short. In the understory, broad-leaved and succulent herbs are abundant, such as *Dieffenbachia* spp. (Araceae), *Heliconia* spp. (Heliconiaceae), *Costus* spp. (Costaceae) and *Calathea* spp. (Marantaceae), as well as *Cyclanthus bipartitus* and *Carludovica drudei* (Cyclanthaceae). Large-leaved araceous climbers are also widespread, but orchids, bromeliads and other epiphytes are uncommon. Clumps of the spiny bromeliad *Chevaliera* (*Aechmea*) *magdalenae* are remarkable.

Forest on well-drained hill-tops and ridges (Pl. 2a,c)
This forest type is tall (trees up to 50 m) and open. The majestic boles of the trees are reminiscent of huge temple pillars. This is the most species-rich forest found in the region with around 190 different tree species/ha (dbh > 10 cm) (HUBER & WEISSENHOFER in prep.). Common representatives of the overstory are *Aspidosperma spruceanum* (Apocynaceae), *Calophyllum brasiliense*, *C. longifolium* (Clusiaceae), *Couratari guianensis* (Lecythidaceae), *Humiriastrum diguense* (Humiriaceae), *Macrolobium hartshornii* (Fabaceae-Caesalpinioideae), *Parkia pendula* (Fabaceae-Mimosoideae), *Peltogyne purpurea* (Fabaceae-Caesalpinioideae), *Qualea paraensis* (Vochysiaceae), *Symphonia globulifera* (Clusiaceae), *Vochysia ferruginea* and *V. megalophylla* (Vochysiaceae). Some of these drop their leaves during the dry season (HUBER & WEISSENHOFER in prep.). In the mid- and understory *Brosimum guianense* (Moraceae), *Compsoneura sprucei* (Myristicaceae), *Marila laxiflora* (Clusiaceae) and *Pausandra trianae* (Euphorbiaceae) are the most common species. The most widespread palms are *Welfia regia* and *Socratea exorrhiza*, which predominate on steep slopes.

The heterogeneous understory is often composed of clustered palms (*Geonoma congesta*) and treelets, mainly from the Melastomataceae (e.g., *Clidemia densiflora*) and Rubiaceae (e.g., *Faramea occiden-*

talis, F. suerrensis, Psychotria solitudinum), as well as *Euphorbia elata* and broad-leaved Heliconias (*Heliconia longiflora, H. irrasa*). The cycad *Zamia fairchildiana* is a notable plant frequently observed in the understory on ridges.

Some species of Cyperaceae such as *Diplasia karatifolia* and *Bequerelia cymosa* are characteristic of the forest floor, mainly in older gaps. Epiphytes are common. Especially widespread is *Guzmannia lingulata* (Bromeliaceae), an epiphyte found growing on tree boles which has conspicuous flowers during June and July. Canopy epiphytes such as *Tillandsia bulbosa* (Bromeliaceae), *Scaphyglottis boliviensis, Maxillaria* spp. (Orchidaceae) and the fern *Elaphoglossum* sp. are well adapted to periodical drought. Lianas and hemiepiphytes are rare. The climbing orchid *Vanilla planifolia* is frequently observed.

Due to the exposed position, wind and rain play an important role in determining forest composition on ridges. Tree-fall gaps caused by falling boles and crowns are common. Larger gaps are invaded by pioneer trees, treelets and tall shrubs such as *Cecropia obtusifolia* (Cecropiaceae), *Isertia laevis*, *Psychotria elata, P. poeppigiana* (Rubiaceae) and *Trichospermum grewiifolium* (Tiliaceae), which frequently form nearly pure stands. In new gaps, the scrambling vine *Scleria secans* (Cyperaceae) and the fern *Dicranopteris pectinata* can form impenetrable thickets (Pl. 6b).

Forest on well-drained slopes (Pl. 2b)
This forest type is more humid than the ridge forest. The tallest trees reach 50 m and species diversity is high with up to 140 species per ha (HUBER 1996, WEISSENHOFER 1996). In general, *Brosimum utile* (Moraceae) is the most abundant tree species in the canopy. Other prominent species are *Carapa guianensis* (Meliaceae), *Aspidosperma spruceanum* (Apocynaceae), *Copaifera camibar* (Fabaceae-Caesalpinioideae), *Humiriastrum diguense* (Humiriaceae), *Otoba novogranatensis, Virola guatemalensis* (Myristicaceae) and *Vochysia megalophylla* (Vochysiacae). Common trees of the mid-canopy layer are *Protium panamense* (Burseraceae), *Symphonia globulifera* (*Clusiaceae), Ruptiliocarpon caracolito* (Lepidobotryaceae), *Brosimum lactescens* (Moraceae), *Virola koschnyi* and *V. sebifera* (Myristicaceae).

In the sub-canopy layer *Compsoneura sprucei* (Myristicaceae), *Marila laxiflora* (Clusiaceae), *Mabea occidentalis* (Euphorbiaceae), *Parathesis aeruginosa* (Myrsinaceae), *Guatteria amplifolia* (Annonaceae) and *Dendropanax arboreus* (Araliaceae) are the most common species. Regarding the palms, the stilt-rooted *Iriartea deltoidea* and *Socratea exorrhiza* as well as the majestic *Welfia regia* are most prolific.

Principally, dwarf palms such as *Asterogyne martiana*, *Calyptrogyne ghiesbreghtiana* and *Geonoma cuneata,* and treelets such as the thick-leaved *Euphorbia elata* (Euphorbiaceae) and the large-leaved Marantaceae and Heliconias form the understory. The forest floor is relatively bare. Species of the Cyclanthaceae, Cyperaceae (*Mapania assimilis*), Rubiaceae *(Amphydasia ambigua*) and the saprophytic *Voyria* sp. (Gentianaceae), with yellow or pinkish flowers, are the most conspicuous elements. Large lianas are rare, while hemiepiphytes, mainly *Clusia* spp. (Clusiaceae), are common. Additionally, epiphytes such as *Guzmania lingulata*, *G. scherzeriana* (Bromeliaceae) and *Gongora tricolor* (Orchidaceae) are commonly found on tree boles. Epiphytes adapted to canopy conditions include *Elleanthus* sp., *Maxillaria* spp., *Scaphyglottis boliviensis* (Orchidaceae), *Tillandsia* spp. (Bromeliaceae), *Codonanthe crassifolia* (Gesneriaceae) and others.

Forest in deep valleys
This forest type is located in deep valleys where microclimatic conditions are extremely humid throughout the year. Due to the steep hills surrounding these forests, gaps are plentiful. In comparison to slope forests and ridge forests, valley forests are not as high, with canopy trees around 30-35 m tall and some individuals rarely reaching 40m. Species diversity is high with ca. 120 species/ha (dbh > 10 cm) and up to 450-500 individuals/ha (HUBER & WEISSENHOFER in prep.). The most prolific canopy trees are *Billia colombiana* (Hippocastanaceae), *Dussia discolor* (Fabaceae-Faboideae), *Mortoniodendrum anisophyl-*

lum (Tiliaceae), *Sloanea medusula* (Elaeocarpaceae), *Terminalia bucidoides* (Combretaceae) and *Virola guatemalensis* (Myristicaceae). Common trees of the mid-canopy layer are *Cordia cymosa* (Boraginaceae), *Dendropanax sessiliflorus* (Araliaceae), *Guatteria recurvisepala* (Annonaceae), *Perrottetia sessiliflora* (Celastraceae) and the palm *Welfia regia*.

The sub-canopy layer is dominated by *Tetrathylacium macrophyllum* (Flacourtiaceae), *Rinorea dasyadena* (Violaceae) and *Iriartea deltoidea* (Arecaceae). Other prominent species are *Apeiba tibourbou* (Tiliaceae), *Calatola costaricensis* (Icacinaceae), *Grias cauliflora* (Lecythidaceae) and the pioneer species *Cecropia obtusifolia* (Cecropiaceae) and *Trichospermum grewiifolium* (Tiliaceae).

The understory comprises of a wide range of species. Broad-leaved and succulent herbs such as *Dieffenbachia* spp. (Araceae), *Heliconia* spp. (Heliconiaceae), *Costus* spp. (Costaceae) and *Calathea* spp. (Marantaceae) as well as *Cyclanthus bipartitus* and *Carludovica drudei* (Cyclanthaceae) are abundant. Noteworthy plants are the ubiquitous tree fern *Cyathea delgadii* and the litter trapping treelet *Clavija costaricana* (Theophrastaceae), which is otherwise rare in adjacent areas. The forest floor contains a remarkably rich flora, e.g., *Dieffenbachia oerstedii* (Araceae), *Gasteranthus delphinioides* (Gesneriaceae). Epiphytes such as *Anthurium* spp., *Philodendron* spp. (Araceae), *Asplundia* spp. (Cyclanthaceae), and ferns (e.g. *Hymenophyllum* spp., *Elaphoglossum* spp., *Nephrolepis* spp.) as well as lianas (e.g. *Bauhinia guianensis*, Fabaceae-Caesalpinioideae) are also present in profusion.

Coastal forest (Pl. 1a-c)
This forest type is extensively represented along the coast of the Esquinas forest and covers a major part of the Piedras Blancas National Park. The steep and rocky hills create frequent tree-fall gaps making these forests particularly dynamic. In fact, the whole forest type can be seen as a mosaic of different stages of regeneration (i.e., gap, building, and mature phases). The forest structure and species composition changes abruptly at the summits of the coastal hills.

The forest is tall (up to 50 m) and the species found there are quite different from those of the hilly interior. In a one-hectare research plot near Playa San Josecito more than 120 tree species (dbh > 10 cm) were found (HUBER & WEISSENHOFER in prep.). The most conspicuous canopy tree is *Schizolobium parahyba* (Fabaceae-Caesalpinioideae), a deciduous pioneer legume with wind-dispersed, winged seeds. *Caryocar costaricense* (Caryocaraceae) is conspicuous during its flowering period in February and March. *Manilkara staminodella* (Sapotaceae) and *Calophyllum longifolium* (Clusiaceae), both with strongly fissured bark, are also common.

Widespread species of the mid-canopy layer are *Ampelocera macrocarpa* (Ulmaceae), *Brosimum costaricanum, B. lactescens* (Moraceae), *Elaeoluma glabrescens, Pouteria* spp. (Sapotaceae), *Pourouma bicolor* (Cecropiaceae), *Protium* spp. (Burseraceae), and *Symphonia globulifera* (Clusiaceae). In the sub-canopy layer *Compsoneura sprucei* (Myristicaceae), *Garcinia madruno* (Clusiaceae), *Guarea pterorhachis* (Meliaceae), *Heisteria concinna* (Olacaceae) and *Sorocea cufodontisii* (Moraceae) are the most abundant species. The understory and ground layer is species-poor, consisting mainly of seedlings and young trees that belong to the upper layers. Among the few ground plants are *Spathiphyllum silvicola* (Araceae), and the palms *Neonicholsonia watsonii* and *Geonoma cuneata*. Big lianas are abundant, e.g., *Doliocarpus multiflorus* (Dilleniaceae), *Mucuna* sp. (Fabaceae-Faboideae), *Aristolochia* sp. (Aristolochiaceae), *Entada* sp. (Fabaceae-Mimosoideae), *Bauhinia* sp. (Fabaceae-Caesalpinioideae) etc. The climbing fern *Lygodium radiatum* which grows on nearly all mid-canopy trees is ubiquitous. The shrubby *Warscewiczia coccinea* (Rubiaceae) with its scarlet bracts is frequent and eye-catching from far away when following the coastline by boat.

Epiphytes are extremely rare on boles and in the canopy. Only some orchids, *Tillandsia* spp. (Bromeliaceae), *Sphyrospermum ellipticum* (Ericaceae), and ferns, all well adapted to drought, are found.

Riverine forest (Pl. 3b)
This forest type is found along small rivers with adjacent flat terraces. Trees are 35-50 m tall and often have massive trunks with large spreading buttresses.

Conspicuous trees of the canopy layer include *Ceiba pentandra* (Bombacaceae), *Carapa guianensis* (Meliaceae), *Hyeronima alchorneoides* (Euphorbiaceae), *Luehea seemanii*, *Mortoniodendron anisophyllum* (Tiliaceae), *Sloanea* sp. and *Virola* spp. (Mystisticaceae).

The mid-canopy layer is relatively open with trees around 25-35 m tall. Common species include *Apeiba membranacea, A. tibourbou* (Tiliaceae), *Bursera simaruba* (Burseraceae), *Castilla tunu* (Moraceae), *Pachira aquatica* (Bombacaceae), *Protium* spp. (Burseraceae), *Spondias mombin* (Anacardiaceae) and *Sloanea medusula* (Elaeocarpaceae). Prominent species of the understory are *Guatteria chiriquiensis* (Annonaceae), *Ocotea mollifolia* (Lauraceae), *Siparuna andina* (Monimiaceae) and the spiny fan-palm *Cryosophila guagara*. The well-represented shrub stratum is dominated by the dwarf palm *Asterogyne martiana* which is characterized by undivided plicate leaves, as well as by other large-leaved plants such as *Carludovica drudei* (Cyclanthaceae), *Calathea* spp. (Marantaceae), *Costus* spp. (Costaceae), *Dieffenbachia* spp. (Araceae) and *Heliconia* spp. (Heliconiaceae). The ground layer is bare except for *Selaginella* spp. and tree seedlings. Epiphytes are common and conspicuous on exposed branches, e.g., *Columnea flaccida* (Gesneriaceae), but lianas are rare.

Cloud forest
This type of forest is found only on the highest mountains of the Osa Península (Cerro Rincón and Cerro Mueller). The unique appearance of cloud forests is due to the abundance of epiphytes and tree ferns (*Cnemidaria choricarpa, Cyathea trichiata*). Common tree species include *Quercus* spp. (*Q. insignis, Q. rapurahuensis*) (Fagaceae), *Alfaroa guanacastensis*, *Oreomunnea pterocarpa* (Juglandaceae), and the recently discovered *Ticodendron incognitum* (Ticodendraceae) (FNT 1992).

Mountain or upland forest
This tall forest — canopy trees reach up to 60 m — shows a high species diversity (ca. 100-120 tree species per ha). Tree trunks are sometimes unbranched up to heights of 35 m or more, and spectacular buttresses are frequently observed. Common palms include the stilt-rooted *Iriartea deltoidea* and *Socratea exorrhiza*. Lianas and vines are abundant. Common tree species include *Ardisia spp.* (Myrsinaceae), *Aspidosperma spruceanum* (Apocynaceae), *Brosimum utile, Poulsenia* sp., *Sorocea pubivena* subsp. *pubivena* (Moraceae), and *Heisteria longipes* (Olacaceae). It must be noted, however, that none of the above-mentioned species dominate the canopy. In an analysis of a site located north of the park (ca. 5.5 km west of Rincón de Osa) 22 tree species over 50 m tall, five over 60 m tall, and a single emergent tree *Minquartia guianensis* (Olacaceae) reaching 73 m in height (FNT 1992), were identified.

Coastal and beach vegetation
Coastal vegetation is highly disturbed due to human interference. Along the coastline of the Golfo Dulce, especially in the Esquinas area, there is a significant alteration of steep rocky hills and sandy beaches. On sandy beaches, the coconut palm (*Cocos nucifera*) is the most widespread species, often being associated with *Bombacopsis sessilis* (Bombacaceae), *Chrysobalanus icaco* (Chrysobalanaceae), *Amphitecna latifolia* (Bignoniaceae), *Hibiscus pernambucensis* (Malvaceae), *Licania operculipetala* (Chrysobalanaceae) and *Terminalia catappa* (Combretaceae). On the Península de Osa, *Bombacopsis sessilis* (Bombacaceae) and *Hippomane mancinella* (Euphorbiaceae) are common elements of the coastal vegetation. Interestingly, these species seem to be completely absent on the beaches of the Esquinas forest. The creeping vine *Ipomoea pescaprae* (Convolvulaceae) and *Canavalia rosea* (Fabaceae-Faboideae) are common sand-dwelling herbs.

Rocky shorelines below the high, forested headlands tend to be dominated by *Swartzia simplex* (Fabaceae-Faboideae), *Apeiba tibourbou* (Tiliaceae), *Alibertia edulis* (Rubiaceae) and *Nectandra* sp.

(Lauraceae). Additionally, species adapted to dry conditions such as *Bursera simaruba* (Burseraceae) and *Byrsonima crassifolia* (Malpighiaceae), as well as the hemiepiphyte *Clusia rosea* (Clusiaceae), are abundant.

Gallery woodlands
This type of vegetation is closely associated with riverbanks and gravel bars of the large rivers draining the Corcovado and Esquinas area. It is characterized by a peculiar arborescent flora with tree species not found in the adjacent forest. The gravel bars are apparently the source of many of the pioneer species that comprise the majority of secondary vegetation. Species commonly observed include *Acalypha diversifolia* (Euphorbiaceae), *Apeiba tibourbou* (Tiliaceae), *Costus pulverulentus* (Costaceae), *Heliconia* spp. (Heliconiaceae), *Malvaviscus arboreus* (Malvaceae), *Myriocarpa longipes* (Urticaceae), *Piper* spp. (Piperaceae), *Vernonia patens* (Asteraceae) and *Vismia ferruginea* (Clusiaceae).

Along the meandering streams, the arrow cane (*Gynerium sagittatum*, Poaceae), whose durable stems are used for construction, often forms pure stands (e.g., Río Bonito). The relative stability of more mature gravel bars facilitate the growth of pioneer trees such as *Ochroma pyramidale* (Bombacaceae), *Cecropia* spp. (Cecropiaceae), *Croton schiedeanus* (Euphorbiaceae), *Dicraspidia donnell-smithii* (Tiliaceae) and *Senna reticulata* (Fabaceae-Caesalpinioideae) which occur together with *Piper* spp. (Piperaceae) and the tree ferns *Cyathea poeppigii* and *Alsophila firma* (LAUTSCH 2000).

Swamp forest (Pl. 4b,c)
Extensive swamp forests are found in the lower part of the Río Coto, at the mouth of the Río Rincón, and at the periphery of the palm swamps on the Corcovado lagoon. This sizeable area is characterized by its low relief and poorly drained soils. The floristic cover changes from place to place and probably reflects soil and salinity differences.

Andira inermis (Fabaceae-Faboideae), *Carapa guianensis* (Meliaceae), *Crateva tapia* (Capparaceae) and *Luehea seemannii* (Tiliaceae) are common canopy trees in this vegetation type. Apart from these well-buttressed trees, stilt-rooted sub-canopy trees such as *Symphonia globulifera* (Clusiaceae), *Bravaisia integerrima* (Acanthaceae) are frequently observed. A fairly open palm understory (*Cryosophila guagara, Prestoea decurrens*) is also characteristic.

Poorly drained alluvia and estuaries are covered by a forest type with comparatively shorter trees such as *Pterocarpus officinalis* (Fabaceae-Faboideae), *Mora oleifera* (Fabaceae-Caesalpinioideae) and *Pachira aquatica* (Bombacaceae). On riversides, the palms *Bactris major, Raphia taedigera* and *Elaeis oleifera* (American oil palm) are typical components of the ecosystem. Extensive stands of the white-flowered, fragrant *Crinum erubescens* (Amaryllidaceae) and the fern *Acrostichum aureum* often make up the ground layer.

Mangroves (Pl. 5a-c)
Mangroves occur in the tidal estuaries of Río Coto, Río Esquinas, Río Sierpe, Río Sirena, Río Llorona, Río Corcovado, and around the shores in the town of Golfito. Their distribution is determined by their inherently high salt tolerance. Only a few species, mostly from unrelated families, are sufficiently salt-tolerant to be able to grow in such an adverse habitat. Mangrove forests are floristically poor, thus representing the opposite extreme of tropical forests with their rich species diversity.

The roots of the Red Mangrove, *Rhizophora mangle* (Rhizophoraceae), are masterpieces of plant engineering, consisting of complicated arching tiers, suited for supporting the trunk and leaves above the shifting currents and tidal flow. Due to sedimentation the soil level rises year after year thereby preparing the ground for less tolerant vegetation types. The Black Mangrove, *Avicennia germinans* (Verbenaceae), occupies higher ground further inside the forest. These trees form nearly pure stands and grow up to 25 m high. They lack the typical stilt roots, but produce erect pneumatophores from their underground radial roots. They trees are able to secrete excess salt through their leaves — older leaves

become coated with salt crystals — giving rise to the Spanish name *palo de sal* (salt tree). Other mangrove species are *Laguncularia racemosa, Conocarpus erectus* (Combretaceae) and *Pelliciera rhizophorae* (Theaceae), the latter tree with conspicuous buttresses forming a solid cone. Two fairly common epiphytes are noteworthy: the bromeliad *Werauhia* (*Vriesea*) *gladioliflora* and the lovely white-flowered orchid *Brassavola nodosa*.

In the swamp forest behind the mangroves, *Mora oleifera* (Fabaceae-Caesalpinioideae) commonly grows in association with *Pterocarpus officinalis* and *Andira inermis* (Fabaceae-Faboideae). These trees form the canopy layer. The understory and the ground layer are species-poor and consist mainly of *Tabebuia palustris* (Bignoniaceae), *Acrostichum aureum* and *Crinum erubescens* (Amaryllidaceae).

In the past *Rhizophora* trees were extensively harvested for their bark — used in leather tanning and charcoal production — but nowadays law prohibits the cutting of mangroves.

Corcovado Lagoon and adjacent areas
The water level of Corcovado lagoon rises up to 1 m during every rainy season. The lagoon supports a central floating mat of herbaceous vegetation including *Eichhornia crassipes* (Pontederiaceae), *Pistia stratiotes* (Araceae), *Utricularia gibba* (Lentibulariaceae), *Ludwigia* sp. (Onagraceae) and the water ferns *Salvinia* sp. and *Azolla mexicana*.

On the margins of the small open-water lagoon is an extensive floating mat of herbaceous vegetation, dominated by the grass *Pennisetum* sp. As the depth of the water decreases, the vegetation diversity increases. The slightly higher natural levels of the streams feeding the lagoon support pure stands of the legume *Inga vera* (HARTSHORN 1983).

Palm swamp (*Yolillo* forest)
The marsh around the Corcovado lagoon is dominated by virtually pure stands of the palm *Raphia taedigera*, which produces leaves up to 15 m long (DEVALL & KIESTER 1987). The area receives substantial floodwaters for a few months each year (HARTSHORN 1983) and then dries out briefly during the dry season. Peripheral to the swamp, species such as *Andira inermis* (Fabaceae-Faboideae), *Carapa guianensis* (Meliaceae), *Crataeva tapia* (Capparaceae) and *Luehea seemanii* (Tiliaceae) are interspersed among the dominant *Raphia* sp.

Herbaceous swamp vegetation
An herbaceous marsh measuring ca. 10 km² borders the Corcovado lagoon. Large areas of herbaceous marshes can also be found in the Laguna Machaca near Piedras Blancas and near the Laguna de Sierpe. This type of vegetation is in sharp contrast to the surrounding arborescent flora. It appears that many of these open tracts represent old lagoons that have been filled by the encroaching vegetation, particularly grasses and sedges. The most common plants are *Hymenachne* sp. (Poaceae), *Panicum maximum* (Poaceae), *Ludwigia* sp. (Onagraceae), *Polygonum* sp. (Polygonaceae) and *Aeschynomene* sp. (Fabaceae-Faboideae) as well as large-leaved plants such as *Heliconia latispatha, H. imbricata* (Heliconiaceae) and *Calathea lutea* (Marantaceae). At the edge of the swamps, colonies of *Symphonia globulifera* (Clusiaceae) and *Pachira aquatica* (Bombacaceae) are abundant.

Aquatic vegetation (Pl. 3c)
In the larger rivers with slower currents (i.e., Río Sierpe and Río Sirena) free-floating plants such as *Eichhornia crassipes* (Pontederiaceae), *Pistia stratiotes* (Araceae) and the water fern *Salvinia* sp. are very common. While very abundant in the Río Sierpe, *Pistia stratiotes* has not been observed in the Río Esquinas nor in the Río Coto. In the Río Sirena, the ground-rooting *Eichhornia azurea* (Pontederiaceae) with its dark blue flowers is frequently observed on the way to the lagoon, especially in fast-flowing parts of the river.

Secondary forests

When primary forest is felled, robust herbs are the first plants to invade the bare land. An arborescent flora, consisting of species that are either rare or absent in primary forest, is the next step in recolonization. These species, with high light requirements, belong to different families and genera. Some are derived from riverbank and gravel bar communities, e.g. *Ochroma pyramidale* (Bombacaceae), *Senna reticulata* (Fabaceae-Caesalpinioideae), while others are rare elements of primary forest, e.g., *Trema micrantha* (Ulmaceae) and *Cecropia* spp. (Cecropiaceae).

The clearing of land initiates a long process, usually involving a succession of distinct associations, which depend on the size of the disturbed area, and culminating in the reestablishment of the quasi-original forest structure. A typical succession may start with rapidly developing herbaceous cover composed of ferns and various Heliconias (e.g., *H. lathispatha*) and *Calathea* spp. (Marantaceae), followed for a few years by *Cecropia* spp. (Cecropiaceae), *Ochroma pyramidale* (Bombacaceae), *Psidium guajava, P. friedrichsthalianum* (Myrtaceae), *Trema micrantha* (Ulmaceae), and *Vismia ferruginea* (Clusiaceae). Species of *Vochysia* (Vochysiaceae) may invade this forest type thereby creating a microclimate more suitable for shade-tolerant, climax species such as *Brosimum utile* (Moraceae) and *Carapa guianensis* (Meliaceae). The latter often reaches canopy height and persists for many years thus completing the process of succession.

Pastures (Pl. 6a)

All pastures in the area are located mainly on flat land and are man-made. Lone trees still persist, presenting evidence of former lowland forest. There is a number of common species such as *Cedrela odorata* (Meliaceae) and *Ceiba pentandra* (Bombacaceae), which seem to be typical in flat forests, but rare in hillside forests.

Grasses and weedy herbs such as *Cyperus* sp. (Cyperaceae), *Desmodium* sp. (Fabaceae-Faboideae), *Hyptis capitata, H. obtusiflora* (Lamiaceae), *Limnocharis flava* (Limnocharitaceae) and *Lycopodiella cernua* (Lycopodiaceae) are the most common plants in disturbed areas. In more humid sites *Acrostichum aureum, Eleocharis elegans* (Cyperaceae), *Limnobium stoloniferum* (Hydrocharitaceae) and the palm *Raphia taedigera* occur. Small treelets may also invade the grasslands, e.g., *Conostegia subcrustulata* (Melastomataceae), *Lantana camara* (Verbenaceae), *Ludwigia octovalvis* (Onagraceae), and *Miconia schlimii* (Melastomataceae).

It is notable that some rare tree species left in this area have been recently recognized as new to the flora of Costa Rica (e.g., *Pradosia* sp. ined., Sapotaceae).

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Utilization and Conservation of the Golfo Dulce Rain Forests

A. WEISSENHOFER & N. ZAMORA

Useful plants (based on HERRERA-MACBRYDE et al 1997, with complements)
Through decades of international and domestic efforts, vast amounts of scientific knowledge on Costa Rica's natural resources have been accumulated. Today it is increasingly recognized as a site for carrying out more complex and long-term biological research. In 1989 the government established a National Biodiversity Institute (INBio) to help accelerate the attempt to complete both a national inventory and an investigation of the commercial utility of Costa Rican flora and fauna (BRANDON & UMAÑA 1991, JONES 1990).

The park region has been chosen as one of the first areas for an intensive inventory. The Copenhagen Botanical Museum (K. THOMSEN), in collaboration with Costa Rica's Fundación Neotrópica, initiated a study of the potential for non-timber forest products from the Osa Península in 1992.

INBio has placed early emphasis on seeking pharmacologically active substances (SITTENFELD-APPEL 1992). Locally, a number of species are used for medicinal purposes, usually by preparing the seeds, bark or wood according to specific guidelines. *Quassia amara* (Simaroubaceae), *Simaba cedron* (Simaroubaceae), *Bursera simaruba* (Burseraceae), *Hymenaea coubaril* (Fabaceae- Caesalpinioideae) and *Bauhinia guianensis* (Fabaceae-Caesalpinioideae) are examples. The latex from *Brosimum utile* and *Ficus* spp. is used as a medicine. Latex from the wounded trunk of *Copaifera camibar* (Fabaceae-Caesalpinioideae) is extracted for production of the "camíbar oil" which has antiseptic properties.

Other commercial products include fibers for handicrafts, e.g. the bark of *Apeiba tibourbou* (Tiliaceae) and the aerial roots of climbing aroids and Cyclanthaceae. The region is a natural reserve for original gene pools, e.g., *Persea americana* ("aguacate") (Lauraceae), *Byrsonima crassifolia* ("nance") (Malpighiaceae) and *Licania platypus* ("sonzapote") (Chrysobalanaceae). The fruits of *Hymenaea coubaril* ("guapinol") (Fabaceae-Caesalpinioideae) may have major potential for sustainable extraction; the fruits are abundant (up to 45 kg per tree fall daily in February and March), store well, and are very edible, frequently being used in cakes and drinks. Other non-timber products with economic potential are natural chewing gum, *Manilkara staminodella* (Sapotaceae), edible nuts (*Sterculia apetala*, Sterculiaceae), palm hearts (*Iriartea*, *Socratea*, *Euterpe* etc.) and cosmetic oil (*Carapa guianensis*, Meliaceae). *Osa pulchra* (Rubiaceae) may have ornamental potential.

In the 1970's, Costa Rica had the fastest deforestation rate (400-600 km² per year) and per capita conversion of any Latin American country. Timber in non-protected areas is likely gone by now and Costa Rica may start to import lumber (GÁMEZ & UGALDE 1988, TANGLEY 1986, OMANG 1987, JONES 1990). Thus, the genetic stocks of many tree species in the park are increasingly valuable for reforestation efforts which have already begun on the peninsula (cf. HERWITZ 1981).

Conservation
When Costa Rican lands were settled in the 1800's, the presence of yellow fever probably preserved the Osa Península region from conversion to ranches and farms (CARR & CARR 1983) while other areas were being rapidly deforested. The absence of roads until recent years further helped preservation. In 1962, national and international organizations began to study the flora, fauna and ecology of the Osa Península more intensively. A great wave of interest arose in 1971 helping establish a large area for protection. Subsequent efforts succeeded in October 1975, when the government established the Çorcovado National Park in response to various escalating ecological threats. In 1976-78, 100-300 families of settlers were relocated, and their cattle and pigs were removed from the Corcovado plain. There, 20-30 km² of pasture and cropland and 1-4 km² of under-cut forest (undergrowth cut prior to felling and sowing),

along with older degraded patches scattered across the plain, are currently recovering to diversified forest (HERWITZ 1981). The park was enlarged over 20% in 1980 in order to provide more natural boundaries and include part of the highlands on the peninsula (BOZA & MENDOZA 1981, WRIGHT 1976, HARTSHORN 1983).

The Esquinas Forest was formally established and declared a national park by a presidential decree in 1991. It has an extension of 148 km² and there is also a 2 km wide marine buffer zone. However, it could only be catalogued as a "park on paper" since the Costa Rican National Park Service did not yet own it. Exploitation permits to utilize and to extract timber from these lush forests had been issued before the declaration of the park and thus deforestation continued, inflicting irreversible damage upon the Esquinas Forest and jeopardizing the objectives of the decree. Later that year, the Austrian musician Michael Schnitzler, founded a non-profit organization called "Rainforest of the Austrians" and began fundraising with the goal of purchasing real estate in the Esquinas Forest from the proprietors. By 1999, over 13,000 Austrians had donated more than 1,200,000 U.S. dollars, enabling the purchase of over 26 km² of rainforest. The property, of which most had logging exploitation permits, was then donated to the Costa Rican National Park Service and became part of the new Piedras Blancas National Park. Additionally, the Costa Rican government and the U.S.-based group Ecoland together bought another 70 km² of land in the Esquinas forest which is about half of the designated park area. Although logging has ceased in the area, the remaining landowners still have the legal right to obtain a logging permit until their land has been purchased. The only way to prevent further logging in the Esquinas forest is to purchase the remaining land and incorporate it into the National Park. Presently, the society "Rainforest of the Austrians" is actively fundraising, not only to purchase land, but also to hire park rangers and to support reintroduction projects for scarlet macaws, ocelots, and margays. The organization also runs the Tropenstation La Gamba, a field station at the edge of the Esquinas Forest and the village of La Gamba, respectively.

In 1987, the Costa Rican government started to integrate park management and community outreach in nine regional Areas of Conservation (AC's). Each of the nine key protected areas and their adjacent buffer zones were merged into a single entity within the National System of Conservation Areas (SINAC). The Osa Conservation Area (ACOSA) combined Corcovado National Park (now 572 km²), the Golfo Dulce Forest Reserve (592 km²), and the Piedras Blancas Nationalpark (148 km²) into a unified system which works with local authorities to define and implement ecologically and economically sustainable activities (BRANDON & UMAÑA 1991). The Guaymí Amerindian Reserve (27.1 km²), situated adjacent to the Corcovado park to the north, is also a protected area. The Manglar Sierpe-Térraba Forest Reserve (227 km²) lies close the peninsula's border with the mainland to the west. One-third of the peninsula is in private hands, including some small ecotourism reserves. The Institute of Agrarian Development (IDA) regards only 97 km² of the available land as adequate for farming.

In 1988, an ecodevelopment program (BOSCOSA) was initiated by Costa Rica's Fundación Neotropica and by U.S.-based World Wildlife Fund (WWF-US) to improve the economical and ecological situation in the region – especially in the Golfo Dulce Forest Reserve (where ca. 5000 families live) and in the Guaymí Reserve (where 24 indigenous families live). The BOSCOSA efforts include research, training, sustainable community forestry, natural forest management, land purchase, reforestation, agroforestry, cultivation of ornamentals, environmental education (including a Tropical Youth Center), artisanry, and ecotourism (CABARLE et al. 1992).

Conservation initiatives have received support from Conservation International, The Nature Conservancy (partly through means of its "Parks in Peril" campaign), WWF-US, rain-forest conservation groups in several countries, Catholic Relief Service, Organization of American States, and the Costa Rican, Austrian, Danish, Dutch, Swedish and U.S. governments among others.

In 1990 Costa Rica launched a cooperative National Strategy for Conservation and Sustainable Devel-

opment (ECODES), which deals with such broad issues as land-capability assessment, integrated land-use processes, development of new environmental laws and regulations, forestry and SINAC. Recently a new law protecting biodiversity (including wild flora and fauna) was enacted. Funding sought from the Global Environment Facility (GEF) would strengthen current efforts (like BOSCOSA and INBio) in the region. Such broad and integrated activities are crucial for the survival of ecosystems large enough to promote the long-term health and survival of local flora and fauna.

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Soils in the Golfo Dulce Region

SUSANNE PAMPERL

This contribution presents a brief survey on the characteristics and distribution of the soil orders and soil types found in the Golfo Dulce area. Terminology follows the classification system of the US Soil Taxonomy (continuously updated, recent version: SOIL SURVEY STAFF 1998).

Main soil types

Soils of tropical rainforests are diverse (for general information see, e.g., MABBERLEY 1992). In Table 1 the main soil types found in the humid tropics are listed (with % representation worldwide). According to the soil map of Costa Rica (VASQUEZ MORERA 1989, Fig. 1) three soil orders prevail in the Golfo Dulce region: **(1) Ultisols, (2) Inceptisols** and **(3) Entisols**. The Ultisols are the most important ones in the region. They are followed by the Inceptisols, while the Entisols are of minor importance.

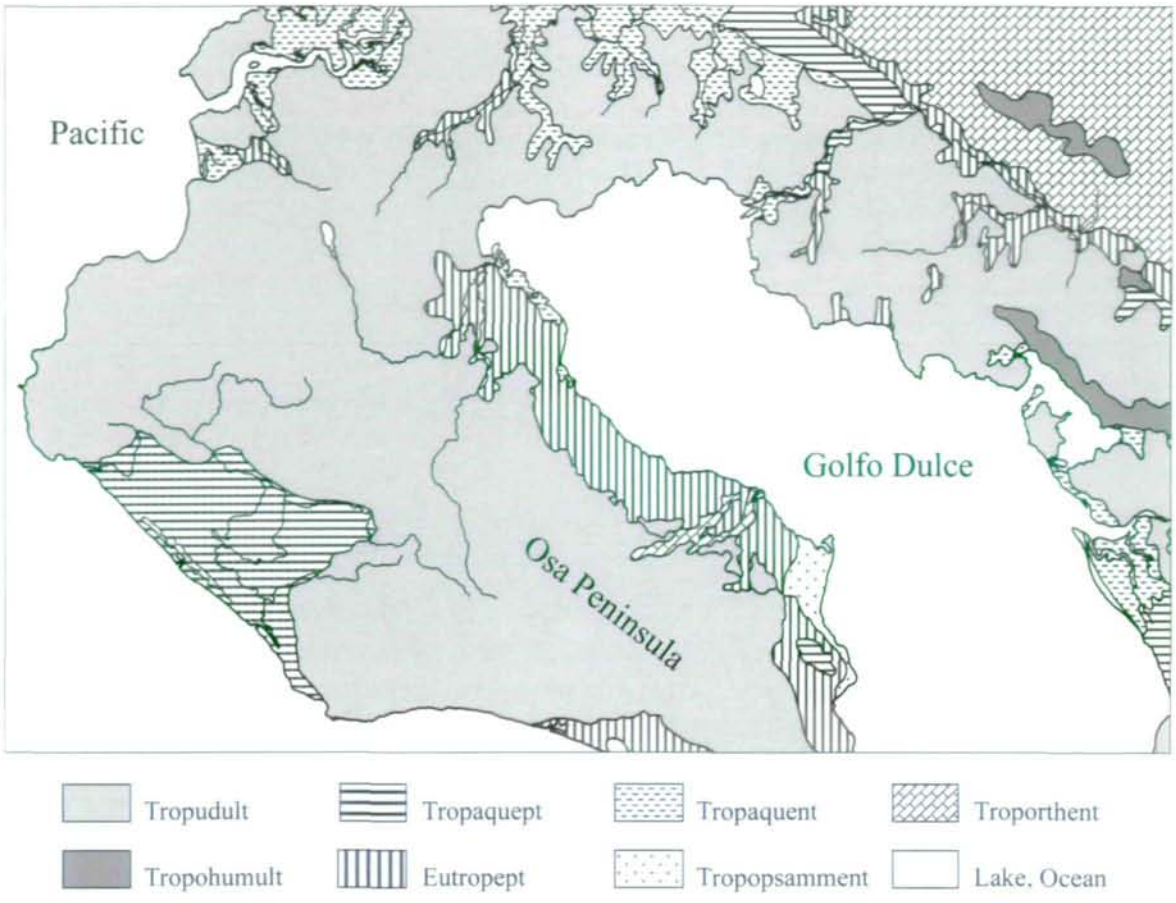
Table 1: Orders and groups of soils of the humid tropics and their global representation (in %) (from WHITMORE 1990)

Old infertile loamy and clayey soils: Oxisols and Ultisols	63
More fertile and less weathered soils:	
of locally less leached conditions: Alfisols and Vertisols	4
on mainly alluvial lowlands: Entisols (Fluvents) and Inceptisols (Aquepts)	12
on volcanic ash: Andosols	1
on steep slopes: Inceptisols (Tropepts) and Entisols (Lithic soils)	11
Infertile sands: Spodosols and Entisols (Psamments)	7
Infertile peats: Histosols	2

Pedogenesis

The most important factor inducing pedogenesis of the Golfo Dulce area is the tropical climate. The constantly high temperatures and high precipitation cause intense, deep-reaching chemical weathering of the original rock and the soil itself. Through undisturbed pedogenesis over geologically long periods of time, the highly weathered, clayey, characteristically yellowish-red and strongly acidic Ultisols have been formed. They would probably cover the main area of their distribution in the Golfo Dulce region as a thick, uniform layer if it were not for the erosive force of the high precipitation rates which have deeply dissected the landscape and still shape the topography. With each downpour, fine soil material is eroded from the soil surface and washed away into the numerous brooks. Erosion has, over thousands of years, produced steep slopes (slope gradients up to 60% and more), which are highly dynamic in the upper layers of the soil. Lateral soil movement is visible in many places in the form of bent tree trunks and as the "staircase relief" of the soil surface. In ravines and lower slopes, soils are younger and less weathered. Only on the ridges and the upper slopes the old clay soils still remain. Thus, even if soil maps display only the highly weathered Ultisols, younger, more moderately weathered Inceptisols can regularly be found in the ravines.

Pedological conditions vary across relatively short distances in the steeply dissected areas from highly weathered, aluminium saturated clay on the hill tops to coarser, nutrient-rich soils with high nutrient retention capacity and optimal hydrological conditions in the small valleys. These pedological differences undoubtedly contribute to the variety of plant habitats and to the distribution of plant species in the National Parks.



Soil map of the Golfo Dulce area, part of the Soil Map of Costa Rica (VAZQUEZ-MORERA 1989); modified. Grey: Ultisols, hatched: Inceptisols, other signatures: Entisols.

(1) Ultisols

Characteristics. These soils have a well-developed, strongly weathered clayey subsoil that does not contain appreciable amounts of parent rock material. The clay mineral kaolinit comprises the main fraction of the soil body and determines the small nutrient budget through its low nutrient retention capacity. Nutrients such as calcium and magnesium cannot subsequently be derived from primary minerals, therefore these soils are low in nutrients and have strongly acidic subsoils. Due to decomposition of leaf litter nutrient supply is slightly higher in the surface horizon. Vegetation growing in Ultisols is thus forced to adapt to nutrient deficiency. However, if the roots are able to penetrate deep enough to reach primary minerals, the plants can absorb cations and then add nutrients to the surface horizon through subsequent litter fall.

The iron oxides haematite, goethite and ferrihydrite give the Ultisols their characteristic yellowish-red color.

Distribution. The highly weathered Ultisols are the oldest and most common soils in the Golfo Dulce region. They can be found all over the region where the parent material for pedogenesis and the developing soil have been exposed to weathering for long periods of time. These are the areas with occurrence of Cretaceous volcanic rock material (according to BERGOEING 1998) and not the areas of younger (Quaternary) sediments. Ultisols are common in the center of the Osa Península and in a broad strip on the north and northeast area of the Golfo Dulce. About two-thirds of the Corcovado National Park on the Osa Península and the major part of the Piedras Blancas National Park are covered predominantly by Ultisols.

Areas with dominant occurrence of Ultisols are often very steeply dissected, with slope inclinations up to 60 % („Fuertemente Ondulado"). These areas include the highest elevations (745m on the Osa Península and 597m in the Esquinas forest).

Origin. The parent materials for soil formation are variable in the region. On the Osa Península Ultisols developed mainly from Pliocene to Pleistocene marine sediments. Along the Golfo Dulce coast, from the Osa Península to the area of the Piedras Blancas N. P. the submarine basalts of the Rincón block make up the parent rock material, whereas in the eastern part of the Piedras Blancas N. P. the more differentiated sediment sequence of the Golfito-Terrane overlays oceanic basalts. Pedogenesis results in Ultisols irrespective of the lithological differences. The geological basement is described in some detail in the account on geological history (MALZER 2001).

Types. Depending on the soil moisture regime and the nutrient supply, Ultisols can be classified into two suborders in the Golfo Dulce area: Udults and Humults[1]. From these suborders the following soil types are found in the area (see soil map Fig. 1):

(a) Tropudults: Ultisols with udic soil moisture regimes (dry period less then 90 cumulative days of the year) under tropical temperatures. This is the typical soil type in the Golfo Dulce area. The water supply for vegetation is good during most time of the year.

(b) Tropohumults: Ultisols with a high content of the nutrients carbon and nitrogen in the upper soil horizons and with tropical temperature patterns. The soil moisture regime is also udic in this area. This soil type only has significant coverage along the Bay of Golfito. In this region slopes reach a gradient of greater than 60%.

Significance for plants. Aluminium saturation can reach critical concentrations in the soil solution, resulting in a toxic effect in the thin roots (see: FOY 1974). The aluminium load (depending on the Ca:Al ratio) may have a selective influence on the species composition of the local flora. A high amount of iron oxide in the soil leads to phosphorous fixation, which generally limits plant growth (YOUNG 1976, BORGAARD 1983) and also may have an influence on species composition (GARTLAN et al. 1986).

(2) Inceptisols

Characteristics. Inceptisols are moderately developed soils with slightly weathered subsoil. The subsoil can contain appreciable amounts of primary minerals and rock material. Since Inceptisols still contain weatherable minerals, plant nutrient supply is moderate to high. Nutrients are bound to clay minerals with moderate to very high nutrient retention capacity.

Secondary iron oxides (goethite) often render Inceptisols yellowish-brown. These characteristics set the Inceptisols apart from the more highly weathered Ultisols.

Distribution. The moderately weathered Inceptisols are the second important soil order in the Golfo Dulce area. These soils developed on parent material exposed to weathering for a shorter period of time and are thus classified as younger. They occur on recently deposited sediments along the rivers and on alluvial planes (Quaternary sediments in the map of TOURNON & ALVARADO 1997). They are also found on terrain where erosion has washed away the formerly overlying more strongly weathered soil material, i.e. in lower parts of steep slopes and in ravines.

Types. Depending on the soil moisture regime, the Inceptisols occur in two suborders: **Aquepts** and **Tropepts**. The following types are present in the Golfo Dulce area:

[1] In the international classification system of the WRB (FAO, ISRIC und ISSS, 1998) the Ultisols of the Golfo Dulce area are classified as **Nitosols** (deep, well drained clay soils with characteristic structure and ped faces) or **Acrisols** (strongly acid soil with high clay content, low cation exchange capacity and low base saturation).

(a) Tropaquepts. Inceptisols that are formed under the influence of high ground-water levels and in tropical climatic conditions. They cover the wide plain in Corcovado National Park near the southwest coast of the Osa Península including the area of Laguna Corcovado. This area is essentially flat and marshy, with alluvial parent material for pedogenesis.

Aquepts are characterized by poor soil aeration, where ground-water levels regularly reach the upper portions of the soil profile for at least part of the year. The temporarily water-saturated, redoximorphic horizons show reddish, pale and black mottling, which is a characteristic sign of the soil moisture regime in this soil type. Nutrient supply is rather low. In these soils vegetation must be adapted to such hydrological conditions.

(b) Eutropepts: Nutrient rich Inceptisols (base saturation >50%) under tropical climate. This soil type is typical in the river basins and on the northeastern, eastern and southern shores of the Osa Península. It also covers small areas of the Piedras Blancas National Park, where it is observed in the river basins of the Río Riyito and Río Esquinas, in the broad valley between Fila Golfito and Fila Gamba, as well as in two places around Playa San Josecito. These soils also develop from alluvial sediments.

If developed from non-calcaric rock, tropepts are relatively acidic soils, but may nevertheless be nutrient-rich. Over calcaric rock the soil-pH is close to neutral and an optimal nutrient supply can create a fertile plant habitat.

Soil studies in the Bosque Esquinas have shown that Inceptisols commonly associated with Ultisols (those occurring on the lower slopes and ravines), also belong to the group of the eutropepts (PAMPERL 2001). The original material for pedogenesis in this case is not alluvial, but in situ weathered rock from the particular geological formation.

(3) Entisols

Characteristics. Morphology and characteristics of the soils of this soil order are very heterogeneous, as it includes all soils that are not classified into any other order. The common qualities of these soils are immaturity and lack of any diagnostic horizon thus classifying them into the soil order of the Entisols. The species composition is more or less characteristic for specific soil types where corresponding vegetation displays different modes of adaptation to the unique hydrological conditions of the soils.

Distribution. The reasonably well developed Entisols represent the third soil order in the Golfo Dulce area. They are typical soil formations in low-lying, plain areas such as swampy lands, coasts and mangroves. The Entisols occur in a patchy distribution along the shore of the Golfo Dulce and make up large parts of the Río Sierpe region.

Types. Depending on soil moisture regime and texture Entisols appear as three different suborders, **Aquents**, **Psamments** and **Orthents**, with the following soil types:

(a) Tropaquents: Entisols that are influenced by high ground water level in tropical climatic conditions. They are typical soils in swampy areas; frequently poorly aerated in the upper layers and water saturated in the lower layers. They are also commonly known as "gleys". The mangrove areas on the northwest coast of the Osa Península and the estuaries of the big rivers (e.g., Río Coto Colorado, Río Esquinas, a.o.) contain this soil type. Soil forming materials are fluviatile deposits from the river load (unconsolidated sandy-silty material). Tropaquents also cover large parts of the landscape also in the swampy lowland of the Río Sierpe.

(b) Tropopsamments: Sandy, but not stony, Entisols with tropical soil temperature regimes. They are only documented in the soil map between Puerto Jiménez and Puntarenitas southwards in a flat band along the beach. Unconsolidated sand is responsible for the weakly developed structure. Because of their low water holding capacity, extreme hydrological conditions characterize these soils.

(c) Troporthents. Entisol with no other special diagnostic characteristics than the tropical climatic soil conditions. These are soils in a very early stage of development. They are limited in depth by weathered or continuous hard rock. In the soil map they are only observed in the lower course of the Río Tigre and, outside of the Golfo Dulce region, as the prevailing soils of the Fila Costeña.

Soil properties and plant diversity

It is well known that plants are adapted to the hydrological soil conditions and that the species spectrum reflects the soil properties. Additionally, the plants are adapted to less conspicuous chemical soil parameters such as pH, nutrient supply and specific element concentrations, as well as to growth limiting factors, e.g., hard rock. RICHARDS (1961) demonstrates the correlation between vegetation and soil in the tropics. Various studies in the tropics reveal relationships such as:

- positive correlation between tree species diversity and soil fertility (e.g., magnesium content) (ASHTON 1982)
- plant species variation in response to phosphorus availability (GARTLAN et al. 1986)
- influence of local soil properties on species diversity in western Amazonia (KORNING et al. 1994)

Recently, an interesting study was carried out by KUBOTA et al. (1998) in Indonesia, who investigated various soil parameters and vegetation in a transect from a ridge down to the valley. Despite soil properties that are less than half as variable as those investigated in the Golfo Dulce region, the study shows a recognizable relationship between tree species diversity and soil properties.

Tree species distributions (HUBER 1996, WEISSENHOFER 1997, HUBER & WEISSENHOFER, unpubl.) in the Piedras Blancas National Park have been compared to the results of the soil studies. The comparison confirms a correlation between composition of the tree flora in the main topographical positions (ravine, slope and ridge) and pedological factors in these plots (PAMPERL 2001). Namely, differences in the number of tree species occur depending on fertility of the surface and subsurface horizons as well as on aluminium load. The results show the highest diversity in the ridge forest, where soils are poor in nutrients, strongly acidic and aluminium is saturated in the subsoil, but rich in calcium and magnesium in the epipedon. On the other hand, in those parts of the ridge where the upper horizon of soils are also poor in Ca and Mg, only a very small number of tree species were observed. The vegetation on slopes, where soil properties much more resemble the conditions on ridges than those in ravines, also share more elements of the ridge forest than of the ravine forest. A relatively low diversity in tree species occurs in ravines where the soil is rich in nutrients.

In order to more fully understand the relation between plant diversity and soil properties a lot of work remains to be done. The first results of the Piedras Blancas National Park study lay the groundwork for further studies in this area. The rainforest of the Golfo Dulce region is extremely interesting to scientists in various disciplines. As investigations continue, knowledge of ecological connections will be more clearly elucidated.

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Geological History of Central America and the Golfo Dulce Region

O. MALZER

Costa Rica occupies a central position on the geologically young land-bridge between the two American continents. This land-bridge spans a gap of some 1600 km, from the Motagua-Polochic fault in southern Guatemala to its anchor point on the northwest tip of South America. The Costa Rican section covers about 200 km of this distance. In the following, an overview of the geological history of the Mesoamerican land-bridge is given in order to appreciate its impact on the development of the flora and fauna of Costa Rica and the Golfo Dulce region. In the present context, of course, only an extremely simplified picture can be given.

Geological History of Central America

As shown in Fig. 1, Central America is the contact area of four (possibly five) megatectonic units (crustal plates): (1) the **North American plate** and (2) the **Caribbean plate** in the north of the Central American land-bridge, and (3) the **Cocos plate** and (4) the **Nazca plate** in the south. (1) and (2) are separated from the others by the deep "**Middle American Trench**", along which the Cocos plate is being subducted under the North American and Caribbean plates.

The plates are associated with the following major land blocks and discontinuities: (1) the **Maya Block**, (2) the **Chortis block** ("Nuclear Central America"), (3) the **Chorotega block** ("Isthmic Central America") and (4) the **Chocó block**. (1) and (2) are separated by the **Polochic-Motagua fault** system, and (3) and (4) are separated by the **Gatun fault**. The boundary between the Chortis and Chorotega/Chocó blocks is not clearly defined since the southern end of the continental basement of the Chortis block is hidden below younger volcanics and sediments. It probably lies in central to southwest Nicaragua.

Chortis block. Like the Maya Block, the relatively stable Chortis block possesses a continental basement of metamorphic Precambrian to Paleozoic rocks and a sediment cover of mostly shallow marine and continental deposits mainly from the Cretaceous period. With minor exceptions these are superimposed by thick Tertiary volcanics and volcaniclastics. Pleistocene to recent volcanism is mainly confined to the western margin. Many of the structures of the Chortis block trend SW-NE as do structures north of the Motagua fault and only the southwest Pacific portion is dominated by trends related to the younger history, i.e. the subduction of the Pacific Cocos Plate under the Caribbean Plate. These characteristics identify the Chortis Block as an original part of the North American continent.

Recent seismic activity at moderate to high magnitudes is associated with the continuous subduction of the Pacific plate (the last major earthquake was in El Salvador in 2001) or is bound to the Polochic-Motagua-Fault system (Guatemala 1976). The latter, over 100 km wide and marking the boundary between the North American and Caribbean plate is a transcurrent fault system, with the two plates not converging but moving laterally past each other.

Chorotega block. Together with the Chocó block the Chorotega block forms the southeastern, longer, narrower and less stable part of the Mesoamerican land-bridge. It is shaped like a double arc and covers part of Nicaragua and all of Costa Rica and Panama. A sialic continental basement is totally absent. Instead, there is a basement of Mesozoic oceanic lavas. Shallow and deep marine sediments, but also continental Tertiary to Pleistocene sediments, most containing some volcanic material, and enormous quantities of volcanic and plutonic rocks form the cover. Morphological and structural trends generally follow the course of the Middle America Trench located off the Pacific Coast.

The Chorotega block shows the classical forearc - central volcanic range - backarc pattern ot the overriding plate margin at a subduction zone, plus a subparallel fourth zone. The latter is of particular sig-

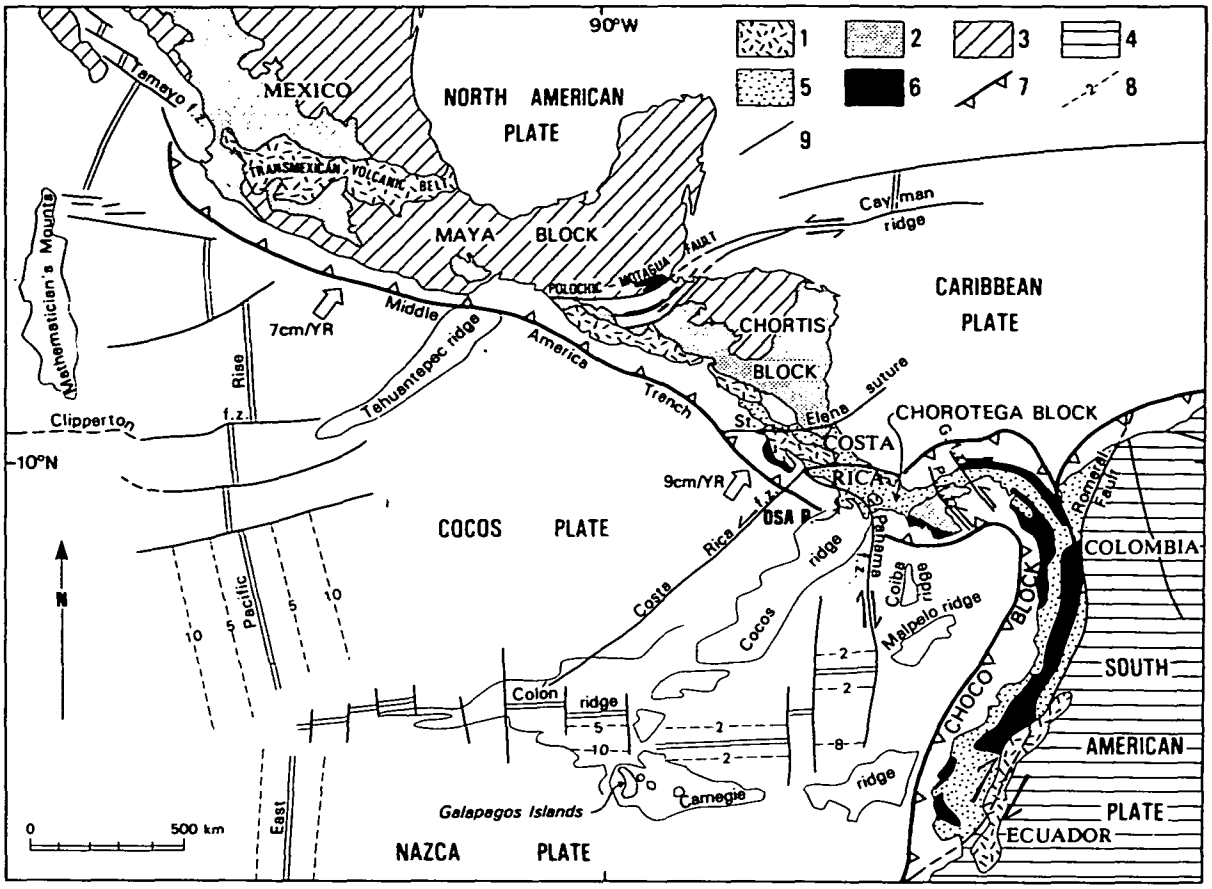

Fig.1. Plate tectonics of the eastern Pazific and the Caribbean and megatectonic units/discontinuities of Central America and the adjacent continental areas. 1 = Pliocene and Pleistocene volcanic rocks; 2 = Oligocene and Miocene volcanic rocks; 3 = North American plate; 4 = South American plate; 5 = Cenozoic formations of the Andes and southern Central America; 6 = Mesozoic and Cenozoic ophiolite complexes; 7 = subduction zones; 8 = magnetic anomalies; 9 = fault or fracture zone; G.f.z. = Gatun Fracture Zone; P.f.z. = Parrita Fracture Zone. (Reprinted from Tectonophysics 147: 193-220, Fig. 1, 1988: BERRANGE, J.P. & R.S. THORPE: The geology, geochemistry and emplacement of the Cretaceous Tertiary ophiolitic Nicoya Complex of the Osa Peninsula, Southern Costa Rica. Copyright 1988, with permission from Elsevier Science).

nificance for the Golfo Dulce area: an older outer arc on the Pacific side which includes the Santa Elena and Nicoya Península, the Herradura and Quepos promontories, the Golfito area and the Osa Península and some smaller peninsulas in Panama.

This zone is composed of a complex of submarine basic volcanics and volcaniclastics, including ultramafic peridotites and layers of deep-sea sediments (pelagic limestones and radiolarites). This older belt may actually consist of several independent "Terranes" (DI MARCO et al 1995) of Pacific origin, which have been accreted to the younger arc during subduction and by left-lateral strike-slip motion.

Pleistocene/Holocene to recent volcanism on the Chorotega block is concentrated in north and central Costa Rica. East of the active Irazu volcano there are only two significant, isolated young volcanic centers, both now inactive, the Chiriqui (or Baru) and El Valle massifs in west and central Panama. Recent seismic activity with moderate to high magnitudes is mostly related to ongoing subduction of the Pacific plate (Golfito 1983, Limon 1991). The Managua 1972 and Arenal 1973 events were bound to fault structures not immediately associated with subduction.

Chocó block. This block of eastern Panama differs in that it does not have a central volcanic range or fore arc and back arc basins. Rather, it consists of ranges and massifs of Cretaceous oceanic volcanic

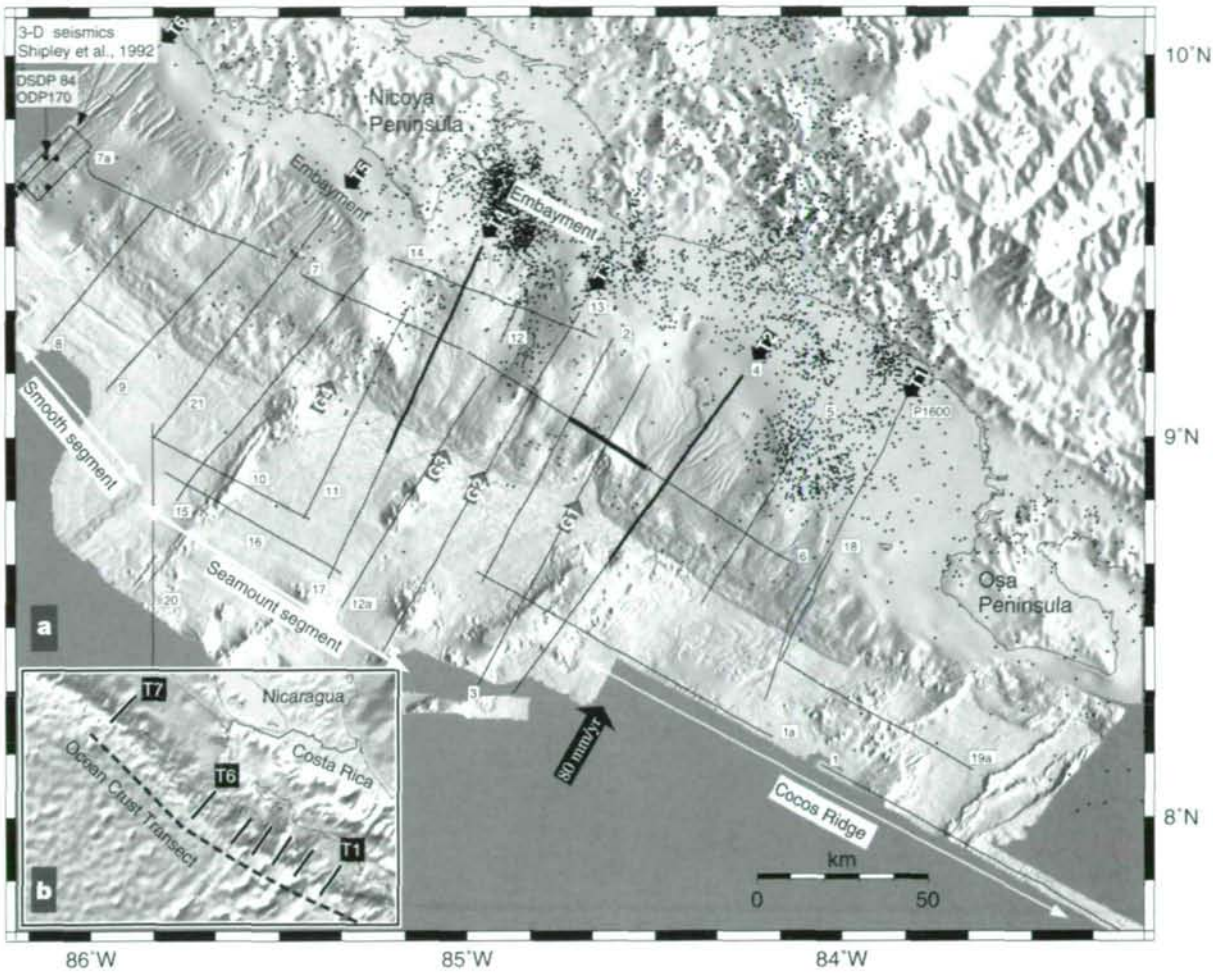

Fig. 2. Multibeam hydrosweep bathymetry off Costa Rica. Morphology of the Pazific shelf, slope, Middle America Trench and the Pazific plate. Black dots are earthquake epicenters (on land hypocenters deeper than 30 km). Indentations in the lower continental slope east of the Costa Rica Fracture zone mark subducted seamounts. (Reprinted with permission from Nature. RANERO C.R. & R. VON HUENE, 2000: Subduction erosion along the Middle America convergent margin. Nature 404: 748-752. Copyright 2000. Macmillan Magazines Ltd.).

basement running along the north and northeast Caribbean coast. In the center there is a wide synclinal valley area filled with Tertiary sediments and along the Pacific Gulf of Panama shorter, broken-up ranges and blocks of Cretaceous and Tertiary volcanics occur. From Panama, the zone of Mesozoic oceanic basement rocks continues into western, coastal Colombia and Ecuador.

Middle America Trench, Cocos Ridge and Panama Fracture Zone. The pacific coast of Central America — nearly unstructured and straight along the Chortis block but interrupted by several conspicuous peninsulas and promontories on the Chorotega block — is accompanied, at an average distance of about 140 km from the coast, by the narrow, deep **Middle America Trench**. This trench marks the line on the sea bottom along which the Pacific Cocos Plate is being subducted under the Caribbean Plate (average rate = 94 mm per year). It reaches depths of more than 6000 m off of Guatemala, 4000 m off of El Salvador, Nicaragua and northern Costa Rica, and then becomes rapidly shallow off of southern Costa Rica. It appears to end between the Nicoya Peninsula and the Osa Peninsula, against the broad Cocos Ridge. The trench then reappears, although less pronounced, offshore of Panama, between the Burica and Sona-Azuero peninsulas, east of the Panama Fracture Zone.

The landward slope of the trench represents a narrow accretion wedge, i.e. material scraped off the down-going Pacific plate. This wedge is composed of NE-dipping slabs of the same Mesozoic oceanic material as that found in the outer forearc (i.e., the peninsulas) of Costa Rica and Panama. It is covered with Tertiary and younger slope sediments. Fig. 2 shows the trace of the Middle America Trench in this segment of Central America and its shallowing against the Cocos Ridge in the southeast corner of the image. The ocean plate to the northwest of the ridge is seen dotted with sea mounts. Indentations on the lower slope between the Cocos Ridge and the Costa Rica Fracture Zone are interpreted as erosional tracks of subducted sea mounts.

The **Cocos Ridge** is the most prominent of a number of aseismic (i.e. not showing any appreciable seismic activity) ridges on the eastern Pacific plate. The ridge is 200 to 300 km wide, more than 1000 km long and its top 1000 to 2500 m are shallower than the surrounding Pacific. It trends to lie NE-SW and consists of oceanic basaltic lavas. It may be the surface trace of an ancient mantle hotspot (CORRIGAN et al. 1990), i.e. a feature similar to the Hawaian island chain. The Cocos Ridge has moved northeast with the Cocos plate and is estimated to have reached the Middle America Trench in the Late Miocene (FRISCH et al. 1992). Subduction of the ridge is believed to have started about 3 My ago. This process has increased the crustal thickness of the Caribbean plate at its Pacific margin and has at the same time strongly modified the structure and morphology of southern Costa Rica and western Panama.

Just east of the Cocos ridge a first order, N-S-trending dextral strike-slip fault system reaches Central America: the **Panama Fracture Zone** (Fig. 1). It then bends NW and splits into a number of branches which dominate the morphology of the Golfo Dulce area of Costa Rica. The relation between the Cocos Ridge, the Middle America Trench and the Panama Fracture Zone is still under debate. The latter also forms the boundary between the N-moving Cocos and NE-moving Nazca plate. It appears to be a Miocene feature, which is still active today as shown by intense seismic activity in the region.
There are other significant fault systems and fracture zones along the Middle America trench east and west of the Cocos ridge, e.g., the Costa Rica transcurrent fault (a result of the Cocos ridge impact), the Santa Elena - Hess suture, etc. These will not be discussed here in detail.

Formation of the Central American land-bridge and early faunal/floristic exchanges
The history of the Central American land-bridge begins with the opening of the central Atlantic Ocean in the late Jurassic and the simultaneous separation of the two American continents along a newly formed Caribbean spreading center. The precise nature and sequence of events resulting in the present morphotectonic configuration of Central America is still under discussion. The main phases of development, some offering limited possibilities for flora and fauna exchange, are here summarized:

Lower-Middle Cretaceous [130 - 80 Million years ago (Mya)]. While North and South America drifted apart at slow rates, the intrusion of large volumes of basaltic melt formed a plateau of relatively thick oceanic crust between the two continents.

Santonian-Campanian (88 - 75 Mya). The direction of movement of South America relative to North America changed to WNW (perhaps a consequence of the opening of the South Atlantic), reversing the stress regime between the two continents from spreading to compressive. The Santa Elena fault, the S-directed Cretaceous nappes of the Santa Elena Península, and the folding on the Nicoya Península may have been results of these compressive movements.

Latest Cretaceous (after 80 Mya). The eastern Pacific and the newly formed Caribbean terrain split into the Pacific and Caribbean plates and subduction of the Pacific plate - also called the Farallon plate - under the Caribbean plate initiated. This was accompanied by an up-bending of the southern edge of the Caribbean plate and shortly thereafter by incipient island arc volcanism.
Structures formed by these processes and by additional emplacement of large basalt amounts seem to have formed the first emerging parts of the future Chorotega block. Reef limestones covered the Santa

Elena nappe and the folded rocks of the Nicoya complex. Juxtaposition of shallow water and deep water sediments suggest the existence of an ephemeral island chain, possibly all the way from Nicaragua to Panama (BERRANGE & THORPE 1988).

According to BONAPARTE (1984) and SEYFRIED & SPRECHMANN (1986) this island chain permitted the first southern migration of North American terrestrial vertebrates.

Maastrichtian-Paleocene (76 - 57 Mya). Predominantly fine-grained, deep-water clastic sediments (Rivas, Samara formations, Quepos and Golfito areas), accompanied by basaltic lavas and intrusives, were formed. These are found today along the central part of the Pacific coast.

Paleocene (66 – 57 Mya). At this time the birth of a new (partially emerged?) central volcanic arc in Costa Rica and western Panama is indicated by the beginning of sedimentation in fore arc and back arc basins to the south and north.

Early to Middle Eocene (57 - 45 Mya). Deposition of sediments and magmatism appear to cease in the realm of the older Cretaceous island arc.

Upper Eocene (ca. 40 - 36 Mya). A carbonate shelf environment prevailed in large parts of Costa Rica and continental volcanics and shallow marine clastics predominated throughout the Eocene in central Nicaragua and also in central Panama. This strongly suggests the existence of an arc of volcanic islands by this time. In eastern Panama, however, thick abyssal sediments accumulated in small deep basins between rising basement blocks and any existing land corridor would not have reached South America. However, a limited number of faunal elements may have reached South America by "island hopping".

Oligocene - Miocene (36 – 3,6 Mya): throughout this period the arc basins of Costa Rica and Panama accumulated thick marine clastic sequences (TOURNON & ALVARADO 1997) in a stratigraphically lower position partly of shallow water origin (Barra Honda formation - BOURGOIS et al. 1984). It can be assumed that also at this time a chain of ephemeral volcanic islands spanned the then still large distance between the Chortis block and the South American continent, but there seems to be no evidence for a faunal exchange until the Middle Miocene.

Upper Miocene - Pliocene (13 - 1,7 Mya): sedimentation concentrated in the backarc basins on the north side of the central volcanic arc of Costa Rica and western Panama and in the core of the Bayano-Chucanaque intra-arc basin of eastern Panama.
In the Upper Miocene (10 - 5,4 Mya) several factors contributed towards an increasingly closer spacing of the islands and the eventual closure of the remaining open passages between the Pacific and Atlantic Oceans in the Pliocene (ca. 3,6 Mya):

- Massive ex- and intrusion of igneous material within the central volcanic arc during the Miocene Pliocene period.
- Accretion of Pacific oceanic material to the slope of the Central American Trench and uplift of parts of the older Cretaceous-Paleogene fore arc.
- Welding to the growing isthmus of exotic oceanic structures, like a Pacific sea mount in the Quepos area of Costa Rica (HAUFF et al.1997).
- The impact of the Cocos Ridge against the slope of the Caribbean plate in the late Miocene. This caused folding and inversion of the southern Costa Rican fore arc basin (Terraba Trough). Subsequent shallow subduction of the Cocos Ridge resulted in rapid uplift of the southeast Costa Rican part of the emerging isthmus.
- The compressive force exerted by the South American continent against the Panamanian isthmus in the late Miocene did not only cause strong lateral deformation of the island arc along the Parrita and Gatun faults (ESCALANTE & ASTORGA 1994), but it also contributed to the closing of the remaining ocean passages in eastern Panama.

- The same relative NW drift of South America also triggered the collision with the Caribbean back arc basin. This caused deformation, inversion and partial uplift of the inner part of the latter (North Panama Deformed Belt) and thus contributed to the consolidation of the Mesoamerican land-bridge. Left lateral wrench faulting on the south side of the isthmus (as a response to the same stress) also helped to eliminate the last seaways between the Pacific and Atlantic Oceans.

The closure of the last passage is thought to have taken place in the Mid-Pliocene (3,5 Mya). This conclusion is based on the final separation of Caribbean and Pacific shallow shelf mollusk faunas (COATES et al. 1992).

Pleistocene to recent (1,7 – 0 Mya): Pleistocene sediments abound in the Caribbean lowlands of Nicaragua and northeast Costa Rica, as well as in some young basins in northwest and southeast Costa Rica (Osa- Burica Pensinsulas).

The ongoing subduction of the Cocos Ridge has increased thereby uplifting the Osa Península and still tending to expand land area. The Limon 1991 earthquake, for example, exposed 75 hectares of modern reef. Sea level oscillations of up to 200 m during the Pleistocene have also significantly expanded or reduced the width of the land-bridge, but only for short periods of time. Interglacial sea level highstands may have caused the short-lived (a few thousand years) revival of one or more of the old sea ways. One such connection may have existed once or repeatedly from the Caribbean Sea via the Río San Juan valley in Costa Rica/Nicaragua and Lake Nicaragua to the Pacific. Lake Nicaragua is believed to have had contact with the Caribbean Sea until about 1,5 Mya (BERGOEING 1998). Sharks and tarpons are thought to live in Lake Nicaragua as relics of the marine history of this fresh water body, but may still "commute" between the lake and the Caribbean Sea (THORSON et al. 1966).

Glaciation occurred only at the highest elevations, namely in the Chirripó massif (approximately 70 km² above 3500 m). Here the only signs of Pleistocene ("Wuerm") glacial land forms and deposits between north-central Guatemala and the South American Andes are found.

Volcanism. Predominantly andesitic (higher SiO_2-content than basalt) volcanism was widespread on the central and eastern Isthmus during the Oligocene (36 - 23 Mya). Magmatism then surged in Miocene time (23 – 5.4 Mya), with andesitic lavas, pyroclastics, ignimbrites and other volcaniclastic sediments covering large areas from central Nicaragua to central Panama.

From El Salvador to the Central Cordillera of Costa Rica, west of the Costa Rica Transcurrent Fault, magmatism has persisted through the Pliocene-Pleistocene (5,4 - 0,1 Mya) to the present. In Panama, it receded during the Pliocene (5.4 - 1.75 Mya) and ended, with few isolated eruptive centers, in the Pleistocene.

In the area impacted by the Cocos Ridge, east of the Costa Rica Transcurrent Fault, a volcanic "gap" almost 200 km wide developed in the late Miocene period. In the Sierra de Talamanca large intrusions of gabbros, diorites and granites replace volcanism and form the highest elevations of all isthmic Central America (Cerro Chirripó 3.819 m). Extrusive magmatic activity was almost absent in this area during the Pliocene to present.

Younger Migration History of Flora and Fauna. As noted above, a limited interchange of faunal elements, in the form of island hopping, may have taken place in the Eocene and late Miocene. Migration in both directions on a larger scale started in the Pliocene with the closing of the land-bridge.

At this point it is important to note that, based on paleomagnetic data, Mesoamerica has remained at latitudes between the equator and its present position, i.e., under tropical climatic conditions, throughout its geological history. This is obviously of great significance for the development of the flora.

Well into the Miocene period, the flora seems to have been similar to that of tropical volcanic islands and probably had a strong affinity to the flora of South America. In contrast to the vertebrate land fauna,

for which strong migration movements from north to south are evident, relatively few northern plants appear to have migrated southwards (RAVEN & AXELROD 1975, RICH & RICH 1983). An example is the walnut tree, which is said to have reached northern South America about 8 Mya (Upper Miocene). Most of the northern plants, generally adapted to cooler and more arid climatic conditions, spread south only after the closure of the isthmus (Mid-Pliocene). Starting 3.5 Mya, rapid uplift of parts of Central America (due to subduction of the Cocos Ridge) followed by cooling during the Pleistocene glacial periods, created corridors of favorable conditions for these plants. From Late Pliocene to Mid Pleistocene relatively arid, savanna-like habitats may in fact have prevailed on significant parts of the then complete land-bridge. Tropical rain forests may have been present in the lowlands but probably gained (or regained) their (until very recently) wide distribution in Central America only towards the end of the Pleistocene. BERGOEING (1998) relates a humid period with dense forest coverage on the lower mountains and lowlands to the Wuerm glacial period, 20,000 years ago, when the Chirripó massif was glaciated above 3500 m. Analysis of pollen from a core taken in the Cordillera de Talamanca indicates paramo vegetation at an elevation of 2400 m at about the same time (HORN 1992), implying that forests did not reach much higher than 2000 m. During the Holocene, from about 10000 y B. P., montane forests migrated upwards to the present timberline.

The Golfo Dulce Region

(a) General

Geographical limits of the Golfo Dulce area are the Fila Costeña in the northeast, the Río Sierpe in the northwest, the Pacific Ocean to the west and south, and the Río Colorado to the east. The main components include the deeply eroded and incised hills (highest point is 579m) of the Fila Golfito and its extension towards the Osa Península, the Golfo Dulce restricted basin, and the Osa Península (highest elevation is 782m).

Geologically, the Golfo Dulce region belongs to the outer belt of pre-Tertiary to Paleogene oceanic basaltic volcanics of the **Chorotega** block.

The NW-trending **Longitudinal Fault Zone** (Ballena-Celmira Fracture Zone) separates the Golfo Dulce area from the Fila Costeña and faults of the same strike, and their NNE-SSW oriented secondaries dominate the structure and morphology of the region.

The land portion of the Golfo Dulce area is divided (Fig. 3) into a **Northern zone**, where the Cretaceous-Paleogene basement is strongly weathered but not covered by younger sediments (except in the valleys), and a **Southern zone**, consisting of the larger part of the Osa Peninsula, where older rocks are covered by Pliocene and Pleistocene sediments.

(b) The Basement

DI MARCO & BAUMGARTNER (1995) divide the Golfo Dulce area (Fig. 4) into three "terranes" or tectono-stratigraphic units of different origin which are separated by steep faults:

(1) The **Golfito Terrane** occupies the land between the Ballena-Celmira fault zone in the north, the northeast shore of the Golfo Dulce and a NNW-striking fault crossing from Playa Gallardo on the Golfo Dulce to the Esquinas River near Piedras Blancas. The terrane is formed by oceanic basalts at the base, followed by pelagic (deep sea) carbonates and volcaniclastics. A volcaniclastic complex without lavaflows occupies the top position. The entire sequence has a Late Cretaceous to Paleocene age.

(2) A mass of submarine basalts with only minor inclusions of deep sea sediment make up the **Rincón block** which borders the Golfito Terrane along the NNW-fault mentioned above and covers the northwest part of the Esquina forest, the hills on the north shore of the Golfo Dulce to beyond the Río Sierpe and the inner part of the Osa Peninsula. A Late Cretaceous to Eocene age of this mass is indicated.

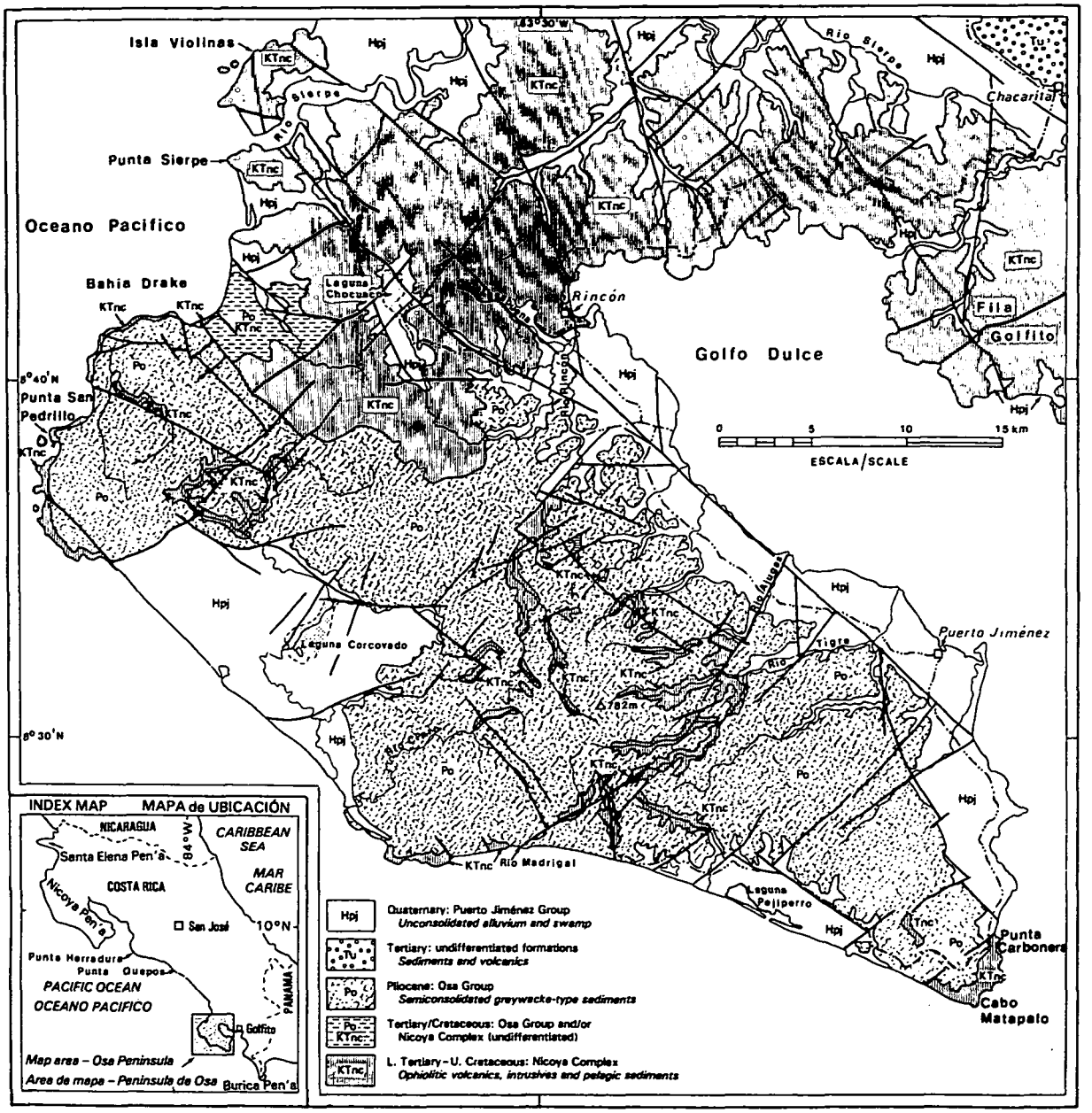

Fig. 3. Golfo Dulce Region: exposed Mesozoic to Paleogene volcanic rocks (Nicoya Complex), Pliocene/Pleistocene sediment cover and fault pattern. (Reprinted from Tectonophysics 147: 193-220, Fig. 2, 1988. BERRANGE, J.P. & R.S. THORPE: The geology, geochemistry and emplacement of the Cretaceous Tertiary ophiolitic Nicoya Complex of the Osa Peninsula, Southern Costa Rica. Copyright 1988. With permission from Elsevier Science).

(3) The **Osa-Cano Accretionary Complex** forms the outer, Pacific part of the Osa Peninsula. Its lithology is fundamentally different in that it consists of typical slope sediments, turbidites and breccias, including large blocks of basalt and ophiolite having a wide age-range from late Cretaceous to Miocene.

The **Northern zone**, which includes the Esquinas rain forest, belongs to a larger part of the Rincón block, but also contains the fault-boundary with the Golfito Terrane which forms the eastern portion. The lack of sediments younger than Eocene in this area indicates that the rocks may have emerged and been exposed to subaerial erosion for millions of years. It is thus not surprising to find rock exposures only along the coast and near the bottom of mostly narrow *quebradas* (streams). Only wider valleys of

the Río Esquinas, the Río Bonito and the lower part of Río Sorpresa have a fill of Holocene and possibly Pleistocene sediments. The remaining topography, up to the highest elevations, is covered by a weathering layer of variable thickness, generally less than 2 m on the slopes and more on the ridges.

The following are the main lithologies and their distributions:

On the north side of the Fila Golfito, southeast and northwest of the village of La Gamba, sediment sequences of the highest layer of the Golfito Terrane are exposed in the Quebradas Bolsa, Chorro, Achiote (SE) and Sardinal (NW). Volcaniclastics (tuffs, siltstones, sandstones, breccias with often very large components) and thin-bedded (pelagic to hemipelagic) limestones, mudstones and radiolarite (colored red, sometimes forming jasper) are seen in the profiles. The Field Station La Gamba and the nearby Esquinas Rainforest Lodge are both located on this unit. Light green tuff crop out on the slope north of the station, whereas fine-grained, medium-gray basalt and boulders of basalt breccia are found in the Quebrada La Gamba to the south (S. PAMPERL, pers. comm.). Further south, massive layers of gray-green, fine-grained basalt and dykes and sills of dolerite appear in the profiles (Quebrada Bolsa, Río Sorpresa). Large amounts of basalt, often developed as pillow lava, as well as dolerite are found exposed along the coast of the Golfo Dulce between Playa Cacao and Punta Gallardo.

Equally all outcrops from Punta Gallardo northwest along the coast, to the Esquinas and then west into Bahia Rincón are formed by basaltic lavas, here belonging to the Rincón block (Fig. 4). Volcaniclastigcs are conspicuously absent in this unit; minor inclusions of limestone and radiolarite are found. Inland, Quebradas Sardinal and Machaca reach into the Rincón block. Its uniformly more erosion-resistant rocks form the highest elevations (over 550 m) of the Fila Golfito.

The Rincón unit appears to rim the Golfo Dulce on three sides and to occupy the northeastern third of the Osa Peninsula. Outcrops are, however, poor to the east of the Río Rincon. In this area Pleistocene-Holocene covers the coastal plain, underlain by sediments of the Pliocene Osa Group which also form the low hills behind the coast.

The **Southern zone**, consisting of the central and southern part of the Osa Peninsula, is composed of a 'basement' formed by the Osa-Cano Accretionary Complex and the unconformably overlying clastics of the Pliocene Osa Group. The accretionary complex (following DI MARCO l.c.) represents a melange consisting of a volcaniclastic graywacke to mudstone matrix in which various types of components from centimeter to very large (hundreds of meters) size are embedded. Oceanic basalt and volcaniclastics, deep-sea limestone and chert, but also shallow water carbonates are found reworked and redeposited in this overall deep water sediment. The combination of component types and the age range determined for either components or matrix are characteristic for each of the three subunits of the complex. Good exposures are found along the coast of the northwest and southeast corners of the peninsula and in riverbeds in the interior. The generally poor outcrop conditions and post-depositional deformation of the rocks may be responsible for the earlier attribution of the entire 'basement' of the peninsula to the Nicoya Ophiolite Complex (Fig. 3).

(c) The Sediment Cover of the Osa Peninsula

With the exception of its northern most corner, the Osa Peninsula carries a cover of Pliocene-Pleistocene sediments. The underground relief, rich in contrasts, is filled with Pliocene sediments and these consist of semi-consolidated gray-green conglomerates, sandstones, siltstones and mudstones. They represent a wide range of facies, depositional environments and depths, from fluvial to marine turbiditic. Conglomerates with locally derived components usually form the basal layers and are gold-bearing in many places. These placer-gold deposits give rise to numerous small mining operations. The bulk of the sediments are fine-grained and many beds are fossiliferous, some containing rich bivalve faunas but also abundant plant fossils including tree logs and possibly upright tree stumps. Other sediments contain foraminifera, suggesting a depth of deposition of several hundred meters. The entire

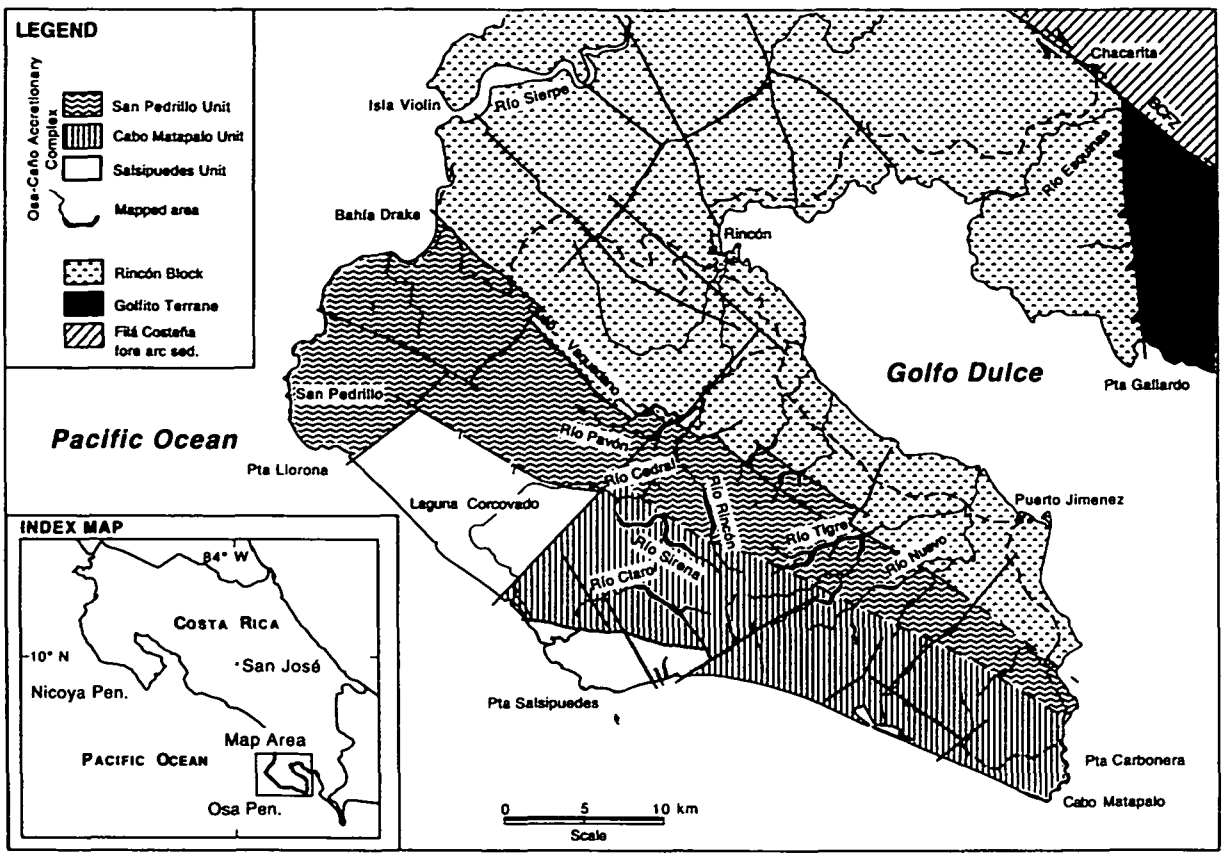

Fig. 4. Interpretive sketch of the pre-Neogene geology of the Osa Peninsula. BCFZ = Ballena - Celmira Fracture Zone (CORRIGAN et al. 1990) which is part of the Longitudinal Fault Zone (LFZ). (Reprinted with permission by GSA from Geol. Soc. Amer. Special Paper 295: 1-27, Fig. 6, 1995, DI MARCO, G., P.O. BAUMGARTNER & J.E.T. CHANNEL. Late Cretaceous - Early Tertiary paleomagnetic data and a revised tectonostratigraphic subdivision of Costa Rica and Western Panama).

sequence, now termed the **Osa Group**, may reach a thickness of over 800m. Its age has been determined as Mid- to Upper Pliocene (3,7 - 2,0 Mya).

Along the north and northeast coasts and into some of the wider valleys and the downfaulted, small basins of Laguna Corcovado and Laguna Pejeperro, the Osa group is unconformably overlain by unconsolidated, mostly fine-grained clastics of the Pleistocene **Puerto Jiménez Group**. Along the southeast coast, the underlying Osa Group is exposed at low tide, making the discordant relationship of the two sequences visible. The sediments of the Puerto Jiménez group are deposited in a shallowing-upward marine environment.

(d) The Golfo Dulce

The Golfo Dulce is a fault-bounded (Fig. 5), marine inlet whose shape is controlled by the NW-trending on-land extensions of the Panama Fracture Zone and their NE-striking secondaries. The northeast boundary fault is clearly expressed as a steep wall with echosoundings (HEBBELN et al. 1996). The southwest boundary is partially hidden under young sediments. The southeast entrance to the gulf is formed by a shallow (60 m) sill, which is not covered by young sediments. From there the gulf deepens rapidly to 185 m and to 210 m close to the northwest coast. The gulf measures approximately 55 x 12 km. The sill at the entrance impedes water circulation. As only occasional flushings occur, the Golfo Dulce has deveoped into a restricted and slightly anoxic marine basin. Bottom sediments consist mainly of turbidites, which enter the gulf via permanent channels. Sediment thickness is unknown. The northeast coast between Río Esquinas and Golfito is flanked by a number of small reefs.

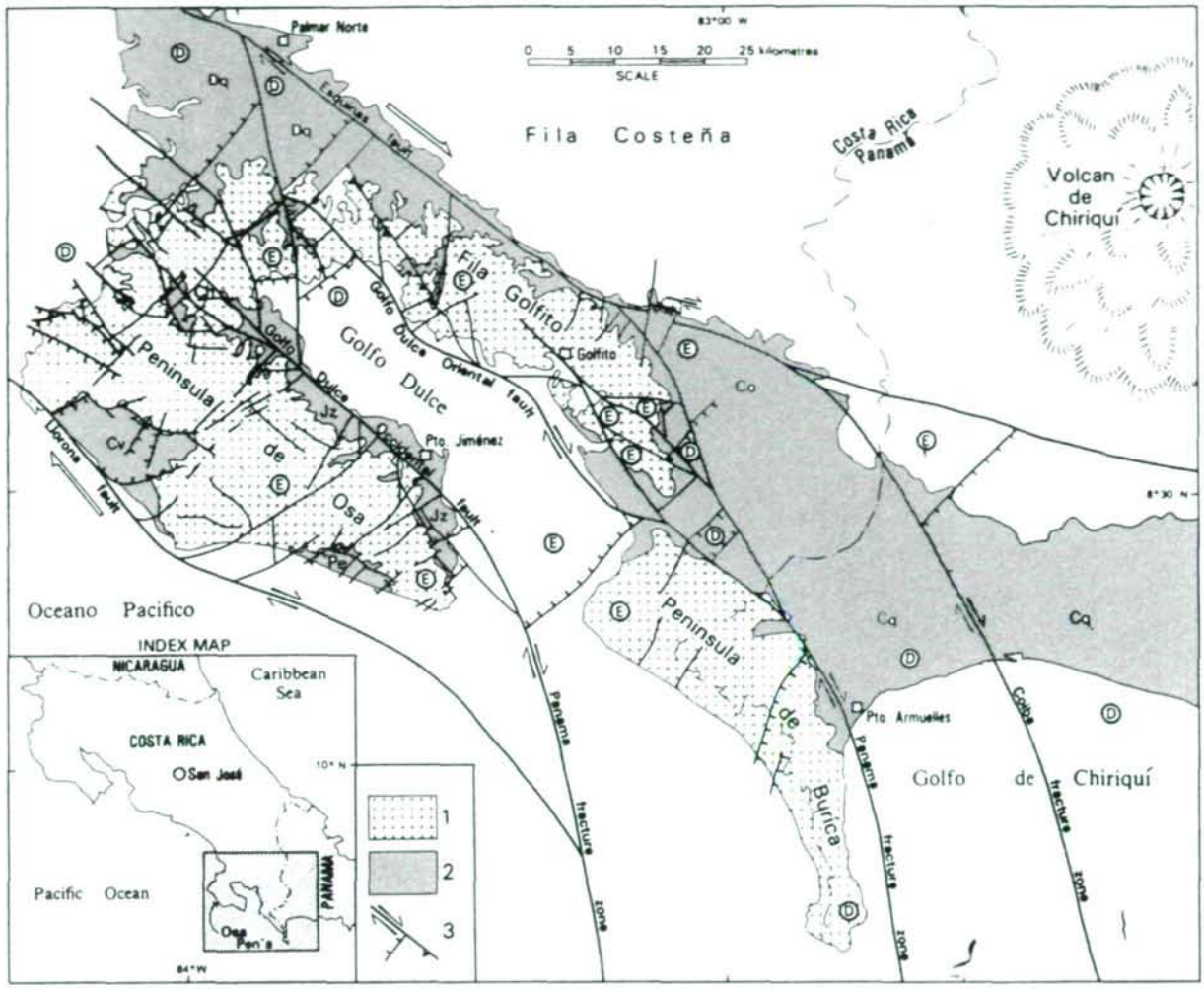

Fig. 5. Tectonic setting of the Golfo Dulce Region. 1= Highland formed by exposed Mesozoic - Cenozoic rock units; 2 = lowland basin covered by Quaternary alluvium; Ch - Chocuaco basin; Co - Coto Colorado lowlands; Cq - Chiriquí lowlands; Cv - Corcovado lowlands; Dq - Diquis lowlands; Jz - Jimenez-Rincón lowlands; Pe - Pejeperro lowlands; 3 = fault or fracture zone; relative movement indicated by arrows, dip direction by solid triangle, downthrown blocks by ticks. Encircled letters: E - elevated segment of fault block; D - depressed segment of fault block. (Reprinted from Tectonophysics 147: 193-220, Fig. 3. BERRANGE, J.P. & R.S. THORPE: The geology, geochemistry and emplacement of the Cretaceous Tertiary ophiolitic Nicoya Complex of the Osa Peninsula, Southern Costa Rica. Copyright 1988, with permission from Elsevier Science).

(e) The Geological History of the Golfo Dulce Region

Two phases of development can be distinguished: the older pre-Cocos Ridge history, and a younger phase characterized by the arrival, impact and shallow subduction of the Cocos Ridge. Likely in the Mid-Miocene, before the arrival of the Cocos Ridge on the N-moving, subducting Pacific Plate, the area was separated from the central volcanic arc by the fore arc basin (Terraba trough). The components of the present-day Golfo Dulce Region, the island (?) complex of the Rincón block, the Golfito Terrane and the slope-trench sequence of the Osa Accretionary Complex) were not yet in their final place. The impact (ca. 6 Mya) of the Cocos Ridge then resulted in the shortening - by folding and thrusting - and uplift of the fore arc basin and the welding-together of the central island arc, the now inverted fore arc basin, and the oceanic blocks. A bundle of NW-trending dextral strike slip faults (Fig. 5) developed, possibly as a lateral escape response to the impact of the Cocos Ridge. These seem to have linked up with the Panama Fracture Zone. These faults determine the latest tectonic history of the area. Subduction of the Cocos Ridge from about the Mid-Pliocene may have partially released the compressive force

of the Cocos Ridge impact and have led to a bulging of the crust. This bulging in turn resulted in a predominantly vertical movement on the controlling faults. Downfaulting and drowning of the Osa Peninsula in the mid-Pliocene and its renewed rapid uplift in the Pleistocene and the opening of the Golfo Dulce appear to have been the most recent processes in an ongoing development.
Regarding the three morphological units of the Golfo Dulce region it follows from the above that

- the Golfito area has not experienced significant vertical movements and has been exposed over a geologically long period of time,
- the Golfo Dulce may still subside,
- the Osa Peninsula has been the subject of an enormous up and down movements of several hundred meters within the last 2 My or so.

With regard to the floristic development of the region one would speculate that the tropical wet forest of the Golfito area has survived the Pleistocene cool periods and may date back to Miocene times. The forest coverage in the greater part of the Osa Peninsula, however, is obviously much younger, since it had to re-colonize this area after its last emergence in the Late Pleistocene. The key to the true age of the forest of the Golfo Dulce area may eventually be found in longer sediment cores from the bottom of the Golfo Dulce.

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Tourist and Research Facilities in and around Corcovado National Park and Piedras Blancas National Park

N. ZAMORA and A. WEISSENHOFER

The southern Pacific zone of Costa Rica harbors one of the last great stands of untouched primary rainforest in all of Central America. This vast swath of forest shows some of the highest levels of biodiversity in the world making it one of the most fascinating and beautiful areas in the Americas. In addition, the region hosts the largest concentration of indigenous peoples in Costa Rica. The new infrastructure established in recent years has facilitated the burgeoning fields of ecotourism and scientific research in the region.
Both the Corcovado and Piedras Blancas National Parks are well-worth visiting. Some basic information on tourist and research facilities in the two parks are given in the following.

Corcovado National Park

There is a great variety of tourist and scientific facilities inside, and on the periphery, of the park.

The **Park Headquarters** is situated in the village of Puerto Jiménez, 371 km south of San José. From Puerto Jiménez, it is possible to access the southern and eastern regions of the park. The northern zone can be reached by boat from the small town of Sierpe. There are various trails inside the park that lead to the ranger stations.

The **Biological Station Sirena** is a good place for researchers and ecotourists to see rare animal species such as the scarlet macaw and the tapir. The station offers accommodation and meals. Booking in advance at the Park office in Puerto Jiménez is a must. La Sirena can be reached by plane or on 6-hour hike along the beach from the small village of Carate.

Contact and information: Park Headquarter Puerto Jiménez ++506 73 55 036 or 73 55 282 (Telfax).

There is a great variety of **Lodges and Hotels** around Corcovado National Park. Names and contact addresses are given below; detailed information about services, facilities and prices can be found in traveler's guides.

Drake Bay
"Aguila de Osa": reserve@aguiladeosa.com;
"Cabinas Las Caletas": fingrspm@sol.racsa.co.cr
"Casa Corcovado": corcovdo@sol.racsa.co.cr
"Cocalito Lodge": BerryBend@aol.com
"Corcovado Adventures Tent Camp": info@corcovado.com
"Delfin Amor Ecolodge": info@divinedolphin.com
"Drake Bay Wilderness Resort": info@drakebay.com
"La Paloma Lodge": info@lapalomalodge.com
"Marenco Beach & Rainforest Lodge": info@marencolodge.com
"Poor Man`s Paradise": nbon@nnex.net

Rincón – La Palma
"Centro Juvenil Tropical – Fundación Neotrópica": tyc@neotropica-tyc.org
"Suital Lodge": cdiseno@sol.racsa.co.cr
"Lodge Ecturístico Neöbe": fundguay@sol.racsa.co.cr

La Palma – Puerto Jiménez
"Cañaza Lodge": léheurteux@canaza.com
"Jardín de las Aves": jhonreid@brevard.net
"Bosque de Río Tigre Santuary & Lodge": info@osaadventures.com

Puerto Jiménez
"Cabinas Agua Luna": agualu@sol.racsa.co.cr
"Cabinas Oro Verde": oroverde@sol.racsa.co.cr
"Cabinas Marcelina": osanatur@sol.racsa.co.cr
"Doña Letas Bungalows": info@donaleta.com
"Osa Aventura": osaaventura@pocketmail.com

Cabo Mato Palo
"Bosque del Cabo": boscabo@sol.racsa.co.cr
"Lapa Ríos": laparios@sol.racsa.co.cr

Carate
"Luna Lodge": info@lunalodge.com
"Terrapin Lodge": bargyle@aol.com
"The Lookout Inn": wendy@lookout-inn.com, terry@lookout-inn.com
"Corcovado Lodge Tent Camp": crexped@sol.racsa.co.cr

Piedras Blancas National Park

(a) The "Esquinas Rainforest Lodge"

This lodge is a superb base for naturalists and ecotourists who feel the desire to experience undisturbed nature off the beaten track. Guided tours into Piedras Blancas National Park are available. The lodge, run by the society "Rainforest of the Austrians" and managed by Prof. Michael Schnitzler, accommodates up to 20 people and is the only non-profit eco-lodge in all of Costa Rica.

Recognizing the importance of supporting alternatives to the destruction of tropical forests, the Austrian government decided to finance the project of constructing the lodge as part of its Development Aid Program for third world countries. Fifty acres of land surrounded by primary rainforest were purchased through donations from Austrian citizens. The construction of the Esquinas Rainforest Lodge was completed in 1994. The non-profit organization "Rainforest of the Austrians" was appointed to administer the project in close cooperation with the Costa Rican NGO "Fundación Neotrópica". Swiss and Costa Rican sociologists conducted detailed studies and made recommendations concerning social and economic aspects in the community adjoining the lodge. The Esquinas Rainforest Lodge as well as the Field Station La Gamba employ up to 18 people, primarily from the village of La Gamba.

Seeing their future livelihoods threatened by new restrictions set up by the National Park Service, a group of local farmers and loggers decided to turn to nature tourism as an alternative to the exploitation of the Esquinas Rainforest. Profits earned through ecotourism flow into community projects, such as the repair of water systems, roads and bridges, reforestation and environmental education. The ultimate goal is to prove that small, ecologically compatible nature lodges, working in cooperation with research stations, can generate enough income to raise the living standard in small communities. This project is currently being used as a model for similar projects in other countries. Michael Schnitzler was honored with the awards "Konrad-Lorenz-Umweltpreis" in 1996 and the "Binding Preis 2000" for his unprecedented efforts in fostering international environmental awareness in conjunction with local community issues.

Information and contact:

Costa Rica: Esquinas Rainforest Lodge, Tel.: ++506 - 775 09 01, Fax: (506) 775 09 01 (775 06 31), e-mail: esquinas@sol.racsa.co.cr.
Austria: Verein "Regenwald der Österreicher", Postfach 500, A-1181 Wien
Tel & Fax: ++43-1-470 42 97, e-mail: verein@regenwald.at.

(b) The Field Station La Gamba ("Tropenstation La Gamba")

In 1993, the society "Rainforest of the Austrians", in conjunction with the University of Vienna, established a field station in the village La Gamba, now called the "Tropenstation La Gamba". The station, consisting of a fully renovated farmhouse and recently constructed annexes, lies on the border of primary rainforest. At the moment there are accommodations for ca. 14 persons. The station has constant electric supply and is equipped with a kitchen, bathrooms, computers, cellular phone, microscopes, drying and collecting equipment, photo herbarium, climbing equipment, telescope and a small research library. It is an excellent base for carrying out scientific work or for simply appreciating the lush rainforest. Students of various scientific disciplines, naturalists, amateur biologists and "rainforest freaks" are welcome. People who wish to assist with ongoing scientific projects or who just want to enjoy the research center atmosphere are also welcome. In addition, the station is an ideal place for university and school excursions.

The staff is helpful and competent, ensuring an instructive and exciting stay. An administrative director is in charge of activities at the lodge. Reasonable rates are offered and special arrangements can be made depending on the length of stay. Customized tours can also be organized. The station is open year round. Professional biologists are present during part of the year and are always happy to share information

with other researchers. In the past, students from universities across Europe, the United States and Costa Rica have stayed at the station while carrying out their research projects. In 2000, a scientific report summarizing scientific activities, research projects, publications, excursions, field courses, etc. carried out since the foundation of the station was published. Copies of the report are available from the contact persons (see below) and excerpts are accessible on the webpage of Field Station La Gamba (http://www.regenwald.at). Current research projects are devoted to biodiversity of the Piedras Blancas National Park, population biology of certain plant and frog species, ecophysiology of epiphytes and epiphyllous organisms, soil biology and cultural anthropology among others.

The small botanical garden surrounding the station contains a collection of plants from significant plant families in the Esquinas Forest. More than 80 species of fruit and ornamental plants are cultivated. Furthermore, a small pond with swamp and aquatic vegetation is located on the premises. A guided tour through the garden is highly recommended. Self-guided tours with an informative brochure available at the station are also possible. For more detailed information visit the webpage: http://www.regenwald.at.

Tours

There is a 10-mile network of well-marked trails in the Esquinas forest. The trails begin immediately behind the Field Station La Gamba and Esquinas Rainforest Lodge. Guests can choose between easy 30 minutes walks, several hour hikes or day-long tours through untouched primary forest. One-day excursions are easily organized. Common tours include the famous Wilson Botanical Garden in Las Cruces and boat trips to the mangrove swamps of the Río Coto. Complete week-long adventures are also offered (see http://www.regenwald.at).

Courses in tropical biology are offered by biologists at the Field Station La Gamba. Customized excursions to interesting places across Costa Rica are available giving an overview of the tropical ecosystems and their fascinating fauna and flora. For more information see http://www.naturreisen.at.

How to get there

Piedras Blancas Nationalpark is situated about 300 km southeast of San José. The Field Station La Gamba and the Esquinas Rainforest Lodge are some 4 kilometers from Villa Briceño ("km 37") on the Interamerican Highway and 10 km from the Golfito airport.

Plane: There are regular daily flights from San José to Golfito with SANSA and TRAVELAIR. Flight time is c. 50 min. From Golfito airport it is a 30-minute taxi ride to the field station and the lodge.

Bus: Public buses run frequently from San José to Golfito, Río Claro or Villa Briceño ("km 37" on the Interamerican Highway). From there the field station and the lodge can be easily reached by taxi.

Private car: From San José, drive ca. 300 km (5-6 hours) southeastwards on the Interamerican Highway to Villa Briceño ("km 37"). Turn right at the sign in Villa Briceño and follow the signs leading to the lodge 4 km further down the road. From Golfito, an unpaved road leads to La Gamba 10 km away; follow the signs to the station and lodge. The roads from the towns/villages mentioned are accessible throughout the year; 4-WD vehicles are not necessary.

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Technical Remarks on the "Field Guide"

A. WEBER

Scope and limitations of the "Field Guide"

Above all, it must be noted that the present "Introductory Field Guide" is **not a flora**. A flora is a complete account of the species of a given area, or at least it aims at completeness. This is and cannot be the case in the Golfo Dulce area. Though there has been done much collection work both on the Osa Peninsula (in first instance by the staff of INBio, to some degree also by the Museo Nacional de Costa Rica), and in Piedras Blancas National Park (Esquinas forest) (in the recent past mainly by the staff and visitors of the Tropenstation La Gamba), the flora of the area is still incompletely known. The state of knowledge is reflected in the species list published at the end of the "Field Guide" (Appendix IV), which is an updated version of the list included in QUESADA & al. (1997).

Species number in the field and in the "Field Guide"

The number of species presently known in the Golfo Dulce area amounts to 182 families, 961 genera, and 2369 species of vascular plants (that is including ferns and fern allies), but does not claim to be exhaustive. There is an estimate of over 3000 species occurring there (ZAMORA, pers. comm.). Many more years of collecting will be necessary to establish a complete inventory. This specially holds true for the Piedras Blancas National Park, in which collection work has been rather fragmentary in the past and intensified only in the recent years through the establishment of the Tropenstation La Gamba.

In the "Field Guide" only the flowering plants (Spermatophytes: Gymnosperms and Angiosperms) are considered. The number of families in the Golfo Dulce area amounts to 158, the number of species is ca. 2200, placed in ca. 900 genera. In the "Field Guide" 627 genera are described in some detail and a selection of 960 species (that is between half and a third of the total species number) is represented by brief descriptions, line drawings and/or color photographs.

Aims of the "Field Guide"

The principal aims of the "Field Guide" are:

(a) to enable the user to **identify the families and genera of flowering plants** known at present in the area,

(b) to provide some **basic "biological" information on the families and selected genera** (species number, morphology, ecology, pollination, dispersal, uses etc.),

(c) to enable the user to **identify the commoner species** through the aid of descriptions, line drawings and color photographs,

(d) to present some **information on these species** (morphological and ecological characteristics, distribution etc.), and

(e) to point out some **species of particular interest**.

For the difficult task of species selection of the excellent field knowledge of Nelson Zamora (INBio) and his collaborators, Werner Huber and Anton Weissenhofer served as an inevitable basis.

For the use of the keys some botanical training and the knowledge of botanical terms is indispensable. However, it should be possible to identify a fair number of genera/species through the aid of the illustrations.

For the identification of the genera and species for which no descriptions are provided, the consultation of scientific literature is necessary. Appropriate references are given at the end of each family treatment.

Structure of the family treatments

Each of the families is treated in a standard way and the treatments have the following structure:

(a) General characteristics of the family. General habit and significance. Stem, leaf, inflorescence, flower, fruit and seed characters. Total distribution, total number of genera/species in the family, number of gen./spp. in Costa Rica (CR), and number of gen/spp. in the Golfo Dulce (GD) area (as documented so far), e.g., [Bignoniaceae] Pantrop. 109/750, CR 38/83, GD 22/34.

(b) Ecological features of general interest. Particular attention is attached to "biological" features such as pollination ecology and seed dispersal. Uses are mentioned where appropriate. Especially in large families the information must be qualified as very selective and incomplete.

(c) Key to the genera

As far as they are known, all genera represented in the Gulfo Dulce area are keyed out. The keys are either based on recent systematic treatments of the respective families or (in a few instances) new keys have been established (see below).

(d) Descriptions of selected genera and species. These cover rather common or in some respects noteable taxa. Plants that can be easily encountered by the visitor have been given first preference. The treatment of the individual families certainly is very uneven. That means that even very important families such as the orchids, which are mostly epiphytic and which are not likely to be seen by the visitor, are treated only fragmentarily.

The description of the genera includes: (a) Rough total distribution and number of species in total/in Costa Rica/and in Corcovado National Park incl. Esquinas forest (as far as they have been collected and identified until now), e.g., [*Tabebuia*] neotrop. ca. 100, CR 6, GD 4). The latter figure is of particular importance as it tells **if more than the species described in some detail are present in the area** (the names of the species can be found in the list in Appendix IV). (b) Significant diagnostic morphological features.

The description of the species refers to morphological features, ecology and distribution.

If suitable, a key to the species of a genus is provided. Selected species are described in some detail, with reference to morphology, ecology, total distribution and eventual uses.

(e) References. A selection of references is given. In some cases papers are cited that are not referred to in the text, but which have been used for establishing the family treatment or which are useful for obtaining further information on the family.

Sequence of the families

For convenience, the families of flowering plants are grouped here into four major categories: (1) Gymnosperms-Cycads (with family Zamiaceae), (2) Gymnosperms-Conifers (Podocarpaceae), (3) Angiosperms-Monocotyledons and (4) Angiosperms-Dicotyledons. Within the latter groups the families are arranged in alphabetical order.

How to identity the plants

Because of the great number of taxa, the identification of tropical plants is a difficult task, even for the professional botanist. Accuracy and patience are indispensable prerequisites. Usually flowering or fruiting, and not rarely flowering plus fruiting material, is required for identification. Keys using mainly

vegetative characters have been established for some countries, but are not available for Costa Rica or any other of the Central American countries.

The first hurdle is to identify the plant family. Traditional dichotomous family keys are mostly very difficult to use. From our experience, the rather unorthodox keys of GENTRY (1993) proved most suitable for family identification. These keys, (1) a "Survey key", (2) a long and more accurate "Annotated key", and (3) a key referring to "Special habits and spot characters" such as presence of spines, tendrils, white or colored latex, saprophytic or parasitic habit etc. (see also the Malesian counterpart by BALGOOY 1997), are reproduced here with some modifications.

For the identification of the genera, keys of recent systematic and floristic treatments of Central American plant families (e.g., for the new "Flora of Costa Rica") have been used as a basis. The editors are indebted to the authors of the sometimes still unpublished treatments to allow us to use extracts of their manuscripts. In some cases it was tried to construct new keys, e.g., based on stipule shape in the Rubiaceae (by Sabine WILL) or on vegetative characters for the Legumes (by Eva SCHEMBERA).

For facilitating plant identification, a fair number of **species illustrations** has been incorporated in the Field Guide: line drawings (from the INBio drawing collection and from the "Flora of Panama", published in the Annals of the Missouri Botanical Garden, 1944-1980, for the nemes of artists see Appendix III) and color photos taken by numerous persons (see Appendix II for detailed references).

The best confirmation of a successful identification is, however, the **comparison with other collections** already identified. For that reason a "**photo herbarium**" has been established in the Field Station La Gamba.. When walking or working and collecting in the Esquinas Rain Forest, the comparison with the large-sized "photo specimens" will be of great help. A proper herbarium cannot be established at the moment as no air conditioned room is availabe.

Errors

As in any book, errors and inadequacies cannot be excluded, and the present Field Guide is certainly far from being. The readers are encouraged to contact the editors when errors, misidentifications, misprints, misleading formulations etc. are discovered. Such information will be compiled and a list of corrections will be produced. If there is the chance of a second edition, these deficiencies can be eliminated.

BALGOOY, M.M.J. VAN, 1997: Malesian seed plants. Vol 1 - Spot-characters. - Leiden: Rijksherbarium/Hortus Botanicus.
GENTRY, A.H. 1993. A field guide to the families and genera of woody plants of northwest South America (Colombia, Ecuador, Peru). - Conservation International, Washington D.C.
QUESADA, F.J., QU. JIMÈNEZ, N. ZAMORA, R. AGUILAR & J. GONZÁLEZ. 1997. Arboles de la Peninsula de Osa. - Heredia: INBio.

Identification of the Plant Families

Because of the large number, identification of tropical plant families is difficult. Here three keys are presented, all based on GENTRY (1993) and adapted and modified in some respects be the editors. The fist ("Survey key") is a short version of the subsequent "Annotated Key", in which the characters and families (and/or particular genera) are described in some greater detail. The third key, which is the least complete, refers to some conspicuous "spot characters" and allows to identify a small number of taxa at first glance. See also the chapter "Technical remarks on the Introductory Field Guide".

Survey key to the Families

I. Plants terrestrial

A. Leaves compound, opposite

A1. Leaves bipinnate to biternate: Bignoniaceae, Asteraceae
A2. Leaves simply pinnate: Bignoniaceae, Brunelliaceae, Zygophyllaceae, Fabaceae, Juglandaceae, Rutaceae, Sapindaceae
A3. Leaves 3-foliate and palmately compound: Bignoniaceae, Asteraceae, Caryocaraceae, Hippocastanaceae, Verbenaceae, Rutaceae

B. Leaves compound, alternate

B1. **Leaves bipinnate**: Fabaceae, Sapindaceae, Araliaceae, Rutaceae, Vitaceae, Meliaceae - *Melia azedarach*

B2. **Leaves simply pinnate**
B2a. Parallel venation: Arecaceae, Cycadaceae
B2b. Rank odor: Juglandaceae, Meliaceae, Proteaceae, Fabaceae
B2c. Odor of essential oils or turpentine: Rutaceae, Anacardiaceae, Burseraceae
B2d. Sweetish odor in trunk: Meliaceae
B2e. Punctations: Rutaceae, Fabaceae
B2f. Bitter taste: Simaroubaceae
B2g. Spines: Fabaceae, Rutaceae, Sapindaceae, Arecaceae, Cycadaceae
B2h. Latex: Sapindaceae, Anacardiaceae, Burseraceae, Fabaceae
B2i. Even-pinnate: Fabaceae, Meliaceae, Sapindaceae, Arecaceae, Cycadaceae
B2j. Miscellaneous useful features: winged rachis: various families; terminal "bud" on rachis: Meliaceae; cylindrical pulvinuli: Connaraceae, Fabaceae, Simaroubaceae; aborted rhachis tip: Sapindaceae; apical tendril: Asteraceae, Fabaceae
B2k. Nondescript: Meliaceae - *Trichilia*, Sabiaceae, Anacardiaceae - *Tapirira*, Simaroubaceae

B3. **Leaves 3-foliolate, alternate**
B3a. Trees: Caryocaraceae - *Anthodiscus,* Sapindaceae - *Allophylus,* Fabaceae - *Erythrina,* Rutaceae
B3b. Vines: Fabaceae, Connaraceae, Sapindaceae, Cucurbitaceae, Vitaceae, Euphorbiaceae, Dioscoreaceae

B4. **Leaves palmately compound, alternate**
B4a. Trees: Arecaceae, Rutaceae, Araliaceae, Bombacaceae, Caricaceae, Cecropiaceae, Sterculiaceae, Cochlospermaceae
B4b. Vines: Passifloraceae, Convolvulaceae, Dioscoreaceae, Araceae, Cyclanthaceae

C. Leaves simple, opposite

C1. Lianas

C1a. T-shaped trichomes: Malpighiaceae

C1b. 3(-7)-veined leaves: Loganiaceae, Melastomataceae, Asteraceae

C1c. Milky latex: Apocynaceae, Asclepiadaceae, Clusiaceae, Asteraceae

C1d. Miscellaneous: Hippocrateaceae, Combretaceae, Rubiaceae, Bignoniaceae, Acanthaceae, Gesneriaceae, Verbenaceae, Nyctaginaceae, Amaranthaceae, Hydrangeaceae

C2. Trees, shrubs and herbs

C2a. Stipules: or stipule scars: Rubiaceae, Quiinaceae, Malpighiaceae, Chloranthaceae, Vochysiaceae, Rhizophoraceae, Caryophyllaceae, Portulacaceae

C2b. Latex: Apocynaceae, Clusiaceae

C2c. Punctations: Myrtaceae, Melastomataceae, Lythraceae, Rutaceae, Clusiaceae, Loranthaceae, Myrsinaceae, Rhizophoraceae

C2d. 3(-7)-veined leaves with parallel cross veins: Melastomataceae

C2e. Odor of essential oils: Monimiaceae, Chloranthaceae, Lauraceae, Verbenaceae, Lamiaceae, Asteraceae

C2f. Glands on twig at petiole base: Vochysiaceae

C2g. Serrate margins: Crassulaceae, Hippocrateaceae, Violaceae, Elaeocarpaceae, Rhizophoraceae, Loganiaceae, Flacourtiaceae, Verbenaceae, Monimiaceae, Brunelliaceae, Chloranthaceae, Acanthaceae, Euphorbiaceae

C2h. Miscellaneous: Nyctaginaceae, Myrtaceae, Melastomataceae, Lythraceae, Polygalaceae, Loganiaceae, Verbenaceae, Hippocrateaceae, Rhamnaceae, Acanthaceae, Gesneriaceae, Caprifoliaceae, Cornaceae, Oleaceae, Buxaceae, Malpighiaceae, Clusiaceae, Elaeocarpaceae

D. Leaves simple, alternate

D1. Trees, shrubs or herbs

D1a. Latex: Sapotaceae, Moraceae, Euphorbiaceae, Olacaceae, Apocynaceae, Papaveraceae, Myristicaceae, Campanulaceae, Anacardiaceae, Chrysobalanaceae

D1b. Conical terminal stipule: Moraceae, Magnoliaceae, Polygonaceae

D1c. Odor of essential oils: Apiaceae, Piperaceae, Magnoliaceae, Hernandiaceae, Annonaceae, Myristicaceae, Lauraceae, Canellaceae, Anacardiaceae, Burseraceae, Fabaceae, Araliaceae, Icacinaceae

D1d. Palmately veined: or 3-veined

(1) Malvalean Pulvinus: Tiliaceae, Sterculiaceae, Bombacaceae, Malvaceae, Elaeocarpaceae, Bixaceae, Euphorbiaceae

(2) Without swollen pulvinus: Ulmaceae, Urticaceae, Euphorbiaceae, Caricaceae, Begoniaceae, Cochlospermaceae, Flacourtiaceae, Hernandiaceae, Araliaceae, Rhamnaceae, Rhizophoraceae, Olacaceae, Fabaceae, Menispermaceae

D1e. Strong bark: Annonaceae, Lecythidaceae, Thymelaeaceae, Boraginaceae, Fabaceae, Malvales, Urticales

D1f. Unequal petioles: Araliaceae, Capparidaceae, Euphorbiaceae, Sterculiaceae, Bombacaceae, Urticaceae, Menispermaceae

D1g. Petiole glands: Chrysobalanaceae, Combretaceae, Euphorbiaceae, Flacourtiaceae, Rhamnaceae

D1h. Serrate margins: Actinidiaceae, Boraginaceae, Celastraceae, Clethraceae, Asteraceae, Dilleniaceae, Elaeocarpaceae, Euphorbiaceae, Fagaceae, Flacourtiaceae, Humiriaceae, Icacinaceae, Lacistemataceae, Fabaceae, Myrsinaceae, Ochnaceae, Rhamnaceae, Rosaceae, Sabiaceae, Solanaceae, Symplocaceae, Theaceae, Theophrastaceae, Violaceae

D1i. Thickened or flexed petiole apex: Elaeocarpaceae, Euphorbiaceae, Flacourtiaceae, Meliaceae
D1j. Punctations: Flacourtiaceae, Rutaceae, Myrsinaceae, Theaceae
D1k. Stipules: Celastraceae, Chrysobalanaceae, Dichapetalaceae, Erythroxylaceae, Euphorbiaceae, Flacourtiaceae, Rosaceae, Violaceae, Portulacaceae
D1l. Lepidote or stellate trichomes: Annonaceae, Capparidaceae, Clethraceae, Asteraceae, Dilleniaceae, Euphorbiaceae, Icacinaceae, Fagaceae, Malvales, Solanaceae, Styracaceae
D1m. Leaves parallel-veined or lacking secondary veins: Podocarpaceae, Theaceae, Poaceae, Arecaceae, Zingiberales
D1n. Parallel tertiary venation: Clusiaceae, Icacinaceae, Lacistemataceae, Lecythidaceae, Myristicaceae, Sapotaceae, Ochnaceae, Olacaceae
D1o. Spines or spine-tipped leaves: Boraginaceae, Asteraceae, Cactaceae, Celastraceae, Euphorbiaceae, Flacourtiaceae, Moraceae, Nyctaginaceae, Olacaceae, Phytolaccaceae, Rhamnaceae, Rosaceae, Solanaceae, Theophrastaceae, Urticaceae
D1p. None of above: Amaranthaceae - *Pleuropetalum*, Bignoniaceae - *Crescentia, Amphitecna*, Boraginaceae, Capparidaceae, Celastraceae - few *Maytenus*, Chrysobalanaceae, Combretaceae, Asteraceae, Dichapetalaceae, Ebenaceae, Euphorbiaceae, Flacourtiaceae, Humiriaceae, Icacinaceae, Fabaceae, Moraceae, Myricaceae, Olacaceae, Onagraceae, Passifloraceae, Phytolaccaceae, Polygonaceae, Rhamnaceae, Sabiaceae, Solanaceae, Violaceae

D2. **Lianas with tendrils:** Passifloraceae, Vitaceae, Smilacaceae, Rhamnaceae, Fabaceae, Cucurbitaceae, Loganiaceae – *Strychnos*, Sapindaceae, Euphorbiaceae - *Omphalea*

D3. **Lianas without tendrils**
D3a. Leaves with parallel veins: Araceae, Cyclanthaceae, Poaceae, other monocots
D3b. Leaves serrate: Dilleniaceae, Ulmaceae, Euphorbiaceae, Malvaceae, Asteraceae, Boraginaceae
D3c. Leaves deeply lobed and/or peltate: Euphorbiaceae, Solanaceae, Menispermaceae, Aristolochiaceae
D3d. "Primitive" odor: Aristolochiaceae
D3e. Glands on petiole or lamina base: Euphorbiaceae
D3f. Leaves palmately 3(-5)-veined: Sterculiaceae, Menispermaceae, Dioscoreaceae, Ericaceae, Rhamnaceae, Asteraceae, Olacaceae, Fabaceae, Euphorbiaceae
D3g. Latex: Convolvulaceae, Euphorbiaceae, Olacaceae
D3h. Spines: Boraginaceae, Polygalaceae, Smilacaceae, Solanaceae
D3i. None of the above: Polygonaceae, Marcgraviaceae, Ericaceae, Dichapetalaceae, Asteraceae, Solanaceae, Convolvulaceae, Polygalaceae, Phytolaccaceae, Boraginaceae, Amaranthaceae, Olacaceae, Dilleniaceae

II. Plants aquatic herbs

A. **Plants thallus-like, not differentiated into stem and leaves**
A1. Plants free-floating, small, disc-like: Lemnaceae (*Lemna*)
A2. Plants clinging to rocks and stones: Podostemaceae

B. **Plants with submersed leaves possessing bladder-like traps, flowers sympetalous, personate**:
Lentibulariaceae (*Utricularia*)

C. **Plants with both submersed and floating leaves, flowers with free petals**
C1. Submersed leaves strongly dissected: Cabombaceae (*Cabomba*)
C2. All leaves entire: Nymphaeaceae (*Nymphaea*)

D. **Plants with emergent linear and basally sheathed leaves; flowers very small, arranged in a dense brown to blackish spadix**: Typhaceae (*Typha*)

E. **Plants with emergent cordate or sagittate leaves**

E1. Plants with milky latex: Limnocharitaceae

E2. Plants without milky latex, inflorescence a panicle, or sometimes an umbel or flowers solitary: Alismataceae

E3. Petiole short to medium-sized, inflorescence a spike or raceme: Pontederiaceae (*Eichhornia azurea*)

F. **Plants with floating rosettes and stolons**

F1. Leaves glabrous, with a thick, inflated petiole, flowers large, showy, lilac, arranged in a raceme: Pontederiaceae (*Eichhornia crassipes*)

F2. Leaves hairy, petiole not thickened; flowers minute, surrounded by a spathe: Araceae (*Pistia stratiotes*)

Annotated Key (terrestrial plants only)

A. Leaves compound, opposite
This is the easiest category. Only one important family (Bignoniaceae) plus a few other small families and miscellaneous genera or species are characterized by opposite compound leaves. If in doubt whether the leaf is compound or not, look for the axillary bud. In deciduous species, thick twigs tend to indicate compound leaves. In fallen leaflets, asymmetric leaf bases often suggest origin from a compound leaf.

A1. Leaves bipinnate, opposite
Bignoniaceae - *Jacaranda*
Asteraceae - Bipinnate only in some herbs: leaflets serrate, plants aromatic.

A2. Leaves simply pinnatel, opposite
Useful differentiating characters include: the rhachis (angled and more or less grooved above in Bignoniaceae, Zygophyllaceae, Brunelliaceae, and Juglandaceae; conspicuously jointed); presence or absence of interpetiolar line or ridge (absent only in: Rutaceae, Juglandaceae, Sapindaceae); type of marginal serrations and pubescence of the leaflets; and presence and type of stipules.
Bignoniaceae - *Tecoma stans*, leaflets petiolulate and sharply serrate.
Brunelliaceae - *Brunellia hygrotermica*, leaflets closely serrate, stipules between the petioles; interpetiolar ridge with small subulate stipule-like projections.
Fabaceae - *Platimiscium* spp., typical legume pulvinus and pulvinuli; green-bean odor.
Juglandaceae - Leaflets asymmetric (*Oreomunnea pterocarpa*) and lower smaller (*Alfaroa guanacastensis*), twigs and petiole hispid or the twigs with conspicuous round white lenticels; typical rank walnutlike odor.
Sapindaceae - *Matayba opposotifolia,* margins entire, petiolule short, thick-based.
Zygophyllaceae - *Kallstroemia pubescens*, herb with leaflets entire, pubescent and round-tipped, sessile on strongly angled and more or less grooved rhachis, stipules present.

A3. Leaves 3-foliolate, opposite
Asteraceae - Several herbs, especially *Bidens*, characteristic composite odor, serrate margins.
Bignoniaceae (most neotropical trees of the family) - Leaflet bases rounded to cuncate, not tapering into petiolule; pubescence usually of stellate trichomes or lepidote scales.
Caryocaraceae - *Caryocar costaricense,* characterized by distinctive gland pair at apex of petiole (unique in opposite-leaved taxa); branchlets with a conspicuous rubiac-like terminal stipule; leaflets serrate or serrulate).
Hippocastanaceae - *Billia colombiana,* vegetatively very similar to *Caryocar* but lacks petiolar glands and elongate terminal stipules; completely entire leaflets. Leaflets turn reddish when are about to fall down.
Rutaceae - *Amyris brenesii,* with conspicuously punctate leaflets; acute to acuminate, petiolulate.
Verbenaceae - *Vitex cooperi,* twigs somewhat square, leaf bases usually gradually tapering into indistinct petioles is unique among opposite 3-foliolate taxa.

B. Leaves compound, alternate
Several families in this group are very difficult to separate on the basis of sterile characters, especially some Sapindaceae (*Cupania, Matayba, Talisia,* etc.) some Meliaceae (*Trichilia*) and a few nonaromatic Anacardiaceae (*Tapirira*).

B1. Leaves bipinnate or biternate, alternate
Fabaceae - Vines, trees or herbs. Bipinnate leaves and spines on trunk, branches, or rhachises are unique to mimosoid legumes and some species of *Caesalpinia;* like nonspiny bipinnate legumes these

taxa are characterized by the typical cylindrical legume pulvinus and pulvinulus and (in mimosoids) by development of an often elaborate gland on the dorsal side of the lower petiole or sometimes between the lower rhachises.
Meliaceae - *Melia azedarach,* a tree cultivated and also escaped, characterized by thin serrate leaflets; young growth often conspicuously whitish; looks much more like Araliaceae than Meliaceae, but lacking characteristic ligule-like base.
Sapindaceae - Vines and lianas (usually basically ternate and usually with milky latex and sometimes characteristic compound stem anatomy) or trees (*Dilodendron costaricense* with many small serrate leaflets and the typical aborted rhachis apex of the family).
Vitaceae - a few *Cissus* spp., vines with basically ternate leaves; leaf-opposed tendrils and enlarged often reddish nodes are characteristic.

B2. Leaves simply pinnate, alternate
B2a. Leaflets with parallel venation
Arecaceae - The only woody monocots with pinnately compound leaves, the leaf segments unmistakable in their parallel venation.
Cycadaceae - *Zamia fairchildiana*, similar only to palms from which the leaflets differ in being more coriaceous; on the petiole and/or rhachis short spine, with spines shorter and thicker-based than in pinnate-leaved spiny palms.

B2b. Rank odor
Fabaceae - Most legumes have a characteristic more or less rank green-bean-like odor. Easy to recognize by distinctively round, swollen petiolules (whole length of petiolule uniformly cylindric) and petiole base; Connaraceae (lianas and occasionally treelets) lack the odor but are otherwise indistinguishable vegetatively from Fabaceae. Some *Picramnia* species (Simaroubaceae) have similarly pulvinate petioles and petiolules, but often with bitter taste and the strongly alternate leaflets becoming much smaller toward leaf base.
Meliaceae - *Cedrela odorata*, somewhat garlic-like odor but always entire leaflets.
Proteaceae - *Roupala montana*, canned-meat odor of leaves, mostly with compound juvenile leaves; the trunk slash has a characteristic odor resembling low-quality canned beef; the leaflets are extremely asymmetrical, usually with one side flat (even concave), the other margin serrate.

B2c. Odor of essential oils or turpentine
Anacardiaceae and **Burseraceae** - These two families usually have a fairly strong turpentine-like or mango-like odor but are very difficult to tell apart vegetatively; check both families.
Anacardiaceae - Usually more weakly turpentine-odored or with a somewhat sweetish mango-like odor; sometimes with a watery latex which dries black (wounded trunks often stained with black); may be considered a derived version of Burseraceae differentiated by the technical character of one anatropous ovule per locule or a single ovule in ovary.
Burseraceae - Usually strongly turpentine-odored, even in bark; almost always with milky latex either in the twigs or as few widely scattered droplets from the bark slash, the latex drying whitish around trunk wounds; technically separated from Anacardiaceae by ovules pendulous, epitropous, and two per locule.
Rutaceae - *Zanthoxylum,* spines on trunk or stems (unique in simply pinnate taxa) and typically punctate leaflets, at least along margin below.

B2d. Sweetish odor in trunk only; excluding mango-like odors
Meliaceae - Most Meliaceae are characterized by a faint but distinctly sweetish odor from the trunk slash (but *Cedrela odorata* has a very different rank garlic-like odor).

B2e. Punctations. Look both against strong light and out of it; punctations are often restricted to the sinuses of marginal teeth or serrulations.

Fabaceae - A few genera of legume have punctate leaves (*Myroxylon balsamum*, *Hymenaea courbaril*, *Copaifera aromatica* and some *Lonchocarpus,* etc.), the punctations often rather linear, at least in part.
Rutaceae - Most species of Rutaceae are punctate at least along leaflet margin; most pinnate-leaved Rutaceae are species of *Zanthoxylum* and most of these have spines on the trunks, branchlets, or leaves.

B2f. Very bitter taste
Simaroubaceae - Most Simaroubaceae are characterized by a bitter taste when the twig is chewed.

B2g. Spines (rare in simply pinnate taxa)
Arecaceae - Several pinnate-leaved palm genera have spiny trunks and/or leaves.
Cycadaceae – *Zamia fairchildiana* has short spines on the petiole and/or rhachis.
Fabaceae - *Machaerium,* mostly lianas, usually only with paired stipular spines and usually with red latex.
Rutaceae - *Zanthoxylum,* always trees in Neotropics; thick spines on trunk typical, also often with spines on petioles and leaflets.

B2h. Latex (rare in compound-leaved taxa)
Burseraceae - Latex sometimes present in twigs, almost always in exceedingly inconspicuous scattered droplets in stem slash, these typically continuing to exude and forming cloudy white drippings below trunk wounds.
Fabaceae - Red latex in a number of papilionate genera (*Dussia, Machaeritan, Pterocarpus, Swartzia*).
Sapindaceae - Latex present in most lianas (characterized also by bifurcating inflorescence-derived tendrils and frequently compound wood) but never in trees.

B2i. Even-pinnate leaves
Fabaceae – *Inga,* unique in being even-pinnate and with glands between all leaflets; *Cassia* often with glands between basal pair or pairs of leaflets, and several other caesalpinioid genera, all with typical pulvinus and pulvinuli and often with typical legume odor.
Meliaceae - Most Meliaceae except *Trichilia* are even-pinnate, especially *Guarea* with typical apical "bud".
Sapindaceae - Most Sapindaceae are basically even-pinnate but with alternate leaflets and a very characteristic aborted rhachis apex at base of what often appears to be a terminal leaflet.

B2j. Miscellaneous useful characters for genera or common species with pinnately compound alternate leaves

(1) Winged rhachis : Individual species of many genera and families,
Fabaceae - Several unrelated genera have winged rhachis *Inga*, even-pinnate with glands between all leaflet pairs.
Meliaceae - *Guarea pterorhachis*, even-pinnate with many thick leaflets and broad coriaceous rhachis wings.
Sapindaceae - many lianas (*Paullinia* and *Serjania*), mostly with compound wood and/or bicompound leaves.
Simaroubaceae - *Quassia amara*, characterized by mostly 5-foliolate leaves and bitter taste.
Solanaceae - Some herbaceous and vine *Solanum* species have winged rhachises, often with incompletely divided leaflets.

(2) Terminal "bud" of unfolding leaflet pair at tip of rhachis
Meliaceae - *Guarea*

(3) Uniformly cylindrical pulvinuli and pulvinus - Typical of nearly all legumes and Connaraceae which are extremely hard to distinguish vegetatively (and to some extent of *Picramnia*). Legumes can be either trees or lianas; in the region Connaraceae are always lianas. Most legumes have the

typical legume green-bean odor and many once-pinnate legume lianas have red latex; Connaraceae generally lack a noticeable vegetative odor and never have red latex. *Ruptiliocarpon caracolito* has unifoliolate leaves with legume-like pulvinulus.

(4) **Naked rhachis apex** - Tree Sapindaceae (especially *Cupania* and *Matayba*) with pinnate leaves almost always have a very characteristic aborted rhachis apex extended as a small projection at base of what appears to be a terminal leaflet.

(5) **Tendril from apex of rhachis**
Fabaceae - Herbaceous *Vicia* (and some species of bipinnate *Entada*) has the leaf rhachis ending in tendril.

B2k. Nondescript (odd-pinnately compound, alternate, no spines, odor, punctations, latex, etc.)
Anacardiaceae - Odorless anacards (e.g. *Tapirira*) that also lack obvious latex are very nondescript and especially easy to confuse with *Trichilia.* Often there is at least a faint trace of a mango-like odor. The commonest species dries with a characteristic reddish tint.
Meliaceae - *Trichilia,* unfortunately the commonest genus of Meliaceae, is atypical in the family in odd-pinnate leaves. The leaflets are entire, and there is usually a sweetish odor from the trunk slash.
Simaroubaceae - Nonbitter simaroubs are often characterized by legume-like cylindrical pulvinuli. *Picramnia* can be distinguished from legumes by the typical alternate leaflets, progressively smaller toward base of the rhachis.

B3. Leaves 3-foliolate, alternate
Alternate consistently 3-foliolate leaves are not very common although they may occur as variants in basically pinnately compound-leaved individuals (or species or genera).
B3a. Trees
Caryocaraceae – *Anthodiscus,* usually blunt apex and crenate leaflet margins.
Fabaceae – *Erythrina,* usually with spiny trunks and branchlets; with the typical legume cylindrical pulvinus and pulvinuli; margin always entire.
Rutaceae - Several genera have 3-foliolate leaves, at least in some species; all are characterized by the pellucid punctations and most have a more or less citrus-like vegetative odor.
Sapindaceae – *Allophylus,* usually acute or acuminate apex and toothed (or entire) margins; a few species have simple leaves.

B3b. Vines
The great majority of 3-foliolate climbers are legumes (the leaflets uniformly entire; very rarely with very broad entire lobes) and Sapindaceae (the leaflets nearly always somewhat serrate or dentate).
Connaraceae - Very like legumes in the cylindrical pulvinuli and pulvinus, but without a green-bean odor and always lacking stipels and red latex. Most 3-foliolate Connaraceae have alternate basal leaflets (rare in legumes). Connaraceae leaflets mostly have finely prominent venation and a characteristic chartaceous texture that is different from those of legume climbers.
Cucurbitaceae - 3-foliolate cucurbits (*Gurania, Psiguria, Cayaponia,* few *Fevillea*) are recognizable by the divided spirally coiling tendrils that make a right angle with base of petiole, and by tendency for remotely toothed margins and/or scabrous surface and/or large glands near apex of petiole (*Fevillea*), and/or cucurbit odor.
Dioscoreaceae - A few species of *Dioscorea,* characterized by the rather thickish and usually curved and angled base of the long petiole, are 3-foliolate.
Euphorbiaceae - Only a few species of *Dalechampia,* all more or less herbaceous, are 3-foliolate vines.
Fabaceae - Most 3-foliolate climbers are papilionate legumes characterized by typical legume odor, uniformly cylindrical pulvinuli and pulvinus and often with (unique) stipels at base of lateral pulvinuli, and red latex.
Sapindaceae - *Thinouia* and a few species of *Serjania* and *Paullinia* have uniformly 3-foliolate leaves; they are characterized by the bifurcating inflorescence-derived Sapindaceae tendril and usually irregu-

larly coarsely toothed margin.
Vitaceae - Several *Cissus* species have 3-foliolate leaves. The commonest of these have a characteristic 4-angled subwinged branchlet; all differ from cucurbits in having the tendril arising opposite the petiole base and are also usually distinctive in swollen nodes.

B4. Leaves palmately compound, alternate
B4a. Trees
Araliaceae - *Schefflera systyla,* hemiepiphytic, characterized by the rank or medicinal odor and the thickly triangular ligule projecting up from the more or less clasping petiole base.
Arecaceae (Palmae) - Fan palms are our only arborescent plants with palmately compound leaves with parallel-veined segments.
Bombacaceae - Most Bombacaceae have palmately compound leaves, always with a Malvalean pulvinus at petiole apex. Several genera have spines on the trunk (at least when young) (a unique combination except for *Jacaratia*), whether with or without spines, Bombacaceae are often unusually large emergents with distinctively swollen thick trunks. One spineless genus has the leaflets continuous with the digitately parted petiole apex (unique in Malvales).
Caricaceae – *Jacaratia* is the only palmately compound-leaved tree with milky latex in the region; they have spiny trunks and resemble Bombacaceae except for the latex and lack of a pulvinus.
Sterculiaceae - *Herrania purpurea* has palmately compound leaves, usually large, conspicuously hairy and borne on pachycaul treelet with maroon cauliflorous flowers and cacao-like fruit; *Sterculia allenii* also has Bombacaceae-like compound leaves; both have Malvalean pulvinus and stipules.

B4b. Vines (Most vines with palmately compound leaves are tendrillate and most are atypical members of predominantly simple-leaved taxa).
Araceae - *Syngonium* and a few atypical species of *Philodendron* and *Anthurium* are hemiepiphytic climbers with palmately compound leaves, very different from the above taxa in succulent stems, adventitious attachment roots, and usually in finely and closely parallel secondary venation.
Convolvulaceae - Most species of *Merremia* have palmately compound leaves; tendrils are absent in Convolvulaceae.
Cyclanthaceae - Nearly all climbing Cyclanthaceae have deeply bifid (rather than truly compound) leaves very distinctive in their parallel venation.
Passifloraceae - Some *Passiflora* species have palmately compound leaves; characterized by distinctive petiolar glands, tendrils are axillary.

C. Leaves simple, opposite or whorled

C1. Lianas, leaves simple, opposite or whorled
The majority of lianas has simple opposite leaves. Look for: serrate or serrulate margins (Hippocrateaceae); petiolar glands and/or sericeous petiole (and/or other parts) with T-shaped trichomes (Malpighiaceae); 3-veined from base (*Strychnos,* Melastomataceae), or above base (Asteraceae [usually aromatic]); milky latex (Apocynaceae and Asclepiadaceae, the former usually woody, the latter mainly herbaceous); spines (several Rubiaceae mostly with paired spines from leaf-axils; *Combretum,* sometimes with branch spines on stem; *Pisonia* with leaves mostly on short-side branches); swollen jointed nodes (Acanthaceae, Amaranthaceae, *Gnetum,* the latter with [slow] resin from cut stem); asperous surface (*Petrea* - Verbenaceae) and some Asteraceae.

The four main liana families with opposite simple leaves are **Apocynaceae**, **Malpighiaceae**, **Hippocrateaceae**, and **Combretaceae**. Apocynaceae lianas always have milky latex, at least in the leaves and young stems and center of stem; the others never do (though a kind of thin watery latex may be present). Only Hippocrateaceae (plus a very few Asteraceae) are ever serrate or serrulate; they also usually have green petioles and twigs, a good indicator for most entire-leaved Hippocrateaceae. Some

Malpighiaceae genera have petiolar glands which may be stipule-like enations on the petiole (*Hiraea*) or secretory glands at the petiole apex (especially *Stigmaphyllon*); when present these are a sure familial indicator. Most Malpighiaceae have tannish petioles (from the T-shaped trichomes) and brownish or tannish twigs. Malpighiaceae with nonglandular petioles might be confused with Combretaceae but the petioles and twigs of the latter are usually brown, lack sericeous indumentum and may have an exfoliating cortex, even on the petioles. Combretaceae mostly have conspicuous rigidly parallel tertiary connecting veins adjacent secondaries, a feature rare in Malpighiaceae and nonexistent in Hippocrateaceae (which may have parallel tertiary venation but then almost parallel to the secondaries); the young branchlets of Combretaceae are generally hollow-centered and even the large stems tend to have one or more small mucilage-secreting channels in extreme center.

Some unusual features of opposite-leaved lianas:
Spines - *Pisonia, Combretum,* Rubiaceae (*Chomelia, Randia*).
Asperous leaves - *Petrea, Prionostemma,* several Asteraceae.
Three-veined leaves - *Strychnos,* Asteraceae, Melastomataceae
Serrate or serrulate margins - Hippocrateaceae; some Gesneriaceae, Asteraceae, *Hydrangea.*
Petiolar enations or "glands" - Malpighiaceae.

C1a. T-shaped trichomes
Malpighiaceae - T-shaped trichomes (= malpighiaceous hairs) give rise to a macroscopically sericeous look, especially on petioles (and buds) and are definitive among plants with opposite leaves; not always obvious to naked eye, if in doubt use a hand lens. Several genera have pair of stipule-like appendages (glands) on petiole or pair of thicker glands near petiole apex. Stems sometimes fragment into cables, unlike Combretaceae and Hippocrateaceae. Sometimes with watery submilky latex approaching that of some Asclepiadaceae in texture.

C1b. Leaves 3-veined
Asteraceae - Only a few opposite-leaved genera (e.g., some *Mikania*) are actually lianas; most other scandent Asteraceae with opposite leaves tend to be clambering, more or less herbaceous vines. The combination of opposite leaves 3-veined above the base and aromatic odor (also frequently more or less asperous) is unique to comps; some *Mikania* species have the leaves 3-veined from base but the leaves then cordate; the margins are usually entire but may be (usually more or less irregularly) toothed, and the surface often distinctively asperous. Liabeae climbers lack odor but have milky leaves.
Loganiaceae - *Strychnos,* opposite 3-veined leaves; rather sparse but very characteristic tendrils are usually present, thick and coiled in a single plane.
Melastomataceae - Leaves with one to four pairs of longitudinal veins arcuately subparallel to the midvein and perpendicularly connected by finer cross veins, these lacking in other 3-veined taxa.

C1c. Milky latex
Apocynaceae - Abundant milky latex is unique to this and the following family among lianas or vines with opposite leaves. The two families are very difficult to distinguish vegetatively. Leaves usually with characteristic glands on midrib above, at least at base of midrib. In general, woody lianas are Apocynaceae while herbaceous climbers are mostly Asclepiadaceae.
Asclepiadaceae - Essentially a herbaceous version of Apocynaceae and often indistinguishable vegetatively. A few species have rather watery latex, a phenomenon which also occurs in a few Malpighiaceae.
Asteraceae - Tribe Liabeae climbers have milky latex but usually triangular or serrate leaves and/or winged petioles.
Clusiaceae - Clusiaceae climbers rarely have conspicuous latex; all have rather strongly coriaceous leaves with *Clusia*-like venation; and they tend to be hemiepiphytic.

C1d. Miscellaneous
Acanthaceae - *Mendoncia* and several genera which include clambering vines. Thickened, more or less

swollen nodes and rather fragile branchlets are typical of all acanth climbers. *Mendoncia* has a soft easily broken stem with an amazingly dissected cross section and often with corky bark; also, more or less membranaceous leaves, often with conspicuous simple trichomes.
Amaranthaceae - *Iresine,* characterized by acanth-like swollen nodes (sometimes shrunken above node when dried), by the evenly striate-ribbed branchlets and hollow twigs.
Bignoniaceae - A few compound-leaved genera (e.g., *Arrabidaea,* but usually also with some tendrillate 2-foliolate leaves) have simple-leaved species or variants which are 3-veined from base.
Combretaceae - The best vegetative character may be the usually hollow or secretory (discolored when dry) stem center of young branches and the tendency to have even older stems with 1 or 3 mucilage-oozing canals in extreme center. Fibrous bark and leaves typically with rigidly parallel often somewhat raised tertiary venation and brown petioles (sometimes with more or less exfoliating cortex) are typical; the leaves tend to be somewhat subopposite and a few species actually have alternate leaves (these species with stem spines); an interpetiolar line or ridge is never present. Pubescence (if present) of simple trichomes.
Gesneriaceae - Some climbing Gesneriaceae are subwoody hemiepiphytes growing appressed to a tree trunk. The leaves are usually membranaceous or succulent and are often either serrate or strongly anisophyllous (sometimes strikingly red-tipped or reddish below or with red apical "eyespots").
Hippocrateaceae - Leaves usually serrate or at least +/- serrulate; the only lowland liana family (except a few subwoody Gesneriaceae and aromatic sub-3-veined Asteraceae) with opposite serrate leaves. Also characterized by typical bent tendril-like lateral branches which twist around support (but sometimes occur in other families). Leaves of nonserrate genera are coriaceous and often dry with a characteristic grayish-olive color and are typically coriaceous, glabrous, and smooth-surfaced with immersed fine venation, this especially pronounced in entire-leaved genera. One genus has reddish or pinkish watery latex. When the tertiary venation is more or less parallel it tends to also be parallel to the secondary veins unlike Combretaceae. Stems of some genera strongly anomalous, typically with a few irregular reddish concentric circles interconnected by spokes.
Hydrangeaceae - *Hydrangea peruviana*, thick woody liana (sometimes hemiepiphytic), with entire or serrate leaves; petiolar bases connected across nodes to form conspicuous ochrea-like joint-sheath.
Nyctaginaceae - *Pisonia aculeata*, characterized by spines and leaves rather clustered, not clearly opposite leaves.
Rubiaceae - Vine genera have the typical interpetiolar Rubiaceae stipules but these are not always obvious in many liana taxa.
Verbenaceae - Two genera of climbers, *Petrea* with asperous leaves, and *Aegiphila.* Both often have squarish stems or twigs; the bark is usually smoothish and light colored; prominent subulate axillary bud scales usually present; the leaves are often membranaceous and/or noticeably simple-pubescent in *Aegiphila.* The only lianas other than *Petrea* with asperous opposite leaves are some Asteraceae (3-veined above base).

C2. Trees and shrubs, leaves simple, opposite or whorled
C2a. Stipules (or stipule scars!) present
Caryophyllaceae - *Drymaria cordata,* small herb with orbiculate to reiniform leaves.
Chloranthaceae - The more or less swollen node has a stipule-like sheath; the plants are easily distinguished by the strong Ranalean odor and the serrate leaves.
Malpighiaceae - The tree genera have intrapetiolar stipules in the axil between the petiole and twig (looking like ligular dorsal projection from petiole base), these differing from the few Rubiaceae with similar stipules by being fused (usually bifid in Rubiaceae); interpetiolar lines are also usually present. The main familial vegetative characteristic is the presence of malpighiaceous or T-shaped hairs, these almost always visible at least on the petioles and young twigs.
Portulacaeae - *Portulaca oleracea*, leaves clustered at the ends of the branches, stipules of minute ridges with slender whitish hairs.

Quiinaceae - The other main family with interpetiolar stipules, these always separate (usually fused in Rubiaceae) and often rather long and subfoliaceous; differs from Rubiaceae in the usually serrate or serrulate leaf margin (deeply incised in juveniles of few species).
Rhizophoraceae - *Rhizophora*, restricted to coastal mangroves, is utterly distinctive as the only mangrove with stilt roots; the other opposite-leaved genera are less striking, with *Cassipourea elliptica* in the leaves usually obscurely and remotely denticulate or serrate (unlike Rubiaceae) and the small, narrowly triangular, early-caducous stipule usually sericeous.
Rubiaceae - Interpetiolar stipules are present at least 99 % of the time; if stipules are not readily apparent check terminal bud to see if it is enclosed by caducous stipules. These should be in plane at right angle to two uppermost leaves and leave an interpetiolar line when they fall.
Vochysiaceae - *Vochysia,* rather thick-based stipules.

C2b. Latex
Apocynaceae (Some genera alternate-leaved and many are climbers) - Latex white and free-flowing (red in some species with alternate leaves), lacks the typical guttifer terminal bud (i.e., the petioles of terminal leaf pair not hollow-based with terminal bud growing from within cavity except in a few species with very profuse latex).
Clusiaceae (Guttiferae) - Very distinctive in typical terminal bud and colored latex; latex commonly yellow, cream, or orange, usually slowerflowing than in Apocynaceae. Terminal bud characteristically from between the hollowed-out leaf bases; typical terminal bud not developed only when latex strongly colored; latex white only when the leaf bases form conspicuous chamber. The latex may not be very obvious; try breaking a leaf and twig as well as the trunk slash; stilt roots are rather common.

C2c. Punctations
Clusiaceae - *Vismia*, usually by orange latex (or a moist orangish area just inside bark where latex should be and some have punctate leaves.
Lythraceae - *Adenaria* and *Lafoensia,* leaves thinner than in most Myrtaceae and with more ascending secondary veins and absence of collecting vein.
Melastomataceae - *Mouriri* completely lacks the ascending veins of other Melastomes, looks almost exactly like Myrtaceae and may have punctations; it differs from Myrtaceae in the somewhat jointed nodes.
Myrtaceae - Usually further characterized by more or less parallel and close-together secondary and tertiary venation ending in a submarginal vein. Many have smooth, white, peeling bark; some have aromatic leaves. The only possible confusion comes from the very few guttifers that have punctations (but also latex, unknown in Myrtaceae) or from some Myrtaceae that are not obviously punctate (also beware *Mouriri* [see below]).
Rhizophoraceae - *Rhizophora,* keyed out above on account of the terminal stipule, can have leaf punctations.
Rutaceae - *Ravenia rosea,* leaves with punctations, characterized by sheathing guttifer-like petiole bases in which the apical bud is protected; differs from Clusiaceae in lacking latex and the small glandular punctations.

C2d. Leaves 3(-7)-veined, with parallel cross veins more or less perpendicular to main veins
Melastomataceae - The very characteristic leaf venation makes this one of the easiest families to identify. *Strychnos* (few shrubby species) have 3-veined bases but lack the typical cross veins. Also beware of *Mouriri* which lacks the typical venation and looks almost exactly like Myrtaceae.

C2e. Odor of essential oils (only two Ranalean families are characterized by aromatic opposite leaves)
Asteraceae - Opposite-leaved Asteraceae are nearly always 3-veined *above* the base (unlike any of the above families) and have more pungent odors.
Chloranthaceae - *Hedyosmum,* very characteristic swollen nodes with stipule-like sheath.

Lauraceae - *Caryodaphnopsis burgeri,* most notably peculiar 3-veined.
Monimiaceae - *Siparuna,* usually puberulous or with lepidote scales; *Mollinedia* often lacks obvious odor but is characterized by very distinctive leaf with few very separated marginal teeth.
Verbenaceae and **Lamiaceae** - These two families have opposite leaves and are usually aromatic but the odor is clearer and sweeter (often somewhat minty) and less pungent than in the Ranales; aromatic members of these families usually have tetragonal branchlets unlike the Ranales. Strongly aromatic species of both families are mostly herbs or subshrubs.

C2f. Glands on twig at base of petiole
Vochysiaceae - Very characteristic glands from the fallen stipules or stipule bases characterize most Vochysiaceae (except *Vochysia*).

C2g. Serrate (serrulate) margins - The combination of opposite simple leaves and serrate margins is a rare one and found only in eight woody neotropical lowland families besides the Quiinaceae, Melastomataceae, and Chloranthaceae which are easily recognized (cf., above). A few additional herbaceous families (e.g., Gesneriaceae) have some viny (see above) or subwoody members with opposite serrate leaves.
Brunelliaceae - *Brunellia hygrotermica*, the laeflets are closely serrate and with prominulously reticulate venation below and numerous secondary veins making obtuse angle with midvein; strong interpetiolar line.
Chloranthaceae - *Hedyosmum,* as noted above unmistakable in the sheathing node and strong Ranalean odor.
Crassulaceae - *Kalanchoe pinnata,* herb with succulent and serrate leaves.
Elaeocarpaceae - *Sloanea* is characterized by a mixture of alternate and opposite leaves, even on the same branch, but the leaves are almost never uniformly opposite; also very distinctive in the flexed, but non-pulvinate petiole apex and strictly pinnate venation. The margins vary from quite entire to rather shallowly and coarsely subdentate; species with more serrate leaves tend to be more pubescent and some of the pubescent species have conspicuous persistent leafy stipules.
Hippocrateaceae - Mostly lianas but a few are trees and *Cheiloclinium* can be both a tree and have serrate leaves; it is characterized by tertiary venation more or less parallel and perpendicular to midvein.
Monimiaceae - *Mollinedia* has the teeth usually very widely separated (typically only one or two per side) and rather sharp; *Siparuna* also is frequently toothed but easy to recognize by the Ranalean odor.
Rhizophoraceae - *Cassipourea,* secondary veins few and brochidodromous strikingly far from margin; margin mostly remotely serrulate; caducous triangular terminal stipule pair leaving interpetiolar line.
Verbenaceae - Typically with more or less tetragonal stem and aromatic odor. Most woody Verbenaceae are entire but usually serrate-leaved *Callicarpa,* with conspicuously floccose indument on leaf undersides and twigs, is a small tree. Interpetiolar lines lacking.
Violaceae - *Rinorea* usually has opposite leaves and is one of the commonest understory-tree genera of many forests. Characterized by the nodes noticeably jointed, the typically short petioles, and the tendency to have a small acute stipule-enclosed apical bud immediately subtended by oblique, whitish-margined, interpetiolar ridge.

C2h. Miscellaneous opposite simple-leaved trees (lacking latex, essential oils, serrate margins)
Acanthaceae - *Bravaisia integerrima,* tree with very weak wood, although several genera include shrubby or small tree species. Most Acanthaceae characterized by conspicuously jointed nodes, swollen when fresh and contracted when dried. Most Acanthaceae have an obvious interpetiolar line. Except for the spiny-margined species, our acanths all have entire or merely serrulate, but never truly serrate, leaves. Cystoliths (look like short black lines) often present on upper leaf surface (also in Urticaceae).
Caprifoliaceae - *Viburnum,* leaves with few strongly ascending veins, puberulous at least below, sparsely and blunty serrulate or more or less bluntly few-toothed toward apex.
Clusiaceae - Occasionally lacks apparent latex like *Chrysochlamys,* but then with the typical hollowed-out Clusiaceae petiole bases that form a protective chamber for the developing bud; a few *Vismia*

species (which lack the typical hollowed petiole base) may not always show the orange latex but there is always a hint of orange color under the bark where the latex should be.
Elaeocarpaceae - *Sloanea* is characterized by a mixture of alternate and opposite leaves, even on same branch, almost never uniformly opposite; also very distinctive in the flexed but non-pulvinate petiole apex and strictly pinnate venation. Margins sometimes bluntly irregularly toothed (see also above).
Gesneriaceae - *Besleria,* sometimes small soft-wooded trees in the region (these usually with entire leaves smaller than in acanths); although several serrate-leaved taxa can be shrubs or treelets. Woody generiads mostly have noticeably membranaceous, long-petioled, often pubescent leaves and differ from most acanths in lacking cystoliths and interpetiolar lines.
Hippocrateaceae - Two genera are sometimes trees, one (*Cheiloclinium cognatum*) usually with finely crenate-serrate margins (also distinguished by conspicuously parallel tertiary venation more or less perpendicular to midvein), the other (*Salacia*) with large very thick-coriaceous entire leaves with immersed fine venation and drying a characteristic dull olive.
Loganiaceae - *Spigelia*, herb, the commonest of which has a terminal whorl of 4 leaves subtending the inflorescence.
Lythraceae - Usually with tetragonally angled young twigs and/or longitudinally exfoliating, often reddish twig bark in older branchlets; interpetiolar lines or ridges in *Lafoensia* (with close-together secondary veins prominulous above and below, each adjacent pair separated by a well-developed intersecondary).
Malpighiaceae - A few genera of shrubs and small trees lack obvious intrapetiolar stipules (as do the lianas); *Malpighia* and many species of *Bunchosia* have neither obvious stipules nor interpetiolar lines and are often characterized instead by pair of ocellar glands near base of lamina below. Like the species with stipules, they are also vegetatively characterized by the typical T-shaped trichomes at least on petioles and young branchlets.
Melastomataceae - *Mouriri* looks much more like Myrtaceae in vegetative condition than like typical 3-7-veined Melastomataceae. It differs from Myrtaceae, most notably, in the jointed nodes.
Myrtaceae - In some Myrtaceae the punctations are not very evident. They are usually characterized (as are the punctate-leaved taxa) by the straight often rather close-together secondary and intersecondary veins that end almost perpendicular to a well-developed submarginal collecting vein.
Nyctaginaceae - Rather nondescript and easy be confused with *Psychotria* or similar Rubiaceae, even when in flower or fruit, except for lacking stipules. The best sterile character is the reddish-brown pubescent terminal bud. The combination of somewhat succulent, often different sized and/or subopposite blackish-drying leaves and rufescent terminal bud immediately indicates Nyctaginaceae.
Oleaceae - *Chionanthus panamensis,* petioles usually somewhat thickened at base (cf. Sapindaceae petiolules), the leaf blade either pubescent or else rather narrow and oblong; twigs lacking interpetiolar lines, often with scattered round raised white lenticels. In flower unmistakable in only 2 anthers and very narrow petals.
Verbenaceae - Usually with tendency to tetragonal branchlets and raised petiole attachments; leaf base typically attenuate onto petiole and in many species (most *Citharexylum*) with an elongate gland in the laminar attenuation on either side of petiole apex. Leaves, at least of forest taxa, usually rather membranaceous and somewhat aromatic.

D. Leaves simple, alternate

This "grab bag" category constitutes by far the largest and generally the most nondescript group. In preceding groups any sterile woody plant should be identifiable to fanily; in this group there will be many plants which end up as family indets, unless they are fertile and technical characters are used.
In trees - Look for (in approximate order of importance): latex, odor of essential oils (Ranalean odor), conical terminal stipules (usually = Moraceae), 3-veined base (frequently suggests Malvales), punctations (and the undersurface texture which accompanies punctations in Myrsinaceae), serrate margins (uncommon in tropical forest species), strong bark (pull a leaf off a twig to see if a strip of bark comes

with it; also check the twig bark itself), petiole length and flexion, glands at tip of petiole (usually Euphorbiaceae or Flacourtiaceae), whether petioles are thickened at base or apex or of unequal lengths, spines. **In vines** - Look for (in approximate order of importance): tendrils (only ten families have true tendrils and the type of tendril is usually specific to a given family), glands on petiole (especially common in Passifloraceae), latex (a few Convolvulaceae lianas have latex).

D1. Trees, leaves simple, alternate

D1a. Latex

Look carefully, breaking the midveins or petioles of several leaves as well as young twigs; be sure to check both trunk and leaves since sometimes obvious latex is apparent only in one or the other; note whether the trunk slash has discrete latex droplets, how these are arranged, and what color the latex is.

Apocynaceae - Relatively few Apocynaceae have alternate leaves. Alternate-leaved Apocynaceae usually have white and milky free-flowing latex but this may be yellowish of *Aspidosperma spruceanum*. The species of *Aspidosperma* are extremely difficult to distinguish from Sapotaceae vegetatively.

Campanulaceae - Herbs with white and milky latex.

Cecropiaceae - *Pourouma bicolor*, leaves palmately lobed, conical terminal stipule and sap dark brown to black.

Chrysobalanaceae - Very rarely with a distinct trace of reddish latex, this not always visible in individual trees. Look for stipules on the young twigs or their scars; lack of Ranalean odor separates from Myristicaceae, the only potential confusion.

Euphorbiaceae - White to cream milky latex typically present, often caustic and harmful to eyes. *Pausandra* and some *Croton* have bright red latex; *Omphalea* (liana) has a cloudy latex that turns rather purplish. Note: Although latex is considered characteristic of Euphorbiaceae, *many* species have no latex at all. Serrate (or serrulatc) leaf margins, long petioles with flexed apices and often of different lengths, and a pair of glands near petiole apex are good indicators of Euphorbiaceae and are unique to this family among species with alternate simple leaves and latex.

Moraceae - Latex of many of the species a unique tan shade (exactly the color of "cafe con leche"), but many other species with milky white latex (usually only watery in *Trophis*), and in a few varying to tannish yellow (some *Naucleopsis*). Conical terminal stipules and the scar from these stipules usually obvious (and definitive for Moraceae). Leaf venation very characteristic with the brochidodromous lower secondary veins closer together and/or joining midvein at different angle from others.

Myristicaceae - Usually with red latex (only in trunk), this sometimes rather watery at first but almost always soon becoming obviously red, especially when drying. Very easy to distinguish from other families with occasional species or genera with red latex by the typical myristicaceous branching, lack of petiolar glands, and presence of Ranalean odor.

Olacaceae - Latex present only in *Heisteria* and *Minquartia* usually present only in leaves and petioles, white and milky (usually) to somewhat watery. Look for a slightly longish, distinctively curved (putatively U-shaped) and somewhat apically thickened petiole; leaves of most species of this family have a characteristic grayish or tannish-green color when dry. The margins are always entire.

Papaveraceae - *Bocconia frutescens,* unique among alternate-leaved taxa in its orange latex, also characterized by the large irregularly pinnatifidly lobed leaves.

Sapotaceae - Latex (in Neotropics) always white and milky; sometimes not very apparent but almost always visible in either trunk slash or leaves (if not both). Leaves typically with base of petiole enlarged (petiole more or less pop-bottle shaped) and with numerous parallel secondary veins. Some genera lack the typical petiole but these mostly have finely parallel tertiary and secondary veins (the extremes with leaves similar to *Clusia*); margins always entire and latex of slash usually emerging in discrete droplets. Never with conical terminal stipule or glands on petiole.

D1b. Conical terminal stipules

These are most distinctive of Moraceae. However, look carefully; the stipule is not always obvious and

in *Trophis* can only be considered present by stretching the imagination; also note that other families may have young leaves which are superflicially somewhat similar to the Moraceae stipules.
Magnoliaceae - *Talauma* has a Moraceae-like terminal stipule that falls to leave a conspicuous nodal ring, but is aromatic and nonlactiferous.
Moraceae - The combination of milky latex and conical terminal stipule (that falls to leave a distinct scar) is definitive for and almost universal in Moraceae. The exception is *Trophis* where neither latex nor stipule may be discernible, where recognizable as Moraceae only by the typical leaf venation.
Polygonaceae - *Coccoloba* and *Triplaris* have conical terminal stipules but these rupture to form an ochrea rather than falling cleanly as in Moraceae.
Theaceae and **Myrsinaceae** - A number of genera of Theaceae and Myrsinaceae and related families have young leaves rolled at branch apex and are superficially similar to the conical terminal stipule of Moraceae.

D1c. Odor of essential oils (Ranalean odor)
Most Ranalean plants have alternate simple leaves and most have more or less conspicuous rank or turpentiny odors. As a group these are easy, to recognize by their "primitive " odor and many, of these families are very common and important in neotropical forests. The beginner almost always complains of either not having an adequately developed sense of smell or of being unable to discriminate nuances of different vegetative odors. Don't despair - with a little bit of practice you really can (usually) pick out the Ranalean families by the combination of simple alternate leaves and their odor. Also, an important warning: There is a common epiphyllous leafy liverwort with a rather licorice-like smell. Learn that anise odor well and eliminate it from consideration. Frequently a twig split longitudinally will give off a more easily, detectable odor than the leaves themselves. In some Lauraceae, with little or no leaf odor, the bark slash is aromatic; in others the reverse may, be true.

Families with Ranalean odors - All with completely entire margins except for a very few somewhat lobed-leaved (but never serrate) species:

(a) Piperaceae - Swollen nodes with shoot proceeding from leaf axil. Distinctive spicate inflorescence; odor tends to be peppery; leaf base often strikingly asymmetrical. Usually shrubs; when trees (usually small), typically with prominent stilt roots.

(b) Magnoliaceae - *Talauma gloriensis*, complete rings around twig at nodes from the distinctive caducous stipule that completely covers terminal bud (like Moraceae), the petiole is conspicuously grooved above.

(c) Hernandiaceae - Three-veined leaves are unique in aromatic Ranalean taxa except for a very few atypical Lauraceae. Also distinctive among Ranales in long often somewhat different-length petioles. The vegetative odor is ranker than in most Lauraceae in which 3-veined taxa also differ in shorter petioles. Differ from similar Araliaceae in lacking conspicuously smaller short-petioled leaves and in basal lateral vein pair curving upward rather than being straight or curving outward. This leaves three very large and very important Ranalean families

(d) Annonaceae, **Myristicaceae**, and **Lauraceae** - which are easy to tell apart when fertile, but can be confusing when sterile.
Typically, **Myristicaceae** have relatively long oblong leaves with dull surfaces, short petioles, and many close-together parallel secondary veins. Typically **Lauraceae** have short elliptic leaves with glossy shiny surfaces, relatively long petioles, and relatively glossy shiny surfaces, relatively long petioles, and relatively few, often strongly ascending and not strictly parallel secondary veins. Although there is little room for confusion between Myristicaceae and Lauraceae, **Annonaceae** are intermediate and overlap with both vegetatively. Both Myristicaceae and Annonaceae (but not Lauraceae) are characterized by myristicaceous branching with the lateral branches at right angles to the trunk and the evenly spaced leaves 2-ranked along these or along their lateral branches; in Myristicaceae, especially, the lateral branches tend to be clustered and appear to have an almost

whorled arrangement ("myristicaceous branching"). Lauraceae never have such a phyllotaxy and their leaves are often irregularly spaced along the branches with a definite clustering towards the branchlet apex. Very many Lauraceae are distinguished by the way the leaf blade gradually merges with the petiole apex, typically with at least the hint of an involution of the margin and sometimes with a distinctly involute auricle on each side. Lauraceae leaves typically have shinier surfaces than do the other two families, and the pubescence, when present is usually sericeous with appressed simple trichomes or softly rufescent. Myristicaceae trichomes are either stellate or 2-branched (T-shaped), frequently very conspicuous, and usually rufescent (to whitish on the leaf undersurface). Annonaceae, as usual, are intermediate but stellate (or lepidote) trichomes are rare (mostly *Duguetia*) and sericeous pubescence is common only in *Xylopia*. Most Annonaceae have strong bark ("cargadero" = useful for tying cargo) a feature not found in Myristicaceae or Lauraceae. Lauraceae twigs are typically green while those of Myristicaceae are brownish; Annonaceae commonly have either green or brown twigs; all the green-twigged Annonaceae have strong bark but only some of the brown-twigged ones. The odor of Lauraceae is usually either clear, spicy, and almost sweetish or foetid and unpleasant; that of Annonaceae tends to be slightly rank; that of Myristicaceae is usually more pungently turpentiny and typically not very strong.

(e) Canellaceae – *Pleodendron macranthum,* highly aromatic elliptic leaves

At least five other taxa with simple alternate leaves have odors that might be confused with the Ranalean group: Most simple-leaved species of Anacardiaceae (*Mangifera* and *Anacardium*) have a more strongly turpentiny odor, as do the few simple-leaved species of Burseraceae. The latter also have prominently flexed petiole apices indicating their compound-leaved affinities. Araliaceae have aromatic leaves and some are reminiscent of some Lauraceae; they differ prominently in their varying petiole lengths. *Dendrobangia* (Icacinaceae) has a more medicinal odor than typical of Ranalean families and is also characterized by a grooved petiole, appressed-stellate indumentum, and black-drying color. Alternate-leaved weedy Asteraceae are mostly not strongly aromatic.

D1d. Leaves palmately 3(-9)-veined at base (and alternate and simple)

The majority of taxa with palmate basal veins (here referred to as "3-veined") belong to one of two quite unrelated main groups: Malvales (Malvaceae, Tiliaceae, Bombacaceae, Elaeocarpaceae, Sterculiaceae) or Hamamelidae (especially Ulmaceae, Urticaceae). The Malvalean woody taxa have petioles with a distinctive swollen apical pulvinus; the Hamamelidae and other three-veined families do not.

D1d(1). Petioles with apical pulvinar thickening (or with leafy stipules) (= Malvales)

Perhaps the main palmately veined group of plants, as an order also characterized by strong barkfibers, by stellate (or lepidote) trichomes and the very distinctive petiole apex which is more or less swollen and pulvinar. Only Elaeocarpaceae and most Malvaceae lack the typical pulvinus, the fomer distinctive in their foliaceous stipules, the latter in their mostly herbaceous habit. Bixa is not usually included in Malvales but has a similar, though shorter, pulvinus. The bark slashes of tree Malvales all tend to have a mucilaginous secretion which can be felt when fresh or seen as globules after a few hours. Although recognition to order on vegetative characters is easy, separation of the individual Malvalean families without flowers is frequently problematic. When sterile, Tiliaceae, Sterculiaceae, and simple-leaved Bombacaceae are reliably differentiated only by first knowing the genera. Bombacaceae are all trees and the simple-leaved ones are entire (very weakly sublobed in *Ochroma*); Malvaceae are mostly herbs and subshrubs, with the woody species in the region serrate-margined; Tiliaceae (mostly serrate) and Sterculiaceae (trees mostly entire except *Guazuma*) include both large trees and small weedy shrubs.

Bixaceae - *Bixa*, closer to Flacourtiaceae than Malvales, has a distinct apical pulvinus similar to that of the Malvales, but shorter. It is also characterized by scattered, reddish, peltate scales below (but lacks the typical Malvalean stellate trichomes).

Bombacaceae - The relatively few simple-leaved genera, exclusively large trees, are best characterized by fused filaments, a feature shared in Malvales only with Malvaceae, which differ in being mostly

herbs and shrubs, and with some Sterculiaceae. The only definitive difference from Malvaceae is the absence of spinulose pollen, although the stamen tube often differs from Malvaceae in being fused only at base.

Elaeocarpaceae - The three genera with 3-veined leaves are distinctive in the order in persistent foliaceous stipules and in lacking the typical Malvalean pulvinus.

Malvaceae - Essentially the herbaceous counterpart of Bombacaceae with which they share the distinctive feature of fused filaments. The most definitive difference is spinulose pollen, a feature never found in Bombacaceae. Mostly differing from Sterculiaceae and Tiliaceae in combination of more broadly ovate leaves with serrate or lobed margins and from most other Malvales in less developed pulvinus. Flowers distinctive by numerous stamens with filaments fused around style into staminal column and/or an epicalyx.

Sterculiaceae - Tree genera differ from most Tiliaceae in being entire-leaved (or palmately lobed or compound), except *Guazuma* which has leaves more jaggedly serrate than in any Tiliaceae. Shrub Sterculiaceae (i.e., most Malvalean shrubs) have serrate leaves (see Tiliaceae above for distinguishing characters). The flowers can have fused or distinct filaments, the former differing from Malvaceae and most Bombacaceae in having 2-celled anthers.

Tiliaceae - Most serrate Malvalean trees are Tiliaceae (see also Sterculiaceae *Guazuma*); entire-leaved Tiliaceae (except *Mortoniodendron*) have the lower leaf surface canescent, a character combination not found in simple-leaved Bombacaceae and only in a few *Theobroma* species in Sterculiaceae (from which entire-leaved *Apeiba* species can be differentiated by longer more slender petioles). Shrub genera *Corchorus* and *Triumfetta*, respectively, differ from Sterculiaceae shrubs by more crenate marginal serrations and a tendency to 3-lobed leaves. Flowers characterized by multiple stamens arranged in single whorl and with free filaments.

D1d(2). Petioles lacking apical pulvinus

Araliaceae - Characterized by leaves with rank odor and of dramatically different sizes and with petioles of different length. Three-veined species of *Dendropanax* differ from *Hernandia* in +/- wrinkled usually tannish-drying twig bark and main lateral vein pair straight or curving slightly outward rather than upward. *Oreopanax* usually either epiphytic or with leaves palmately lobed and conspicuously tannish-pubescent below.

Caricaceae - Some milky latex usually present.

Cochlospermaceae – *Cochlospermum vitifolium*, palmately lobed with serrate margins, a combination unique among area trees.

Euphorbiaceae - Conspicuously 3-veined Euphorbiaceae mostly have glands at apex of petiole (sometimes also with latex, see above) or at base of lamina (usually in axils of basal vein pair below) or have stellate or peltate trichomes (*Croton*) or are deeply palmately lobed.

Flacourtiaceae - *Lunania mexicana*, have a very characteristic pair of glands at petiole apex (euphorbs with similar glands differ in having latex or leaves larger and more broadly ovate).

Hernandiaceae - Leaves long-petioled and entire, usually rank-smelling (but the odor not clearly Ranalean). Very similar to Araliaceae.

Rhamnaceae - *Zizyphus chloroxylon*, conspicuously 3-veined leaves.

Ulmaceae - Most taxa with pinnate venation, but *Trema* and *Celtis* have 3-veined alternate leaves, the petioles always of equal lengths; the common *Trema* has asperous leaves with fine close-together teeth; *Celtis* is often spiny and has leaves with coarse rather irregular teeth, but the commonest erect species has entire leaves recognizable by the noticeably asymmetric base that characterizes most Ulmaceae.

Urticaceae - Close to Ulmaceae but leaves usually with cystoliths in upper surface and/or with stinging hairs, in tree taxa always serrate.

D1e. Strong bark

Pull off a leaf and see if a long strip of bark comes off with it. All neotropical species with strong bark

fibers have alternate, mostly simple, leaves, and this is a very useful character for several families, some of them (e.g., Thymelaeaceae) otherwise nondescript.
Annonaceae - Keyed out above under plants with primitive odors; if odor not apparent, can be identified by the strong, often greenish, twig bark, entire leaf margins, and vertical fiber lines in a very shallow bark slash.
Lecythidaceae - Differs from other strong-barked families in bark of trunk peeling off in layers rather than as single unit. Faint but characteristic "huasca" odor. Leaves nearly always with serrate or serrulate margins and distinctive secondary (and usually intersecondary) veins that turn up and fade out at margins.
Malvales and **Urticales** - The Malvalean and Urticalean families, keyed out above on account of 3-veined leaves, are also characterized by strong bark fibers, the entire trunk bark peeling off when pulled (as opposed to peeling in layers in Lecythidaceae).
Thymelaeaceae - Very distinctive in the thick homogeneous bark that strips as a unit from entire twig; the only family with thick strong non-layered homogeneous bark.

D1f. Unequal petioles
Araliaceae - Leaves with rank vegetative aroma.
Capparidaceae - Petioles unequal only when leaves terminally clustered; leaves more oblong and/or petioles more wiry than in other taxa with unequal petioles.
Euphorbiaceae - The combination of serrate leaf margins with conspicuously different-length petioles having flexed apices is definitive for Euphorbiaceae; nonserrate *Sagotia racemosa* with unequal petioles also have the flexed petiole apex.
Sterculiaceae – *Sterculia,* although *Sterculia* petioles are conspicuously unequal, the genus is keyed out above on account of the Malvalean pulvinus.

D1g. Petiole glands present
Chrysobalanaceae - Some Chrysobalanaceae species have a pair of lateral glands at extreme apex of petiole or at extreme base of leaf blade below; they can usually be recognized by small inconspicuous stipules on young twigs.
Combretaceae - Most tree Combretaceae (except most *Terminalia*) have a distinctive pair of glands on upper petiole surface, also characterized by leaves clustered at tips of ascending short-shoot branchlets or branch tips.
Euphorbiaceae - All taxa with pair of glands near petiole apex have latex and/or are conspicuously 3-veined (see above).
Flacourtiaceae - The genera of Flacourtiaceae with glands at apex of petiole have conspicuously 3-veined leaves (see above).
Rosaceae - *Prunus subcorymbosa*, leaves have distinctive large ocellate glands near base of lamina below and a strong odor.

D1h. Leaves with serrate (or serrulate) margins
Actinidiaceae - Numerous straight parallel secondary veins; surface frequently rough-pubescent; petiole base not enlarged, unlike Sabiaceae; trichomes simple, unlike *Clethra.*
Asteraceae - Rather few arborescent Asteraceae have alternate serrate leaves, *Baccharis* (usually shrubby and characterized by resinous coriaceous leaves), *Tessaria* (with shallowly remotely serrate, narrow, gray leaves), and *Verbesina* (typically deeply pinnately lobed) being the most frequently encountered. Like most other Asteraceae these can be recognized by their rather pungent aroma.
Boraginaceae - Although most tree Boraginaceae have entire leaves, a few arborescent *Cordia* and *Tournefortia* species have serrate or serrulate margins.
Celastraceae - Twig usually irregularly angled from decurrent petiole base and often zigzag and/or greenish when fresh.
Clethraceae - *Clethra mexicana*, distinctive in the densely tannish-stellate tomentum of the leaf under-

surface, remotely serrate or serrulate, sometimes only toward apex.
Elaeocarpaceae - Some *Sloanea* spp. have remotely serrate or serrulate margins; they are recognizable by the flexed petiole apex and tendency to have both opposite and alternate leaves.
Euphorbiaceae - Only a few arborescent euphorbs have pinnately veined leaves with eglandular equal petioles, lack latex, and have serrate margins. These very nondescript taxa include *Alchornea, Richeria* (the margin only slightly crenulate, leaves cuneate and petiole base slightly enlarged), and *Acidoton*, a shrub.
Fabaceae - The vanishingly few truly simple-leaved legume genera are generally characterized by olive-drying leaves with serrulate margins.
Fagaceae - Characterized by clustered terminal buds with scales; round white lenticels. Inconspicuously serrate or serrulate, cuneate to short petiole.
Flacourtiaceae - Many serrate (-serrulate)-leaved pinnate-veined Flacourtiaceae are characterized by very small pellucid punctations; stipules are always present but usuall early caducous and leaving inconspicuous scar. Slightly zigzag twigs are another frequent character. *Xylosma* lacks punctations but is frequently spiny.
Humiriaceae - Most genera (except entire *Vantanea barbourii*) have crenate margins and festooned-brochidodromous venation. Young leaves at shoot apex rolled into narrow cone, inner bark red or dark red.
Icacinaceae - *Calatola costaricensis,* have groove on top of the often somewhat twisted petiole and black-drying leaves.
Lecythidaceae - Nearly all Lecythidaceae (keyed out above on account of their strong bark) have serrate or serrulate margins.
Myrsinaceae - A very few mostly shrubby Myrsinaceae have finely serrate leaf margins; like other members of the family they are characterized by the typical, usually nonpellucid punctations (see below). Serrate Myrsinaceae can be differentiated from similarly punctate Theaceae (*Ternstroemia*) by the more elongate punctations that are pellucid in bud.
Ochnaceae - Always serrate or serrulate, usually with caducous stipules leaving annular scar; three leaf types - one with secondary veins marginally curved and becoming almost submarginal (with several of these marginal extensions paralleling each other at a given point), or with close, rigidly parallel, secondary veins and finely parallel tertiary veins perpendicular to secondaries.
Sabiaceae - Most *Meliosma* species have conspicuously serrate, or at least serrulate margins, usually with numerous, fairly straight, secondary veins. Similar to *Saurauia,* but more coriaceous and the petiole base thickened and often woody; trichomes simple unlike *Clethra.*
Solanaceae - Leaves of many *Solanum* species distinctively irregularly, broadly, and shallowly toothed, usually also with stellate or dendroid trichomes and/or prickles.
Symplocaceae - *Symplocos limoncillo*, characterized by festooned-brochidodromous venation, the leaves usually loosely and rather irregularly reticulate below with trichoms.
Theaceae - *Gordonia, Pelliciera* and *Ternstroemia* have more or less serrate leaves (although this can vary even within a species), at least inconspicuously near apex. Secondary venation often immersed and non-apparent. *Ternstroemia* (usually only inconspicuously serrate near apex) has well-developed petiole but is distinctively punctate with blackish glands.
Theophrastaceae - *Clavija,* consisting mostly of pachycaul treelets, always has narrowly obovate to oblanceolate leaves, typically with strongly spiny-serrate margins; when not obviously serrate-margined the margin usually distinctively cartilaginous or the plant reduced to a small erect subshrub.
Violaceae - Very nondescript and often impossible to differentiate from Flacourtiaceae vegetatively. Stipules present, but usually caducous; leaves usually membranaceous; *Gloeospermum* leaves often dry light green with a paler central area.

D1i. Thickened and/or flexed petiole apices
Elaeocarpaceae - *Sloanea,* usually recognizable by the highly unusual mixture of opposite and alternate leaves, most species also distinctive in the large, unusually thin buttresses; a few large-leaved

species have distinctive leafy stipules.
Euphorbiaceae - Many Euphorbiaceae have flexed petiole apices but most are 3-veined and/or serrate and/or have latex and/or petiolar glands. A few entire-margined non-lactiferous Euphorbiaceae that lack petiolar glands have thickened or flexed petioles; taxa that do not always have conspicuously different-lengthed petioles include *Sagotia*.
Flacourtiaceae - A few flacourts (*Carpotroche, Mayna*) have flexed petiole apices and +/- entire margins; their petioles tend to be shorter and/or less variable in length than the above euphorbs.

D1j. Punctations
Flacourtiaceae - Some genera (*Casearia, Xylosma*) have pellucid-punctate, sometimes with almost linear punctations, but the majority of their species serrate-margined. Usually have stipules or stipule scars, unlike Myrsinaceae which also differ in usually dark non-pellucid punctations.
Myrsinaceae - Punctations usually non-pellucid (except in bud), usually elongate, and often reddish or blackish; associated with distinctive pale green "matte" undersurface; stipules completely absent unlike Flacourtiaceae. Trichomes, when present, nearly always +/- branched, unlike other punctate taxa.
Rutaceae - Only a few (mostly non-aromatic) genera have simple leaves, these almost always narrowly obovate to oblanceolate with cuneate bases and clustered at branch apices or at apex of pachycaul treelet.
Theaceae - Some punctate Theaceae (*Ternstroemia*) have entire leaves; these differ from Myrsinaceae in having rounder punctations, which are blackish even in juvenile leaves and buds.

D1k. Stipules present
Chrysobalanaceae - The stipules are typically small and inconspicuous and are usually visible only on young twigs. Many Chrysobalanaceae have very characteristic leaves with close-together, rigidly parallel, secondary veins and a whitish undersurface, but *Hirtella* and some *Licania* species are very nondescript. The whole family is usually recognizable by having red inner bark with a gritty-sandy texture.
Dichapetalaceae – *Dichapetalum* has conspicuous stipules, sometimes with a very unusual serrate or fimbriate margin.
Erythroxylaceae – *Erythroxylon,* when present, faint venation lines paralleling the midvein below are very typical; stipules triangular and brownish or tannish, often longitudinally striate.
Euphorbiaceae - Several entire-margined nondescript euphorb genera have distinctive +/- caducous stipules (e.g., *Margaritaria* with reddish slightly zigzag puberulous twigs and conspicuous stipule scar, *Sagotia* with terminal stipule like Moraceae falling to leave conspicuous scar).
Flacourtiaceae - *Casearia* and *Lacistema, Lacistema* have leaves usually subentire with faint tendency to marginal serrulation; characterized by stipule caducous to leave conspicuous scar, with both stipule and young twigs tending to dry blackish, contrasting with the whitish stipule scar and a very few nondescript *Casearia* species are both entire and lack punctations; stipule scars are about their only useful character.
Portulacaeae - *Portulaca oleracea*, leaves clustered at the ends of the branches, stipules of minute ridges with slender whitish hairs
Rosaceae - *Prunus subcorymbosa,* entire-leaved, have early-caducous inconspicuous stipules; they are usually recognizable by the pair of large dark-drying glandular ocelli near base of lamina below.

D1l. Lepidote scales and/or stellate trichomes
Annonaceae - *Duguetia* and some *Annona* species have stellate trichomes or lepidote scales but should key out above under primitive odor.
Asteraceae - A few arborescent Asteraceae have stellate trichomes, usually distinctive in a blackish inner bark layer.
Capparidaceae - *Capparis,* conspicuous tannish scales in many species including some that have uniform petioles; a characteristic patelliform gland just above the leaf axil on young twigs is frequently apparent.
Clethraceae - *Clethra mexicana*, distinctive in the densely white-stellate leaf undersurface, but most

species +/- serrate or serrulate (see above). Its margin entire differs from area *Styrax* in longer, laxer arms on twig trichomes, and in lacking the scattered rufescent trichomes of the more strongly reticulate leaf undersurface.
Euphorbiaceae - Pinnate-veined euphorbs characterized by lepidote scales and/or stellate trichomes include *Hieronyma, Pera,* some *Croton.*
Fagaceae - Margins usually +/- serrulate; when entire the mostly stellate trichomes a useful indicator.
Icacinaceae – *Dendrobangia,* leaves characteristically membranaceous and black-drying.
Malvales - Most Malvales have stellate trichomes or scales but are keyed out above by the pulvinar petiole apex.
Solanaceae - Several genera (especially many *Solanum* species) have stellate to variously dendroid trichomes; the family is usually recognizable by the rank tomato-like odor of crushed leaves; and many *Solanum* species are spiny.
Styracaceae - Characterized by densely white-stellate or lepidote leaf undersurface, usually also rufescent with reddish-stellate hairs, especially on twigs; similar densely white-below Solanaceae lack the rufous-stellate twig pubescence and are usually spiny.

D1m. Leaves parallel-veined or lacking secondary veins
Gramineae - Bamboos have parallel-veined leaves, the plants distinctive in the segmented often hollow stems with characteristic swollen nodes.
Podocarpaceae - Leaves very coriaceous, linear-oblong with a strong midvein, completely lacking secondary veins or with a few faint longitudinal veins paralleling midvein.
Zingiberales - Cannaceae, Costaceae, Heliconiaceae, Marantaceae, Musaceae, Zingiberaceae; like most monocots parallel-veined leaves and often very big leaves.

D1n. Parallel tertiary venation
Lecythidaceae - Strong bark (the only combination of strong bark and parallel tertiary venation). Brochidodromous genera lacking the family's typical upcurved veins and serrate margins have tertiary veins closely parallel and perpendicular to midvein.
Myristicaceae - *Compsoneura sprucei,* the tertiary veins are conspicuously finely parallel and perpendicular to the midvein and the primitive odor is not always apparent.
Olacaceae - Most genera have finely parallel tertiary venation +/-perpendicular to the midvein or secondary veins; usually there is a slight bit of latex in petiole.
Sapotaceae - Many Sapotaceae have conspicuously parallel tertiary venation or *Clusia*-type venation. They have latex (and are keyed out above), but the latex sometimes is not very conspicuous, especially during periods of water stress.

D1o. Spines or spine-tipped leaves
Euphorbiaceae - The family that can have virtually any characeristic has only a few spiny members, including spiny-trunked *Hura* (with latex).
Flacourtiaceae - *Casearia* and *Xylosma* sometimes have branchspines, the latter sometimes with very striking branched spines covering trunk.
Moraceae - The only spiny Moraceae in the region are *Maclura* and *Poulsenia*, both with milky latex (see above).
Nyctaginaceae - *Pisonia* actually has opposite leaves but in spiny taxa they are mostly clustered on short shoots and the disposition is not evident.
Olacaceae - *Ximenia americana*, has branch spines and leaves clustered at lateral branch tips, drying olive to blackish, usually retuse at apex.
Rhamnaceae - *Ziziphus chloroxylon,* densely branched, spiny branches.
Solanaceae - The small thick-based spines that characterize many species of *Solanum* are actually prickles and may be present on leaves as well as on twigs and branches; spiny members of the family have stellate trichomes (and are keyed out above), in addition usually recognizable by the rank tomato-

like odor of crushed leaves.
Urticaceae - The few spiny-trunked Urticaceae have serrate or incised leaf margins.

D1p. None of the above
Amaranthaceae - *Pleuropetalum pleiogynum,* black-drying, membranaceous, narrowly elliptic, long-petiolate leaves.
Anacardiaceae - *Anacardium* and *Mangifera*, aromatic leaves.
Asteraceae - Tree composites with alternate entire leaves mostly have the leaves +/- conspicuously whitish- or grayish-pubescent below. Some (especially Vernonieae) have a distinctive blackish layer in inner bark.
Bignoniaceae - *Crescentia* and *Amphitecna* are totally unbignoniaceous vegetatively in simple alternate leaves. *Crescentia* has the narrowly obovate leaves in characteristic fascicles alternating along thick branches; *Amphitecna* has elliptic to obovate coriaceous leaves, poorly demarcated from woody based petioles, drying grayish with pale secondary veins below.
Boraginaceae - Leaves and stem often stiff-pubescent and asperous. Most tree *Cordia* species have distinctive node with a leaf arising from each branch dichotomy and held parallel to the dichotomy.
Capparidaceae - *Capparis* that lack different-length petioles have the leaves 2-ranked, usually with a raised patelliform axillary gland.
Celastraceae - A few lowland *Maytenus* species have entire leaves, these mostly drying olive with paler inconspicuous secondary veins.
Chrysobalanaceae - Although small stipules are present, they are usually inconspicuous and early-caducous; even if stipules not apparent, recognizable by the gritty-textured, red inner bark.
Combretaceae - Leaves usually apically clustered; except for *Terminalia,* usually with petiole glands. Alternate-leaved taxa typically with leaves clustered and pagoda branching form or bark very smooth and white.
Dichapetalaceae - Tree Dichapetalaceae usually have serrate stipules (*Dichapetalum*) or uniformly terete tannish-puberulous thickish petiole, usually in part with distinctive scars from fallen petiole-borne inflorescence.
Ebenaceae - Tropical species with trunk slash characterized by black bark ring; leaves typically with large darkish glands on lower surface usually scattered along (but removed from) midvein.
Euphorbiaceae - A notoriously heterogeneous and difficult to recognize family. "Left-over" genera include *Drypetes* (asymmetric base and prominulous tertiary venation), *Margaritaria* (caducous stipules and a characteristic twig apex), and *Phyllanthus* (sometimes resembling a compound-leaved legume).
Fabaceae - Rare simple-leaved legumes have the entire petiole cylindrically pulvinate (cf., pulvinulus of leaflets of compound leaves). They usually have asymmetric bases, frequently serrulate margins, and dry a distinctive light olive-green; *Lecointea* are often remotely serrate. Unifoliolate legumes (e.g., some *Swartzia*) are more common and easy to recognize by the apical and basal pulvinular area of the 2-parted "petiole" with typical cylindrical pulvinus of the single leaflet forming its apical part.
Flacourtiaceae - While Flacourtiaceae have stipules, these are often not very evident; a few *Casearia* species with non-obvious stipules have entire margins and lack punctations.
Humiriaceae - *Vantanea barbourii,* has coriaceous, +/- obovate leaves, usually drying a dark reddish color; young leaves rolled at shoot apex.
Icacinaceae - Groove on top of the often twisted petiole; *Calatola,* usually with at least a few serrations, lack conspicuously parallel tertiary venation and blackdrying.
Moraceae - *Trophis* usually lacks conical stipule and the latex is watery, not milky, but the leaf venation is typically moraceous.
Olacaceae - Usually characterized by curved (sometimes almost U-shaped) green petiole, slightly thicker toward apex; most taxa have slight latex in petiole and/or finely parallel tertiary venation.
Onagraceae - A few *Ludwigia* species are subarborescent; they are restricted to swampy areas and have exfoliating reddish bark.

Polygonaceae - The whole family very easy to recognize by presence of an ochrea, an irregular broken sleeve of stipular tissue that covers the node above petiole base.
Sabiaceae - A few *Meliosma* species are essentially entire; like their more numerous serrate-leaved congeners they are recognizable by the thickened sometimes subwoody petiole base (cf., Sapotaceae).
Solanaceae - Some species of *Cestrum* and *Solanum* are glabrous or have simple trichomes and are very nondescript; the best vegetative character is the rank tomato-like vegetative odor; some species of *Solanum* also distinctive in the peculiar nodes, apparently with very small leaves opposite the regular ones.

D2. Lianas, leaves simple, alternate, with tendrils
In the region seven families include taxa with alternate simple leaves and tendrils. They are very easy to distinguish by the form and position of the tendril - axillary in Passifloraceae, arising at 90° angle from petiole in Cucurbitaceae, arising opposite petiole in Vitaceae, arising in pairs from lower part of petiole in Smilacaceae, coiled in one plane like a butterfly's tongue in Rhamnaceae. (*Bauhinia* can have tendrils similar to those of Rhamnaceae but apparently not in the few nonbifid-leaved species).
Cucurbitaceae - Tendril arising at 90° angle from petiole base, often bifurcate; also distinctive in palmate-veined (usually palmately lobed) leaves usually with remote teeth on the margin; stems soft and variously (often complexly) anomalous in cross section.
Fabaceae - Several compound-leaved legume vines have tendrils, and one scandent tendrillate genus, *Bauhinia* has incompletely 2-foliolate leaves that are sometimes barely split only at extreme apex and rarely not at all. The tendrils of *Bauhinia* are rather woody and hooklike and not strongly twining, but may not occur in non-bifid species.
Passifloraceae - Tendril axillary; also the leaves distinctive in having either striking petiolar glands or large glands in the axils of basal vein pair, or both, and in many species in their peculiar shapes, often broader than long. Stems of lianas usually woody, often somewhat irregularly lobed or with an inconspicuous 4-5-armed cross in cross section.
Rhamnaceae - The main scandent genus (*Gouania*) has a distinctive tendril coiled in one plane exactly like a butterfly's tongue, this usually terminal on young branch; leaves with rather straight, parallel, strongly ascending secondary veins and tertiary veins perpendicular to the secondaries and parallel to each other, with gland pair at base of lamina above and/or serrate.
Smilacaceae - Unique tendrils arising in pair from near base of petiole, actually representing modified stipules partially fused to base of petiole; leaves entire, palmately veined (with the lateral veins continuing into leaf apex: actually a monocot despite the net venation); stems smooth green and spiny (could be confused only with *Dioscorea* with usually thicker spines).
Vitaceae - Tendril arising opposite from petiole; also recognizable by the nodes distinctively jointed and or swollen and the leaves palmately veined or 3-5-foliolate; stems soft and flexible, with large vessels and characteristically differentiated outer layer but no obvious anomalous structure; often with papery reddish bark and/or pendent stem-like aerial roots.

D3. Lianas, leaves simple, alternate, without tendrils
Note: the young branch apex can be coiling and tendril-like in a few taxa (e.g., *Omphalea*). Be aware that the categories below are not mutually exclusive.

D3a. Parallel veins - (All veins parallel to midvein or with finely parallel secondary and tertiary venation more or less perpendicular to midvein (cf. *Clusia*-venation).
Araceae - Climbing Araceae are mostly parallel-veined (unlike mostly non-scandent *Anthurium*) with the venation arising +/- perpendicular to the strong midvein; only *Heteropsis* is truly woody, the others more or less succulent.
Gramineae - Climbing bamboos are easily recognized by their parallel leaf venation and the distinctive segmented stems with characteristic swollen nodes.
Other Monocots - Commelinaceae, Liliaceae (s.str.), Amaryllidaceae, and Orchidaceae all have a few scandent herbaceous genera or species with strictly parallel-veined leaves.

D3b. Serrate leaves

Except for Dilleniaceae, our climbers with serrate alternate leaves are all habitually atypical genera (or species) of predominantly erect families.

Asteraceae - Most are erect and most composite climbers are opposite-leaved and/or entire-leaved, but a scandent species of Senecioncae (*Pseudogynoxys cummingii*) mostly with young stems hollow, can have alternate, +/- remotely serrate leaves.

Boraginaceae - Most Boraginaceae are erect and most of the climbers are entire-leaved species of *Tournefortia.* Only *Cordia spinescens* is a serrate-leaved, more or less clambering liana, distinctive in the inflorescence base fused to the base of subtending leaves with the remnants of this structure forming a blunt, subwoody spine on older stems.

Dilleniaceae - Characterized by the combination of usually sharply serrate margins (at least when young), and usually asperous surface. (*Doliocarpus* is non-asperous and can also be subentire). The leaf shape is also distinctive with strictly pinnate secondary veins and the leaf base typically narrowly cuneate, at least when young. Bark usually distinctive: papery peeling and more or less reddish; stem uniformly woody, the section always showing concentric growth rings crossed by paler rays radiating out from center.

Euphorbiaceae - The family is mostly erect but we have three genera that are lianas (but with entire leaves) and two that are +/herbaceous vines (sometimes with urticating hairs) with a few erect genera also having a scandent species or two. All euphorb climbers in the region have the leaves 3-veined (rarely 3-foliolate or deeply 3-lobed in *Dalechampia* and *Manihot*) at the base, usually broadly ovate in shape, and usually with a pair of glands at apex of petiole or near base of blade. Most of our euphorb climbers lack milky latex, although entire-leaved *Omphalea* has a cloudy-watery sap that sometimes turns pinkish or bluish with oxidation.

Malvaceae - The only species known to become a true liana is *Malvaviscus arboreus* and even that species is more often erect or subclambering. It looks vegetatively much like *Urera,* but lacks cystoliths and usually has a more broadly ovate sub-3-lobed leaf.

Ulmaceae - *Celtis iguanea,* the only area ulmac liana, has spiny branchlets and is the only area vine with alternate serrate leaves and spines; the leaves are 3-veined.

D3c. Leaves deeply lobed and/or peltate

Aristolochiaceae - *Aristolochia leuconeura* and *A. pilosa* have deeply 3-lobed leaves, these with leafy stipules.

Euphorbiaceae - *Manihot brachyloba* has deeply palmately 3-5-lobed leaves that is mostly scandent in the region; a few species of scandent *Dalechampia* have deeply lobed leaves but are subwoody weedy vines.

Menispermaceae - *Cissampelos tropaeolifolia* has slightly peltate leaves.

Solanaceae - The only family in the region with climbers having deeply pinnately lobed leaves; the lobe-leaved climbers all belong to *Solanum* and most have spiny prickles on the branchlets.

D3d. Primitive odor

Only one Ranalean family in the region is primarily scandent - Aristolochiaceae.

Aristolochiaceae - Besides the vegetative odor, characterized by the distinctly palmately veined leaves, usually with three ascending main veins and two laterals forming margin of sinus and then branching to send main vein to sinus, the frequent presence of foliaceous stipules, and the petiole with base almost always extended into thickened nodal ridge or decurrent as raised striation on opposite side of branchlet.

D3e. Glands on petiole or lamina-base glands

Glands at extreme base of lamina occur in they the nonserrate scandent euphorb genera *Omphalea* and *Plukenetia.*

Euphorbiaceae - Our two true liana genera of Euphorbaceae both have a pair of glands near petiole apex. In *Plukenetia,* the commonest species also characterized by squarish basal "corners"- on the ovate

leaf, the glands are at extreme base of the lamina and tend to be narrow or on basal auricles. In *Omphalea* the pair of thick glands are at the petiole apex.

D3f. Leaves entire, palmately 3-5-veined

In addition to the 3-veined Ranalean taxa (Aristolochiaceae see above), milky latexed Moraceae, there are a number of non-tendrinate families with scandent taxa characterized by otherwise unremarkable 3-veined or palmately veined entire leaves.

Dioscoreaceae - Despite the conspicuously reticulate venation, a monocot; characterized by several lateral veins running evenly and uniformly all the way to leaf apex and by the base of the well-developed petiole which is usually flexed and/or twisted above the extreme base which tends to be rigid and is usually somewhat decurrent onto the slender evenly striate branchlet (+/-) hinting at the typical sheathing petiole base of many monocots). Stems never becoming >2.5 cm diameter, except at nodes, often green and spiny (with the spines thicker than in similar *Smilax*). Many species have conspicuous enlarged tubers.

Ericaceae - The leaves are typically the most coriaceous of any of the 3-veined scandent taxa and are generally 3-5-plinerved rather than truly 3-nerved, usually 2-ranked and borne on a short petiole that becomes subwoody. Some of the scandent Ericaceae are hemiepiphytic, often with adventitious roots.

Euphorbiaceae - Although the euphorb lianas are a mixed bag, most of them have 3-veined entire leaves. Most are also characterized by petiolar or lamina-base glands (*Omphalea, Plukenetia*), or deep lobing (*Manihot*). However, a few weedy *Dalechampia* species lack all these characters, and might not be recognizable when not fertile.

Fabaceae - A few scandent *Bauhinia* species have the two leaflets fused together all the way to the apex; apparently the non-bifid species do not have the *Gouania*-like butterfly-tongue tendrils that characterize most scandent *Bauhinia*. Sometimes simple-leaved *Bauhinia* can be recognized by the bifid drip tip of some leaves; otherwise only by the cylindrical pulvinus at both base and apex of petiole.

Menispermaceae - The main neotropical liana family with entire 3-veined alternate leaves. Most of the truly woody genera have a characteristic wiry or subwoody pulvinal flexion at the petiole apex; genera lacking the apical thickening have the petiole base conspicuously flexuous and usually also have relatively soft flexuous stems and corky bark. A useful vegetative character for most of the woody lianas is the contrasting concentric rings of xylem that are usually strikingly asymmetric and/or flattened with the center of the stem usually far to one side.

Olacaceae - *Heisteria scandens,* the only scandent species of its family is a canopy liana, characterized, like most other species of the family, by the curved greenish petiole slightly thicker toward the apex, and usually with a bit of latex in it. The scandent species has distinctly sub-3-veined leaves unlike most of its relatives.

Sterculiaceae - *Byttneria* is the only scandent Malvalean genus, thus easy to recognize by the Malvalean characters of pulvinate petiole apex and usual presence of stellate trichomes; some species have recurved prickles on the branchlets.

D3g. Latex

While presence or absence of latex is usually an important taxonomic character, in alternate simple-leaved climbers it is of relatively little importance, characterizing only part of Convolvulaceae plus miscellaneous species of other families.

Convolvulaceae - Our only climbing family with essentially pinnately veined leaves having conspicuously cordate bases. Only *Ipomoea* and its relatives, most of which are slender vines, have latex. The only woody Convolvulaceae lianas with latex are the unusually woody species of the *Ipomoea* group (e.g., the common *I. phinomega*).

Olacaceae - *Heisteria scandens,* sometimes has a trace of latex in its petioles.

D3h. Spines

While spines are taxonomically useful for recognizing a few genera of climbers, they are generally variable from species to species within a genus, and thus, not very useful for familial recognition. Other-

wise, spines occur in miscellaneous scandent taxa including *Cordia spinescens*. Another spiny liana, *Pisonia aculeata* of the Nyctaginaceae, might be confused with this group; it has opposite leaves but these tend to be clustered and might be taken for alternate.

Boraginaceae - *Cordia spinescens*

Dioscoreaceae - Many *Dioscorea* species (see 3-veined taxa above) have irregularly scattered thickish spines, the stems easy to recognize on account of their smooth green surface.

Polygalaceae – *Moutabea longifolia,* has inconspicuous prickles scattered on its branches; it is distinctive in the rather narrow, thick-coriaceous, olive-drying, leaves with immersed and hardly visible secondary and tertiary venation.

Smilacaceae - The smooth green stems of *Smilax* (see tendrillate taxa above) could be confused only with *Dioscorea* from which the stem spines differ in being small and evenly recurved or (when larger) in having the remnants of dried tendril bases at their apices.

Solanaceae - Many scandent Solanaceae have recurved prickles on the branchlets. They can be identified by the stellate trichomes and the leaves with completely pinnate venation, usually also with spines on main veins below, and often with irregularly remotely dentate-lobed margin.

D3i. Scandent plants with alternate simple leaves and lacking any of the above characters

The taxa belonging to this most nondescript group of climbers are listed individually with their individual distinguishing characters, if any.

Amaranthaceae – *Chamissoa altissima,* is vegetatively nondescript with membranaeous narrowly ovate leaves. Most likely to be confused with *Tournefortia* from which it differs in longitudinally finely striate, usually hollow twigs and especially in the long slender petiole with flexion at base.

Asteraceae - Alternate-leaved scandent composites are mostly pinnately veined, lack latex, and tend to be rather nondescript. Many have the typical composite odor, but *Senecio* relatives often do not. Senecioneae climbers often have hollow branchlets with fine longitudinal striations; Vernonieae climbers usually have a thin blackish layer in the inner bark similar to trees of that tribe, and the leaves tend to be grayish-pubescent below.

Boraginaceae - Most of the liana species of *Tournefortia* are utterly nondescript and especially likely to be confused with *Trichostigma* and *Chamissoa.* A few common species have distinctive long dark-brownish trichomes. The leaves of lianas are non-coriaceous but often subsucculent, differing from *Chamissoa* in shorter petioles with non-flexed bases; from Phytolaccaceae lianas in lacking anomalous stem section, and unlike thin-leaved Polygalaceae in having prominulous tertiary venation.

Convolvulaceae - The woody lianas mostly lack latex and are characterized by anomalous stem cross sections with interrupted rings of secondary xylem. Most likely to be confused with Solanaceae on one hand and Icacinaceae on the other. The leaves of the nonlactiferous genera are more or less recognizable from the unusually long eglandular, epulvinate, often sericeous petiole and the oblong leaf, either +/- sericeous below or very coriaceous.

Dichapetalaceae - Most area *Dichapetalum* climbers have nondescript pinnately veined leaves (usually with characteristic but inconspicuous early caducous stipules), the best vegetative character being the smooth usually light-colored trunk with conspicuously raised darker, round lenticels.

Dilleniaceae - A few Dilleniaceae species (mostly *Doliocarpus*) have virtually entire mature leaf margins. Unfortunately, most of these same species also have non-asperous leaves; however, they are obviously Dilleniaceae in the reddish, papery outer bark, and the typical leaf shape with more or less cuneate base and usually numerous straight secondary veins.

Ericaceae - Some Ericaceae climbers are only slightly or not at all 3-nerved; they are mostly strongly coriaceous and the vines are hemiepiphytic, usually with loose fibrous bark.

Marcgraviaceae - Characterized by hemiepiphytic habit and the usually succulent-coriaceous leaves, frequently dark-punctate and/or with the secondary venation reduced or suppressed; these often rolled around branchlet apex prior to expansion and resembling the terminal stipule of Moraceae. The distinctive juvenile form of *Marcgravia* has overlapping leaves appressed against a tree trunk which it

climbs by adventitious roots (cf. juvenile *Monstera*).

Olacaceae - *Heisteria scandens,* the only Olacaceae liana has an indistinct tendency to 3-veined leaf bases and also usually has a faint trace of latex in the petioles. Otherwise it can be recognized by the curved greenish petiole slightly thickened toward the apex. Frequently with scattered linear glandular area on midvein above.

Phytolacaceae - *Trichostigma octandra* is a nondescript liana with membranaceous black-drying leaves; stem with anomalous broken rings of secondary xylem like Convolvulaceae and Polygalaceae, but *Trichostigma* differs from liana members of both in either thinner more membranaceous leaves and/or nonprominulous tertiary venation.

Polygalaceae - Leaves coriaceous, usually with prominent venation (except *Moutabea* which has secondary and tertiary veins immersed but is distinctive in the inconspicuous prickles on the branchlets). Polygalaceae lianas have anomalous stem cross sections with more or less interrupted concentric rings of secondary xylem, similar to Convolvulaceae, but the leaves have shorter petioles; the secondary veins are less strongly ascending. *Securidaca* is distinctive in the sensitive greenish-olive twigs that make tendril-like twists (cf., opposite-leaved Hippocrateaceae).

Polygonaceae - Some species of *Coccoloba* are scandent; like erect members of the family they can be readily distinguished by the sheathlike ochrea at the nodes. Prior to its rupture to form the ochrea, woody Polygonaceae have a distinctive Moraceae-like conical terminal stipule (this especially useful in a few *Coccoloba* species where the ochrea is poorly developed).

Solanaceae - Scandent species of *Solanum* recognizable by stellate trichomes and frequent presence of prickles on leaves and branchlets; other climbing genera are mostly +/- hemiepiphytic, typically with elliptic to obovate +/- coriaceous clustered leaves, and mostly occur in cloud forest. Except for hemiepiphytic tendency, climbing Solanaceae are mostly nondescript and difficult to recognize although the rather few widely separated secondary veins and sometimes presence of branched trichomes or tomato-like odor can be useful characters.

Reference

Gentry, A.H. 1993. A field guide to the families and genera of woody plants of northwest South America (Colombia, Ecuador, Peru). - Conservation International, Washington D.C.

Special habits and "spot characters" of some conspicuous Golfo Dulce Plants

With this list, in combination with the descriptions of the families and genera, it should be possible to identify a number of plants exhibiting most conspicuous vegetative characters.

Leafless achlorophyllous parasites and saprophytes
Balanophoraceae – *Corynaea, Helosis*
Burmanniaceae – *Apteria, Gymnosiphon, Thismia*
Gentianaceae - *Voyria*
Orchidaceae - *Wullschlaegelia*
Triuridaceae - *Sciaphila*

Ant domatia on petioles or leaf base
Fabaceae - *Tachigali*
Melastomataceae - *Tococa,* few *Clidemia*

Ant domatia in hollow twigs (stems)
Cecropiaceae - *Cecropia*
Euphorbiaceae – *Sapium, Richeria*
Flacourtiaceae – *Tetrathylacium*
Lauraceae – *Ocotea, Aiouea, Cinnamomum*
Fabaceae – sometimes *Ormosia, Lonchocarpus, Macherium, Senna* and *Inga*
Moraceae - *Ficus*
Piperaceae - *Piper*
Polygonaceae - *Coccoloba, Triplaris*

Ant domatia in swollen thorns
Fabaceae - *Acacia*

Spines - Mostly useful at level of individual species.

Trees with white milky latex
Apocynaceae – *Lacmellea, Stemmadenia, Tabernaemontana, Peschiera*
Caricaceae - *Carica*
Euphorbiaceae – *Hura, Sapium*
Moraceae – *Castillea, Ficus, Brosimum, Batocarpus, Naucleopsis, Olmedia, Perebea, Poulsenia, Pseudolmedia, Sorocea, Trophis*
Olacaceae – *Heisteria, Minquartia* – at least in the petiole and youngest twigs
Sapotaceae – *Chrysophyllum, Manilkara, Micropholis, Pouteria*
Clusiaceae - *Clusia*

Trees with conspicuously colored latex
Apocynaceae – *Aspidosperma*
Clusiaceae – *Calophyullum, Clusia, Garcinia, Symphonia, Tovomita, Vismia*
Cochlospermaceae - *Cochlospermum*
Euphorbiaceae - *Croton, Hippomane, Pausandra, Richeria*
Fabaceae – *Dussia, Machaerium, Pterocarpus, Swartzia*
Myristicaceae – *Compsoneura, Virola, Otoba*
(black sap: *Pourouma, Prioria*)

Lianas with spines on leaves and/or twigs
Arecaceae - *Desmoncus*

Dioscoreaceae - *Dioscorea*
Fabaceae - scandent *Senna*, *Caesalpinia, Machaerium, Acacia, Mimosa* (most mimosoid climbers)
Nyctaginaceae - *Pisonia*
Polygonaceae - *Moutabea*
Rubiaceae – *Randia, Chomelia*
Sapindaceae – few *Paullinia*
Smilacaceae - *Smilax*
Solanaceae - *Solanum*
Sterculiaceae- *Byttneria*
Ulmaceae - *Celtis*

Trees with spines on leaves, trunks, twigs, branch-tips or at ends of twigs or short-shoots
Apocynaceae – *Lacmellea*
Arecaceae – *Acrocima, Astrocaryum, Bactris, Cryosophila, Raphia*
Bombacaceae - *Ceiba*
Caricaceae - *Jacaratia*
Euphorbiaceae - *Hura*
Ferns (Tree ferns) - *Cyathea, Alsophila*
Flacourtiaceae - *Xylosma,* few *Casearia*
Fabaceae - *Acacia, Erythrina, Machaerium, Bauhinia,* etc.
Moraceae - *Maclura, Poulsenia*
Olacaceae - *Ximenia*
Rhamnaceae - *Zizyphus*
Rubiaceae - *Chomelia , Randia*
Rutaceae - *Zanthoxylum*
Solanaceae - *Lycium, Solanum*
Ulmaceae - *Celtis*
Urticaceae – *Urera*

Unbranched pachycaul growth form
Theophrastaceae – *Clavija*
Myrsinaceae – *Cybianthus*
Sapindaceae - *Talisia*

Strongly fenestrated trunks
Apocynaceae –*Aspidosperma*
Celastraceae - *Perrottetia sessiliflora*
Dichapetalaceae – *Stephanopodium*
Fabaceae - *Lecointea*
Olacaceae - *Minquartia*
Rubiaceae – *Guettarda, Macrocnemum*
Sapotaceae - few *Pouteria*

Stranglers or hemiepiphytic lianas, shrubs or trees
Araliaceae – *Schefflera, Oreopanax*
Asteraceae - *Neomirandea*
Burseraceae - *Bursera standleyana*
Cecropiaceae - *Coussapoa*
Clusiaceae - *Clusia*
Ericaceae – *Cavendishia, Satyria, Psammisia*
Gesneriaceae - *Drymonia*

Hydrangeaceae - *Hydrangea*
Marcgraviaceae – *Marcgravia, Marcgraviastrum, Norantea, Sarcoptera, Souroubea*
Melastomataceae – *Blakea, Topobea*
Moraceae - *Ficus*
Scrophulariaceae - *Schlegelia*
Solanaceae – *Juanulloa, Markea*

Flowers and fruits produced directly from the trunk or branches (cauli- and ramiflory)
Bignonicaeae – *Crescentia, Amphitecna*
Caricaceae – *Carica*
Clusiaceae - *Garcinia*
Flacourtiaceae – *Carpotroche*
Lecythidaceae – *Couroupita, Grias*
Fabaceae – *Swartzia, Zygia*
Melastomataceae –*Bellucia, Henriettea*
Moraceae – *Castilla*
Myrtaceae - *Plinia*
Sapotaceae - *Pouteria*
Sterculiaceae – *Theobroma, Herrania*

Trees with stilt roots
Acanthaceae – *Bravaisia*
Arecaceae – *Socratea, Iriartea*
Bombacaceae – *Pachira*
Burseraceae – few *Protium*
Cecropiaceae – *Cecropia, Pourouma*
Chloranthaceae – *Hedyosmum*
Clusiaceae – *Clusia, Symphonia, Tovomita*
Euphorbiaceae - *Alchorneopsis*
Moraceae – *Ficus*
Lauraceae – few *Ocotea*
Piperaceae - *Piper*
Rhizophoraceae - *Rhizophora*
Sterculiceae - *Sterculia*

Trees with very large buttresses
Bombacaceae – *Ceiba, Huberodendron, Bombacopsis,*
Elaeocarpaceae – *Sloanea*
Euphorbiaceae – *Hyeronima*
Fabaceae – *Pterocarpus, Dussia, Enterolobium, Peltogyne, Tachigali, Dialium, Mora, Newtonia, Parkia, Phyllocarpus, Uribea, Vatairea*
Moraceae – *Ficus*
Sterculiaceae – *Pterygota, Sterculia*
Theaceae – *Pelliciera*

The Plant Families

GYMNOSPERMS - CYCADS

Zamiaceae

Small to large dioecious trees or plants with subterranean stem, usually with palm-like habit, pubescent when young, becoming glabrous. **Leaves** spirally arranged, rather large, pinnately divided, pinnae 10-60 in opposite or subopposite pairs, with parallel longitudinal veins, lacking a midvein; micro- and megasporophylls in determinate cones, scale-like or subpeltate, forming compact strobili, male sporophylls with numerous small globose sporangia, female sporophylls bearing 2 ovules; seeds large, often reddish. In the tropics and subtropics worldwide. Pantrop. + subtrop. 8/125, CR 1/4, GD 1/1.

Morphological features and field observations demonstrate that the members of Zamiaceae are pollinated by insects, but wind also plays a role in some genera (KIEM 1972, NORSTOG & STEVENSON 1980, NORSTOG et al. 1986, DONALDSON 1997, WANG et al. 1997). NIKLAS & NORSTOG (1984) found evidence in three cycad genera that wind disperses the pollen uniformly over the megasporophylls and that an additional vector (water or insects) is needed to carry the pollen grains to the ovaries.

Investigation of *Zamia* spp. showed that several beetles (*Rhopalotria*, *Pharaxonotha*) serve as pollinators, sometimes effecting pollination in combination with wind (NORSTOG et al. 1986, TANG 1987).

GÓMEZ (1993) reported the dispersal of the seeds of *Zamia fairchildiana* by various species of birds.

After removing the toxic components through washing and roasting, the stems and seeds of several Zamiaceae (including *Zamia* spp.) are used as a source of starch (STEVENSON 1991, JOHNSON & WILSON 1990a).

Zamia (neotrop. + subtrop. 40, CR 4, GD 1)
Plants with the stem subterranean and tuberous or forming a short, naked, arial trunk.

Z. fairchildiana L.D. Gómez, Pl. 8a-d
Plant with arborescent stem, up to 1 m tall; leaves 3-10, with 10-30 pairs of pinnae, pinnae oblong, sessile, smooth, sparsely serrulate in the upper part, male strobili 10-40 cm long, cylindrical, cream to yellow, female strobili yellow-green to light brown, cylindrical, 20-30 cm long, seeds red, ovoid, 1-1,5 cm long. In primary and secondary rainforests, from Costa Rica to Panama.

DONALDSON, J.S. 1997. Is there a floral parasite mutualism in cycad pollination? The pollination biology of *Encephalartos villosus* (Zamiaceae). - Amer. J. Bot. 84 (10): 1398-1406.

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STEVENSON, D.W. 1991. Zamiaceae. pp.: 7-11. In: GORTS VAN RIJN (ed.): Flora of the Guianas, ser. A, Fasc.9. Fam. 208.1. Koeltz Scientific Books.

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TANG, W. 1987. Insect pollination in the cycad *Zamia pumila* (Zamiaceae). - Amer. J. Bot. 74 (1): 90-99.

WANG, A., C.I. LI, S.Y. YANG, R. HUANG & F.L. CHEN. 1997. Pollination biology of *Cycas panzhihuaensis* L. Zhou & S.Y. Yang. - Acta Bot. Sin. 39 (2): 156-163.

WOODSON, R. 1943. Cycadaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 30: 97-98.

GYMNOSPERMS - CONIFERS

Podocarpaceae

A family of dioecious or rarely monoecious resinous trees and shrubs, with very characteristic thick coriaceous, linear to linear-oblong leaves and naked seeds. **Leaves** simple, usually spirally arranged, entire, large or scale-like; male **inflorescences** (cones) axillary or terminal, cylindric, catkin-like, clustered or solitary, with numerous spirally arranged scales, female inflorescences (cones) axillary or terminal, usually solitary, variable in shape; **seeds** naked, on a red, fleshy receptacle, or sometimes enveloped by a fleshy pseudo-aril. Usually plants of the southern hemisphere, but a few species also reach northwards up to southern Japan. Cosmopol. 17/168, CR 2/5, GD 1/1.

The seeds, usually have a fleshy, colored part. They attract birds, which serve as the main dispersers. Additionally, autochory and hydrochory is assumed to occur (PAGE 1990).

Podocarpus (cosmopol. 94, CR 4, GD 1), Pl. 8e
Trees, usually with narrow and flat leaves. The genus is characterized by the female cones with 2-4 scales, only 1 or 2 of them bearing ovules. The seeds are inserted on a fleshy, red receptacle, appearing drupe-like.

P. guatemalensis Standl., Pl. 8e
Tree, up to 30 m tall, leaves lanceolate, up to 14 cm long, up to 12 mm wide; male cones axillary or in the axils of fallen leaves, sessile, solitary, female inflorescences axillary; mature receptacle purple to bright red, pseudo-fruit with a distinct crest. In primary rainforests, from Belize to Bolivia and Brazil. In the Golfo Dulce region, the species grows near sea level.

BUCHHOLZ, J.T. & N.E. GRAY. 1948. A taxonomic revision of *Podocarpus*. IV. The American species of section *Eupodocarpus*, sub-sections C and D. - J. Arnold Arbor. 29: 123-151.

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ANGIOSPERMS – MONOCOTYLEDONS

Alismataceae

A small family of aquatic and amphibious herbs, most of them growing in marshes or living submerged, rooting in the bottom. The plants always contain a milky latex. Nectar secretions are present at the basal part of the carpels and sometimes the tepals and stamen bases are nectariferous as well (*Echinodorus*). **Leaves** basal, sessile or petiolate, simple, usually having a long sheath, sometimes pellucid punctate, margin usually entire; **inflorescences** usually erect, basally inserted, simple or compound, racemose, paniculate or sometimes umbellate; **flowers** bisexual or unisexual (plants then monoecious or rarely dioecious), tepals 6, in two rows, greenish or whitish, stamens 3-6-9-numerous, ovary superior, of 6-numerous, free, unilocular carpels; **fruits** achenes or rarely follicles, usually numerous, sometimes longitudinally costate, aggregated in an infructescence, seeds 1-several. Distributed worldwide, but primarily in temperate and tropical regions of the northern hemisphere. Cosmopol. 11/92, CR 2/9, GD 2/2.

Some species are used as ornamental plants in pools and aquaria (e.g. *Sagittaria, Alisma, Echinodorus*). The roots of *Sagittaria latifolia* are used as food by the ancient North Amerian Indians, and are still a food source for Chinese people in North America.

Key to the genera (after Crow 1996)

1 Flowers bisexual; inflorescences mostly with more than 3 flowers per whorl, or umbelliform; fruits plump, ribbed — *Echinodorus*

1* Flowers unisexual; inflorescences mostly with only 3 flowers per whorl; fruits laterally flattened, smooth — *Sagittaria*

Echinodorus (neotrop. + Africa 48, CR 7, GD 1)
Monoecious, perennial or annual, erect rhizomatous herbs, usually living submersed. The long petiolate, cordate or sagittate leaves are arranged in a basal rosette, and are emergent, floating or submersed. The flowers are always bisexual.

E. grisebachii Small
Submersed to emergent perennial herbs; leaves erect, lanceolate, 8-11 cm long, 2-3 cm wide; inflorescences usually unbranched, whorls of (4-) 5-9(-11) each with 3-9(-11) flowers. In marshes and on open, swampy sites, from Honduras to Bolivia and Brazil.

Crow, G.E. 1996. Alismataceae. In: Family treatments for the for the Manual to the Plants of Costa Rica. (WWW document) URL: http://www.mobot.org/MOBOT/research/treat/alismata.html. (12.9.2000).

Gomez, L.D. 1984. La plantas acuáticas y anfibias de Costa Rica y Centroamérica. San José: Editorial Universidad Estatal a Distancia.

Haynes, R.R. & L.B. Holm-Nielsen. 1994. Alismataceae. - Fl. Neotrop. Monogr. 64.

Haynes, R.R., D.H. Les & L.B. Holm-Nielsen. 1998. Alismataceae. pp: 11-18. In: K. Kubitzki (ed.): The families and genera of vascular plants. Vol IV. Alismatanae and Commelinanae (except Gramineae). - Berlin: Springer Verlag.

Lot, H. & A. Novelo R. 1994. Alismataceae. Pp.: 3-8. In: G. Davidse, M. Sousa S. & A.O. Chater (eds.): Fl. Mesoamericana Vol. 6. Alismataceae a Cyperaceae. - Universidad Nacional Autó noma de México, Missouri Botanical Garden, Natural History Museum (London).

Amaryllidaceae

A large, horticulturally important family of perennial, herbaceous plants that includes *Crinum*, *Narcissus*, *Galanthus* and *Hippeastrum*. The family is characterized by the presence of an underground bulb instead of any above ground stems. **Leaves** basally inserted or distributed along the stem, usually linear; **inflorescences** terminal, umbel-like thyrses on a long scape, sometimes reduced to a single flower, subtended by one or several scarious spathes; **flowers** often large and showy, tepals 6 in 2 whorls, free or connate into a short to long tube, stamens 6, free or sometimes basally connate, ovary inferior,

3-locular, style and stigma 1; **fruits** capsules or berries. Distributed primarily in warm temperate to tropical regions, most diverse in South Africa, Andean South America, and the Mediterranean region. Cosmopol. 65/725, CR 6/9, GD 3/3.

The family is closely related to the Liliaceae, Iridaceae, Agavaceae, Velloziaceae and Alstroemeriaceae. The flowers of *Crinum* and *Hymenocallis* are white and have a long, slender, tubular corolla. Pollinators are probably hawkmoths, though the flowers are also open during the day and are visited by a variety of pollen foraging insects. Smaller insects, however, cannot effect pollination, since the stamens and styles are widely separated.
Several Amaryllidaceae with showy flowers are used as ornamentals.

Key to the genera (after MEEROW 1990)

1	Stamens free	*Crinum*
1*	Stamens basally connate	2
2	Flowers white, declinate or pendulous; tube strongly curved; tepals broadly lanceolate to ovate	*Eucharis*
2*	Flowers white (rarely pale greenish-yellow), suberect or perpendicular to the scape; tube mostly straight; tepals narrowly-lanceolate to linear	*Hymenocallis*

Crinum (pantrop. 120, CR 1, GD 1)
The genus contains many tall species with false leaf sheaths (as in *Musa)*, a number of which are cultivated.

C. erubescens Ait., Pl. 9a,b
Large herb with ovoid bulb; leaves 1-2 m long; flowering scapes stout, usually shorter than leaves; flowers 4-12 per inflorescence, sessile, perianth salverform, 15-25 cm long, white, usually tinged with maroon, often persisting in fruit, stamens 6, long-exserted (7 cm and more), white at base, maroon above, anthers more than 1 cm long; fruits fleshy capsules, irregularly rounded, to 7 cm long. Widespread and often cultivated throughout tropical America.

Eucharis (neotrop. 19, CR 1, GD 1)
The white or slightly yellowish flowers have a short perigone tube dilated at some distance from the base. The filaments, inserted on the margin of the perigone tube, are basally indistinctly appendiculate and narrow. Some species are popular ornamental plants. The majority of species are endemic to the western Amazon Basin and adjacent lower slopes of the eastern Andes.

E. bouchei Woodson & P. H. Allen
Herb with subglobose bulb; leaves 1-3(-4), widely (ovate-)elliptic, slightly succulent; scape ca. (40-)55 cm tall, ca. 1 cm in diameter proximally, ca. 5 mm in diameter distally; flowers usually (3-)5(-6), usually pendent; fruits leathery capsules, 1,5-2 cm long, 2-3 cm wide, bright orange. Lowland rainforests, premontane and lower montane forests in Guatemala, Costa Rica and Panama.

Hymenocallis (neotrop. 30-40, CR 1, GD 1)
The usually white and fragrant flowers are subtended by hyaline bracts. The filaments are basally fused into a cup of various shape.
One unidentified species of this genus has been collected at the GD.

MEEROW, A.W. 1989. Systematics of the Amazon lilies, *Eucharis* and *Caliphruria* (Amaryllidaceae). - Ann. Missouri Bot. Gard. 76 (1): 136-220.
MEEROW, A.W. 1990. Amaryllidaceae. In: G. HARLING & L. ANDERSSON (eds.): Flora of Ecuador 41 (202): 1-53.
MEEROW, A.W. & D.A. SNIJMAN. 1998. Amaryllidaceae. Pp.: 83-110. In: K. KUBITZKI (ed.): The families and genera of vascular plants. Vol III. Monocotyledons Lilianae (except Orchidaceae). - Berlin: Springer Verlag.

Araceae

A large family of perennial herbs, terrestrial, epiphytic or rarely aquatic, with rhizomes or tubers and often having watery or milky pungent sap. Roots adventitious, mycorrhizal; **leaves** simple to pinnately

or palmately compound, alternate, basally clustered or cauline, entire, parallel-, pinnately or palmately veined, with membranaceous basal sheath; **inflorescences** terminal, spicate and composed of numerous flowers packed onto a cylindrical fleshy axis (spadix), subtended by a usually large, foliose or petaloid bract (spathe); **flowers** actinomorphic, bisexual or unisexual (then plants monoecious), minute, ebracteate, tepals 4 or 6, sometimes absent, distinct (scale-like) to completely connate (cup-like), fleshy, inconspicuous, stamens 1-6, opposite the tepals, ovary basically superior (sometimes appearing inferior when embedded in spadix), usually 1-locular (but the genera of the GD usually with more than 1 locule); **fruits** dry or fleshy berries. The great majority (92 %) of the species are found in the tropics, with the centers of diversity in Southeast Asia and Central to South America. Pantrop. + few temperate 104-105/2550, CR 20/251, GD 13/76.

According to recent molecular data the family is related to the Alismatiflorae. Apparently the Araceae are monophyletic, based on characters such as the inflorescence type. Notably, the genus *Acorus* has been recently removed from the family (GRAYUM 1987, BOGNER & NICHOLSON 1991, DUVAL & AL 1993).

Araceae are almost always adapted to pollination by insects. In many cases very sophisticated interactions between the plants and the pollinators have evolved. Several genera have developed complicated trap mechanisms which serve to retain the flower visitors during anthesis. Though many studies have been carried out, much work needs to be done to understand the floral biology in more detail as well as the evolutionary trends within the family. The main pollinators are beetles, flies and euglossine bees, which are mostly attracted by odor. The release of odor is often combined with thermogenesis (MOODIE 1976). Many species of *Anthurium* have a faint aroma (e.g., *A. fragrantissimum*) and are visited by male euglossine bees (*Euglossa, Eulaema*). These bees collect scent compounds which they use for sexual attraction of the females (CROAT 1980). Other species of *Anthurium* have flowers with a foul scent and dark spathes and spadices and attract flies. Other insects which were observed include weevils and staphylinid beetles (CROAT 1980). *Spathiphyllum* species attract euglossine bees with their sweet scent and white spathe. MONTALVO & ACKERMAN (1986) found that stingless bees of the genus *Trigona* serve as the main pollinators in *Spathiphyllum friedrichsthalii*, while euglossine bees are of lesser importance. The flowers of *Dieffenbachia* are well adapted to beetle-pollination. The convolute spathe opens widely at flowering time (CROAT 1983b) and the stigmata of the pistillate flowers become receptive either immediately (CROAT 1983b, VALERIO 1984) or after a period of 24 hours (*D. longispatha*, YOUNG 1986). During this time the spadix warms noteably above air temperature and the plants emit a pleasant scent which attracts large dynastine beetles (especially *Cyclocephala* spp.). As many as 26 individuals, all of the same species, have been counted in a single inflorescence, mainly aggregating for mating. By the morning of the following day, when the anthers of the staminate flowers open, the spathe has already started to close in order to prevent insects from contacting with the staminate part. However, before the spathe closes completely, the beetles squeeze out and are thereby covered with pollen. They fly away and subsequently become entrapped in another plant in the pistillate phase. Fruit set is positively correlated with the number of beetles visiting the inflorescence (YOUNG 1988). The inflorescences of *Philodendron* exhibit similar features as *Dieffenbachia* and indicate a highly spezialized pollination strategy. Many species are fragrant and the release of scent is often precisely timed to coincide with the habit of their pollinators, that is scarab beetles belonging to the families Rutelinae and Dynastinae. Several detailed studies have been carried out on the pollination mode of *Philodendron bipinnatifidum* and *P. selloum* (WALKER et al. 1983, GOTTSBERGER & AMARAL 1984, GOTTSBERGER 1986, GOTTSBERGER & SILBERBAUER-GOTTSBERGER 1991). One day before anthesis the spadix heats up continuously (NAGY et al. 1972, GOTTSBERGER & AMARAL 1984) up to a maximum of 30°C above air temperature (GOTTSBERGER 1986,1990; GOTTSBERGER & SILBERBAUER-GOTTSBERGER 1991). Heating is combined with strong odor emission. The beetles *Erioscelis emarginata, Cyclocephala cribrata* and *C. variolosa* are guided to the female part of the inflorescence. Here they stay for 24 hours, copulating and feeding on the stigma exudations. In the evening of the next day they leave the inflorescence after being covered

with pollen when crawling over the fertile male flowers. Some species of *Monstera* are thought to be pollinated by *Trigona* bees. They are attracted by a sticky substance which oozes from sterile flowers at the base of the spadix. The bees collect this for food and for gluing nest materials together (RAMÍREZ & GÓMEZ 1978). GRAYUM (pers. comm.) states that *Trigona* bees are non-effective visitors of *Monstera*, while dynastine scarabs are the true pollinators. The inflorescences of *Heteropsis* are visited by bees and plant bugs (Hemiptera). Species of *Xanthosoma* growing in the dim understory usually have pale fruit-scented inflorescences, which are pollinated by Rutelinae beetles. The unpleasant-smelling inflorescences of *Dracontium* are generally pollinated by flies. The flowers of some *Syngonium* species emit a sweet scent and posess spiny pollen grains. The plants seem to have the same pollination syndrome as *Philodendron* and *Dieffenbachia* (CROAT 1981).

Several species have reddish infructescences with white to brownish fruits, which are mainly dispersed by birds. The color of the persistent spathe of *Syngonium* changes from green during the protective phase to red in the mature phase in order to attract dispersers (MADISON 1979). The berries of several species of *Heteropsis* are pendulous at the end of the stems and (in *H. oblongifolia*) emit the odor of fermenting or decaying fruits. This suggests dispersal by bats.

Some species of *Philodendron* have extra-floral nectaries ocurring on spathes, stalks, sheaths and on the leaf undersides. The secretions attract ants whose presence deters insect pests which would otherwise devour the plant. An example for the myrmecophytic habit is *P. myrmecophilum* of the Amazon Basin. It grows in trees, together with bromeliads and species of *Epiphyllum* and *Peperomia*. The ants feed from extrafloral-nectaries and set up home near this food supply. The plant benefits from their presence as bodyguards and from the nutrients of the nesting material.

Alocasia, Colocasia ("taro") and *Xanthosoma* ("yautia") produce underground stem tubers that contain up to 29% carbohydrates and up to 3,7% proteins. In many tropical regions, especially in the Pacific, where rice and other cereals do not grow well, these aroids are cultivated as a source of carbohydrates. Numerous species of more than 50 genera are used as indoor and outdoor ornamental plants, such as *Anthurium* spp., *Dieffenbachia* spp., *Monstera* spp., *Philodendron* spp., and *Spathiphyllum* spp. Some members of *Anthurium* are well known ornamental plants, called "flamingo flowers", especially *A. scherzerianum* and *A. andraeanum* with bright red spathes. *Alocasia* and *Homalomena* have medicinal properties. The roots of some species of *Heteropsis* are used for lashing together poles used in the construction of buildings and are said to be as strong as nylon parachute cord. For use in basket and wicker work, the outer layer (cortex) is stripped off and the inner fiber is woven in the fresh condition (BOWN 1988). The uses of *Philodendron* are manifold. *P. bipinnatifidum* with its robust roots is ideal for construction of buildings, a jelly is made of the fruits (Brazil) and the seeds have vermicidal properties. The stems of *P. scandens* serve as basket handles in the West Indies.

Key to the genera (after CROAT 1997a)

1	Plants aquatic	*Pistia*
1*	Plants terrestrial or epiphytic	2
2	Petiole variegated, appearing snake-like; leaf blade thin, usually 3-parted, each division further divided	*Dracontium*
2*	Petioles solid green, not appearing snake-like, leaf blades not as above, either simple, or if compound, not thin or prominently 3-parted	3
3	Plants terrestrial, never epiphytic or hemi-epiphytic	4
4	Flowers bisexual, spadix uniform in appearance, the spathe free (not enclosing the spadix except in bud), plants occurring typically along water courses.	5
5	Petiole conspicuously sheathing, with roots growing through sheath; leaf blades oblong, much longer than broad, venation parallel; spathe ovate; flower with 4-6(-7) tepals	*Spathiphyllum*
5*	Petiole sheathing only near base, with roots emerging from between petioles;	

leaf blades cordate or deeply 3-parted, if cordate, only slightly longer than broad; venation prominently reticulate, spathe lanceolate; flower with 4 tepals — *Anthurium*

4* Flowers unisexual; spadix not uniform in appearance; staminate flowers aggregated at apex and pistillate flowers at base with intervening sterile staminate flowers, the spathe enclosing the spadix, prominently convolute at base, at least the tube portion closing after anthesis; plants occurring in many habitats — 6

6 Leaf blades with parallel venation; whole spathe closing over spadix after anthesis; female spadix with club-shaped staminodia — 7

7 Leaf blades usually much longer than broad; petioles and veins of lower surface of blade glabrous; female flowers remote from one another, each surrounded by 4 or 5, club-shaped, white staminodia — *Dieffenbachia*

7* Leaf blades ovate-cordate to hastate, not markedly longer than broad; petioles and veins of lower surface of blade reddish-brown pubescent; pistillate flowers closely compacted on spadix with a few, scattered, club-shaped white staminodia, not several with each pistil — *Homalomena*

6* Leaf blades with reticulate venation; upper portion (blade) of spathe deciduous after anthesis; female spadix without club-shaped staminodia; stem rhizomatous — *Xanthosoma*

3* Plants epiphytic or hemiepiphytic, not persisting indefinitely when fallen to ground (note: juvenile plants may be found terrestrial) — 8

8 Leaf blade with parallel venation, not forming collective veins nor with prominent reticulate veins — 9

9 Leaf blade with primary lateral veins lacking or very inconspicuous (minor veins always visible); spadix nodding at anthesis; plants true epiphytes, not appressed climbing hemiepiphytes — *Stenospermation*

9* Leaf blades with primary lateral veins conspicuous; spadix not nodding at anthesis — 10

10 Flowers bisexual; spadix uniform; spathe promptly deciduous; petioles usually fully sheathed or nearly so; stems > 6 mm in diameter, not slender and wiry; vegetative parts with trichosclereids — *Rhodospatha*

10* Flowers unisexual; spadix divided into a staminate and a pistillate portion (staminate at apex, pistillate at base); spathe persisting; petioles not fully sheathing; vegetative parts lacking trichoscleroids — *Philodendron*

8* Leaf blades with venation not parallel (at least the secondary veins), forming collective veins and/or reticulate — 11

11 Sap usually milky; leaf blades with several collective veins; juvenile blades simple and hastate; adult blades pedately lobed, the lateral lobes with prominent auricles; inflorescence with male and female flowers segregated on spadix; spathe white, deciduous; fruit an ovoid syncarp, surrounded by a persistent spathe tube until maturity, usually > 1,5 cm in diameter — *Syngonium*

11* Sap not milky; leaf blades with only a single collective vein (or lacking a collective vein); juvenile blades never hastate; adult blades simple or compound, but when compound lacking milky sap and prominent auricles on leaflets; inflorescence with only bisexual flowers (i.e. uniform in appearance); spathe entire, lanceolate and persistent or boat-shaped to globose and deciduous; fruits not syncarpous, each berry resulting from a single flower — 12

12 Spathe ± lanceolate, usually greenish, usually spreading or at least not enclosing the spadix, persisting even into fruiting condition — *Anthurium*

12* Spathe boat-shaped or subglobose, often whitish, usually somewhat enclosing spadix, usually promptly falling off after anthesis — 13

13 Adult plants slender vines, highly branched and spreading in canopy; stem apparently firm, wiry, stiff, terete, < 7 mm in diameter; often producing long adventitious roots which extend to the ground; spadix < 7 cm x 7 mm — *Heteropsis*

13* Adult plants hemiepiphytes, usually appressed-climbing on trunks, with short, thick internodes; stem firm and hard but not appearing woody, not slender and wiry,

producing short roots usually on the tree-side of the usually somewhat flattened stem; spadices usually much > 7 cm x 7 mm — *Monstera*

Anthurium (neotrop. > 700, CR 85, GD 24)
The largest genus of the family and highly variable, consisting mostly of epiphytes (rarely true climbers) but also of numerous terrestrial species. The leaves are very variable in shape, but distinct in having a (sub-)marginal collecting vein. The spathe is persistent and the spadix uniform, bearing perfect, usually protogynous flowers.

A. acutifolium Engl.
Terrestrial or rarely epiphytic herb; cataphylls persisting as fibrous network; leaves simple, oblanceolate to broadly oblanceolate, (11-)25-62 cm long, (3,5-)5,5-27 cm wide, long attenuate at base, petioles (2-)6-22 cm long; inflorescences erect, usually shorter than the leaves, spathe linear-lanceolate, 5-12 cm long, 0,7-1,1 cm wide, green, spadix sessile, 7-16 cm long, green to white, sometimes tinged with red-violet; fruits greenish-yellow. In moist and wet forests in Costa Rica and Panama.

A. bakeri Hook.f., Pl. 9d
Epiphyte, rarely terrestrial, stems less than 10 cm long; cataphylls coriaceous, persistent as fibers; leaves simple, narrowly elliptic-lanceolate to narrowly oblanceolate, 19-55 cm long, 2,8-9 cm wide, narrowly rounded at base, conspicuously reddish brown glandular-punctate beneath, petioles (1,5-)8-27 cm long; inflorescences erect-spreading, much shorter than the leaves spathe oblong-lanceolate, 2-5,5 cm long, 7-28 mm wide, pale yellow-green, spadix 2-11 cm long, 4,5-15 mm wide, creamy white; fruits red. Widespread in wet forests, from southern Mexico to Venezuela and Ecuador.

A. brownii Mast.
Epiphyte, stems short; cataphylls persistent, rather intact, ultimately weathering to fibers; leaves simple, trilobate, narrowly ovate-triangular, 15-66 cm long, 11-48 cm wide, prominently lobed at base, petioles 16-70 cm long; inflorescences erect, spathe lanceolate, 4,5-12,3 cm long, 0,8-2 cm wide, green mottled with purple, spadix 7,5-30,5 cm long, purple; fruits red-orange to red. In wet forests, from Costa Rica to Venezuela and Ecuador.

A. clavigerum Poepp., Pl. 9f
Scandent epiphyte, stems 2 m long; cataphylls coriaceous, weathering to fibers; leaves pedately compound, to 2 m wide, with 7-13 leaflets, the leaflets 25-100 cm long, 4-12 cm wide, petioles 65-150 cm long; inflorescences arching to pendent, spathe lanceolate, 18-65 cm long, 1-3,5(-11) cm wide, violet-purple, spadix 20-75 cm long, grayish to lavender-purple; fruits obovate, purple. In wet forests, from Nicaragua to the Guianas, Brazil and Bolivia.

A. eximium Engl., Pl. 9e
Epiphyte, stems up to 1 m long, cataphylls persistent intact; leaves simple, narrowly oblanceolate, 23-80 cm long, 3-10 cm wide, petioles 4,5-15 cm long; spathe ovate to lance-cordate, 5-10 cm long, green, often tinged pinkish, spadix 3,7-6,3 cm long, sessile, creamish to yellowish, white or grayish. Endemic to Costa Rica.

A. hacumense Engl., Pl. 9c
Subacaulescent epiphyte, cataphylls persistent as fibers; leaves simple, oblanceolate to obovate, 37-67 cm long, 9-18,5 cm wide, black-glandular beneath, petioles 2-14 cm long; spathe lanceolate to lance-oblong, 4,4-12,5 cm long, pale green, spadix 7-18,5 cm long, pinkish to purple; fruits red. From Costa Rica to northwestern Colombia.

A. lancifolium Schott
Terrestrial or rarely epiphytic or epilithic plant, 30-90 cm tall; cataphylls persistent as fibers; leaves simple, narrowly lanceolate to broadly elliptic to ovate, 20-47 cm long, 3-20,7 cm wide, cuneate at base, conspicuously black glandular-punctate on both sides, petioles 7-51 cm long; inflorescences erect, spathe oblong-lanceolate, 4,3-8,5 cm long, 0,8-1,9 cm wide, green, spadix 4,5-12,5 cm long, gray- or greenish-white; fruits white or purple. In wet forests, from Costa Rica to Colombia.

A. obtusum (Engl.) Grayum, Pl. 9g
Erect or pendent, subacaulescent epiphyte, cataphylls weathering to persistent fibers; leaves simple, narrowly to broadly elliptic, rarely lanceolate to oblanceolate, 6-19,5 cm long, 1,1-6,7 cm wide,

black glandular below, petioles 1,2-8,8 cm long; spathe 1,2-3,8 cm long, ovate to lance-ovate or –oblong, white to greenish, spadix 1,5-5,4 cm long, subsessile, usually purplish or sometimes white to greenish; fruits white or bluish. In wet forests, from Belize to the Guianas and Peru.

A. obtusum (Engl.) Grayum
(syn. *A. trinerve* Miq.)
Epiphyte, stems creeping, up to 50 cm long; cataphylls thin, persisting around stems as fibers; leaves simple, elliptic to ovate-elliptic, rarely lanceolate, 6-19,5 cm long, 1,1-6,7 cm wide, acute to attenuate at base, conspicuously black glandular-punctate beneath, petioles 1,2-8,8 cm long; inflorescences erect, spathe thick, oblong-elliptic, 2,5-3,5 cm long, 0,5-1,1(-1,9) cm wide, greenish-white, spadix 1,5-5,4 cm long, dark lavender or green to white; fruits white to pale lavender. In wet forests, from Guatemala and Belize to the Guianas, Peru and central Brazil.

A. ochranthum K. Koch
Terrestrial plant, stems to ca. 25 mm long; cataphylls persistent as fibers; leaves simple, ovate-triangular, 30-75 cm long, 18-48 cm wide, deeply lobed at base, petioles 21-91 cm long; inflorescences erect, spathe lanceolate, 7,5-18 cm long, 0,9-2,3 cm wide, green to purple, spadix 6,5-23,5 cm long, greenish to golden yellow to purplish; fruits white to red. In wet forests, from Nicaragua to Colombia.

A. pentaphyllum (Aubl.) G. Don
A. pentaphyllum var. *bombacifolium* is the only subspecies occurring in the GD.
Epiphyte with creeping stem, to 1 m long, growing appressed to a tree trunk; cataphylls deciduous or persistent; leaves digitately compound, 20-48 cm long, 14-38 cm wide, ovate to suborbicular, pedately compound with 5-11 leaflets, petioles 10-43 cm long; inflorescences erect, peduncle 1-6 cm long, spathe lanceolate to ovate, pale green to purple, early caducous, spadix 2,2-10(-15) cm long, whitish to greenish to pale purple violet; fruits red to dark red violet. In wet forests, from central Mexico to Bolivia, the Guianas and Brazil.

A. ravenii Croat & R.A. Baker, Pl. 10a,b
Epiphyte, stem usually 25- 40 cm long; cataphylls soon deciduous, leaving a few fibers; leaves simple, ovate-triangular, 30-75 cm long, 16-40 cm wide, prominently lobed at base, petioles 19-70 cm long; inflorescences erect-spreading, spathe oblong-elliptic or ovate-elliptic, 7,9-19 cm long, 1,5-4,4 cm wide, greenish-white to pale green, spadix 8,5-24 cm long, cream, yellow to pale green; fruits orange-red. In wet forests, from Honduras to Colombia.

Dieffenbachia (neotrop. ca. 20, CR 15, GD 6)
Common names (Costa Rica): sahinillo, loteria (GRAYUM, in prep.)
Terrestrial and somewhat succulent forest understory herbs with milky latex and with well-developed erect stems and always entire, usually oblong or elliptic leaves without basal lobes. Usually with rather unpleasant pungent odor (skunk-like) and sometimes with the leaves dotted white above. Spathe entirely enclosing spadix except during a very brief anthesis, the fruiting inflorescence is curling to split irregularly and reveal rather separated orange-arillate seeds.

D. aurantiaca Engl.
Plant to 2 m tall; leaves oblong-elliptic, 31-57 cm long, 11,5-27 cm wide, petioles triangular in section, sharply keeled to ridged abaxially, the margins thickly winged; spadix ca. 16-20 cm long. In wet forests and on swampy sites in the Golfo Dulce region of Costa Rica and Panama.

D. concinna Croat & Grayum, Pl. 10e
Plant to 1 m tall; leaves elliptic to ovate or broadly lanceolate, 17-36 cm long, 7-22 cm wide, rather glossy above; petiole 8-37 cm long, sheaths rounded distally, unsheathed portion rounded below; spadix 11-16 cm long. In wet forests, endemic to the Costa Rica.

D. oerstedii Schott, Pl. 10c,d
Plant to 75 cm tall; leaves mostly ovate to lanceolate, 7-26 cm long, 1,5-13 cm wide, petiole subterete, rounded abaxially, margins not winged; spadix 7-12,5(-17) cm wide. In wet and moist forests, from Mexico to Panama.

Dracontium (neotrop. 23, CR 4, GD 2)
Terrestrial forest understory plants, seasonally dormant, consisting of one giant, trisect leaf, borne from the underground rhizome. The inflorescence is also borne from the rhizome, near the

leaf. This genus includes some of the tallest herbs of the family in the Neotropics.

D. pittieri Engl., Pl. 11a-c
Giant herb, tuber 7-20 cm in diameter; leaves large, blade 1-2 m in diameter, deeply divided, petioles 1,8-3,5 m long; inflorescence emerging from the ground near base of the petiole, spathe 30-70 cm long, 8-12 cm wide, margins overlapping at base, wide acuminate, maroon; fruits deep purplish. Endemic to Costa Rica.
D. pittieri is one of the largest species of the genus. Another distinct character of the species is that the leaf and the inflorescence are sometimes present at the same time.

Heteropsis (neotrop. 13, CR 1, GD 1)
A genus of slender, rather woody climbers or hemiepiphytic vines often occurring in the canopy. The subsessile leaves are distinctive in having straight, closely spaced, prominulous, parallel secondary veins and a strong marginal collecting vein. The inflorescence is composed of a caducous spathe and a uniform spadix, bearing bisexual flowers, of which the lowermost are often functionally pistillate.

H. oblongifolia Kunth, Pl. 11d
Canopy liana; leaves distichous, simple, entire, narrowly elliptic to oblong-lanceolate, 10,5-21 cm long, 2,7-7,2 cm wide; inflorescences solitary, spathe cream-yellow to greenish, soon deciduous, spadix cream-yellow to light green; fruits orange-yellow to reddish. In wet forests, from Nicaragua to Bolivia and Brazil.

Homalomena (pantrop. 140, CR 4, GD 2)
Terrestrial understory herbs with underground rhizomes and aromatic fragrance.

Key to the species of *Homalomena* (after CROAT 1997a)

1 Leaves deeply cordate to sagittate at base, plain green, pubescent below (at least along midrib and major veins); plants not strongly aromatic; capitate staminodia present among female flowers — *H. wendlandii*

1* Leaves attenuate to broadly cuneate or rounded at base, plain green or spotted to variegated, glabrous; plants (incl. herbarium specimens) redolent with strong, spicy aroma; staminodia absent among female flowers — *H. erythropus*

H. erythropus (Schott) Engl.
Acaulescent herb; leaves narrowly or broadly elliptic to obovate or oblanceolate, 15-38 cm long, 5,3-14,1 cm wide, glabrous; inflorescences erect, spadix 6,2-9,1 cm long. In wet forests, from Costa Rica to Amazonian Brazil.

H. wendlandii Schott
Acaulescent terrestrial herb; leaves deeply ovate-cordate to sagittate, 34-67 cm long, 22,5-50 cm wide, puberulent beneath on the venation; inflorescences erect, spadix 11,5-18 cm long. In wet forests, from Costa Rica to Colombia.

Monstera (neotrop. 25, CR 27, GD 6)
More or less succulent hemiepiphytic climbers, the juvenile plants terrestrial with elongate internodes and mostly ovate small, overlapping blades, growing appressed against tree trunks. The mature leaves are usually fenestrate or deeply laciniate. The spathe is early caducous. The sessile uniform spadix is white to yellow and cylindroid, bearing the bisexual flowers, which are densely aggregated in several spirals.

M. adansonii Schott, Pl. 11e-g
Epiphytic climbers, growing in 1-5 m height; leaves ovate to lance-ovate or oblong (7,5-)17-48(-70) cm long, (5-)7-31(-35) cm wide, mostly perforate, margin entire; inflorescences yellow-green to cream-yellowish, spathe white within, spadix 4,5-11(-15,5) cm long, 0,8-1,7 cm wide. In dry, moist and wet forests, from Honduras and the Lesser Antilles to Peru and Brazil.

Philodendron (neotrop. 350-400, CR 57, GD 19)
The second largest genus of the family, consisting of hemiepiphytic climbers or vines and less frequently terrestrial plants, with completely parallel secondary and tertiary venation, lacking a marginal collecting vein. The spathe is persistent and typically somewhat constricted above tube, opening widely at anthesis. The spadix is differentiated into a thick cylindrical part of female flowers

and a slender apical part with male flowers.

Philodendrons show a great variety with regard to growth-form. *P. wendlandii* from Central America grows in the canopy and builds "bird nests". *P. martianum* exhibits an organization analogous to orchids: the shiny leathery leaves are supported by swollen, spongy stalks which are similar to the pseudobulbs of orchids. Another species, the Brazilian *P. bipinnatifidum,* is arborescent and can reach 10 m in height and 10 cm in diameter.

The genus can be subdivided into 3 subgenera, 2 of them occurring in the GD, the third restricted to South America.

Key to the relevant subgenera of *Philodendron* (after GRAYUM, in prep.)

1 Stems of mature (flowering) plants lacking cataphylls (leaves reduced to petiole sheath), though cataphylls sometimes present among the inflorescences; petioles of all leaves narrowly amplexicaul, sheathed more than halfway to base of blade subgenus *Pteromischum* (incl. *P. sulcatum*, *P. rhodoaxis*, *P. popenoei*)

1* Stems of mature plants with foliage leaves regularly alternating with cataphylls, the latter sometimes quickly deciduous, or weathering to fibers; petioles of all leaves attached flush with stem (not amplexicaul), sheathed less than halfway to base of blade subgenus *Philodendron* (*incl. P. fragrantissimum, P. pterotum,grandipes, P. sagittifolium, P. tripartitum*)

P. auriculatum Standl. & L.O. Williams, Pl. 12a,b
Appressed-creeping trunk epiphytes, usually high in canopy; cataphylls ultimately caducous intact; leaves narrowly elliptical to lance-oblong, truncate to rounded or auriculate at base, 37-75 cm long, 8-24 cm wide, petioles ca. 17-49 cm long; inflorescences solitary in axils, spathe tube deep reddish within, spadix ca. 11-20 cm long; mature fruits orange. In wet forests, endemic to Costa Rica.

P. fragrantissimum (Hook) G. Don
Hemiepiphytic climber, usually appressed climbing in about 3,5-5 m height; cataphylls persistent, weathering to fibers; leaves ovate to ovate-triangular, cordate at base, (25-)34-70 cm long, 28-65 cm wide, petioles D-shaped to C-shaped, 22-70 cm long; inflorescences 1-3 per axil, erect to semi-erect, spathe tube deep red to maroon on both sides, spathe blade white to greenish, or rarely reddish outside, spadix 9-16 cm long; fruits bright red to purple-red. In moist and wet forests, from Belize to Peru and Brazil.

P. grandipes K. Krause
Terrestrial herb with creeping stem, rarely climbing appressed to a tree; cataphylls persistent, sometimes weathering to fibers; leaves broadly ovate-cordate, cordate at base, 20-50 cm long, 15,5-36 cm wide, petioles D-shaped, 25,5-73 cm long; inflorescences 1-4 per axil, erect, spathe pale green to reddish or purplish on both side, spadix 6,6-11,8 cm long; fruits creamy white. In moist and wet forests, from Nicaragua to Pacific Colombia and Pacific Ecuador.

P. popenoei Standl. & Steyerm.
Terrestrial plant, or sometimes becoming scandent to at least 5 m above ground; cataphylls infrequent or inconspicuous; leaves broadly lanceolate to broadly ovate or suborbicular, rounded-cordate basally, (19,5-)26,7-36,6(-42,9) cm long, (9,3-)17,6-32,3(-34,7) cm wide; inflorescences (1-)2-3 per axil, spathe white to cream, spadix 8,5-11,3 cm long; fruits yellow-orange. In wet forests, from Guatemala to Costa Rica and Western Panama.

P. pterotum K. Koch & Augustin, Pl. 11h
Hemiepiphytic or epiphytic plants, appressed climbing; cataphylls persisting as reddish brown, semi-intact fibers; leaves ovate, deeply cordate at base, 45-115 cm long, 34-86 cm wide, petioles (37-)47-111 cm long, D-shaped, marginally winged; inflorescences erect, 2-4 per axil, spathe tube reddish to purplish outside, reddish inside, spathe blade white to greenish on both sides, spadix 11,1-19 cm long; fruits pale brown to

white. In moist and wet forests, from Nicaragua to central Panama.

P. rhodoaxis G.S. Bunting
Epiphytic climber, appressed climbing, ca. 1,5-3,5 m above the ground; cataphylls borne only among the inflorescences, early caducous; leaves usually narrowly to broadly lanceolate or oblanceolate, (25,2-)27-56,2 cm long, (5,7-)10-23,2(-25,2) cm wide, cuneate to rounded or truncate at base; inflorescences (1-)2(-3) per axil, spathe green to greenish or yellowish green, spadix 8,7-15,3 cm long, fruits translucent-whitish. In wet forests, from Costa Rica to Pacific Ecuador and coastal Venezuela.

P. sagittifolium Liebm., Pl. 11i
Epiphytes, usually appressed climbing, rarely terrestrial; cataphylls usually soon deciduous; leaves ovate to ovate-triangular, cordate to somewhat sagittate at base, 24,5-63,5 cm long, 9-32,5 cm wide, petioles 20-65(-91) cm long, convex to flattened or broadly channeled above; inflorescences 1-4 per axil, spathe usually green, sometimes plum-red, often purple-spotted on both sides, spadix (8-)9-16 cm long; fruits white. In moist forests and premontane wet forests, from Mexico to Colombia and Venezuela.

P. sulcatum K. Krause
Epiphytes, appressed climbing, 1,5-4 m above the ground; cataphylls borne only among the inflorescences, early caducous; leaves ovate to narrowly or broadly elliptic to lanceolate, cuneate or rounded at base, ca. 14,3-28 cm long, 4,1-12,8 cm wide; inflorescences usually 1-2 per axil, spathe pale green or cream, spadix 7,6-12,6(-13) cm long; fruits whitish. In wet forests, often on somewhat disturbed sites, from Nicaragua to Pacific Ecuador.

P. tripartitum (Jacq.) Schott
Hemiepiphytic climbers, appressed climbing to loosely scandent; cataphylls greenish, not weathering, deciduous; leaves trifoliolate or deeply trilobate, (15,5-)22-45(-49) cm long, 21-43(-46) cm wide, petioles 20-61 cm long, terete to subterete; inflorescences usually solitary or sometimes 2(-3) per axil, spathe usually medium green to yellow-green, rarely creamy white, with dark purple dots, spadix 9-16,5 cm long; fruits white. In lowland and premontane moist and wet forests, from Mexico to Ecuador.

Pistia (pantrop. 1, CR 1, GD 1)
A monospecific genus that plays an important role in the ecology of tropical waterways.

P. stratiotes L., Pl. 12c
Free floating, acaulescent, stoloniferous herb forming large colonies; leaves arranged in a rosette, subsessile fleshy, apex rounded, base cuneate parallel veins sunken, impermeable pubescent; inflorescences axillary, solitary, spathe 1,3-1,5 cm long, convolute and adnate to the spadix below, whitish, spadix with a single pistillate flower at base, 2-8 staminate flowers above, shorter than the spathe; flowers unisexual, stamens 2, ovary 1-locular; fruits thin-walled berries, seeds 4-13. In lagoons, canals, and rice fields throughout the tropics worldwide.
In its natural habitat *P. stratiotes* plays an important role in the nutrient cycle of tropical water systems. It mainly grows and reproduces in lakes and swamps, often in stagnant water, which it helps to purify, and is flushed out into streams and rivers during the rainy season. The problem is that the plant is cultivated in ornamental pools, from where it invariably finds its way into major waterways. Together with *Eichhornia crassipes,* it has the reputation of a pernicious weed because of its exponential growth.

Rhodospatha (neotrop. 12, CR 5, GD 2), Pl. 12d
This is a little known genus of the Neotropics. As the generic name ("rhodon" meaning rose) suggests, the spathes and the new leaves are often pinkish.
Mostly appressed hemiepiphytic climbers or sometimes on rocky stream banks, vegetatively very similar to some *Philodendron* spp. in having oblong leaves with numerous secondary veins and without basal lobes, but the petiole winged to near apex. Some *Philodendron* species also have fully winged petioles, but these are not oblong-leaved. The spadix is uniform unlike in *Philodendron.*

Key to the species of *Rhodospatha* (after GRAYUM, in prep.)

1 Primary lateral leaf veins < 25 per side; petiole sheaths persistent; petioles 4,3-19,5 cm long; leaves ca. 2,7-9,4 cm wide ..... *R. osaensis*

1* Primary lateral leaf veins > 25 per side on at least some larger leaves; petiole sheaths deciduous; petioles (13-)30-83 cm long; leaves (8,8-)15-35 cm wide — *R. wendlandii*

R. osaensis Croat & Grayum
Epiphytic vine; leaves narrowly elliptic or oblong-lanceolate to oblanceolate; spathe pure white within, spadix cream colored; fruits blue-green. In wet forests, endemic to Costa Rica.

R. wendlandii Schott
Epiphytes, appressed climbing; leaves lance-ovate to narrowly elliptic or oblong-lanceolate, (23,5-)36-75 cm long, (8,8-)15-35 cm wide; spathe white or cream to pinkish, spadix pinkish to purplish or reddish at anthesis; fruits pale yellow or yellow-orange. In wet forests, from Mexico to Colombia.

Spathiphyllum (neotrop. + SE Asia 36, CR 8, GD 3)
Terrestrial rhizomatous herbs, mostly growing in colonies in swampy places. The leaves are always somewhat elliptic with a cuneate base and with completely parallel and rather strongly ascending secondary and intersecondary veins without a marginal vein. The inflorescence is very characteristic with a leaf-like, large, open, white or greenish spathe and a uniform spadix with bisexual flowers.
The distribution of the genus is remarkable. Most of the 45 species occur in South America, but unlike other neotropical genera of the Araceae it never reached further into the Antilles than Trinidad (*S. cannifolium*). There are none in Africa and just three species in SE Asia and Melanesia.

S. silvicola R. Baker
Leaves narrowly elliptic or lance-oblong, usually cuneate at base, 15-38,5 cm long, 4,5-11,5(-15,3) cm wide; spathe lanceolate or narrowly elliptic or ovate, 7,9-14,5 cm long, 1,7-4,3 cm wide, light green or white with greenish veins, spadix white; fruits white with yellow cap. In wet forests, endemic to Costa Rica.

S. wendlandii Schott, Pl. 12e,f
Leaves narrowly or broadly elliptic to lance-oblong or oblanceolate, usually attenuate at base, 38-74 cm long, 11-28 cm wide; spathe narrowly to broadly elliptic, 16-29 cm long, 5,5-9,8 cm wide, white, spadix white. In wet forests in Costa Rica and Panama.

Stenospermation (neotrop. ca. 30, CR 8, GD 2)
Epiphytes or hemiepiphytes, rarely terrestrial, climbing on trunks and on branches, characterized by spirally arranged, simple leaves. The inflorescence is composed of a caducous spathe and a uniform spadix with naked flowers.

Key to the species of *Stenospermation* (after GRAYUM, in prep.)

1 Spadix (1,2-)1,7-3,8 cm long, sessile or stipitate by up to 0,2 cm — *S. angustifolium*
1* Spadix (2,5-)4,3-7,9 cm, stipitate by 0,3-1,3 cm — *S. marantifolium*

S. angustifolium Hemsl., Pl. 12g
Epiphyte, growing at least 30 m above the ground; leaves mostly lanceolate or narrowly elliptic to lance-oblong or oblanceolate, ca. 4,5-23,7 cm long, 1,2-5,6 cm wide; spathe white, spadix white to grayish or greenish; fruits white. In wet forests, from Nicaragua to Pacific Ecuador.

S. marantifolium Hemsl.
Trunk epiphyte, growing ca. 2-3 m above the ground or in canopy; leaves elliptic to lance-oblong, oblanceolate or obovate, ca. 9-34 cm long, (2,8-)4,5-11 cm wide; spathe white or light green, spadix white; fruits white. In wet forests, from Nicaragua to Peru.

Syngonium (neotrop. 33, CR 16, GD 6)
Appressed, succulent, terrestrial or hemiepiphytic climbers, mostly distinctive in palmately 3-5-parted leaves with basal lobes on the lateral leaflets. Species with undivided leaves have strong basal lobes. The parallel-reticelate leaf venation is intermediate between reticulate-veined *Anthurium* and strictly parallel-veined *Philodendron*. The peduncle is erect in flower and pendent in fruit. The fruits are distinct in being united into a syncarp and the often colored spathe tube is persistent until maturity. Except for being scandent, very similar to *Xanthosoma*.

S. hastiferum (Standl. & L.O. Williams) Croat, Pl. 12h
Epiphytes, appressed climbing; leaves simple, rarely deeply trisect to trifoliolate, sagittately to subhastately lobed at base; inflorescences 3-9 per axil, spathe tube green, spathe lamina cream to greenish white, spadix sessile, white; mature syncarp yellowish brown. In wet forests, probably endemic to Costa Rica.

S. macrophyllum Engl.
Scandent epiphytes, growing appressed, stems glaucous; leaves pedately compound with (3-)5-7(-9) leaflets; inflorescences 4-8 per axil, peduncles sometimes glaucous, spathe tube green and glaucous outside, green inside, spathe blade green, becoming cream-colored; syncarp brown. In wet forests, from Mexico to Pacific Ecuador.

S. triphyllum Birdsey ex Croat
Epiphytes, apressed climbing; leaves 3-foliolate to pedately 5-foliolate, leaflets ovate to elliptic or oblong elliptic; inflorescences 1-5 per axil, spathe tube narrowly ellipsoid, pale green outside, red inside to near the apex, spathe blade white on both sides; syncarp white. In wet forests, from Honduras to Panama.

Xanthosoma [neotrop 57, CR 5 (incl. 1 introduced), GD 2]
This is the main terrestrial genus of aroids, characterized by palmately dissected or triangular succulent leaves with strong basal lobes, reticulate venation, and usually marginal and submarginal collecting veins. Typically rather coarse herbs, occasionally with soft "trunk" to 2 m in height. Spathe strongly constricted at throat and with upper part of spathe more open than in *Philodendron* and caducous immediately after anthesis.
In general, *Xanthosoma* shows the tendency to grow in rather wet places, often in bright light and only a few species occur in the forest.

X. dealbatum Grayum
Leaves simple, sagittate at base, 31-57 cm long, 17,5-32 cm wide, strongly bicolored (matte and whitened abaxially); inflorescences to at least 4 per axil; spathe tube green on both sides, spathe lamina white to cream-colored, spadix white to yellow; fruits yellow-orange to orange. In wet forests, endemic to Costa Rica.

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Arecaceae (Palmae)

A large and easily recognized family of small to large, solitary or clustered, unarmed or armed, pleonanthic or rarely hapaxanthic, hermaphroditic, polygamous evergreen shrubs, treelets or trees. Most species are inhabitants of the understory of the rainforest, and only a few are arborescent. Stems always woody, usually unbranched, sometimes short or subterranean, sometimes spiny, often covered with dead and partly rotten leaf sheaths; **leaves** alternate, usually apically clustered, entire or variously compound, palmate or pinnate, leaflets folded, variously shaped, often linear, lanceolate or sigmoid, leaves always sheathed at the base, sheath sometimes persistent, sometimes closed and forming a crownshaft; **inflorescences** axillary, rarely- terminal, inserted among or below the leaves, paniculate or spicate, subtended by 1-several bracts; **flowers** bisexual or unisexual, plants then monoecious or dioecious, usually small and inconspicuous, greenish-white, white, yellow or purple-red, tepals usually 6, in two whorls, free or connate, stamens (3-)6(-numerous), ovary superior, apocarpous or variously syncarpous, 1-3 (-10)-locular; **fruits** berries or drupe, very variable in size, seeds usually 1 (sometimes 2-3-10). Pantrop. 194/ca. 2500, CR 30/110, GD 23/ca. 45.

In most cases pollination, of the palms is by insects, while pollination by wind plays a minor role. Several recent studies on neotropical palms have identified bees, beetles and flies and as the main pollinators within the family (MORA URPI & SOLIS 1980, HENDERSON 1985, 1986, BARFOD et al. 1987, LISTABARTH 1992, 1993a, 1993b, 1993c, BORCHSENIUS 1997, KÜCHMEISTER et al. 1997, 1998, ERVIK et al. 1999, HENDERSON 2000).

The palms are commercially one of the most important families in the world. The endosperm of the coconut palm (*Cocos nucifera*) is used in various ways in the fresh state or dried as "copra". By pressing, coconut oil is produced, which is still one of the worlds most important commercial oils, used as staple oil for margarine, various kinds of foods, cosmetics, pharmaceuticals and for industrial purposes. The fibers of the mesocarp, known as "coir", are used for mats, brooms and paddings. Also, the unripe fruits, the so-called drink-coconuts, with their fully liquid endosperm are sold as refreshments. Apart from the fruits, the coconut palm has various other uses. Palm sugar is produced from the sap, tapped from the inflorescences. By fermenting this sap, palm wine, known as "toddy", liquor ("arrak") and vinegar are obtained. The leaves are used for thatching and weaving, the wood of the trunk for household products and handicrafts, and the roots as medicine. From the sap of the inflorescences and the stems of *Acrocomia aculeata* the popular "Coyol" wine is produced. It is still in demand in some Central American countries such as Honduras, and was until recently also produced in Costa Rica in larger quantities. Currently, *Acrocomia* is also considered a promising oil-producing plant in drier areas. The mesocarp of the fruits of *Bactris gasipaes* is used as a carbohydrate source. The palm-heart of this species is eaten as a vegetable, the stems are sometimes used in construction. As already evident from its popular name, the main use of the oil palm (*Elaeis*) is the extraction of oil from the fruits. The

mesocarp especially contains a high amount (35 to 60%) of oil, but also the seeds, used for their oily endosperm similar in quality to coconut oil. The mesocarp oil is primarily used as cooking oil. The endosperm oil is only used for industrial purposes, particularly for lubricants. While the African oil palm (*Elaeis guineensis*) has become one of the most important oil crops and is cultivated throughout the tropics, *E. oleifera* is only of minor importance, used only in rural areas. *Euterpe precatoria* var. *precatoria* is an important economic palm in the western Amazonian lowlands, used in the same way as *E. oleracea,* provider of edible palm hearts, which are eaten as vegetables. *Iriartea deltoidea* has various uses among indigenous people of South America, such as the edible palm-heart and a very hard and durable outer part of the trunk for flooring, spears and arrows. But this species is only seldom used in Costa Rica. In South America most species of *Oenocarpus* are used in various manaus. From the mesocarp of the fruits an oil of very high quality, similar to olive oil, is extracted. The fruits are also used for preparing a tasty cocoa-like beverage. Different kinds of fibers are obtained from the leaf bases for weaving and the production of darts. The hard wood of the trunk is used for spears and blow-pipes, the leaves for weaving and rural constructions. Several other minor uses are known. But apparently little or no use is made of these palms in Central America. *Raphia* palms are used for various purposes in Africa. Palm wine produced from the inflorescences is high in demand. The palm heart, the oil-rich mesocarp and the unripe seed of some species are eaten. Fruits of other species are used as fish poison. The stripped epidermis of young leaflets provides the internationally traded "raffia" fibers. The leaf sheaths also yield fibers. The petioles are used in rural construction or for household products and handicrafts. Only the latter use is sometimes seen in the Americas, the other uses seem to be unknown there.

Key to the genera

1	Leaves palmate, i.e. all leaflets inserted at the apex of the petiole, and radiating, thus blade fan shaped; leaf divided to the base into numerous segments, these also split deeply along the adaxial folds/veins; hastula conspicuous on the upper side, small on the lower side of the blade insertion; trunk up to 10 m tall and to 13 cm in diameter, armed with branched rootlet-thorns	*Cryosophila* (*C. guagara*)
1*	Leaves bifid, i.e. blade divided by an apical split along the rhachis into two equal parts, or leaves pinnate, i.e. leaflets inserted along an elongate rhachis, not to differentiate from the petiole; no hastula present; trunk subterranean (appearing "acaulescent"), prostrate or erect, slender or massive	2
2	Leaves bifid	3
3	Plants armed with spines on leaf sheath, petiole, ribs; at least blade margins armed with minute spines (rub with finger tips along blade margin from apex to the base)	4
4	Leaves greenish below	*Bactris*
4*	Leaves white below	*Astrocaryum*
3*	Plants not armed with spines in any part	5
5	Sheaths of lower (living!) leaves green, tubular and enclosing the stem completely, or split opposite the petiole down to their base; old sheaths usually clearly abscising, if persisting normally remaining entire and not disintegrating into a fibrous mass on the trunk; stem, when apparent, slender, with green elongate, rarely closely spaced internodes, maybe to some part covered with old leaf sheaths; leaf surfaces always without hairs (use pocket lens!); leaves never with indumentum (i.e. densely aggregated, often brown to reddish hairs, giving the covered parts a slightly wooly appearance)	6
6	Leaf sheaths of lower leaves tubular and at least in the lower part completely enclosing the stem, not or only to 2/3 their length split opposite the petiole; petiole maybe with yellow strip on the lower side; plants always solitary	*Chamaedorea*
6*	Leaf sheaths of lower leaves not completely tubular and split to the base opposite	

	the petiole; plants always clustered, when trunked; petiole never with yellow strip below	*Synechanthus warscewiczianus*
5*	Sheaths of lower (living!) leaves brown to gray, not perfectly tubular and completely enclosing the stem, split to the base opposite the petiole, or consisting of interwoven brown/gray fibers; old sheaths often not clearly abscising, disintegrating on the stem into fibers; plants solitary or clustered stem, when visible, slender, but internodes usually brown or gray, very rarely green, elongate or closely spaced; lower surface of leaves always with hairs; petioles and ribs often carrying an indumentum	7
7	Blade margins clearly dentate; plants clustered, not reaching more than 1,5 m in height; flowers never sunken immersed in pits on the rachillae (i.e. flower carrying branches of the inflorescence)	*Reinhardtia simplex*
7*	Blade margins not dentate, entire or eventually shallowly notched; plants solitary or clustered, small or to several meters tall; flowers always immersed in pits onto the rachillae	8
8	Leaf sheaths of older (living) leaves except the petiole completely fibrous; plants solitary or clustered; stems aerial, up to 7 m (rarely 10 m) tall or subterranean, with elongate or seldom condensed internodes	*Geonoma*
8*	Only margins of older (living) leaf sheaths fibrous; plants always solitary; stems usually subterranean, rarely erect, if so never reaching more than 2 m in height, and internodes always condensed	9
9	Leaf much longer than wide; leaf base elongate cuneate, with nearly equal insertion of blade on both sides of the rhachis; peduncular bracts, one or two, inserted at the base of the peduncle (i.e. stalk of the inflorescence)	*Asterogyne* (*A. martiana*)
9*	Leaf not much longer than wide, with base wide rounded, and clearly unequal insertion of blade; peduncular bract, always solitary, inserted just below the flowers in the upper part of the peduncle	*Calyptrogyne* (*C. ghiesbreghtiana*)
2*	Leaves pinnate, leaflets (pinnae) regularly or irregularly spaced, equal or unequal wide	10
10	Leaflets more or less wedge-shaped, apical margins praemorse, i.e. jagged, giving the pinnae a "bitten off" appearance, in adult plants single leaflets often further divided to the base and held in different planes, giving the leaf a plumose appearance; adult plants large solitary tree-palms with long stilt roots, these emerging up to 1 or 2 m up the trunk	11
11	Apical leaflet entire; if pinnae segments held in different planes, tips erect; stilt roots forming a dense cone, up to 1 m tall, side-rootlets on stilt roots rounded, not thorn-like; inflorescence in bud pendulous and strongly curved	*Iriartea* (*I. deltoidea*)
11*	Apical leaflet bifid; if pinnae segments held in different planes, tips pendulous; stilt roots forming an open, loose cone, up to 2 m tall, covered with sharp conical rootlet thorns; inflorescence in bud erect and straight	*Socratea exorrhiza*
10*	Leaflets lanceolate, ovoid or sigmoid, never wedge-shaped, not further divided; margins entire, notched or toothed, never jagged; if leaves plumose then plants small and/or armed with spines on leaves and/or trunks; if stilt roots at the base, these only very small, less than 50 cm	12
12	Plants armed with spines on leaves and sometimes on stems; if not armed otherwise, at least blade margins with minute spines (rub with finger tips along blade margin from apex to the base)	13
13	Only petiole armed with two parallel rows of thorns, representing modified basal leaflets; not armed in any other part, including leaflet margins; plants large, with creeping or erect stem usually more than 20 cm in diameter; usually in swampy depressions, along rivers or cultivated areas	*Elaeis*

13*	Also other parts, at least margins of the leaflets, armed with spines	14
14	Leaves white below; large black spines also on trunk or persistent leafbases	*Astrocaryum*
14*	Leaves green below	15
15	Plants large, usually over 5 m in height, with trunk more than 10, up to 50 cm in diameter; leaflet always held in different planes, giving the leaf a plumose appearance; leaves green or grayish	16
16	Trunk always solitary and aerial, 4–11 m tall, 10-50 cm in diameter, spiny, partly covered with persistent, also spiny, not disintegrating leaf bases; leaves gray-green, usually over 2 m long, spines on base, petiole, rhachis and midribs of leaflets; occurring only on open, dryer sites, as pastures	*Acrocomia* (*A. aculeata*)
16*	Trunk usually clustered; leaves never grayish	17
17	Trunks 1-6 m tall, 20-40 cm in diameter, often obscured by persistent, non spiny, leaf bases disintegrating into fibers; leaves very large, to 10 m long, pinnae only armed along margins and veins with small spines; infructescence pendulous, more than 2 m long, fruits covered with overlapping scales; only found in swampy areas and along streams, common in mangrove zones	*Raphia* (*R. taedigera*)
17*	Stems to 18 m tall, 10-25 cm in diameter, not covered with persistent leafbases, but nearly always with rings of long black spines; leaves to about 4 m long, but never reaching 10 m, armed also along rhachis; petiole and sheath with large brown to black spines; infructescence shorter than 1 m, fruits with smooth green to red surface; occurring only cultivated in cleared areas	*Bactris gasipaes*
15*	Plants much smaller, if over 5 m tall, then stems less than 5 cm thick; leaflets in one or rarely in different planes, never grayish	*18*
18	Plants always clustered; leaves with ovoid, but not sigmoid pinnae, these always single and evenly spaced and held in one plane; eventually climbing by means of "cirri", i.e. extensions of the rhachis armed with thorns modified from terminal leaflets ("acanthophylls")	*Desmoncus*
18*	Plants solitary or clustered; leaflets linear lanceolate or sigmoid, never ovoid, single or compound, evenly spaced or aggregated, held in one or different planes; never climbing	*Bactris* p.p.
12*	Plants not armed throughout	19
19	Plants with well-defined crownshaft, i.e. the entire tubular sheath of the lowest leaf encloses the shafts of the younger leaves nearly completely	20
20	Plants solitary or clustered, up to 20 m tall; leaflets regularly arranged, in one plane, green beneath; new emerging roots at the base of the stem deeply red; inflorescence branches spreading	*Euterpe*
20*	Plants always clustered, up to 15 m tall; basal and middle leaflets irregularly arranged, usually held in different planes, glaucous beneath; emerging roots whitish to brown; inflorescence branches pendulous, resembling a horse-tail	*Oenocarpus mapora*
19*	Plants with open crowns, i.e. the leaves are wider spaced on the trunk or the sheaths split opposite the petiole, so that the lowest cannot enclose the sheaths of the younger ones	21
21	Large tree palms, usually more than 10 m in height, always solitary	22
22	Plants only found in the rainforest, never in open areas (except for clearings); stems 15 cm or less in diameter, up to 20 m tall; young unfolding leaves reddish	*Welfia* (*W. regia*)
22*	Plants only found in open areas, drier forests or along the seashore; never in the true rainforest; stems more than 20 cm in diameter, up to 20 m tall; young unfolding leaves green	23
23	Trunk widened at the base, due to new emerging roots, tapering towards the apex, at the seashore often arching; leafbases, petioles and pinnae-midribs yellowish; infructescences nearly always present, with large, up to 25 cm wide, green to brown fruits; found on or in the vicinity of the seashore, inland only in cultivated areas	*Cocos* (*C. nucifera*)

23*	Trunk always straight and columnar, leaves green throughout; inflorescence also usually present, containing many more fruits, but these are much smaller, 4-8 cm, orange-yellow to brown colored; found in drier (semi-deciduous) forests or open areas, not occurring directly on the sea shore	*Attalea butyracea*
21*	Smaller, always understory palms, far less than 10 m tall, if approaching that height always clustered	24
24	Plants with erect stems	25
25	Stems with green internodes	26
26	Leaflets always linear-lanceolate, single and equally spaced; plants always clustered, 1,5-7(-10) m tall; old leaf bases persistent and usually disinte grating	*Prestoea decurrens*
26*	Leaflets sigmoid, often joined to segments of different width on the same leaf and thus unequally spaced - if lanceolate, single and equally spaced then plants always "acaulescent", not above 2 m tall and solitary; old leaves abscissing, or if persisting normally not disintegrating; plants solitary or clustered	27
27	Sheaths of lower leaves not or only to 2/3 their length, split opposite the petiole; plants nearly always solitary, if clustered plants up to 7 m (10 m) tall, with stilt roots at the base; petiole sometimes with yellow strip on the lower side	*Chamaedorea*
27*	Sheaths of lower leaves split to the base opposite the petiole; plants always clustered; petiole never with yellow strip below	*Synechanthus warscewiczianus*
25*	Stems with brown to gray internodes	28
28	Leaflet margins toothed; small windows at the bases of joined leaflets always present	*Reinhardtia latisecta*
28*	Leaflet margins entire or shallowly notched; no windows at the base of joined leaflets	29
29	Leaf irregularly pinnatisect, no space on rhachis between inserted leaflets; leaf base elongate cuneate	*Asterogyne* (*A. martiana*)
29*	Leaf regularly or irregularly pinnate, but (joined) leaflets always spaced on rhachis, with base usually wide rounded	30
30	Leaflets always regularly spaced, all of equal width, but pinnae in the middle longer than at the apex and base of the rhachis	*Pholidostachys pulchra*
30*	Leaflets regularly or irregularly spaced, often of different width, but of equal length throughout the rhachis	31
31	Leaf sheaths of older (living) leaves except the petiole completely fibrous; plants solitary or clustered; stems aerial, up to 7 m (rarely 10 m) tall or subterranean, with elongate or rarely condensed internodes; peduncular bracts, always more than one, inserted at the base of the peduncle (i.e. stalk of the inflorescence)	*Geonoma*
31*	Only margins of older (living) leaf sheaths fibrous; plants always solitary; stems usually subterranean, rarely erect, if so never reaching more than 2 m in height, and internodes always condensed; peduncular bract, always solitary, inserted just below the flowers in the upper part of the peduncle	*Calyptrogyne* (*C. ghiesbreghtiana*)
24*	Plants with subterranean stem	32
32	Leaves regularly pinnate, pinnae single, evenly spaced	33
33	Pinnae in the middle longer than at the apex and base of the rhachis	*Pholidostachys pulchra*
33*	Pinnae of the same length throughout the rhachis	34
34	Sheaths of lower leaves not or only to 2/3 their length split opposite the petiole	*Chamaedorea*
34*	Sheaths of lower leaves split to the base opposite the petiole	*Neonicholsonia* (*N. watsonii*)
32*	Leaves irregularly pinnate, at least a part or the pinnae within one leaf fused and irregularly spaced	35

35 No space between the leaf segments on the rhachis; only margins of older (living) leaf sheaths fibrous — *Asterogyne* (*A. martiana*)

35* Leaf segments regularly or irregularly spaced on the rhachis; leaf sheaths of older (living) leaves except the petiole completely fibrous — *Geonoma*

Acrocomia (neotrop. 1, CR 1, GD 1)
A small genus consisting of two species, which are confined to savannas and dry forests. As a member of the Bactridineae subtribe, *Acrocomia* is characterized by spines covering the trunk, leaves and inflorescence-bracts and by fruits with a thick, woody endocarp, which encloses an oil-rich seed.

A. aculeata (Jacq.) Lodd. ex Mart., Pl. 13a
Stem solitary, to 11 m tall and 30 cm in diameter, gray, covered with horizontal rows of black spines or with persistent spiny leaf bases; leaves 10-30, pinnate, spiny, leaflets linear-lanceolate, greyish or glaucous beneath, irregularly arranged and orientated in different planes, giving the leaf a plumose appearance, leaf sheaths short and open, not forming a crownshaft; inflorescences borne between the leaves, enclosed by a large, woody and spiny peduncular bract in bud, branched to one order, bisexual, protandrous; flowers unisexual, yellow; fruits globose, 2,5-5 cm in diameter, yellowish to brown, epicarp easily cracking, mesocarp whitish yellow, mealy and fibrous, endocarp black, with three equatorial pores, to 7 mm thick, seed with white, coconut-like endosperm. Confined to savannas and dry, deciduous woodlands, from Mexico and the Antilles to Bolivia, Argentina and Paraguay.

Asterogyne (neotrop. 5, CR 1, GD 1)
A small genus of undergrowth-palms with large, simple, bifid leaves.

A. martiana (H. Wendl.) H. Wendl. ex Hemsl., Pl. 13g,h
Stem solitary, to 2 m tall and up to 5 cm thick, gray to brown; leaves simple, bifid, to 2 m long and 40 cm wide; inflorescences held between the leaves, branched to one order, protandrous; flowers in pits, white in anthesis; fruits ovoid, to 1,2 cm long, black when mature. Undergrowth species in closed forest or in small gaps, predominantly on valley bottoms and slopes, sometimes occurring in large numbers, from Guatemala and Belize to northwestern Colombia.

Astrocaryum (neotrop. 18, CR 2, GD 2)
A genus characterized by almost all parts of these plants, as leaves, stems, inflorescence and sometimes even the fruits, covered with flattened, black spines, which may - on the trunks - reach lengths of up to 30 cm. It is usually easy to distinguish from its closely related sister genus *Bactris* by the striking white lower surface of the leaves and the restriction of the female flowers to the base of the flowering branches. The species may be medium to 30 m large solitary palms or small plants with short, solitary, subterranean or thin clustering stems, mostly confined to the understory and subcanopy of lowland rainforests.

Key to the species of *Astrocaryum*

1 Leaflets regularly arranged, spreading in one plane, sometimes joined together, leaf-blade thus appearing simple; trunk often covered with persistent, spiny leaf-bases, stem itself not spiny; flowering branches with a single female flower at the base; fruits yellowish to brown, densely covered with short black spines — *A. alatum*

1* Leaflets irregularly arranged and clustered, spreading in different planes, giving the leaf a plumose appearance; trunk spiny, usually not covered with persistent leaf-bases; flowering branches usually with several (up to 8) female flowers at the base; fruits bright orange-red, appearing smooth due to minute spinules — *A. standleyanum*

A. alatum Loomis, Pl. 13b,c
Common name (Costa Rica): coquito (N. ZAMORA pers. comm.)
Stem solitary, to 10 m tall, spineless, but often covered with persistent spiny leafbases; up to 30 leaves, to 3 m long, regularly pinnate, leaflets white beneath, regularly arranged, spreading in one plane, often joined together to wider segments, sometimes leaf blade almost simple, bifid, with serrate margins, leafbases open, not forming a crownshaft, long black flattened spines covering leafbases, petiole, rhachis and midribs of leaflets; inflorescences monoecious, borne among the leaves, pendulous, covered by a persistent, spiny, boat-shaped peduncular bract, bisexual, rachillae with one female flower at the base and only male flowers distally; flowers unisexual, plants then monoecious, protogynous; fruits densely crowded, ovoid to globose, sometimes conical. A very frequent to rare component of the understory to lower subcanopy of lowland to submontane rainforest, from Costa Rica to Panama.

A. standleyanum L.H. Bailey, Pl. 13d-f
Common name (Costa Rica): pejibaye de montaña (N. ZAMORA pers. comm.)
Stem solitary, to 16 m tall, armed with broad bands of long black, flattened spines; leaves up to 20, to 4 m long, irregularly pinnate, leaflets white beneath, irregularly arranged, spreading in different planes, giving the leaf a plumose appearance, leaf bases open, not forming a crownshaft, long black flattened spines covering leaf bases, petiole, rhachis and midribs of leaflets; inflorescences borne among the leaves, pendulous, covered by a deciduous spiny, boat-shaped peduncular bract, bisexual, rachillae usually with 2-8 (rarely only 1) female flowers at the base and only male flowers distally, protogynous; flowers unisexual, plants monoecious; fruits densely crowded, obovoid, epicarp bright orange-red, covered with minute spinules, thus appearing smooth, mesocarp orange, fleshy, edible. Very frequent to rare component of the subcanopy of lowland rainforests, from Costa Rica to western Colombia and Ecuador.

Attalea (neotrop. ca. 29, CR 1, GD 1)
Attalea palms are among the most commonly encountered palms of the Americas.The large stately tree palms of the genus with their huge but nevertheless elegant pinnate leaves are an impressive sight in the open landscape as well as in the forest. Besides the up to 30 m tall arborescent palms, the genus also contains understory palms with condensed subterranean stems. The one to six seeds of each fruit are enclosed by an often massive woody endocarp and often extracted for their oil. The leaves and leaf sheaths yield a valuable fiber.

A. rostrata Oerst., Pl. 14a,b
[syn. *A. butyracea* (Mutis ex L. f.) Wess. Boer]
Common name (Costa Rica): palma real (N. ZAMORA pers. comm.)
Stem solitary, aerial, to 20 m tall, relatively smooth, in younger individuals often covered with persistent leaf bases; leaves large, to 6 m long, regularly pinnate, leaflets arranged in one plane, single-fold, linear-lanceolate with an unequal bifid tip, green on both sides, with a brown tomentose strip on one margin of the lower side, leaf sheaths open, not forming a crown shaft; inflorescences large, borne among the leaves, unisexual but changing sex with time, erect in bud and enclosed by a large boat-shaped, woody bract, then pendulous; fruits oblong ovoid, to 8 cm long, yellow to brown, endocarp fibrous, mealy to oily, yellow to orange, seeds 1-3. Component of the canopy of dryer, eventually deciduous forests or woodlands, also often in open areas in association with high water tables, from Mexico to Peru, Bolivia and Brazil.

Bactris (neotrop. 64, CR 15, GD 6)
This is not only the largest genus of the spiny Bactridinaeae subtribe, but also the second largest palm genus of the Americas (next to *Chamaedorea*). Most characteristic is the presence of spines, differing from heavily armed species with stout, yellow to black, spines to 15 cm long in nearly all parts of the plant, to species almost without spines, except for minute spinules along the leaflet margins. The growth form of the genus is very variable, ranging from small understory palms with subterranean or thin aerial stems to medium and large, arborescent palms, either solitary or clumping.

Key to the species of *Bactris*

1	Cultivated palm, never occurring in the forest	*B. gasipaes*
1*	Forest palms, or rarely surviving in forest clearings but never cultivated	2
2	Leaves regularly or irregularly pinnate	3
3	Spines on trunks and leaves thin, to 5 cm long; leaflets linear, covered with minute, fine hairs on the lower or both sides; inflorescence with many (40-50) short, thread-like flowering branches; fruits orange-red to red	*B. glandulosa*
3*	Spines broadly flattened, to 10 cm long; leaflets sigmoid or lanceolate, not pubescent; inflorescence with relatively few (3-17) flowering branches; fruits purple-black	*B. maraja*
2*	Leaves simple-bifid	4
4	Stems to 2 m tall and to 1,5 cm in diameter; leaf blade broad-ovate, densely covered with minute soft hairs, to 75 cm long; usually on well-drained slopes	*B. hondurensis*
4*	Stems to 5 m tall and to 4 cm in diameter; leaf blade elongate-wedge shaped, not hairy, to 3,5 m in length; only in swampy areas	*B. militaris*

B. gasipaes Kunth, Pl. 14e-g
Common name (Costa Rica): pejibaye
Stems clustering, rarely solitary, to 18 m tall, usually fiercely armed with broad bands of densely packed stout spines, covering the internodes; leaves 9-20, to 3,5 m long, always irregularly pinnate with leaflets clustered and spreading in different planes, leaflet tips strongly unequal in length, spines along the petiole in three distinct rows; leaf sheaths without short extension above the petiole, spiny, open, not forming a distinct crownshaft; inflorescences borne among the leaves, branched to one order, covered by a (persistent) spiny, boat-shaped peduncular bract in bud, bisexual, rachillae with flowers in triads (central female, lateral males), distally with additional solitary or paired males, protogynous; fruits ovoid, to 5 cm long, yellow to red, with a thick, starchy mesocarp. Throughout the humid tropical areas of Central and South America.

B. glandulosa Oerst., Pl. 14c,d
Stems clustering, to 5 m tall, variously armed on the elongated internodes with up to 5 cm long, needle-like, yellow to black spines as also the leaf sheath, petiole and rhachis; leaves to 6, irregularly to almost regularly pinnate, leaflets linear or lanceolate, spreading in different or more rarely in the same plane, with or without a golden pubescence on one or both sides, leaf sheaths with a short extension above the petiole, open, fibrous, not forming a distinct crownshaft; inflorescences borne among or below the leaves, branched to one order, covered by a (persistent) wooly but non-spiny, boat-shaped, peduncular bract in bud, bisexual, rachillae numerous (40–50), filiform, with flowers in triads (central female, lateral males), distally with additional solitary or paired males, protogynous; fruits globose, to 1,6 cm in diameter, red, with a thin, pulpy mesocarp. In lowland rainforests, from southern Central America to adjacent northwestern Colombia.
Two varieties are currently recognized, which both occur in the Corcovado/Esquinas forests: *B. glandulosa* var. *glandulosa* with less spiny petioles and rhachises but densely hairy leaflets and *B. glandulosa* var. *baileyana* with spiny petioles and rhachises and sparsely pubescent leaflets. The latter variety seems to prefer ridges and the upper parts of slopes, while the former is more often found on lower parts of slopes.

B. hondurensis Standl.
Common name (Costa Rica): biscoyol
Stems clustering, rarely solitary, to 2 m tall, sparsely armed with up to 2 cm long, needle-like, yellow to black spines as also the leaf sheath, petiole and rhachis; leaves to 6, bifid or rarely with few additionally basal leaflets, leaf blade densely covered with short, soft hairs, margins with short spinules, leaf sheaths with a short extension above the petiole, open, fibrous, not forming a distinct crownshaft; inflorescences borne below the leaves, branched to one order, covered by a persistent, spiny, boat-shaped, peduncular bract in bud, bisexual, rachillae few (3-7), with flowers in triads (central female, lateral males), distally with additional solitary or paired males, protogynous, pollinated by beetles; fruits globose, to 1,5 cm in diameter, red, with a thin, pulpy mesocarp. In lowland rainforests, from Central America to adjacent northwestern Colombia.

B. maraja Mart., Pl. 14h,i
This species is regarded as very variable and is currently divided into three varieties (HENDERSON 1995), one of them found in Central America.

B. maraja var. ***maraja***
Stems clustering, to 7, rarely 10 m tall and 1-4 cm in diameter, variously armed on the elongated internodes with to 10 cm long, flattened, broad, yellow to black spines, as also the leaf sheath, petiole and rhachis; leaves to 10, regularly or irregularly pinnate, leaflets sigmoid or lanceolate, spreading in different or in the same plane, not hairy, leaf sheaths with a short extension above the petiole, open, fibrous, not forming a distinct crownshaft; inflorescences borne among or below the leaves, branched to one order, rarely spicate, covered by a (persistent) spiny or non-spiny, boat-shaped peduncular bract in bud, bisexual, rachillae few (3–17), with flowers in triads (central female, lateral males), distally with additional solitary or paired males, protogynous, pollinated by beetles; fruits depressed obovoid, to 2 cm in diameter, purple-black, with a thin, pulpy mesocarp. In lowland rainforests, on well drained or inundated soils, from southern Central America, the adjacent Pacific and Caribbean lowlands of Colombia throughout the Amazon Basin.

B. militaris H.E. Moore
Stems clustering, to 5 m tall, spiny; leaves to 8, to 3,5 m long, erect, simple-bifid, elongate wedge-shaped, strap-like, petiole and rhachis covered with needle-like, to 10 cm long, black spines; leaf sheaths spiny, with a short extension above the petiole, open, fibrous, not forming a distinct crownshaft; inflorescences borne among or below the leaves, branched to one order, covered by a (persistent) wooly, sparsely spiny, boat-shaped peduncular bract in bud, bisexual, rachillae 14–23, with flowers in triads (central female, lateral males), distally with additional solitary or paired males, protogynous, pollinated by beetles; fruits globose, to 1,7 cm in diameter, orange-red, with a thin, pulpy mesocarp, endocarp woody. In lowland swamp forests, endemic to Costa Rica.

Calyptrogyne (neotrop. 8, CR 4, GD 1)
Another small genus of the Geonomeae tribe, with 8 species, ranging from western Colombia to Central America, centered in Panama. This genus of small, solitary undergrowth palms is especially remarkable for its unusual in palms pollination by mammals: while one species (*C. anomala*) is probably pollinated by small ground mammals, the majority of species (including all Costa Rican members) are pollinated by bats.

C. ghiesbreghtiana (Linden & H. Wendl.) H. Wendl., Pl. 15a,b
Common name (Costa Rica): coligallo (HENDERSON 1995)
Stem condensed and subterranean, plant thus appearing stemless; leaves often irregularly divided into few broad and narrow leaflets, but sometimes also simple, but then with a convex bifid apex; inflorescences spicate, erect, held well above the leaves, peduncular bract inserted just below the rachilla, leaving a distinct scar after falling, protandrous, reddish in fruit; flowers in pits, white in anthesis with an intense garlic odor, females with petals forming a deciduous cup and fleshy staminodial tube, males with fleshy flower base; fruits obovoid, 1,6-2 cm long, black when ripe, mesocarp with strong net-like fibers. From Mexico to Panama.

Chamaedorea (neotrop. ca. 96, CR 33, GD 11)
The largest American genus, consisting of rather small, mostly solitary or sometimes clustered palms. The leaves are usually smooth, unlike in most of the other understory genera. Best dinguishable from other understory genera in the closed sheaths (except in the oldest leaves), which remain green and sometimes with a yellow strip along the rhachis, the petioles and the sheaths beneath. The inflorescences are very variable, but mostly borne from the stem and bearing several peduncular bracts.

C. allenii L.H. Bailey, Pl. 15c
Solitary palm, to 2 m tall; leaves 3-6, pinnate or sometimes simple and bifid, leaflets 7-11 per side; inflorescences spicate, unisexual, male inflorescences solitary or few-branched, pendent, female inflorescences erect; fruits globose, 0,7-1,3 cm in diameter, black. In premontane rainforests, from Costa Rica to northwestern Colombia.

C. dammeriana Burret, Pl. 15d
Solitary palm, to 1 m tall; leaves 4-15, pinnate, occasionally simple and deeply bifid, leaflets 2-7 per side; inflorescences borne among the leaves,

male inflorescences with 2-10 flowering branches, female inflorescences spicate or with 2-5 erect branches; fruits globose to ovoid, 0,8-1,5 cm long, black. In rain forests, from Costa Rica to Panama.

C. deckeriana (Klotzsch) Hemsl.
Solitary palm, erect or creeping, to 2 m tall; leaves to 4-5, simple and bifid to half of their length, obovate, 50-70 cm long, margins toothed; inflorescences spicate, unisexual, male inflorescences 4-10, female inflorescences solitary; fruits obovoid-globose, 1-1,5 cm long, 0,5-1 cm wide, black. In rain forests, from Costa Rica to Panama.

C. macrospadix Oerst.
Solitary palm, erect or creeping, to 3 m tall; leaves to 3-7, pinnate, leaflets 7-13 per side; inflorescences erect, unisexual, male inflorescences with 10-25 flowering branches, female inflorescences with 8-15 flowering branches; fruits oblong 0,7-1 cm long, 6-8 mm wide, black. In lowland and montane rain forests, endemic to Costa Rica.

C. matae Hodel
Solitary, erect palm, up to 3 m tall; leaves to 6; inflorescences held on a long, erect stem, unisexual; fruits black, infructescence rhachis orange. In lowland rain forests, endemic to the Golfo Dulce region.

C. pumila H. Wendl.
Solitary, erect or creeping palm, up to 0,5 m tall; leaves 5-15, simple, bifid to three quarters of their length, margins toothed; inflorescences erect, unisexual, male inflorescences with 4-10 flowering branches, female inflorescences spicate or bifurcate; fruits globose, 0,6-1 cm in diameter, black. In lowland to montane forests, endemic to Costa Rica.

C. *sullivaniorum* Hodel & Uhl
Solitary, creeping to erect palms, up to 25 cm tall, leaves 10-15, simple, oblong, 25-40 cm long, bifid to one third of their length, margins toothed; inflorescences erect, male inflorescences with 4-8 flowering branches, female inflorescences spicate or bifurcate; fruits globose, 0,6-0,8 cm in diameter, black. In Costa Rica and Panama.

C. tepejilote Liebm., Pl. 15e
Common name (Costa Rica): palmito dulce (HENDERSON 1995)
Solitary or sometimes clustered, erect or rarely creeping palm, up to 7 m tall; leaves 3-7, pinnate, leaflets 6-25 per side; inflorescences unisexual, male inflorescences 1-5 with 7-50 pendulous flowering branches, female inflorescences 1-4, with 5-20 erect flowering branches; fruits ellipsoid to ovoid, 1-1,5(-2) cm long, 0,7-0,8 cm in diameter, black. From southern Mexico to western Colombia.

Cocos (pantrop. 1, CR 1, GD 1)
Monotypic genus.

C. nucifera L., Pl. 15f
Common name (Latin America): coco
Stem solitary, to 25 m tall, obliquely ringed with leaf scars, conical widening at the base with a mass of adventitious roots, along the shore typically inclining to the sea; up to 30 leaves, to 6 m long, regularly pinnate, leaflets single fold, glossy, green on both sides, petiole, rhachis and midribs of leaflets yellowish, leaf sheaths open, fibrous, not forming a crown-shaft; inflorescences large, borne among the leaves, enclosed by a large boat-shaped, striate, woody peduncular bract in bud, branched to one order, bisexual, male and female flowers in triads at the bases of the rachillae, distally only males in pairs; fruits depressed ovoid, to 30 cm long, green to yellow or orange, seed 1, with a 1-2 cm thick layer of solid, white endosperm and a large cavity, partly filled with a clear, liquid endosperm fraction. Naturally occurring along seashores, worldwide in the tropics, but also cultivated inland.

Cryosophila (neotrop. 9, CR 4, GD 1)
This genus is one of the few rainforest genera among the palmately leaved American palms. A striking feature of these usually solitary, arborescent palms is the formation of aerial, often branched, root spines on the lower part of the trunk, by which the genus is easy to identify.

C. guagara Allen, Pl. 15g,h
Common names (Costa Rica): guagara, surtuba (N. ZAMORA pers. comm.)
Stem solitary, to 13 m tall and 13 cm in diameter, gray with rough surface from old leaf scars, usually covered with sometimes branched root spines, but these may also eventually be weathered; leaves to 30, palmate, divided nearly to the base into up to 70 leaflets, these white below, leaf sheaths split opposite and below the petiole, not forming a crownshaft; inflorescences branched to

two orders, borne among the leaves, pendulous, covered with large papery bracts; flowers white, hermaphrodite, protogynous, pollinated by beetles; fruits globose, 1,3-2 cm in diameter, white, containing a large grooved seed. In lowland rainforests, endemic to Costa Rica and adjacent Panama.

Desmoncus (neotrop. 7, CR 3, GD 2)
One of the few liana genera and the only true liana genus of the Neotropics with only 1 non-climbing species (*D. stans*). Generally all *Desmoncus* species carry spines at least in some parts, as the genus belongs to the spiniferous Bactridineae subtribe, being very closely related to *Bactris* itself. A very characteristic feature is the presence of so-called "cirri", which represent the actual "climbing devices" of these palms. Such a cirrus is an extension of the midrib of the pinnate leaf, which carries modified, reflexed, hook-like leaflets.

D. stans Grayum & Nevers
Plant not climbing up to 2,5 m tall, stems clustering with 3-5 stems per clump, erect or leaning, covered with weakly spiny leaf sheaths; leaves 4-7, regularly pinnate, leaf midrib only with a few cm long thread-like extension, leaflets broadly elliptic with spiny midribs, margin often undulate, leaflet tips usually with a several cm long thread-like appendix, leaf sheaths closed, weakly spiny, extending into a cylindrical tube above the petiole, closely and usually completely sheathing the stem, but not forming a crownshaft; inflorescences borne among or below the leaves, spicate, bisexual, enclosed by a usually non-spiny peduncular bract in bud, flowers in triads (2 males with one female) distally or single or paired males apically; flowers unisexual, creamy white; fruits obovoid, to 2 cm long, bright red when mature. In lowland rainforests, in southern Costa Rica and northern Panama.

Elaeis (Africa + neotrop. 2, CR 1, GD 1)
Massive palms, arborescent or procumbent, developing solitary trunks up to 40 cm in diameter.

E. oleifera (Kunth) Cortes, Pl. 16a,b
Common name (Costa Rica): coquito, corozo
Stem solitary, massive, creeping, with only apical part erect, to 6 m long, but not exceeding 2 m in height, rough, obscured by persisting leafbases, disintegrated into fibers; leaves to 8 m long, always regularly pinnate, leaflets linear lanceolate, orientated in the same plane, leaf sheaths open, fibrous, not forming a crownshaft; inflorescences borne among the leaves, forming a condensed cone, unisexual with one individual producing inflorescences of different sexes alternating, female inflorescences with flower bracts not extending into a spine; fruits elliptic, 2,5-3 cm long, orange-red when mature, mesocarp orange, fibrous-pulpy and very oily. In open, regularly or permanently flooded habitats, along rivers and in swamps of disjunct distribution in Central America and in the Amazon Basin.

Euterpe (neotrop. 7, CR 1, GD 1)
The medium to large, solitary or clustered palms have a distinct crownshaft, elegantly drooping leaflets (in most species) and densely hairy inflorescence branches. Most species of the genus are found in periodically or permanently inundated habitats. To cope with the oxygen deficiency of these waterlogged soils they produce upright breathing roots, so-called "pneumatophores", which can be observed on the soil surface around the trunk.

E. precatoria var. ***longevaginata*** (Mart.) Henderson, Pl. 16c,d
Common names (Costa Rica): palmito, palmito dulce
Stem solitary or clustering, then with only few suckers and these distinctly shorter than the main stem, stem(s) to 20 m tall, with a cone of reddish adventitious roots at the base; leaves 5-20, to 4,5 m long, regularly pinnate, leaflets narrow-linear, spreading horizontally, leaf sheaths closed, forming an elongate, well developed crownshaft; inflorescences borne below the crownshaft, erect and spreading, branched to one order, bisexual, flowers in triads (central female, lateral males), protandrous, rachillae densely covered with short hairs; flowers unisexual, white; fruits globose, to 1,1 cm in diameter, purple-black, with a weekly rough surface and lateral stigmatic remains, mesocarp purplish and pulpy. In the subcanopy or canopy of lowland to upper montane rainforests, from Belize through Central America to Andean and adjacent regions, from Colombia to Bolivia

and Brazil (Acre).

Geonoma (neotrop. ca. 51, CR 15, GD 7)

The third largest genus of the family in the Americas. Although it contains only understory palms, the genus is remarkably diverse in growth form and ecology, with one of the largest altitude amplitudes in the family, ranging from sea level to over 3000 m elevation. The flowers, arranged in groups of one female flower with 2 lateral male flowers are characteristically sunken in rather deep pits along the rachillae, a feature shared with the other members of the Geonomeae tribe: *Asterogyne*, *Calyptrogyne*, (*Calyptronoma*), *Pholidostachys* and *Welfia*.

Key to the species of *Geonoma*

1	Solitary palm	2
2	Stem pencil-thin, less than 1 cm in diameter; leaf usually divided into three broad sigmoid leaflets; inflorescence with threadlike flowering branches, flower pits widely spaced	*G. scoparia*
2*	Stem 2-12 cm in diameter; leaf bifid or regularly to irregularly divided into few to numerous leaflets; inflorescence with one or several but stout flowering branches, flower pits closely spaced	3
3	Stem usually less than 5 cm in diameter, subterranean or to 2 m tall; leaf bifid or regularly to irregularly divided into 2-15 leaflets; inflorescence spicate, borne among the leaves, purplish in fruit	*G. cuneata*
3*	Stem usually more than 5 cm, up to 12 cm in diameter, to 10 m tall; leaf in most cases regularly to irregularly divided into up to 40 narrow leaflets; inflorescence branched to 1-3 orders, usually borne below the leaves, reddish in fruit	*G. interrupta*
1*	Clumping palm	4
4	Clusters with up to 20 stems, these to 7 m tall and to 4 cm in diameter; leaf usually irregularly divided into 3 or more broad to straight leaflets intermixed with narrow ones per side, petiole with sharp margins; youngest unfolding leaf greenish; inflorescence branched to one order, orange in fruit; flower pits evenly spaced; fruits with a rough surface	*G. congesta*
4*	Clusters with usually far less than 10 stems, these to 4 m tall and to 3 cm in diameter; leaf usually regularly divided into three broad sigmoid leaflets per side, petiole margins not sharp; youngest leaf reddish; inflorescence branched to 1-2 orders, dark orange to reddish in fruit; flower pits arranged in whorls of three; fruits smooth	*G. deversa*
4**	Plant not matching 4 or 4*, may be clustering forms of	*G. cuneata or G. interrupta* see 3

G. congesta H. Wendl. ex Spruce, Pl. 16e,f

Common name (Costa Rica): caña de danto (N. ZAMORA pers. comm.)

Large clumping understory palm, stem clumps with up to 20 stems, these to 7 m tall; leaves to 1,7 m long, irregularly divided into usually three leaflets per side, petiole with sharp margins; inflorescences branched to one order, borne among or below the leaves, erect, protandrous, rachillae orange in fruit; flowers in pits, white in anthesis; fruits globose to obovoid, to 1,5 cm in diameter, surface rough, violet-black when mature. Usually on well drained slopes, from Honduras to northwestern Colombia.

G. cuneata H. Wendl. ex Spruce, Pl. 17a

Small, usually solitary undergrowth palm, stem solitary or rarely clustered, subterranean or up to 2 m tall; leaves to 1,2 m long, leaf-shape very variable, ranging from simple to regularly or irregularly divided, leaflets straight to sigmoid or sickle-shaped; inflorescences borne among or below the leaves, erect, spicate, rachillae purplish in fruit; flowers in pits, white in anthesis; fruits ovoid to ellipsoid, to 8 mm long, black when mature. From Nicaragua to western Colombia and Ecuador.

G. deversa (Poit.) Kunth
Small, undergrowth palm, stem usually clustered, rarely solitary, 1-4 m tall; leaves often loosely arranged along the stem, blade to 70 cm long, leaf division very variable, but often divided into three equal leaflets per side, youngest leaf reddish; inflorescences branched to one or two orders, borne below the leaves, protandrous, rachillae orange to reddish in fruit; flowers in pits, these arranged in whorls of 3, white in anthesis; fruits globose, to 7 mm in diameter, black when mature. Abundant in disturbed areas, from Belize and Honduras to Bolivia and Brazil.

G. interrupta var. *interrupta* Henderson, Pl. 17c-e
Medium to large undergrowth palm, stem solitary or clustered, subterranean or rarely up to 10 m tall; leaves to 2 m long, regularly or irregularly divided into numerous leaflets; inflorescences branched to 1-3 orders, usually borne below the leaves, protandrous, rachillae reddish in fruit; flowers in pits, white in anthesis; fruits globose, 3-6 mm in diameter, black when ripe. Widely distributed from Mexico and the Antilles to Bolivia and Brazil.

G. scoparia Grayum & Nevers, Pl. 17b
Small, rare understory palm, stem solitary, usually less than 3 m tall, pencil-thin; leaves to 60 cm long, mostly divided into three leaflets per side; inflorescences branched to 2-3 orders, borne below the leaves, with thread-like flowering branches, protandrous; flowers in pits, these widely spaced along the branches, white in anthesis; fruits subglobose, 5-6 mm in diameter, black when mature. On ridge-tops, very infrequent, endemic to the Osa Peninsula area.

Iriartea (neotrop. 1, CR 1, GD 1)
Monotypic genus.

I. deltoidea Ruiz & Pav., Pl. 17f-h
Common names (Costa Rica): maquenque, chonta (QUESADA et al. 1997)
Massive solitary tree palm up to 25(-30) m tall, stilt-roots present, with round non-spiny side-rootlets, new stilt-roots black, forming a dense compact cone; leaves large, pinnate, leaflets broadly wedge-shaped with irregular apical margin ("fishtail" or "bitten off" appearance), leaflets undivided and held in one plain in juvenile stages, divided into several segments, these orientated in different planes (of which the proximal segment widest) in the adult plant, giving the leaf a plumose appearance, leaves forming an prominent crownshaft; inflorescences decurved and pendulous in bud, borne below the leaves, branching to two orders, inflorescences usually bisexual, rarely unisexual, protandrous; flowers white, male flowers with 10-17 stamens; fruits globose, 2-2,8 cm in diameter, green to yellowish, seed 1. In lowland to montane rainforest, especially common and abundant on slopes, from Nicaragua to Peru, Bolivia and Brazil.

Neonicholsonia (Central America 1, CR 1, GD 1)
Monotypic genus.

N. watsonii Dammer, Pl. 18a
Common name (Costa Rica): coladegallo
Small, "stemless" understory palm, stem solitary, short, with condensed internodes, subterranean, rarely shortly aerial; leaves to 9, to 2 m long, regularly pinnate, leaflets linear-lanceolate, leaf sheaths closed, not forming a distinct crownshaft; inflorescences spicate, erect, held above the leaves by an elongate peduncle, bisexual with flowers in closely spaced triads (2 male, 1 female), male flowers only apical solitary or paired; flowers unisexual; fruits ellipsoid, to 1 cm long, apically beaked, black when mature, rhachilla orange-red. In lowland rainforests, from Honduras to Panama.

Oenocarpus (neotrop. 9, CR 1, GD 1)
The growth form of this genus is quite variable, ranging from solitary to clustering, small to large, simple leaved to pinnate palms. Their ecological amplitude thus also reaches from understory to canopy palms on waterlogged or well-drained soils of tropical rainforest. A common characteristic is the inflorescence borne below the leaves, with long, pendulous flowering branches resembling horse's tails.

O. mapora H. Karst.
Common name (Costa Rica): maquenque
Arborescent, clustering palm, to 20 m tall, stems ringed by distant leaf-scars; leaves to 10, to 3 m (or more) long, regularly (in young individuals/stems) to (slightly) irregularly pinnate (in adult individuals/stems), basal and central leaflets grouped and spreading in different planes, leaflets linear-lanceolate, glaucous beneath, leaf

sheaths open, dark green to purplish with fibrous margins, forming a partial crownshaft; inflorescences horse-tail shaped, to 75 cm long, branching to one order, borne below the leaves, bisexual, rachillae turning orange-red to maroon in fruit; flowers unisexual, in triads, white; fruits ellipsoid to ovoid, to 3 cm long, purple to black, mesocarp lavender to purple, pulpy and oily, seed 1, large. In the subcanopy or canopy of lowland and lower montane rainforests, from Costa Rica to western South America to northern Bolivia.

Pholidostachys (neotrop. 4, CR 1, GD 1)
A small genus of understory palmlets with the characteristic features of a commonly solitary habit, irregularly divided leaves with broad leaflets and thick flowering branches.

P. pulchra H.Wendl. ex Burret
Usually solitary palm, stems subterranean to aerial, then rarely exceeding 2 m in height, brownish; leaves to 1 m long, slightly irregularly divided into almost equal wide broad leaflets, these in the middle of the leaf longer than towards the end and apex of the leaf; inflorescences spicate, the flower- bearing part well exserted from the fibrous peduncular bract, about 1 cm in diameter, two semicircular, overlapping bracts covering each of the densely arranged flower pits, protandrous; fruits obovoid, to 2,8 cm long, purple-black when ripe, mesocarp with large interwoven fibers. In lowland or premontane rain forests, from Nicaragua to northwestern Colombia.

Prestoea (neotrop. 11, CR 3, GD 1)
A genus of usually small to medium sized, clustering palms. *Prestoea* is closely related to *Euterpe*, from which it can be distinguished by its open leaf sheaths, not or only partly forming a crownshaft, the horizontally spreading leaflets and the flowering branches, which change color in fruit and are not covered with short hairs.

P. decurrens (H. Wendl. ex Burret) H.E. Moore, Pl. 18b
Common name (Costa Rica): palmito mantequilla
Clustering, arborescent palm, to 12 m tall, stems green to yellow, with distant internodes and yellowish adventitious roots at the base; leaves 4 to 10, to 2 m long, regularly pinnate, leaflets linear-lanceolate, spreading horizontally, green on both sides, with unequal tips, one half sometimes extending into a long stiff thread, leaf sheaths semi-open, forming a partial crownshaft, but this enveloped by old leafbases, disintegrated into a fibrous mass; inflorescences borne below the leaves, erect, branched to one order, bisexual, rachillae becoming reddish in fruit; flowers unisexual, in triads, white; fruits globose, to 1,1 cm in diameter, purplish-black, with a lightly rough surface and lateral stigmatic remains, seed 1. Predominately in lowland rainforests, from southern Nicaragua to the Pacific lowlands of Colombia and Ecuador.

Raphia (Africa + neotrop. ca. 28, CR 1, GD 1)
Solitary or clustered hapaxanthic palms, with very long, pinnate and spiny leaves. The fruits are very distinct in being covered with overlapping scales.

R. taedigera (Mart.) Mart., Pl. 18c,d
Common names (Costa Rica): yolillo, palma real
Clustering palms with up to 6 stems of unequal age, main (oldest) trunk usually apparent, to 6 m tall, mostly covered with persistent leaf bases and sometimes with upwards pointing rootlets, these breathing roots also forming a mat around the trunk; leaves massive, to 15, 5-15(-17) m long, held vertically but arching at the top, leaflets to 2 m long, linear-lanceolate, irregularly arranged and spreading in different planes, giving the leaf a plumose appearance, armed with short spines along the midribs and margins, leaf sheaths unarmed, splitting opposite the petiole, not forming a crownshaft, disintegrating into fibers; inflorescences 3-5, usually to 2 m long, pendulous, branched to 2 orders, rachillae and flowers distichuously arranged, female flowers at the base, males at the top of the rachillae; fruits ellipsoid to oblong ovoid, 5-7 cm long, covered with rhomboid orange-brown overlapping hard scales. Along waterways and in permanently inundated areas, from Nicaragua to northwestern Colombia and in the estuary of the Amazon in eastern Brazil.

Reinhardtia (neotrop. 6, CR 3, GD 2)
A small but variable genus of minute to medium rainforest palms. The leaves are either regularly pinnate with single fold leaflets or consisting of several broad compound leaflets or are simple. The species can be distinguished from other understory palms by their two strongly unequal long tips of each single fold leaflet and their pro-

jecting midribs which make the blade margins appear clearly dentate.

R. latisecta (H. Wendl.) Burret
Clustered palms, to 8 m tall, stems brown, smooth, with elongate internodes; leaves pinnate, to 1,5 m long, usually consisting of 2-3 pairs of broad compound leaflets, the apical ones broader than the basal one(s), sometimes single fold leaflets between the compound ones, compound leaflets always with windows at the base of the joined single-fold leaflets, tips of (single-fold) leaflet-halves unequally long with a shortly projecting midrib, leaflet margins thus appearing dentate, leaf sheaths disintegrated into interwoven fibers, not forming a distinct crownshaft; inflorescences branched to one or two orders, exceeding the leaves by an elongate peduncle, bisexual, rachillae white in anthesis, bright orange to red in fruit; flowers unisexual, in triads (2 males with one female) distally or single or paired males apically, flowers white; fruits ellipsoid to ovoid, to 1,5 cm long, black when ripe, seed 1. In lowland rainforests, from Belize to Costa Rica.

Socratea (neotrop. 1, CR 1, GD 1)
A genus easy to discriminate even from its close relatives by the large open cone of few, widely spaced, thick, spiny stilt roots, and from most other American palms by its wedge shaped "fishtail" leaflets.

S. exorrhiza (Mart.) H. Wendl., Pl. 18e,f, 19a,b
Common names (Costa Rica): palmito amargo, chonta patona (QUESADA et al. 1997)
Solitary palm, to 20 m tall, stems smooth and gray, supported by an open, up to 2 m tall cone of up to 25, to 7 cm thick stilt roots, which carry short spiny side-rootlets; leaves large, pinnate, narrowly wedge shaped with irregular apical margin ("fishtail" or "bitten off" appearance), leaflets undivided and held in one plain in juvenile stages, divided into several segments, these orientated in different planes (of which the distal segment widest), with pendulous tips in the adult plant, giving the leaf a plumose appearance, leaves forming a prominent crownshaft; inflorescences straight and erect in bud, borne among the leaves, branching to one order, bisexual, protogynous; flowers white; fruits ellipsoid to ovoid, 2,5-3,5 cm long, yellowish to brown, seed 1. In lowland and montane rainforests, widely distributed from Nicaragua to Bolivia and Brazil.

Synechanthus (neotrop. 2, CR 2, GD 1)
A small genus of understory palms. Its species may be distinguished from the closely related *Chamaedorea* by the lack of a yellow line on the abaxial side of the petiole, the arrangement of the flowers in alternating lines (averculi), the "brain-like" grooved seed and in being monoecious with bisexual inflorescences in opposite to the strictly dioecious *Chamaedorea*.

S. warscewiczianus H. Wendl., Pl. 19e
Clustered palm, to 6 m tall with several stems; leaves simple to regularly or irregularly pinnate, leaflets narrow to broad, one to several veined, the apical ones usually the widest, leaf bases elongate, enclosing the stem, but splitting to the base opposite the petiole, petiole without yellow line on the lower surface; inflorescences bisexual, with long peduncle (inflorescence stalk), branched to one order, flowers arranged in rows, which alternate on opposite sides of the rachillae, with the basal flower female, followed by males; fruits ellipsoid, 1,5-3 cm long, bright red when ripe, seed with net-like, deep grooves. From Nicaragua to western Colombia and Ecuador.

Welfia (neotrop. 1, CR 1, GD 1)
Monotypic genus.

W. regia H. Wendl. ex André, Pl. 19c,d
Solitary palm, up to 20 m tall, stem smooth and ringed with distant leaf scars, commonly with a mass of adventitious roots at the base, without forming distinctive thick stilt-roots; leaves massive, 3-6 m long, regularly pinnate, strongly reddish in color when young, leaf sheaths open, not forming a distinct crownshaft, leaflets to 1 m long and 10 cm wide, lanceolate; inflorescences branched to one order, rachillae pendulous, to 3,5 cm thick and up to 1 m in length; flowers borne in triads (one central female accompanied by two lateral males) in deep pits arranged in lines along the rachillae, proterogynous; fruits to 5 cm long and 2 cm thick, shaped like an almond or a pecan nut, reddish brown to dark brown, seed 1, large. In the subcanopy and lower canopy, frequent to abundant on ridges and upper parts of slopes, but may also occur in other parts of the forest, from Honduras to western Colombia and Ecuador.

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Bromeliaceae

Perennial rosette herbs with a short axis, more rarely with an elongated stem, or rosette trees, from a few cm (*Tillandsia*) to more than 10 m (*Puya*) tall, terrestrial, saxicolous, or epiphytic. Roots absorbing in terrestrials, modified to holdfasts in epiphytes and epilithes, rarely lacking (*Tillandsia usneoides*); **leaves** spirally arranged, dilated-sheathing at base, undivided, entire or spinose-serrate, usually bearing peltate trichomes at least when young; stipules lacking; **inflorescences** terminal, often becoming pseudolateral by sympodial growth, scapose or sessile, compound or simple, usually bearing brightly colored conspicuous flower bracts or "petaloid" scape bracts; **flowers** bisexual or sometimes functionally unisexual (*Androlepis*, *Aechmea mariae-reginae*, *Catopsis* p.p.), usually actinomorphic, perianth heterochlamydeous, sepals 3, free or connate, petals 3, free or connate, often with scale-like basal appendages and/or longitudinal callosities, stamens 6, in two whorls, filaments free, or joined to the petals and/or to each other, ovary superior to inferior, 3-locular; **fruits** septicidal or loculicidal capsules or berries, seeds winged, plumose, or naked. Neotropical family, extending into the southeastern United States and into central Argentina. A single species (*Pitcairnia feliciana*) occurs in tropical western Africa. Highest diversity in the Andes, in northern Central America, and in southeastern Brazil. Neotrop. ca. 56/ca. 3000, cr 17/212, cnp 9/39.

The family is systematically isolated and is usually placed in a distinct order (Bromeliales). However, molecular studies suggest the Rapateaceae as its sister family and they relate both to the Commelinales. Three subfamilies are usually recognized: Bromelioideae (ovary inferior, fruits baccate, seeds usually naked, leaves usually spinose serrate), Pitcairnioideae (ovary superior to inferior, fruits usually a loculicidal capsule, seeds usually winged, leaves often spinose serrate), and Tillandsioideae (ovary usually superior, fruit a septicidal capsule, seeds plumose, leaves always entire). The largest genera are *Aechmea*, *Pitcairnia*, and *Tillandsia* respectively.

The peltate trichomes have a basic function in the absorption and retention of moisture by the leaves and are most elaborate in Tillandsioideae. Here they consist of a foot cell anchored in the epidermis, a stalk of a few living cells, and a shield of dead cells which are arranged in a strictly regular pattern: 4 central cells surrounded by 1 or 2 circles of 8 or 16 cells, and by 64 wing cells. The shield conducts water nutrient-rich by capillarity toward the stalk cells where it is absorbed and transported to the leaf tissue. In addition, the dense layer of trichomes protects the leaf tissue from high insolation in xeromorphic species. Epiphytism is frequent due to a tank-forming habit or the presence of succulent leaves with a dense layer of peltate trichomes. Tank bromeliads are usually associated with a great number of biota ranging from animals to prokaryota, algae, myxomycota, and higher plants. Carnivory has been reported for *Brocchinia reducta* and *Catopsis berteroniana*, but as the plants have no digestive glands they exhibit protocarnivory at best. True carnivory is only known in *Brocchinia tatei*. Several species of Bromeliaceae are associated with ants, either in ant-gardens or through the formation of pseudobulbs which are inhabited by ants (*Tillandsia balbisiana, T. bulbosa, T. dexteri*).

Many species of Bromeliaceae are pollinated by hummingbirds. In these cases the flowers are brightly colored and often possess contrasting colored bracts. These flowers are odorless. Many species of *Werauhia* are visited by bats and have pale campanulate corollas and frequently a disagreeable odor. Insect pollination is uncommon and is effected either by butterflies or by moths. In the latter case, corollas are often white and the flowers strongly fragrant. The majority of species are outbreeders, but self-fertility seems to be quite frequent.

Wind-borne seeds prevail in subfam. Pitcairnioideae and are obligatory in subfam. Tillandsioideae. The fruits of Bromelioideae are mainly dispersed by birds and less often by bats. Ants appear to disperse seeds of several bromelioid genera. Dispersal in the vegetative state (e.g., by birds using plant parts for nest construction) is common in *Tillandsia usneoides*.

Ananas comosus is the most important species economically. It is cultivated for its edible syncarps: the "pineapple". It also provides bromelain (a mixture of at least 5 proteolytic enzymes) which is pharmaceutically used. *Tillandsia usneoides*, the Spanish moss, was formerly important as a source of pillow and cushion stuffing. Fibers are used from *Ananas lucidus*, *Neoglaziovia variegata* (caróa, caruá), and from *Bromelia* species, some of the latter also have edible fruits and are planted as living fences. Many bromeliads are cultivated as ornamentals.

Key to the genera

1	Mature seed appendaged; fruit capsular and dehiscent; ovary superior or largely so in most genera to partly inferior; leaves spinose-serrate or entire; plants epiphytic, or terrestrial	2
2	Seed appendage entire, seeds bicaudate; fruit loculicidal; leaves mostly spinose-serrate; indument of finely to scarcely divided scales; germination epigeal; plants usually terrestrial; petal blades usually bright red, yellow, or white, foliage usually dimorphic to trimorphic; leaf blades often narrowly elliptic, often more or less petiolate; plants of tropical forests, roadcuts, and natural clearings (subfam. Pitcairnioideae)	*Pitcairnia*
2*	Seed appendages finely divided and forming a coma, always present; fruit septicidal; leaves always entire; indument almost always of obviously radially symmetric scales; germination hypogeal; plants mostly epiphytic (subfam. Tillandsioideae)	3
3	Appendage of the seed largely apical (= chalazal), folded at maturity; sepals strongly asymmetric in most species; leaves often cretaceous-coated, glabrous; perianth whitish, distinctly shorter than 1,5 cm, rarely yellow	*Catopsis*
3*	Appendage of the seed wholly or largely basal (= on the micropylar end), straight at maturity; sepals usually symmetric (if asymmetric, then the leaves distinctly lepidote: *Racinaea*); leaves not cretaceous coated, often distinctly lepidote; perianth mostly colored, often tubular, longer than 1,5 cm (if shorter, then the leaves distinctly lepidote: *Racinaea*)	4
4	Petal-claws conglutinated in a tube equaling the sepals, always without appendages; leaves green or colored, not lepidote (at most very inconspicuously)	*Guzmania*
4*	Petal-claws free or with a very short tube exceeded by the sepals; flowers distichous in most species; leaves often lepidote, sometimes somewhat succulent	5
5	Petals bearing scales on the inside of the claw; inflorescence of one or more distichous-flowered spikes; flowers often secund	6
6	Flowers with brilliant coloration in most species, bright yellow, orange, or red, rarely dull to white, light yellow or light orange; the adaxial petal pair arranged apically in respect to the abaxial; petal appendages tongue-shaped; stigma with the convolute blade type morphology that is, three obviously spreading lobes covered with papillae; leaves green and glabrous or gray and lepidote	*Vriesea*
6*	Flowers generally dull in color, white, greenish-white, light-green, yellowish-green, yellow, or light orange; the adaxial petal pair arranged basally in respect to the abaxial; petal appendages dactyloid with 1-5 fingers of varying length; stigma with the cupulate type morphology that is, three apical, capitate, cup-shaped lobes, without papillae; leaves green or coloured but glabrous (at most very inconspicuously lepidote)	*Werauhia* (*Vriesea* p. p.)
5*	Petals naked; inflorescence of one or more distichous-flowered spikes or rarely reduced to a single flower; flowers never secund	7
7	Sepals symmetric or if slightly asymmetric, then ovate or lanceolate and broadest below the middle, free or variously connate; seeds usually with a distinct apical appendage; leaves often stiff and somewhat succulent, often distinctly lepidote	*Tillandsia*
7*	Sepals asymmetric, free or nearly so, broadest near apex, not over 12 mm long; seeds without apical appendage; leaves subcoriaceous to thin, not succulent	*Racinaea* (*Tillandsia* subgen. *Pseudo-Catopsis*)

1*	Mature seed unappendaged or with a sticky appendix; fruit baccate; ovary inferior; leaves mostly spinose-serrate; plants often terrestrial (subfam. Bromelioideae)	8
8	Sepals symmetric or nearly so, ca. 1,5 x 2 mm; flowers 8 mm long; inflorescence few-branched; floral bracts relatively large, strongly pectinate, reflexed, coarsely dentate	*Araeococcus pectinatus*
8*	Sepals asymmetric, 5-38 mm long	9
9	Sepals 35-38 mm long. Petals naked or with lateral folds or rudimentary or reduced scales. Inflorescence lax; axes visible. Inflorescence dense, *Ananas*-like but the ovaries not fused; petals bearing rudimentary or reduced appen-dages; floral bracts mostly thick and ligneous; leaf-blades never petiolate	*Chevaliera* (*Aechmea*) *magdalenae*
9*	Sepals 5-8 mm long. Petals appendaged with well developed scales	*Aechmea*

Alternative key to the species based on vegetative characters only

1	Leaf margins dentate-serrate, at least in part, or leaves dimorphic and some reduced to spinose-serrate spines	2
2	Leaves apparently succulent (at least thick-leathery)	3
3	Leaves channeled	4
4	Leaves broadly obtuse and minutely apiculate, not constricted, over 1 m long and 5 cm wide	*Aechmea tonduzii*
4*	Leaves acute	5
5	Leaves constricted at base, 50-70 cm long and 20 mm wide	*Araeococcus pectinatus*
5*	Leaves only narrowed above the base, to 1 m long and 25-50 mm wide	*Aechmea pubescens*
3*	Leaves not channeled	6
6	Leaves very stiff, to 2 m long and 5-10 cm wide, pungent, laxly armed with dark uncinate spines to 5 mm long, rosettes very large	*Chevaliera magdalenae*
6*	Leaves not very stiff, 30-70(-140) cm long	7
7	Leaf blades acuminate with a long slender terminal mucro, 20-40 mm wide; leaf spines to 2,5 mm long; leaf sheaths broadly elliptic	*Aechmea tillandsioides*
7*	Leaf blades acute, 30-75 mm wide, leaf spines 3-10 mm long; leaf sheaths elliptic	8
8	Leaves rather pale green, leaf spines to 10 mm long	*Aechmea dactylina*
8*	Leaves medium dark green, leaf spines 3-5 mm long	*Aechmea angustifolia*
2*	Leaves not succulent, either grass-like or petiolate and the blade longitudinally plicate	9
9	Leaf blades entire, linear, c. 12 mm wide; outermost leaves reduced to spinose-serrate spines. Coastal cliffs at high tide level	*Pitcairnia halophila*
9*	Leaf blades spinose at least at the base, especially on the petiole if such present	10
10	Leaf blades narrowed but not petiolate, to 150 cm long, 15-25 mm wide, spinose at the base	*Pitcairnia megasepala*
10*	Leaf blades distinctly petiolate	11
11	Leaf blades oblanceolate, 85-95 cm long, 105-150 mm wide	*Pitcairnia oblanceolata*
11*	Leaf blades lanceolate, 40-50 cm long, 55-100 mm wide	12
12	Leaf blades 50 cm long, 55-60 mm wide, often dark winered suffused	*Pitcairnia atrorubens*
12*	Leaf blades 40 cm long, 75-100 mm wide, green	*Pitcairnia arcuata*
1*	Leaf margins completely entire	13
13	Leaves petiolate	*Pitcairnia maidifolia*
13*	Leaves never petiolate	14
14	Internodes strongly elongated, plants pendent like beards. Leaves filiform, densely gray lepidote	*Tillandsia usneoides*

14*	Internodes not elongated, plants of rosette growth	15
15	Leaves forming a pseudobulb often inhabited by ants	16
16	Leaf sheaths dark castaneous, pseudobulbs to 3 cm high; leaf blades filiformous, to 40 cm long and pendent	*Tillandsia dexteri*
16*	Leaf sheaths concolorous with the blades	17
17	Leaf blades flat with somewhat uprolled margins, concolorous	*Tillandsia balbisiana*
17*	Leaf blades terete, leaf sheaths with conspicuous red margin	*Tillandsia bulbosa*
15*	Leaves not forming a pseudobulb but a funnelform to closed rosette	18
18	Leaves distinctly gray lepidote	19
19	Leaves cross-banded	20
20	Leaves broadly triangular, distinctly twisted, the apices spreading	*Tillandsia flexuosa*
20*	Leaves narrowly triangular, not or very weakly twisted, the apices stiffly erect	*Tillandsia subulifera*
19*	Leaves not cross-banded	21
21	Leaf sheaths concolorous with the blades; leaf blades very narrowly triangular, to 20 cm long, 10-15 mm wide	*Tillandsia monadelpha*
21*	Leaf sheaths dark castaneous; leaves narrowly triangular	22
22	Leaves stiff, rosette radially symmetric	*Tillandsia acostae*
22*	Leaves soft, rosette usually somewhat secund	*Vriesea chontalensis*
18*	Leaves green, not notably lepidote	23
23	Leaf blades very narrowly triangular	24
24	Leaf blades with a narrow pale margin, green, quite soft	*Catopsis juncifolia*
24*	Leaf blades without a narrow pale margin, ± stiff	25
25	Leaf sheaths concolorous with the blades	*Tillandsia monadelpha*
25*	Leaf sheaths and base of leaf blades with longitudinal red stripes	*Tillandsia anceps*
23*	Leaf blades ligulate to subligulate	26
26	Leaf blades with a narrow pale margin, green, quite soft	*Catopsis morreniana* or *C. sessiliflora*
26*	Leaf blades without a narrow pale margin	27
27	Leaves longitudinally red striped at base	28
28	Red stripes only on leaf sheath, sheath and blade ± concolorous	*Guzmania patula*
28*	Red stripes also on leaf blade, yellowish sheaths contrasting with the green or red suffused blades	*Guzmania zahnii*
27*	Leaves not longitudinally red striped	29
29	Green upper surface strongly contrasting with the white lepidote lower surface (especially toward base)	*Werauhia dodsonii*
29*	Upper leaf surface concolorous with the blades or suffused with red beneath *Guzmania lingulata, Tillandsia excelsa, Tillandsia leiboldiana, Vriesea heliconioides, Vriesea osaensis, Werauhia gladioliflora, Werauhia sanguinolenta, Werauhia viridiflora*	

Aechmea s.l. (excl. *Chevaliera*) (neotrop. ca. 220, CR 15, GD 6)

Usually epiphytic rosette herbs with spinose-serrate leaves. Flowers sessile, sepals mucronate, petals appendaged. Fruits berries

Key to the species of *Aechmea*

1	Sepals unarmed, only mucronulate; floral bracts decurrent and forming pouches around the flowers; flowers often distichous	*A.* (*Hoplophytum*) *tillandsioides*
1*	Sepals armed; floral bracts not decurrent and forming pouches around the flowers	2
2	Inflorescence simple	*A.* (*Pothuava*) *tonduzii*
2*	Inflorescence compound (*Aechmea* subgen. *Aechmea*)	3
3	Floral bracts distinctly surpassed by the sepals	*A. angustifolia*

3*	Floral bracts (exclusive of the mucro) about equaling to exceeding the sepals. Spikes dense or subdense; floral bracts at least twice as long as the internodes	4
4	Floral bracts even or nearly so, glabrous, 15-20 mm long	*A. dactylina*
4*	Floral bracts prominently nerved, densely white-arachnoid at first, 6-13 mm long	*A. pubescens*

A. dactylina Baker, Pl. 19f
Spikes dense, distichously flowered, floral bracts carinate, glabrous, completely covering the rhachis. From Costa Rica to Colombia and Ecuador.

Araeococcus (neotrop. 7, CR 1, GD 1)
Mesophytic, epiphytic, stemless herbs with paniculate inflorescences, nearly symmetric sepals, unappendaged petals and free filaments.

A. pectinatus L.B. Sm., Pl. 19g
Floral bracts serrate, conspicuously recurved. From Costa Rica to northwestern Colombia.

Catopsis (neotrop. 16, CR 10, GD 3)
Epiphytic rosette herbs usually with branched inflorescences and mostly small flowers with white petals (but larger and yellow in *C. nutans*).

Key to the species of *Catopsis*

1	Leaf blades triangular or subtriangular, attenuate. Leaf-sheaths distinct, contracted into the very narrow blades; leaves to 10 cm long, their blades 5 mm wide	*C. juncifolia*
1*	Leaf blades ligulate, very broadly acute or rounded or even emarginate, apiculate	2
2	Scape bracts exceeding the internodes or rarely the highest slightly shorter. Leaf-blades prominently pale-margined	*C. morreniana*
2*	Scape bracts mostly much shorter than the internodes	3
3	Leaf blades to 53 mm wide; branches of the inflorescence with long sterile bases	*C. sessiliflora* f. *werckleana*
3*	Leaf blades not over 25 mm wide; branches of the inflorescence, if any, with short sterile bases	*C. sessiliflora* f. *sessiliflora*

C. juncifolia Mez & Wercklé
Leaves narrowly triangular. In Nicaragua and Costa Rica.

C. sessiliflora (Ruiz & Pav.) Mez, Pl. 19h
Leaves in a funnelform rosette, ligulate, not over 25 mm wide, scape bracts shorter than the internodes. From southern Mexico to Ecuador and Peru.

Chevaliera (neotrop. 22, CR 2, GD 1)
(syn. *Aechmea* subgen. *Chevaliera*)
Terrestrial rosette herbs with coarsely spinose leaves similar to *Bromelia*. The inflorescences are compact as in *Ananas*, but the flowers are solitary.

C. magdalenae André, Pl. 20a,b
Flowering 1 m or more high with usually compound inflorescences, composed of subglobose heads.

Guzmania (neotrop. 200, CR 32, GD 4)
Mesophytic rosette herbs with polystichously arranged flowers and simple or compound inflorescences.

Key to the species of *Guzmania*

1	Sepals wholly covered by the floral bracts, these large and red at anthesis; petals white	*G. lingulata*
1*	Sepals exserted, not wholly covered by the floral or primary bracts	2
2	Spikes dense throughout; inflorescence compound; petals yellow	*G. zahnii*
2*	Spikes lax, at least toward base	3
3	Sterile base of at least the terminal branch bracteate and much exceeding the primary bracts, inflorescence simple or laxly compound from 2-6 spikes, petals white or greenish yellow	*G. patula*
3*	Sterile base of all the branches naked and shorter than the primary bracts, petals bright yellow	*G. scherzeriana*

G. lingulata (L.) Mez, Pl. 20c
Inflorescences simple, corymbose. From Nicaragua to Peru and Bolivia.

G. patula Mez & Wercklé
Inflorescences simple or compound, elongate; flowers laxly arranged, petals white or green. From Costa Rica to Ecuador.

G. scherzeriana Mez, Pl. 20d
Inflorescences compound; flowers sublaxly arranged, bracts red, petals yellow. From Honduras to Colombia and Ecuador.

G. zahnii (Hook. f.) Mez
Inflorescences simple or compound, elongate; flowers densely arranged, bracts and petals yellow. In Nicaragua and Costa Rica.

Pitcairnia (incl. *Pepinia*) (neotrop. ca. 350 + 1 sp. W. Africa, CR 20, GD 6)
Rosette herbs with grass-like leaves, these sometimes petiolate. Forest understory or on slopes after landslide and roadcuts.

Key to the species of *Pitcairnia*

1	Floral bracts narrowly lanceolate, exposing much of the pedicels and all of the flower; inflorescence simple to few-branched, rather laxly flowered; leaves not petiolate	2
2	Sepals 30-40 mm long, alate carinate; petals red, yellow, or white, with basal appendages; larger leaf-blades deciduous along a straight transverse line, grass-like, almost never petiolate; plants of xerophytic habitats like roadcuts	*P. megasepala*
2*	Sepals 20-24 mm long, carinate; petals cream-yellow, without basal appendages; leaf-blades persistent, grass-like, hanging down; cliffs at high tide level	*P. halophila*
1*	Floral bracts elliptic or broadly ovate and covering most of the flower, especially the sepals; inflorescence simple, dense or subdense; leaves petiolate	3
3	Sepals exceeding at least the upper floral bracts, these green or yellow and often tinged with bright red; sepals 26-30 mm long	*P. maidifolia*
3*	Sepals completely covered by the floral bracts	4
4	Floral bracts with divergent to spreading apices; leaves, especially below, and inflorescence (including the floral bracts) dark wine red, petals cream yellow; sepals 25 mm long	*P. atrorubens*
4*	Floral bracts straight toward apex, usually strict and closely imbricate; sepals 45-50 mm long	5
5	Leaf-blades oblanceolate, to 125 mm wide; sepals broadly acute and apiculate	*P. oblanceolata*
5*	Leaf-blades lanceolate or linear-lanceolate, 75-100 mm wide; sepals acuminate	*P. arcuata*

P. halophila L.B. Sm.
Petals pale yellow. On rocks near seashores, endemic to Costa Rica.

Racinaea (neotrop. ca. 60, CR 5, GD 2?)
Rosette herbs with small flowers and white to yellowish petals and distinctly asymmetric sepals
2 species, *R. contorta* with triangular, often dotted leaves, flowering ca. 20 cm high and *R. spiculosa*, similar to the previous but somewhat larger and leaves ligulate, are expected from elevations of 600 m upwards.

Tillandsia (neotrop. ca. 550, CR 44, GD 11-12)
Polymorphic genus with mesophytic to extreme xerophytic species, all of them epiphytic.

Key to the species of *Tillandsia*

1	Leaf blades ligulate or subligulate, never tapering evenly from base to apex; leaves green or suffused with red or purple, not notably lepidote	2
2	Lower primary bracts (exclusive of blades) equalling or exceeding the axillary branches	*T. leiboldiana*
2*	Lower primary bracts (exclusive of blades) shorter than the axillary branches	*T. excelsa*
1*	Leaf blades narrowly triangular and tapering evenly from base to apex or linear and not over 2 mm wide; leaves distinctly lepidote	3

3	Plant caulescent with elongated internodes, hanging in beards	*T. usneoides*
3*	Plants stemless, leaves rosulate	4
4	Leaf sheaths convergent at their apices, inflated and forming a pseudobulb	5
5	Sepals exserted above the floral bracts; flowers erect, inflorescence simple; leaves succulent, rigid, leaf-blades quite strictly erect, ± cross-banded	*T. subulifera*
5*	Sepals wholly covered by the floral bracts (if only slightly covered and leaf-blades filiform see *T. dexteri*)	6
6	Floral bracts carinate toward the apex, nerved, 10-11 mm long; leaf sheaths dark castaneous, leaf-blades filiform, to 40 cm long, pendent; inflorescence subsessile, of 1-3 spikes; epiphytic in gallery forest	*T. dexteri*
6*	Floral bracts ecarinate, 15-22 mm long; leaf sheaths concolorous with the blades	7
7	Floral bracts glabrous or obscurely lepidote; leaf blade flat with upward bent margins; plants flowering 13-65 cm high	*T. balbisiana*
7*	Floral bracts densely lepidote; leaf blades strongly uprolled; leaf-sheaths green with distinct red margin; plants flowering 7-22 cm high	*T. bulbosa*
4*	Leaf sheaths divergent and not forming a pseudobulb	8
8	Floral bracts broad, densely imbricate and covering the rhachis at anthesis	9
9	Leaf blades green, not notably cinereous or ferrugineous; inflorescence simple, broadly elliptic, strongly compressed; petals spreading; leaves longitudinally red striped towards the base	*T. anceps*
9*	Leaf blades distinctly and densely cinereous- or ferrugineous-lepidote (at least beneath); inflorescence subdigitate to simple, spikes ± terete; petals tubular-erect; leaves not striped towards the base, leaf sheaths dark castaneous	*T. acostae*
8*	Floral bracts spreading or so narrow as to expose the rhachis at anthesis; flowers not continguous with each other nor with the fully exposed rhachis	10
10	Internodes of the rhachis 20-30 mm long; leaves cross-banded, almost always conspicuously twisted; petals red	*T. flexuosa*
10*	Internodes of the rhachis not more than 15 mm long; leaves not cross-banded, concolorous, very narrowly triangular; petals white	*T. monadelpha*

T. acostae Mez & Tonduz
plants with non-impounding rosettes; leaves hard, somewhat succulent, narrowly triangular; inflorescences dense but only slightly compressed. From Honduras to Costa Rica.

T. anceps Lodd.
Plants with non-impounding rosettes; leaves rather soft, flat, narrowly triangular, longitudinally red striped at base, inflorescences very dense, strongly compressed and flat. From Mexico to Colombia, Venezuela and Brazil.

T. balbisiana Schult. f., Pl.20e
Plant with pseudobulbs; leaf-blades flat. From Mexico to Bolivia and Brazil.

T. bulbosa Hook., Pl. 20f,g
Plant with pseudobulbs; leaf-blades terete and channelled, sheaths with red margin. From Honduras to Colombia and Venezuela.

T. caput-medusae E. Morren, Pl. 21a
Not recorded so far from Corcovado and Piedras Blancas N.P., but occurrence probable.

T. dexteri H. Luther
Plant growing in clusters, pseudobulbs present; leaf blades extremely subulate. Endemic to Costa Rica.
This species is restricted to the Carribean side of Costa Rica and only known from the type collection, therefore, it is probably an incorrect identification.

T. excelsa Griseb.
Leaves green ligulate, forming impounding rosettes; inflorescences orange-red; sepals free. From Honduras to Panama.

T. flexuosa Sw.
With twisted rosette leaves which are usually ± cross-banded, inflorescences laxly flowered and usually branched. From Costa Rica to Colombia to Venezuela.

T. leiboldiana Schltdl.
Leaves green ligulate, forming impounding rosettes; inflorescences violet-red; sepals adaxially ± connate. From Honduras to Panama.

T. monadelpha (E. Morren) Baker
Plants with non-impounding rosettes; leaves soft and flat, narrowly triangular; inflorescences very lax. From Honduras to Colombia, Ecuador and Venezuela.

T. subulifera Mez
Similar to *T. flexuosa*, but smaller and more slender; inflorescence a single spike. From Nicaragua to Costa Rica.

T. usneoides (L.) L.
Lichen-like plant, hanging from trees. From the United States to Bolivia and Paraguay.

Vriesea (neotrop. ca. 250, CR 11, GD 2)
Meso- to xerophytic rosette herbs.

Key to the species of *Vriesea*

1	Leaf blades narrowly triangular, densely lepidote; floral bracts 16 mm long, equalling to exceeding the sepals; petals pale green	*V. chontalensis*
1*	Leaf blades ligulate to linear, glabrous; floral bracts to 45 mm long, spreading horizontally, much longer than the sepals; petals white	*V. heliconioides*

V. chontalensis (Baker) L.B. Sm.
Leaves narrowly triangular, gray; floral bracts small, in dense spikes. From Costa Rica to Ecuador.

V. heliconioides (Kunth) Hook. ex Walp.
Leaves green, ligulate; floral bracts large, boat-shaped. From Honduras to Bolivia and Brazil.

Werauhia (neotrop. ca. 80, CR 54, GD 5)
(syn. *Vriesea* sect. *Xiphion* p. p.)
Mesophytic rosette herbs. Inflorescences elongate, simple or compound.

Key to the species of *Werauhia*

1	Flowers not secund except sometimes, insofar as the petals are exserted from the bracts on one side; inflorescence simple	2
2	Floral bracts narrowly elliptic	*W. osaensis*
2*	Floral bracts very broadly ovate	*W. gladioliflora*
1*	Flowers secund at anthesis and after, floral bracts also often secund	3
3	Inflorescence compound; floral bracts distinctly shorter than the sepals; petals white	*W. sanguinolenta*
3*	Inflorescence simple	4
4	Inflorescence lax, the floral bracts slightly larger than the internodes; floral bracts distinctly exceeded by the sepals; plant less than 30 cm high	*W. dodsonii*
4*	Inflorescence dense, the floral bracts at least twice as long as the internodes	5
5	Floral bracts rugulose or verrucose throughout when dry	*W. gladioliflora*
5*	Floral bracts even or nerved but neither rugulose nor verrucose except sometimes near their apices	6
6	Rhachis subalate, up to 10 mm in diameter, dark, its internodes narrowly obconical; leaves mostly red-spotted; plant 1-2 m high	*W. sanguinolenta*
6*	Rhachis terete or angled with its internodes subcylindrical, rarely more than 5 mm in diameter; leaf-blades concolorous; plant barely 1 m high	*W. viridiflora*

W. dodsonii (L.B. Sm.) J.R. Grant
Leaf-blades long apiculate; inflorescences reduced to 2-3 flowers. Endemic to Costa Rica.

W. gladioliflora (H. Wendl.) J.R. Grant, Pl. 21b,c
Floral bracts brown; flowers ± secund at anthesis. From Honduras to Ecuador.

W. osaensis J.F. Morales
Floral bracts green; flowers not secund at anthesis. Endemic to Costa Rica.

W. sanguinolenta (Linden ex Cogn. & Marchal) J.R. Grant
Inflorescences compound. From Costa Rica to Ecuador.

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Burmanniaceae

A small family of annual or perennial, usually unbranched, tropical forest herbs. Most of the genera are saprophytic, cream- or purple-colored plants with scale-like leaves. **Leaves** simple, alternate, sessile, in autotrophic species green, large and often rosulate, in saprophytic species usually amplexicaul and scale-like; **inflorescences** terminal, usually bifurcate, cymose, 1-many-flowered; **flowers** actinomorphic or rarely zygomorphic (*Thismia*), bisexual, 3-merous, tepals 6, in two whorls, these mostly unequal, sometimes one whorl reduced or obsolete, petals basally connate, forming a sometimes winged tube, stamens 3 or 6 (*Thismia*), inserted in the tepal tube, ovary inferior, 1-3-locular; **fruits** capsules, longitudinally or transversally dehiscent, seeds minute, numerous. Pantrop. 16/160, CR 6/14, GD 3/7.

The flowers of Burmanniaceae seem to be highly specialized and most of the genera are probably insect-pollinated. The flowers of *Thismia* exhibit several floral structures facilitating cross-pollination: a colored annulus combined with nectar guides and tepal appendages that direct flower visitors to the flower center (MAAS et al. 1986). VOGEL (1962) was the first to suggest that *Thismia* is pollinated by dipters attracted by scent. *Thismia fungiformis* is thought to be a fungus-mimic that is pollinated by fungus-gnats (VOGEL 1978). Also, MAAS et al. (1986) suggest that the saprophytic species of the family are mainly pollinated by insects of the soil fauna, but some species of the family are probably self-pollinators (MAAS et al. 1986).

The dispersal mode of Burmanniaceae is still little known. VAN DER PIJL (1968) suggested earthworms as possible dispersers. CROAT (1978) suspects that the fruits of *Thismia panamensis* are eaten by birds. STONE (1980) concluded that the seeds of *Thismia* are dispersed by a rain-splash mechanism.

Key to the genera (after MAAS VAN DE KAMER & MAAS 1997)

1	Leaves inserted just below flower; flowers zygomorphic; the perianth circumscissile close to base; stamens 6, pendent	*Thismia*
1*	Leaves scattered along stem; flowers actinomorphic; the perianth not circumscissile close to base; stamens 3, erect	2
2	Perianth lobes entirely caducous, leaving a naked floral tube	*Gymnosiphon*
2*	Perianth lobes with at least the lower part persistent on fruit	*Apteria*

Apteria (neotrop. 1, CR 1, GD 1)
Monotypic genus.

A. aphylla (Nuttall) Barnhart ex Small, Pl. 21d
Saprophytic herb to 6(-30) cm tall, stems and leaves purple to brown or sometimes white; leaves scale-like; inflorescences unilateral cymes, 1-10-flowered; flowers erect, 6-lobate, purple with a whitish basal part, stamens 3; capsules widely ellipsoid to globose, cream-colored to brownish. In lowland wet forests, sometimes in

savannas, ranging from the southeastern United States and the West Indies to Peru, Bolivia, Brazil and Paraguay.

Gymnosiphon (pantrop. ca. 50, CR 5, GD 4)
Saprophytic herbs with distinct bifurcate, cymose inflorescences and the capsules crowned with the persistent lower perianth part.

G. breviflorus Gleason
Herb, up to 10-20 cm tall, stems and leaves white to brownish or red; leaves scale-like, ca. 1 mm long; inflorescences 2-branched; flowers white to purplish white, stigma with yellow, tortuous, filiform appendages; capsules broadly ovoid, with 6 slightly prominent longitudinal ribs. In lowland forests, from Costa Rica (only found in the GD) to Amazonian Brazil and Bolivia.

Thismia (pantrop. ca. 29, CR 2, GD 2)
Erect and somewhat fleshy saprophytic herbs with unbranched stems and solitary, zygomorphic flower.

T. panamensis (Standl.) Jonk.
Herb, 4-12 cm tall; stem slender, white to cream-colored, leaves 4, ovate, whitish, in a rosette just below the flower; flowers whitish, stamens 6, perianth 6-lobate, strongly zygomorphic, persisting in fruit, inner 3 lobes spreading and tapering into filiform, 3-4 cm long, purplish appendages. From Costa Rica to Colombia and Amazonian Ecuador.

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Cannaceae

A small monogeneric family closely related to the Marantaceae, consisting of perennial, rhizomatous, sometimes very large herbs with distichous leaves. **Leaves** simple, entire, with an open sheath, ligule lacking; **inflorescences** terminal, simple or compound thyrses or racemose, bracts subtending cincinni of 1-few flowers; **flowers** bisexual, asymmetric, often showy, sepals 3, free, green, equal, persistent, petals 3, basally connate, unequal (one smaller than the others), red, orange, yellow, or rarely white, stamen 1, petaloid, with a single theca, staminodes 1-4(-5), basally connate, petaloid, unequal, the inner staminode (labellum) often recurved and smaller than the others (wings), ovary inferior, 3-locular; **fruits** loculicidal capsules, verrucose to tuberculate, becoming glabrous, crowned by the persistent sepals, seeds numerous. In the tropics and subtropics of the New World, also cultivated in Asia and Africa. Neotrop. 1/8-10, CR 1/5, GD 1/1.

The flowers of *Canna* are probably ornithophilous, with the exception of *C. brittonii* which is pollinated by bats (VOGEL 1969b).

Canna edulis is cultivated in the tropics (mainly in the Paleotropics) for its starchy rhizomes. Several *Canna* spp. are used as ornamentals.

Canna (neotrop. 1/c.10, CR 1/5, GD 1/1).
See characters of the family.

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Commelinaceae

A medium-sized family of small to large herbs, of which many species are popular garden, greenhouse or indoor plants. Annual or perennial, somewhat succulent, rarely epiphytic (*Cochliostema*), usually with long, erect or creeping (rarely twining) stems with distinct internodes, often with adventitious roots at the nodes; **leaves** simple, alternate or pseudoverticillate, entire, with closed basal sheath; **inflorescences** terminal or axillary, usually panicle-like thyrses of several cincinni or a solitary cincinnus, sometimes subtended by a boat-shaped spathe or foliaceous bract; **flowers** bisexual, actinomorphic or zygomorphic, sepals 3, free or basally connate, petals 3, free or basally connate, variously colored, stamens 6, sometimes unequal or partly staminodial (*Cochliostema*), filaments often with long hairs, ovary superior, 2-3-locular; **fruits** mostly 3-valved capsules, indehiscent berry-like capsules or berries. Pantrop. to subtemp. ca. 39/640, CR 11/34, GD 5/5.

Because of their closed leaf sheaths the Commelinaceae can be confused with *Costus* (Costaceae). In the latter, however, the leaves are arranged in the conspicuous form of a "spiral staircase". The epiphytic *Cochliostema* can be easiliy confused with bromeliads in the vegetative condition.

The flowers of Commelinaceae have colorful petals and often fringed filaments. They are attractive to insects, mainly bees and diptera. Due to the lack of nectar, the flowers only provide pollen as a reward. The flowers of *Dichorisandra* were found to be buzz-pollinated (SIGRIST & SAZIMA 1991). This also seems to be true for other genera with poricidal anthers (FADEN 1992). Self-pollination may occur in certain genera when the stigma and stamens make contact as the flower withers (OWENS 1981).

Several taxa, e.g. *Dichorisandra*, have colorful fruits or arillate seeds, well suited for bird dispersal, while others have tiny seeds in small, thin-shelled capsules.

The members of the family have no agricultural importance, but some of them (e.g., *Commelina* and *Tradescantia* spp.) are often cultivated as indoor plants or as garden ornamentals. The African *Aneilema beninense* is used as a laxative. The Asian *Floscopa scandens* is used against inflammations of the eye.

Key to the genera (after GRANT & FADEN, IN PREP.)

1	Bromeliad-like epiphytes; inflorescences all axillary; petals fringed	*Cochliostema*
1*	Habit various, but not epiphytic; inflorescences variously arranged; petals not fringed	2
2	Cymes enclosed in or subtended by large bracts (spathes)	3
3	Bracts paired; cymes fused back to back, one per bract; flowers actinomorphic; stamens 6, all fertile	*Tradescantia*
3*	Bracts not paired; cymes free, 1-2 per bract; flowers zygomorphic; stamens 3, staminodes 2-3	*Commelina*
2*	Cymes not enclosed in or subtended by large bracts	4
4	Perennial climbers or bushy herbs; anthers with poricidal dehiscence; seeds arillate	*Dichorisandra*
4*	Decumbent perennials; anthers with longitudinal dehiscence; seeds exarillate	*Floscopa*

Cochliostema (neotrop. 2, CB 1, GD 1)
A genus of bromeliad-like tank epiphytes with very long leaves (to 1 m), somewhat narrowed towards the base and then expanded into the sheathing base. The genus has a rather isolated position within the family.

C. odoratissimum Lem., Pl. 21e,f
Large acaulescent epiphyte; leaves spirally arranged, oblong to lanceolate, glabrous; inflorescences axillary, thyrses, 30-80 cm long, bracts conspicuous, pinkish; flowers large, bisexual, sepals white to pinkish and fringed, petals blue, stamens 3, staminodes 3; fruits ca. 3 cm long, 0,5 cm wide, capsules 3-locular. Epiphytic on trees and on rocks in very damp places (e.g., riverine forests) near the forest floor up to midcanopy height, from Nicaragua to Ecuador. It can be distinguished vegetatively from most bromeliads by its more or less succulent leaves and obvious midrib.

Commelina (pantrop. ca. 170, CR 7, GD 1), Pl. 22a
Prostrate to weedy, rather succulent herbs with the leaves mostly distichous, unlike *Floscopa.* The leaf blades are usually sessile and more or less clasping at base, but sometimes with very short petiole-like construction. The inflorescence is leaf-opposed, and subtended by a characteristic conspicuous bract.

C. diffusa Burm. f.
Creeping herb, stem 20-50 cm long; leaves sessile to subsessile, elliptic to lanceolate, 2,5-6 cm long, 1-2 cm wide, almost glabrous; inflorescences terminal, solitary, bracts spathe-like, to 2 cm long; flowers blue; fruits capsules, ca. 5 mm in diameter, 2-valvate, seeds usually 4-5, black. Pantropical weed, ranging from Florida, Mexico and the Antilles to Argentina.

Dichorisandra (neotrop. 25, CR 2, GD 1)
Twining vines or erect herbs with monopodial stem, mostly terminal inflorescences without spathe-like bracts and zygomorphic, white or blue flowers with poricidal anthers. The seeds are black and surrounded by a coral red aril.

D. hexandra Aubl., Pl. 22b
Scandent or subscandent herb, stems to 1 m long, usually branched; leaves elliptic-ovate, to 20 cm long; inflorescences usually globose, 2-5(-6) cm long, pubescent; flowers showy, petals to 13 mm long, blue, rarely white. From Mexico to Brazil and Paraguay, as well as in the Old World.

Floscopa (pantrop. 20, CR 1, GD 1)
Small forest understory herbs with erect flowering stems, terminated by conspicuously pubescent, paniculate inflorescences with small, white to bluish flowers. The elliptic leaf blades are gradually contracted into a narrow petiole-like base.

F. robusta (Seub.) C.B. Clarke
Subprostrate herb up to 20 cm tall; leaves elliptic to oblong-elliptic, 10-30 cm long, (2,5-)4-8 cm wide, broadly petiolate; inflorescences 4-10 cm long, densely pubescent with glandular hairs; petals white; fruits 3-3,5 mm long, 3 mm wide, pale brown. In primary forests, from Nicaragua to northern Brazil and Peru.

Tradescantia (neotrop. 70, CR 8, GD 1)
A poorly defined, largely Central and North American genus of succulent herbs with erect, monopodial or prostrate stems. The most important character is the inflorescence, composed of fused pairs of cicinni, usually subtended by a pair of conspicuous, conduplicate bracts.

T. zanonia (L.) Sw.
Robust plant, stem to 1 m tall, usually erect; leaves at the apex of the stem, elliptic to (ob-) lanceolate, 35 cm long, 8 cm wide, mostly glabrous, rarely pubescent, sometimes ciliate at the margins; inflorescences 1-3, axillary; sepals 3-5 mm long, purple to black, accrescent and succulent in fruit, petals, free, usually white; capsules 3-5 mm in diameter (the fruits are berry-like because they are held within the persistent and succulent, dark purple sepals). From Mexico and the Antilles to Bolivia and Brazil.

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Costaceae

A family of perennial, rhizomatous understory herbs, terrestrial or sometimes epiphytic and characterized by the spiral arrangement of the leaves. **Leaves** simple, narrowly to broadly elliptic, sheaths closed, ligule truncate to bilobate; **inflorescences** terminal, cone-like, condensed spike, bracts strongly overlapping and often brightly colored or rarely flowers solitary and axillary; **flowers** bisexual, zygomorphic, calyx tubular, shortly bi- trilobate, petals 3, basally united into a tube, stamen 1, often petaloid, staminodes 5, forming a large tubular or spreading, petaloid labellum which equals or exceeds the corolla, ovary inferior, (2-)3-locular; **fruits** capsules, (2-)3- locular, somewhat fleshy, crowned by the persistent calyx, usually loculicidally dehiscent; seeds numerous, aril white to yellow. In wet forests throughout the tropics worldwide Pantrop. 4/c.100, CR 2/24, GD 1/14.

The Costaceae were formerly included in the Zingiberaceae, from which they differ in being non-aromatic, having spirally arranged leaves and a closed leaf sheath.

There are two centers of diversity: (1) Costa Rica, Panama, western Colombia, Venezuelan Andes, Ecuador, (2) the Guianas and the Amazonian parts of Pará, Brazil. Nearly all Costaceae grow in wet and fairly shady habitats. They are found mainly in the shaded forest understory, but also often in clearings.

A variety of ants has been recorded as visitors of the extrafloral nectaries of *Costus laevis*. They presumably protect the plant from seed predators. 26 ant species were recorded on Barro Colorado Island.

According to MAAS (1972), the structure and color of the labellum is crucial for pollination. The following three labellum types can be distinguished in the flowers of Costaceae: (1) Labellum tubular, rather small, yellow, orange or red, with bracts of the same color or rarely green (e.g. *Costus pulverulentus*): visited by hummingbirds (STILES 1978). (2) Labellum with a short, rather broad tube and a distinct limb, white or yellow, lateral lobes with red or purple stripes, bracts mainly green: highly adapted to bee pollination (*Xylocopa,* euglossini bees) (SCHEMSKE 1981). The limb of the labellum provides a landing platform for these strong bees. They penetrate into the flower by lifting the stamen, and thereby touch the anther with their back. The "honey chamber" (formed by a tubular part of labellum and stamen) is also adapted to the visitor through its thick, fleshy wall. (3) Labellum with a long narrow tube and a distinct limb, white, red, yellow or purple, bracts yellow to green: these types of flowers are probably pollinated by hummingbirds, but observations are rare. The primary pollinators of *Costus laevis* are the females of *Euglossa imperialis*, while hummingbird visits are rare and illegitimate (SCHEMSKE 1983). An intermediate form of pollination was observed by SYTSMA & PIPPEN (1985), who described a *Costus* hybrid which is legitimately pollinated by hummingbirds as well as by bees.

The bright red inner surface of the bracts of *Costus* contrasts sharply with the white fruit and thus attract dispersers, probably birds (LARSEN 1998).

The succulent stems and the leaves of *Costus* contain an acidic juice, hence the common name "caña agria". Some species of *Costus* are used by natives, mainly for medicinal purposes (for gonorrhoea, coughs, as laxatives etc.). Some species such as *C. speciosus* from Asia are cultivated as ornamentals.

Costus (pantrop. ca. 90, CR 23, GD 14)
Common names (Costa Rica): caña agria, cañagria (MAAS & MAAS VAN DER KAMER 2000)
The largest genus of the Costaceae, consisting of tall to short herbs, most of them occurring in the American tropics. It can be distinguished from the other neotropical genera by the cone-like inflorescences in combination with a 3-locular ovary.

C. comosus (Jacq.) Roscoe
Herbs up to 2,5 m tall; leaves 10-35 cm long, 2,5-8 cm wide, densely puberulous to velutinous on both sides; inflorescences ovoid to cylindric, 6-10(-12) cm long, 4,5-5,5 cm in diameter, bracts appendaged, green to red; corolla densely puberulous, sometimes glabrous, labellum tubular, yellow. From Costa Rica to Colombia and northern Venezuela.

C. laevis Ruiz & Pav., Pl. 22c-e
Plant up to 6 m tall; leaves narrowly elliptic to narrowly obovate, long-acuminate, glabrous; inflorescences large, broadly cylindric 5-10 cm long, 3-7 cm in diameter, up to 25 cm long and 9 cm wide in fruit, bracts not appendaged, green or sometimes red; corolla yellowish to reddish white, labellum broadly obovate when spread out, strongly purple-yellow-striped; seeds white arillate. This is probably the most abundant species of *Costus* in the GD. Occurring in light gaps, riverbank forests and swamps, from Guatemala to Bolivia.

C. lima K. Schum., Pl. 23a
Herb, up to 4 m tall; leaves 15-60 cm long, 5-15 cm wide, densely sericeous beneath; inflorescences broadly ovoid to cylindric, 5-20 cm long, 6-8 cm wide; corolla densely puberulent-sericeous, labellum tubular, white with yellow to reddish apex. In primary and secondary forests, from Nicaragua to Ecuador.

C. osae Maas & H. Maas, Pl.23b
Small herb up to 1 m tall; leaves few, obovate-elliptic, densely villous; inflorescences terminal, 6-8 cm long, 4-6 cm in diameter, up to 10 cm long in fruit, bracts appendaged, red to orange-red; calyx reddish to red-orange, corolla pink to red with dark red apex, labellum tubular, white with red apex. In very wet primary lowland forests, mainly along small streams, endemic to the Golfo Dulce region.

C. pulverulentus C.B. Presl, Pl. 22f-h
Plants up to 2,5 m tall, glabrous to densely villous; leaves narrowly elliptic to narrowly obovate, inflorescences slender, 3-7(-15) cm long, 1,5-4,5 cm in diameter, to 20(-30) cm long in fruit, bracts woolly pubescent, not appendaged, red to orange-red (to green); calyx reddish, corolla red to yellow, labellum tubular, red, stamen far exceeding the labellum. Abundant near riversides and light gaps, from Mexico to Ecuador.

C. ricus Maas & H. Maas
Herb, to 2 m tall, leaves long-acuminate, upper side densely strigose, lower side densely sericeous to glabrous, midrib and margins densely ferruginous, sheaths and petioles densely ferruginous; ligule unequal and bilobate; inflorescences globose to ovoid, 4-7 cm long, 4-5 cm wide, to 12 cm long in fruit; bracts red to orange, appendaged or apical part ± reflexed and concave; corolla densely puberulous, labellum tubular, orange to red. Endemic to the Osa Peninsula and vicinity.

C. stenophyllus Standl. & L.O. Williams, Pl. 23c-e
Plant up to 4 m tall, glabrous throughout; sheaths glaucous, becoming white with red upper margin. Leaves linear, up to 2,5 cm wide, ligule truncate; inflorescences ovoid, 9-14 cm long, 3,5-4,5 cm wide, basal terminating a leafless shoot, bracts red, not appendaged; corolla glabrous, labellum yellow, tubular. Endemic to the southern Pacific lowlands of Costa Rica.

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Cyclanthaceae

A characteristic family of the Neotropics, consisting of herbs, herbaceous vines and lianas, which are strongly reminiscent of palms. Plants stemless, terrestrial or with long stems and climbing by special roots, or plants epiphytic; **leaves** distichous or spirally arranged, entire, bifid or 4-parted, often plicate, texture palm-like; **inflorescences** axillary or terminal, spadices stout, cylindrical or globose, subtended by 2-several (usually caducous) bracts ("spathes"), spadix either covered with numerous groups of 1 female flower, surrounded by 4 male flowers (Carludovicoideae) or in alternate cycles or spirals of male and female units (Cyclanthoideae); **flowers** small, unisexual, plants monoecious, male flowers: tepals 0-6, stamens 6-numerous, female flowers: 0-4-merous, staminodes 4, often filiform, white, ovary inferior or half-inferior, rarely superior, 1-locular; **fruits** berry-like, free or united and forming a fleshy syncarp, seeds very small. Exclusively in the Neotropics, in primary and secondary forests of low to high altitude. Neotrop. 12/200, CR 9/51, GD 8/15.

The family was monographed by HARLING (1958), who established two subfamilies: Cyclanthoideae (*Cyclanthus*) and Carludovicoideae (all other genera).

Several studies have been carried out on the pollination biology of the exclusively cantharophilous Cyclanthaceae. The pollination biology of Carludovicoideae is most interesting. It was clarified only recently, after having been enigmatic for a long time (SCHREMMER 1982). HARLING (1958) supposed weevil beetles to be the legitimate pollinators, but detailed studies were conducted by GOTTSBERGER (1990, 1991) and ERIKSSON (1994). They found that the pollination mode of the carludovicoid genera is fairly similar, differing only in the time and length of the male and female phases, as well as in the presence or lack of thermogenesis. The plants show a one- or two-day rhythm, with the female phase in the first morning and the male phase in the second morning. Anthesis starts a day before with the unfolding of the spathes. During the night, the four staminodes of each female flower protrude between the male flowers and surround the spadix as a mass of white, winding, spaghetti-like threads. Apart from the visual attractivity, the staminodia function as osmophores. The emitted scent, which is sometimes combined with thermogenesis of the spadix (sometimes of the staminodes too), attracts mainly small and medium-sized weevil beetles (Curculionidae, Derelomini: *Phyllotrox* spp.) and small Staphylinidae in the early morning hours. The weevils pass through the holes left by the staminodia and enter the interior of the spadix where the female flowers are situated. They lick the sweetish liquid exuding from the scars of the staminodia and the exudate of the receptive stigma and, if covered with pollen from another inflorescence, deposit the pollen on the stigmas. The beetles stay in the "female chambers", copulating and feeding on the stigmatic exudate. In the morning of the next day, the weevils crawl to the surface and become covered with pollen from the numerous anthers. They then leave the inflorescence. The pollination mode in the subfamily Cyclanthoideae, containing a single species, *Cyclan-*

thus bipartitus, was investigated by BEACH (1982). *C. bipartitus* has a flowering period of 2 days. It is pollinated by large beetles of the genus *Cyclocephala* (Scarabaeidae), which arrive at the inflorescences in the female phase during the first evening. They use the inflorescence as an aggregation site for feeding and mating and remain in the inflorescence for 24 hours until the end of the male phase. During this time they consume the specialized tissue of the inner bracts which consists of almost 50% lipids by dry weight, along with pollen.

The seeds of Cyclanthaceae are assumed to be dispersed by various animals, which are attracted by the bright colors of the open spadices, but few detailed observations exist. The outer layer of the fruiting spadix of *Carludovica* becomes fleshy and separates, rolling back and falling off in pieces. All inner parts of the infructescence are bright red. The ripe and open infructescences catch the eye from far away and are apparently advertised to birds (*Carludovica* is presumably the only ornithochorous member of Cyclanthaceae). Species of other genera have been reported to be dispersed by bats (HAMMEL & WILDER 1989) and monkeys (KNOGGE et al. 1998).

The leaves of several Cyclanthaceae are used for thatching roofs. The fibrous leaf blades of *Carludovica palmata* are cut in thin slices and used in basketry and for making the famous "Panama" hats. Sometimes the young inflorescences and stem hearts, as well as the basal portion of the leaf buds, are eaten like palm hearts ("palmito") (BENNETT et al. 1992; HAMMEL, in prep.).

Key to the genera (after HAMMEL, in prep.)

1	Leaf blades deeply bifid to the base (rarely remaining unsplit), each half with a thick lateral costa running nearly to the apex; plants terrestrial	*Cyclanthus*
1*	Leaf blades divided to entire, the two thick lateral costae (if present) always disappearing well below the apex	2
2	Petioles mostly 1,5-3 m long, leaf blades palmately divided into 4 segments, the segments toothed; lateral costae short and far removed from the margin; surface of mature spadix irregularly splitting to reveal bright orange seed pulp and rhachis; seeds angular; plants terrestrial	*Carludovica*
2*	Petioles mostly less than 1 m long, leaf blades bifid, rarely entire, the segments rarely toothed, but then the lateral costae long and running in the margin; surface of mature spadix not irregularly splitting; seeds flat or terete	3
3	Leaf blades never bifid; pistillate tepals very reduced, fruits entirely connate and the spadix nearly smooth; plants lianas	*Ludovia*
3*	Leaf blades of mature individuals bifid; pistillate tepals variously prominent, fruits variously connate to free but the fruit spadix not smooth	4
4	Lateral costae present, about as thick as the median costa	*Asplundia*
4*	Lateral costae absent	5
5	Petioles broadly concave throughout; leaves of new shoots often undivided; plants lianas; mature fruits tan and rather hard	*Thoracocarpus*
5*	Petioles slightly or not at all concave; leaves bifid; plants terrestrial or epiphytic; mature fruits otherwise	6
6	Leaves distichous	*Sphaeradenia*
6*	Leaves spirally arranged; plants terrestrial or climbing	7
7	Spathes dispersed along the spadix	*Asplundia*
7*	Spathes all attached immediately below spadix	8
8	Plants long-stemmed and openly branched, climbing; leaves scabrous when dry; fruits separate	*Evodianthus*
8*	Plants mostly short-stemmed and clumped, rarely climbing a short distance on trunks, usually found on rocks along streams; leaves smooth; fruits connate	*Dicranopygium*

Asplundia (neotrop. 89, CR 22, GD 7)
The largest genus consisting of short-stemmed terrestrial herbs and long-stemmed root climbers. The leaves are alternate, usually dull-surfaced and thin-textured, the 3-5 spathes (or their scars) are scattered along the upper half of the inflorescence stalk.

A. alata Harling
Short-stemmed terrestrial plant; leaves 55-110 cm long, bifid to ca. 1/3-1/2 of their length, tricostate, petiole often winged; spathes 7-14 cm long, drying thin, tan to rusty brown. In Costa Rica and Panama.

A. leptospatha Harling
Root-climbing liana, leaves clustered at the end of the branchlets, 16-18 cm long, bifid to ca. 4/5 of their length; spathes probably greenish-white. Costa Rica, endemic to the Golfo Dulce region.

A. multistaminata Harling
Much-branched climber; leaves 25-40 cm long, bifid to ca. 1/2-2/3 of their length, unicostate; upper spathes clustered ca. 1 cm below spadix. From Nicaragua to Panama.

A. pittieri (Woodson) Harling, Pl. 23f-h
Short-stemmed, terrestrial plant; leaves 22-35 cm long, the margins often distinctly undulate in life, bifid 1/3-1/2, the segments 5-10 cm wide, uni- or subtricostate, the lateral costae very weak and mostly on the margin; petiole base dull green. From Costa Rica to Colombia.

A. sleeperae Grayum & Hammel
Short-stemmed terrestrial plant; leaves 65-115 cm long, bifid to ca. 2/3 of their length, tricostate; spathes thin, often pink. Distributed from Nicaragua to Panama.

Carludovica (neotrop. 4, CR 4, GD 2)
Common names (Costa Rica): toccoca, pita, palma de sombrero (HAMMEL, in prep.)
An unmistakable "giant herb" with underground stem and long-stalked leaves with a 4-partite lamina consisting of 4 wedge-shaped, strongly plicate segments. As in *Asplundia* and related genera the spadix is studded with unisexual flowers in an extremely regular pattern: each female (pistillate) flower is surrounded by four male flowers in a cross-like arrangement.

C. drudei Mast., Pl. 24a-e
Robust, terrestrial plant, up to 2(-2,5) m tall; leaves palmately divided into 4 segments, (30-)40-70(-80) cm long, as wide as long, regularly toothed; spadix 9-12(-16) cm long, narrowly cylindrical, spathes 3-4, just below the spadix, staminodes white to yellowish white, 8-10 cm long, from southern Mexico to Colombia and Ecuador.
Another less frequent species of the area is *C. rotundifolia*, which is very similar to the former, but differs mainly in the shorter tepals curving over the stigmas and the stigmas placed on a definite style (vs. tepals straight, stigma sessile in *C. drudei*).

Cyclanthus (neotrop. 1, CR 1, GD 1)
Monotypic genus and the only representative of the subfamily Cyclanthoideae, standing apart from the rest of the family by its unique spiralled inflorescence.

C. bipartitus Poit., Pl. 24f,g
A giant, stemless terrestrial herb; leaves unmistakable, to 2 m long, blade divided in the middle nearly to the base, each half bearing a single "midrib"; inflorescences thick-cylindrical, borne on a stout stalk, spadix bearing 12-15 alternating cycles of each, female and male flowers, which are completely fused and whose individuality is no longer discernible, bracts 4, cymbiform just below the spadix, inner bracts bearing a 2-3 mm thick, salmon pink-colored layer of homogeneous, mealy tissue on the adaxial surface as a reward for pollinators. In forests on banks, along rivers, forest edges, as well as in large stands in open, swampy areas, very widespread, from Central America and the Lesser Antilles to tropical South America.

Dicranopygium (neotrop. 49, CR 6, GD 1)
A genus of terrestrial or rarely low root-climbers, closely related to *Asplundia*, but characterized by tiny, few-flowered inflorescences, with rather separated individual flowers with reduced perianth. One species (under description) is known from the Golfo Dulce region, growing on rocks along streamsides.

Evodianthus (neotrop. 1, CR 1, GD 1)
Monotypic genus.

E. funifer (Poit.) Lindm.
Root climbing liana or epiphytic, rarely terrestrial; leaves bifid, 55-75 cm long, unicostate, scabrous when dry, smaller leaves entire; spathes

3, crowded just below the spadix; male flowers: tepals well developed, receptacle with deep central depression; female flowers: free from each other, tepals well developed; fruiting spadix ellipsoid-globose 2,5-3 cm long, fruits pale orange. Widespread and common, from Central America to tropical South America.

Ludovia (neotrop. 3, CR 1, GD 1)
A small genus of root climbing lianas and a few epiphytes and terrestrial plants, distinct in having entire, distichous leaves.

L. integrifolia (Woodson) Harling
Viny, root-climbing epiphyte; leaves elliptic to oblanceolate, 15-25(-35) cm long, 4-6(-9) cm wide, unicostate margin usually crenate; spathes 3,4-5 cm long, 1,5-2,5 cm wide, spadix narrowly cylindrical to fusiform. In wet forests, sometimes in disturbed areas, from Costa Rica to Colombia. Due to the undivided leaves this species is easily mistaken for an aroid.

Sphaeradenia (neotrop. 40, CR 10, GD 1)
A genus of terrestrial or epiphytic herbs and a few climbers, usually with short stem and bifid leaves, differing from *Asplundia* mainly in the distichous leaf arrangement.

S. acutitepala Harling, Pl. 24h
Epiphyte, short-stemmed, rarely terrestrial; leaves (27-)57-140 cm long, bifid to 1/5 to 1/2 of its length; male flowers caducous, stamens 11-27; fruiting spadix yellow to orange. In wet forests, from Nicaragua to northern Colombia.

Thoracocarpus (neotrop. 1, CR 1, GD 1)
Monotypic genus.

T. bissectus Vell.
Common name (Costa Rica): bejuco del hombre (HAMMEL, in prep.)
High climbing liana, stem up to 15 m long; leaves spirally arranged, 30-40 cm long, bifid, smaller leaves entire, petioles broadly flattened, channelled; spathes 8-11, greenish to yellowish-white or white, spadix shortly cylindrical to ellipsoid or obovoid; male flowers funnel-shaped, stamens 40-80, female flowers: staminodes 3-5 cm long, white. Widespread and common in wet forests, from Costa Rica to Bolivia and Brazil.

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Cyperaceae

A large family of mainly perennial grass-like herbs with a creeping underground rhizome, differing from the true grasses (Poaceae) by 3-ranked leaves and usually triangular solid stems. **Leaves** generally tristichous, borne basally or along the stem, mostly linear, closed sheath mostly present, sometimes with a ligule, rarely with a contraligula (*Scleria*); **inflorescences** small spikelets or spike-like structures arranged in panicles, spikes, fascicles or heads, rarely solitary and terminal; **flowers** bisexual or unisexual, then plants monoecious or rarely dioecious, perianth lacking or present in form of bristles, hairs or scales, stamens 1-3(-6-numerous), ovary superior, 1-locular; **fruits** achenes, rarely drupes. Usually in wet and swampy habitats, abundant in the tropics, but also widely distributed in temperate regions worldwide. Cosmopol. 98/4350, CR 25/189, GD 13/24.

All or at least nearly all Cyperaceae are wind-pollinated. Some species (*Calyptrocarya glomerulata, Bequerelia cymosa*) are possibly insect-pollinated, as they grow on the calm forest floor (LOROUGNON 1973).

The genera *Torulinium* and *Pycreus* are sometimes included in *Cyperus*. They are treated here as distinct genera according to the Flora Mesoamericana (ADAMS 1994).

Key to the genera

1	Plants climbing and vine-like; plants generally on trails	*Scleria secans*
1*	Plants erect or leaning but never vine-like	2
2	Flowers bisexual or at least the fruit-bearing bisexual flowers	3
3	Stigmas 3	*Cyperus*
3*	Stigmas mostly 2	4
4	Hypogynous bristles present; spikelet scales spirally arranged	*Eleocharis*
4*	Hypogynous bristles absent; spikelet scales spirally or distichously arranged	5
5	Spikelet scales spirally arranged; spikelets fusiform	6
6	Style base (tubercle) persistent, triangular to deltate, nearly as wide as or as wide as achene	*Rhynchospora*
6*	Style base deciduous or present as an apiculus, much narrower than achene	*Fimbristylis*
5*	Spikelet scales distichous; spikelets laterally compressed	7
7	Fruits bony-white to beige or purple, glabrous, culms 30-150 cm tall	8
7*	Fruits bony-white to beige or purple, puberulent; culms 6-50 cm tall	*Calyptrocarya*
8	Inflorescence paniculate, spikelets usually unisexual, therefore two sizes of spikelets	*Scleria melaleuca*
8*	Inflorescence corymbose, spikelets usually bisexual, uniform in size	*Becquerelia*
7**	Fruits not bony white, mostly brown, green, tan, gray or black	9
9	Inflorescence a terminal, sessile capitulum or a cluster of spikes; the involucral bracts blade-like, almost as long as leaves to far exceeding leaves in length	*Mapania*
9*	Inflorescence various, seldom capitulate or sessile; involucral bracts not blade-like or, if so, then clearly shorter than leaves	10
10	Leaf blades 1-veined, V-shaped in transverse section, with midvein clearly larger than all other veins	*Diplasia*
10*	Leaf blades 3-5 veined, M-shaped in transverse section, with 1 or 2 veins on either side of the midvein clearly larger than other lateral veins	*Hypolytrum*
2*	Flowers unisexual (plants monoecious or dioecious)	11
11	Stigma 2, achenes lenticular	12
11*	Stigma 3, achenes trigonous	*Torulinium*
12	Rhachilla of spikelets persistent, glumes imbricate, at maturity separate and caducous	*Pycreus*
12*	Rhachilla of spikelets articulated at base and containing one achene	*Kyllinga*

Becquerelia (neotrop. 10, CR 1, GD 1)
Medium to large perennial herbs with paniculate inflorescences of numerous spikelets.

B. cymosa Brongniart, Pl. 25a,b
Herb with solitary erect culms, 45-150 cm tall; largest leaves to 1,5 m long, margin slightly

scabrous; inflorescence 3-7-branched panicles, peduncle 3-7 cm long, bract subtending each panicle, leaf-like, to 100 cm long, 28 cm wide, comprising 6-12 branches, each branch terminating in 1-3 fruit-bearing spikelets; fruits 1,7-2,8 mm long, 0,6-1,2 mm wide, white to tan or rarely brown, smooth to slightly rugulose. From Nicaragua to southern Brazil.

Cyperus (trop. + subtrop. c. 300, CR 43, GD 6), Pl. 25c
A genus characterized by grass-like leaves and umbellately branched inflorescences, subtended by a whorl of 3 or more leaf-like bracts.

Diplasia (neotrop. 2 + 1 sp. Southeast Asia, CR 1, GD 1)
Tall perennial herbs with thick rhizomes and the leaves lacking a ligule. The inflorescences are large corymbs, composed of numerous spicate partial inflorescences.

D. karatifolia Rich., Pl. 25 d
Herb, up to 4 m tall; leaves up to 3 m long, 3-5 cm wide; inflorescences up to 40 cm long; achenes ca. 6 cm long, 4 cm wide, black. From Costa Rica to Peru, Bolivia and Brazil.

Mapania (pantrop. 73, CR 2, GD 1)
A genus of perennial herbs, technically characterized by the spikelets reduced to a pair of unisexual flowers, arranged in pseudo-spikelets. Several species are members of the forest floor with very distinctive broad leaves contracted into a basal petiole.

M. assimilis T. Koyama, Pl. 25e
Herb with solitary erect culm, 20-50 cm tall; leaves reduced (1,5-10 cm long); bracts 3, 14-21 cm long, 3-5,3 cm wide, foliaceous; fruits subglobose, 2-3 mm long, black. From Honduras to Colombia.

Scleria (pantrop. + subtrop. 200, CR 11, GD 2)
Mostly perennial herbs or climbers with unisexual flowers (plants monoecious) and very distinctive broad leaves. The genus is also distinct in lacking a perianth and 1-flowered pistillate spikelets. In most species the ovary and fruits are subtended by an often trilobate hypogynium. The achenes are globose to ovoid, bony-white or occasionally purple.

S. secans (L.) Urban
Climbing, vine-like herb, 3-10 m tall; leaves less than 30 cm long, 2-7 mm wide, culms and margins with very sharp, retrorsely scabrous to hispid trichomes; inflorescences paniculate, usually purplish, spikelets unisexual, male spikelets many-flowered, female spikelets with 1 flower and several empty scales; achenes usually few, ovoid, 2-4 mm long, white, shiny. The edges of the culms and leaves are very sharp. This is one of the most appropriately avoided plants of the neotropical forests. Locally quite common along forest edges and forest openings, from Mexico and the West Indies to Bolivia and Brazil.

ADAMS, C.D. 1994. Cyperaceae. Pp.: 402-485. In: G. DAVIDSE, M. SOUSA S. & A.O. CHATER (eds.): Fl. Mesoamericana Vol. 6. Alismataceae a Cyperaceae. - Universidad Nacional Autónoma de México, Missouri Botanical Garden, Natural History Museum (London).

CORE, E.L. 1936. The American species of *Scleria*. - Brittonia 2 (1): 1-105.

GOETGHEBEUR, P. 1998. Cyperaceae. Pp: 141-190. In: K. KUBITZKI (ed.): The families and genera of vascular plants. Vol IV. Alismatanae and Commelinanae (except Gramineae). - Berlin: Springer Verlag.

LOROUGNON, G. 1973. Le vecteur pollinique chez les *Mapania* et les *Hypolytrum*, cypéracées du sous-bois des forêts tropicales ombrophiles. - Bull. Jard. Bot. Belg. 45: 181-184.

Dioscoreaceae

A mainly tropical family of perennial climbers and herbaceous vines. **Leaves** alternate, opposite or whorled, lamina often cordate, entire, palmately lobed or digitately compound, palmately veined, petiole usually pulvinate, stipules sometimes present; **inflorescences** axillary, paniculate, racemose or spicate; **flowers** actinomorphic, dioecious, rarely monoecious or bisexual, usually inconspicuous, tepals 6, in 2 whorls, basally connate, stamens 6, in 2 whorls, third inner staminodial whorl sometimes present, ovary inferior, 3-locular; **fruits** usually loculicidal capsules, 3-winged, or sometimes berries or samaras. In the tropics and subtropics worldwide, with some *Dioscorea* spp. also extending into temperate regions. Pantrop. + subtrop. 8/880, CR 1/19 and 3 cultivated, GD 1/7 and 1 cultivated.

Little is known about the pollination of the inconspicuous flowers of the Dioscoreaceae. Several authors assumed wind-pollination in *Dioscorea*, but the flowers often have a sticky pollen, septal nectaries and sweet scent, and are therefore probably entomophilous. BARROSO et al. (1974) observed stingless bees of the genera *Melipona* and *Hypotrigona*, visiting the flowers of several *Dioscorea* spp. SEGNOU et al. (1992) identified several insects, mainly coleoptera, diptera and hymenoptera as visitors of the African *Dioscorea rotundata*.

The only economically important genus in the family is *Dioscorea* (yams). The tubers of about 60 species are cultivated as subsistence crop in three main centers (Southeast Asia, West Africa and Central and South America). The tubers contain the poisonous alkaloid dioscorine, but in all the cultivars the concentration is rather low and the alkaloid is destroyed by boiling. Some species (e.g., *D. villosa*) are the source of diosgenin, a steroidal sapogenin, chemically modified in recent years for the use in oral contraceptives. In some species of *Dioscorea* the poison is used as an arrow-poison (*D. hispida* from tropical Asia). Some species are cultivated as ornamentals ("elephant's foot").

Dioscorea (pantrop. + subtrop. 850, CR 19 and 3 cultivated, GD 7 + 1 cultivated)
A genus of mostly dioecious, slender twining vines with smooth green stems. The simple, alternate leaves are not very monocot-like: heart-shaped (sometimes lobed), venation reticulate, parallel and arcuate main veins with a network of lateral veinlets (secondary and tertiary veins). The petioles are long and pulvinate on both ends (basal pulvinus jointed and twisted, a stipule-like flange often occurs). The only genus which can be confused with *Dioscorea* is *Smilax*, from which it differs in lacking petiolar tendrils, well-defined transversally parallel secondary cross veins and 3 winged capsular fruits.

This huge genus has been subdivided into 75 sections. Not uncommonly, male and female plants of the same species have been described as different species, contributing to overdescription and confusion.

Key to the species of *Dioscorea* (B. HAMMEL)

1	Leaves 3-5-lobate	2
2	Stem winged, cultivated species	*D. trifida*
2*	Stem cylindric, natural species	*D. liebmannii*
1*	Leaves simple, not lobed	3
3	Petiole with spines	*D. urophylla*
3*	Petiole without spines	4
4	Flowers with obvious pedicel	*D. racemosa*
4*	Flowers ± (sub)sessile	5
5	Stamens 3, filaments ± obvious; stems twining to the left	*D. polygonoides*
5*	Stamens 6; stems twining to the right	6
6	Flowers solitary, rhachis of inflorescence zig-zag, floral tube obvious	*D. remota*
6*	Flowers usually clustered up to 4 together; rhachis not zig-zag	7
7	Inflorescence with flowers grouped at the end of the cymes	*D. mexicana*
7*	Inflorescence with flowers along the rhachis, or the twigs reduced and the flowers in glomeruli, ± sessile and green	*D. spiculiflora*

D. liebmannii Uline
Leaves 3-foliolate or 3-lobate, 14-17 cm long, 13-18 cm wide, glabrous, veins 7-9; inflorescences racemes or panicles of racemes, 5-20 cm long, rhachis glabrous or hirtellous; flowers solitary, green, stamens 3; fruits 4-6 mm wide. In the margins of tropical wet forests, from Mexico to Panama.

D. mexicana Scheidw., Pl. 25g
Leaves lanceolate, ovate to suborbicular, base cordate, 8-16 cm long, 4-12,5 cm wide, glabrous, veins 7-9 (-11); inflorescences racemose, rarely paniculate, ca. 7-23 cm long, rhachis glabrous; flowers 2-4 per cyme, sessile to subsessile at the end of the cyme, red to purple, stamens 6; fruits 1,3-1,7 cm long. In tropical wet forests, from Mexico to Panama.

D. polygonoides Humb. & Bonpl. ex Willd.
Leaves ovate to suborbicular, 8-16 cm long, 6-14 cm wide, glabrous, veins 7-11; inflorescences glomerate, ca. 10-30 cm long; flowers 2-4 per glomerule, sessile to subsessile, green to coffee-brown, rhachis sparsely verruculose; fruits 0,7-1,2 cm long. In tropical wet forests, from Mexico and the Antilles to Brazil.

D. racemosa (Klotjsch) Uline
Leafes ovate to suborbicular, 6,5-15(-21) cm long, 3,5-9(14) cm wide, glabrous, veins 7-11, usually with glands above the veins; inflorescences racemose with cymose branches, ca. 9-32 cm long; flowers pedicellate, (1)2-3 per cyme, stamen 3, subsessile; fruits 0,4-0,7 cm long. In tropical wet forests, from Costa Rica to Panama.

D. remota C.V. Morton
Leaves ovate to suborbicular, 17-24 cm long, 10-19 cm wide, glabrous, veins 7-9(-11); inflorescences spicate or paniculate, ca. 10-20 cm long, rhachis glabrous; flowers solitary, sessile to subsessile, floral tube red to dark purple, rarely yellow to cream-colored, stamens 6; fruits winged, 3-4 cm long. In tropical wet forests, from Costa Rica to Panama.

D. spiculiflora Hemsl.
Leaves triangular or suborbicular, base truncate or cordate, 8-22(-26) cm long, 5-20(-26) cm wide, glabrous, veins 7-11; inflorescences ca. 8-40 cm long, racemose or paniculate, rhachis glabrous; flowers subsessile, (1-)3-4 per spiculum, stamens 6, sessile to subsessile; fruits 2-3 cm long. In tropical dry to tropical wet forests, from Mexico to Panama.

D. trifida L., Pl. 25f
Stem winged, bulbils tuberculate; leaves 3-5 palmately-lobed, 9-20 cm long, 8-20(-23) cm wide, glabrous, veins 7-9; inflorescences ca. 10-20 cm long, racemose or paniculate with racemose branches, rhachis pubescent to glabrous, (dark) purple to coffee-brown; flowers solitary, stamens 6; fruits 1,7 cm long. Cultivated species, from Honduras to Peru, Surinam to Brazil.

D. urophylla Hemsl.
Stem basally with curved spines, bulbils verrucose; leaves alternate, sometimes opposite, ovate, base rounded to cordate, 10-18 cm long, 6-12 cm wide, glabrous, veins 7-9, glands on the veins; inflorescences ca. 8-30 cm long, racemose or spicate, rhachis glabrous; flowers solitary, sessile or subsessile, petals cream, yellowish-green to reddish, stamens 6; fruits ca. 1 cm long. In tropica wet forests, from Mexico to northern South America.

BARROSO, G.M., D. SUCRE, E.F. GUIMARÃES & L.F. DE CARVALHO. 1974. Flora de Guanabara. Familia Dioscoreaceae. - Sellowia 25: 9-256.

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HUBER, H. 1998. Dioscoreaceae. In: K. KUBITZKI (ed.): The families and genera of vascular plants. Vol III. Monocotyledons Lilianae (except Orchidaceae). - Berlin: Springer Verlag.

TÉLLEZ, O. & B.G. SCHUBERT. 1994. Dioscoreaceae. Pp.:53-65. In: G. DAVIDSE, M. SOUSA S. & A.O. CHATER (eds.): Fl. Mesoamericana Vol. 6. Alismataceae a Cyperaceae. - Universidad Nacional Autónoma de México, Missouri Botanical Garden, Natural History Museum (London).

Haemodoraceae

A family of perennial herbs with rhizomes tubers or stolons; rhizomes often with red latex. **Leaves** entire, distichous, parallel-veined, arising from the ground and sheathing one another at the base (equitant); **inflorescences** terminal on aerial shoots, racemose, corymbose, paniculate, capitulate or rarely flowers solitary; **flowers** bisexual, actinomorphic to strongly zygomorphic, tepals 6, in 2 whorls, free or sometimes basally connate into a short tube, variously colored, stamens 1-3-6, unequal, staminodes 0-2, ovary superior to inferior, 3-locular; **fruits** usually loculicidal capsules, sometimes poricidal or indehiscent, crowned by the persistent style. In tropical and warm temperate regions. North and tropical America, South Africa, Australia and New Guinea 14/100, CR 1/1 GD 1/1.

BUCHMANN (1980) investigated the flowers of *Xiphidium coeruleum*, which attract pollen-collecting euglossine bees by a scent produced by the osmophores. These bees, of the genera *Euglossa* and *Paratetrapedia,* pollinate the flowers by buzz-pollination.

Xiphidium (neotrop. 1, CR 1, GD 1)
Monotypic genus.

X. coeruleum Aubl., Pl. 26a-c
Perennial herb, 15-200 cm tall; rhizome with red-orange sap, rather creeping; leaves linear, somewhat succulent, equitant, 20-65 cm long; inflorescences few- to much-branched, thyrsoid, 2-44 cm long, with 5-25-flowered cincinni; flowers white to yellowish white, distinctly pedicellate, stamens 3, opening by apical pores, staminodes absent, ovary globose; capsules globose, 5-10 mm in diameter, orange, red to black when mature, seeds numerous. Common along trails in the forest, from Mexico and the West Indies to Brazil and Bolivia.

BUCHMANN, S.L. 1980. Preliminary anthecological observations on *Xiphidium caeruleum* Aubl. (Monocotyledonae: Haemodoraceae) in Panama. - J. Kansas Entomol. Soc. 53 (4): 685-699.

MAAS, P.J.M. & H. MAAS VAN DE KAMER. 1993. Haemodoraceae. Fl. Neotrop. Monogr. 61.

NELSON, C. 1994. Haemodoraceae. Pp.: 47-48. In: G. DAVIDSE, M. SOUSA S. & A.O. CHATER (eds.): Fl. Mesoamericana Vol. 6. Alismataceae a Cyperaceae. - Universidad Nacional Autónoma de México, Missouri Botanical Garden, Natural History Museum (London).

SIMPSON, M.G. 1998. Haemodoraceae.Pp.: 212-222. In: K. KUBITZKI (ed.): The families and genera of vascular plants. Vol IV. Alismatanae and Commelinanae (except Gramineae). - Berlin: Springer Verlag.

Heliconiaceae

A family of large herbs, sometimes over 10 m tall, with pseudo-stems formed by the sheaths of the distichously arranged leaves. **Leaves** simple, distichous, usually large, entire, oblong or oblong-elliptic with well developed midvein and numerous very fine, parallel secondary veins, sheath present without ligule, petiole nearly absent (zingiberoid), medium-length (cannoid) or long (musoid); **inflorescences** large and showy, erect or pendent, terminal on leafy stems or on specialized shoots bearing only bladeless sheaths, thyrsoid, bearing cincinni with up to 50 flowers, each cincinnus subtended by a large, brightly colored bract; **flowers** zygomorphic, bisexual, sepals 3, petals 3, all perianth elements basally fused, fertile stamens 5, staminode 1, scale-like, ovary inferior, 3-locular, nectaries present at the base of the styles; **fruits** drupaceous, usually blue at maturity, pyrenes 3, operculate. Plants of the family are among the most striking and characteristic features of the rainforests mainly in the Neotropics, with a few species in Melanesia and Polynesia. Pantrop. 1/c. 200, CR 1/43, GD 1/16.

The bracts of some *Heliconia* species contain an acidic liquid, which supports communities of aquatic insects. These bract fluids help to protect the submersed reproductive flower parts from herbivores (BRONSTEIN 1986, WOOTTON & SUN 1990).

All Costa Rican species of *Heliconia* are hummingbird-pollinated (LINHARD 1973; STILES 1975, 1979, 1985; KRESS 1985a) The individual species are adapted in various ways to pollination by hermits (hummingbirds with curved bill) and non-hermits (hummingbirds with a nearly straight bill). Hermit-pollinated species typically grow as small, scattered clones with small numbers of nectar-rich flowers available during the flowering season, the flowers having long and/or curved corollas. Non-hermit-pollinated species have short, straight flowers that are produced in greater numbers; they tend to grow as large clones with more inflorescences, thus often attracting territorial birds, since one or a few adjacent clones can supply all of a bird's daily energy needs. Four of the Old World species of *Heliconia* have nocturnal flowers, pollinated by bats (KRESS 1985b), while the remaining two are pollinated by honeyeaters (PEDERSEN & KRESS 1999).

The blue fleshy fruits of most *Heliconia* species attract a large number of birds and non-flying mammals (STILES 1979). The orange or red fruits of the Old World species are assumed to be eaten by various bats and birds (KRESS 1990).

Many species of *Heliconia* are used as ornamental plants (BERRY & KRESS 1991), and hybrids. The leaves and other vegetative parts of Old World species are widely used for various purposes in the household and for cooking as well as for a kind of wrapping paper by the native people (KRESS 1990).

Key to the species of *Heliconia*

1	Inflorescence erect	2
2	Plants with *Zingiber*-like leaf arrangement (> 5 leaves with blades nearly sessile, held rather horizontally and arranged along the erect pseudostem in ladder-like fashion)	*H. longiflora*
2*	Plants with *Canna*-like or *Musa*-like leaf arrangement (4-5 leaves with relatively long petioles, held rather erect and clustered towards base of pseudostem)	3
3	Inflorescence spirally twisted	4
4	Old leaves usually with narrow maroon margin	*H. latispatha*
4*	Old leaves not as above	*H. irrasa*
3*	Inflorescence completely distichous	5
5	Bracts of major inflorescences not overlapping	6
6	Inflorescence elongated, flowering from December to June	*H. osaënsis*
6*	Inflorescence compressed, flowering from June to December, the basal bract may have a distal green keel and tip or leaflet	*H. vaginalis*
5*	Bracts of major inflorescences distinctly overlapping	7
7	Basal inflorescence bracts with a thin, long, greenish tip	*H. wagneriana*
7*	Basal inflorescence bracts with a blunt tip, tips of older bracts turning black by necrosis	*H. imbricata*
1*	Inflorescence pendent	8
8	Ovary and fruit minutely pubescent	9
9	Bracts red to rose-red, basal bract with green infusion, tips becoming necrotic with age	*H. trichocarpa*
9*	Bracts pink, with flush of cream at base and at lip, basal bracts with green tips	*H. colgantea*
8*	Ovary and fruit glabrous	10
10	Inflorescence strictly distichous	*H. stilesii*
10*	Inflorescence distichous to spirally twisted	11
11	Bracts and rachis very hirsute or woolly	12
12	Cincinnal bracts bichromatic, red and yellow	*H. pogonantha*
12*	Cincinnal bracts monochromatic, orange red	*H. danielsiana*
11*	Bracts or rachis glabrous	*H. longa*

Heliconia (pantrop. 200-250, CR 43, GD 18)
Common name (Costa Rica): platanillo (KRESS, in prep.)
See characters of the family.

H. colgantea R. R. Sm. ex G. S. Daniels & F. G. Stiles
Musa-like herb, 2,0-3,5 m tall; leaves 6 per shoot, green, longest blade to 140 x to 20 cm; inflorescences pendent, to 70 cm long, bracts rose to rose-red spirally arranged, 7-11 per inflorescence, the middle bract with outer surface dark pink at base and light at the apex, sparsely pubescent; flowers 15-20 per cincinnus, perianth yellow, pubescent; fruits sparsely pubescent. In Costa Rica and Panama.

H. danielsiana W. J. Kress, Pl. 26d-f
Musa-like herb, 4,5-8,0 m tall; leaves 2-4 per shoot, green, longest blade to 280 x 57 cm; inflorescences pendent, to 1 m long, bracts distichous to spirally arranged, 20-30 per inflorescence, the middle bract with outer surface orange-red and woolly with buff to orange hairs; flowers 15-20 per cincinnus, perianth white (basally) to yellow (distally), glabrous to velutinous with buff to cinnamon hairs distally. Endemic to Costa Rica.

H. imbricata (Kuntze) Baker, Pl. 26g-i
Musa-like herb, 3,5-6,0 m tall; leaves 3-4 per shoot, petiole pubescent, lower surface of blade with minute reticulate pattern, sometimes suffused with maroon (especially when juvenile), longest blade to 230 x 50 cm; inflorescences erect, cincinnal bracts distichously arranged, imbricate; flowers 20-30 per cincinnus, perianth green distally, becoming white or yellow basally, sepals glabrous to sparsely hirsute along the margins. From Nicaragua to Panama.

H. irrasa R. R. Sm., Pl. 27a
Musa-like herb, 1,5-2,0 m tall; longest leaf blades to 100 x 27 cm; inflorescences erect, to 29 cm long, cincinnal bracts spirally arranged, undulate, 6-9 per inflorescence; flowers 10-15 per cincinnus, perianth white to pale yellow basally, becoming yellow distally, sepal essentially glabrous to sparsely pubescent along the margin. In Costa Rica and Panama.

H. latispatha Benth., Pl. 27b
Musa-like herb, 2,0-4,0 m tall; leaves 3-5 per shoot, longest blade to 150 x 33 cm, usually with very thin maroon margin along leaves; inflorescences erect, to 45 cm long, cincinnal bracts spirally arranged, 8-13 per inflorescence, middle bract with outer surface orange to red, glabrous; flowers 10-15 per cincinnus, perianth green, yellow or orange, sepal margins dark green, glabrous, sometimes sparsely puberulous. Common and often abundant in open secondary growth and recently cut areas, very tolerant against heat and drought, from Mexico to South America.

H. longa (Griggs) H. J. P. Winkl.
Musa-like herb, 5-7 m tall; leaves 4-7 per shoot, green with white waxy coating beneath, longest blade to 300 x 55 cm; inflorescences pendent, to 1,6 m long, cincinnal bracts usually distichous to subdistichous, sometimes spirally arranged, 12-40 per inflorescence; flowers 10-20 per cincinnus, perianth white to yellow basally, becoming deep yellow distally, entirely glabrous or slightly puberulous toward apex. From Nicaragua to Ecuador.

H. longiflora R. R. Sm., Pl. 27c,d
Slender *Zingiber*-like herb, 1,0-3,0 m tall; leaves 10-16 per shoot, petiole short, 3-4 mm long, longest blade to 36 x 8 cm; inflorescences erect, to 16 cm long, cincinnal bracts distichous, 4-8 per inflorescence; flowers resupinate, 7-8 per cincinnus, perianth entirely yellow or white, becoming orange at base and glabrous. From Nicaragua to Colombia.

H. osaënsis Cufod., Pl. 28a,b
Canna-like herb, 1,0-3,0 m tall; leaves 5-6 per shoot, longest blade 150 x 25 cm; inflorescences erect, to 20 cm long, cincinnal bracts distichous, 5-12 per inflorescence; flowers resupinate, 8-12 per cincinnus, perianth orange to red orange basally to yellow green or green distally and sparsely hirsute. From Costa Rica to Panama.

H. pogonantha Cufod. Pl. 27e-g
Musa-like herb, 4-7,5 m tall; leaves 3-6 per shoot, lower surface often glaucous, longest blade to 120-330 x 40-65 cm; inflorescences pendent, up to 160 cm long, cincinnal bracts usually spirally arranged, 20-55 per inflorescence, middle bract with outer surface red (sometimes yellow near rhachis) and glabrous to velutinous; flowers 10-30 per cincinnus, yellow, glabrous basally, becoming velutinous with golden hairs toward apex. From Nicaragua to Colombia.

H. stilesii W. J. Kress, Pl. 28c-e
Musa-like herb, 5,0-6,0 m tall, leaves 4-6 per shoot, lower surface with white waxy coat, longest blade to 230 x 55 cm; inflorescences pendent, to 100 cm long, cincinnal bracts distichously arranged, often touching one another, 20-35 per inflorescence; flowers 10-20 per cincinnus, perianth white to pale yellow basally, deep yellow distally, sepal margins glabrous to puberulous. Endemic to Costa Rica.

H. trichocarpa G. S. Daniels & F. G. Stiles, Pl. 28 f,g
Musa-like herb, 2,0-4,0 m tall; leaves 4-6 per shoot, all tending to lie in horizontal plane, longest blade to 175 x 30 cm; inflorescences pendent, to 60 cm long; cincinnal bracts spirally arranged, 6-10 per inflorescence; flowers 10-20 per cincinnus, perianth yellow, glabrous to puberulous; fruits tomentose. From Costa Rica to Colombia.

H. vaginalis Benth.
Slender to coarse, *Zingiber*- to *Canna*-like herb, 2,5-5,0 m tall; leaves 8-10 per shoot, longest blade to 90 x 17 cm; inflorescences erect, to 21 cm long, cincinnal bracts distichous, 5-8 per inflorescence; flowers resupinate, 8-19 per cincinnus, perianth yellow with green apex, glabrous. From Costa Rica to Colombia.

H. wagneriana Petersen, Pl. 29a,b
Musa-like herb, 1,75-4,0 m tall; leaves 3-4 per shoot, blades undulate, longest blade to 150 x 30 cm; inflorescences erect, to 21 cm long, cincinnal bracts distichous, 7-13 per inflorescence; flowers 15-20 per cincinnus, perianth white basally, dark green distally, essentially glabrous, sepals sometimes sparsely hirsute. From Belize through Central America to Colombia.

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Lemnaceae

A family of small free-floating or submersed herbs reduced to a leaf-like frond of various shapes and one to several roots which also may be lacking. The plants mostly reproduce vegetatively. Fronds thin or thick, green, sometimes reddish, with 1-2 lateral or terminal reproductive pouches; roots 0-1-several; 1-2 staminate **flowers** and 1 pistillate flower per frond, unisexual, plants usually monoecious, rarely dioecious, stamens 1-2, ovary 1-locular; **fruits** dry, indehiscent, seeds 1-several. Cosmopol. 4/25, CR 3/5, GD1/1.

The adult structure of *Lemna* is very similar to that of the seedlings of the aquatic genus *Pistia* (Araceae), and it seems likely that *Lemna* evolved from *Pistia* by pedomorphosis (sexual maturity reached at a juvenile stage).

The pollination biology of Lemnaceae is largely unknown, due to the rare occurrence of flowers. LANDOLT (1998) suggested entomophily. Species with more frequent flowering (*Lemna aequinoctialis*) are mostly self-pollinators (LANDOLT 1998).

No uses of this family are known, but the plants are important as a source of food for waterfowl and fish. In some parts of the world, *Lemna* spp. and *Wolffia* spp. are eaten by humans as a kind of vegetable.

Lemna (cosmopol. 7, CR 2, GD 1)
Monoecious, submersed or floating aquatic herbs, forming large clusters of individuals cohering by their leaves. The plants are reduced to a flat, thin or spongy frond.

L. aequinoctialis Welw.
Floating herb, covering the surface of the water, plants solitary or in clusters of 3-5; fronds 1-2,5 m long, 0,7-2 mm wide, membranous, oblong to ovate, upper surface papillate, obscurely 3-nerved;

root 1, winged at the connection with the frond. Occasionally in temporary bodies of fresh water or abandoned wells, in lowland areas worldwide.

LANDOLT, E. 1986. The family Lemnaceae - A monographic study. - Veröff. Geobot. Inst Eidg. Techn. Hochsch. Stift. Rübel 71: 1-566.
Landolt, E. 1998. Lemnaceae. Pp.: 264-270. In: K. Kubitzki (ed.): The families and genera of vascular plants. Vol IV. Alismatanae and Commelinanae (except Gramineae). - Berlin: Springer Verlag.

Limnocharitaceae

EEmergent, floating or submersed aquatic herbs, easily recognized by the presence of milky latex. Stems erect, unbranched; **leaves** of juvenile plants always submersed and linear, leaves of adult plants basally inserted or alternate along the stem, linear-lanceolate to lanceolate, ovate to elliptic, entire, petiole with sheathing base; **inflorescences** terminal, erect or prostrate, floating on the water, cymose, umbel-like, scapose, or flowers solitary; **flowers** bisexual, actinomorphic, sepals 3, free, persistent, petals 3, free, white or yellow, caducous, stamens 6-numerous; **fruits** clusters of follicles, seeds numerous. In wet places throughout the tropics worldwide, mainly in the Neotropics. Pantrop. 3/8 CR 2/3, GD 1/2

Pollination has not been observed in the family so far, but it can be assumed that the flowers are pollinated by insects (HAYNES & HOLM-NIELSEN 1992, HAYNES et al. 1998).

The seeds of Limnocharitaceae are generally water-dispersed. Dispersal by birds may also play a role (HAYNES et al. 1998).

Limnocharis (neotrop. 2, CR 2, GD 2)
Annual or perennial herbs with emergent leaves, linear lanceolate to broadly ovate. The flowers are always yellow.

L. flava (L.) Buchenau, Pl. 29c,d
Plants up to 110 cm tall; leaves broadly ovate to oblong, petioles 20-85 cm long; inflorescences umbelliform, 4,5-19 cm in diameter, with 3-12 flowers, peduncles usually longer than the petioles; flowers ca. 5 cm wide, stamens numerous; fruiting heads 1,1-1,6 cm long, 1,4-2,4 cm wide. In muddy soil or shallow water, in lagoons, marshes and rivers, from Mexico to northern Argentina and eastern Brazil, introduced to Asia.

CROW, G.A. In prep. Limnocharitaceae. Manuál de las plantas de Costa Rica. Missouri Botanical Garden. Instituto Nacional de Biodiversidad. Museo Nacional de Costa Rica.
HAYNES, R.R. & L.B. HOLM-NIELSEN. 1992. Limnocharitaceae. Fl. Neotrop. Monogr. 56: 1-34.
HAYNES, R.R., D.H. LES & L.B. HOLM-NIELSEN. 1998. Limnocharitaceae. pp: 271-274. In: K. Kubitzki (ed.): The families and genera of vascular plants. Vol IV. Alismatanae and Commelinanae (except Gramineae). - Berlin: Springer Verlag.
NOVELO, A. & A. LOT. 1994. Limnocharitaceae. pp: 8-9. In: G. DAVIDSE, M. SOUSA S. & A.O. CHATER (eds.): Fl. Mesoamericana. Vol. 6. Alismataceae a Cyperaceae. - Universidad Nacional Autónoma de México, Missouri Botanical Garden, Natural History Museum (London).

Marantaceae

AA family of terrestrial, large-leaved herbs with well developed rhizome, which can be recognized vegetatively by the two-layered (brittle epidermal layer), cylindrical pulvinar area at the apex of petiole and the fine closely parallel lateral veins, curving from the midvein to the margin. **Leaves** large, often asymmetrical, distichous (spiro-distichous), sometimes clustered by suppression of internodes, sheath present, petiole often long, sometimes lacking; **inflorescences** terminal or lateral, simple or a synflorescence, usually spiciform or capitate thyrses, usually conspicuously bracteate, each bract mostly subtending 1-several cymules of (1-)2 flowers; **flowers** bisexual, asymmetric, sepals 3, free, petals 3, basally connate, fertile stamen 1, with only one lateral theca, staminodes 2-4, petaloid, one of them hood-like, ovary inferior, 1-3-locular; **fruits** loculicidal capsules, 3-valved, rarely berries. Most of the genera

are native to tropical America. Pantrop. 29/535, CR 10/66, GD 7/25.

Marantaceae is the most advanced family of the order Zingiberales. This is suggested by the extreme reductions and elaborations in the stamens and the carpels.

The pollination mechanisms of Marantaceae are highly specialized, but only few detailed studies have been carried out. The pollinators of the flowers of the largest American genus, *Calathea*, are usually euglossine bees of the genera *Euglossa*, *Eulaema* and *Exaerete* (KENNEDY 1978, ACKERMAN et al., 1982). *Pleiostachya pruinosa* is visited by *Euglossa imperialis*.

The seeds of many species of Marantaceae have an aril, which can be considered as a morphological adaptation for seed dispersal by ants. HORVITZ & BEATTIE (1980) observed that the seeds of the Mexican species *Calathea microcephala* and *C. ovandensis* attracted 21 ant species, which fed on the aril. They found that removal of the aril improved seed germination (HORVITZ & BEATTIE 1980, HORVITZ 1981). The fruits of some other *Calathea* species with bright blue seeds are assumed to be dispersed by birds (ANDERSSON 1998).

Maranta arundinacea is commercially important, because its rhizomes contain high amounts of starch. Many species of *Calathea* and *Maranta* are popular ornamentals because of their attractive foliage.

Key to the genera (after KENNEDY et al. 1988)

1	Ovary with 3 fertile locules, fruits commonly 2- or 3-seeded	*Calathea*
1*	Ovary with 1 fertile locule, the 2 others empty and completely compressed	2
2	Cymules 1-flowered	*Monotagma*
2*	Cymules 2-flowered	3
3	Corolla tube very long and narrow (more than 10 x longer than wide); cymule axes poorly differentiated	4
4	Florescences flattened, spathes conduplicate	*Pleiostachya*
4*	Florescences terete (at least before anthesis), spathes rolled up around the rhachis and the enclosed florescence component	*Ischnosiphon*
3*	Corolla tube very short to moderately long (usually less than 5 x longer than wide), sometimes rather long in *Maranta*, but never narrowly cylindrical	5
5	Leaf sheath with the flanks precociously decaying into a meshwork of fibers	*Hylaeanthe*
5*	Leaf sheath flanks not prematurely decaying	6
6	Cymules with a very long peduncle, whereby the flowers are entirely exposed at anthesis	*Maranta*
6*	Cymule peduncle shorter, only the distal part of the flowers exposed at anthesis	7
7	Spathes bright orange	*Stromanthe*
7*	Spathes greenish, sometimes ± extensively purplish-tinged	*Thalia*

Calathea (neotrop. 300, CR 41, GD 16)
The largest neotropical genus of Marantaceae, consisting of erect, rosulate forest herbs, mostly 1-2 m tall. The dense spike-like inflorescences (only 1 to few per shoot) bearing strongly overlapping, distichously or spirally arranged and rather coriaceous bracts.

C. crotalifera S. Watson, Pl. 29e,f
(syn. *C. insignis* Petersen)
Large understory herb, to 2,5 m tall; leaves very large, whitish beneath; inflorescences bright yellow, laterally flattened, rectangular, consisting of a series of conduplicately folded bracts, each bract subtending 8-10 pairs of flowers; the young inflorescence with slightly sweet odor that may serve to attract bees (KENNEDY 1983); petals yellow. Commonly near trails and in old secondary growth, from Mexico to Peru.

C. lasiophylla H. Kennedy, Pl. 30d,e
Caulescent herb, 1-1,9 m tall; leaves ovate, 53-78 cm long, 22,5-33,6 cm wide, leaves subtending the inflorescences smaller than the others, light gray-green beneath; inflorescences terminal, ovoid-cylindrical, 5,5-13,5 cm long, bracts 9-32; flowers in pairs, up to 13 pairs subtended by a single bract, sepals cream to yellow, corolla tube white below, cream above; fruits broadly obovate capsules, seeds usually 3. Endemic to the Golfo Dulce region.

C. latifolia (Willd. ex Link) Klotzsch
Caulescent herb, 2-3 m tall; leaves 14-74 cm long, 9-33 cm wide, broadly elliptic to almost rounded, grayish green beneath, petioles 1,2-2 m long; inflorescences solitary, spicate, ovoid to cylindrical; flowers in pairs, up to 13 pairs subtended by a single bract, sepals whitish at base and purple above or with tips tinged pale violet, persistent in fruit, petals purple, staminodia white to cream-colored; fruits obovoid capsules, seeds 3, basally arillate. From Costa Rica to Colombia and Venezuela.

C. lutea (Aubl.) Schult., Pl. 30a-c
Caulescent herb, up to 5 m tall; leaves very large, whitish-glaucous beneath; inflorescences emerging from sheath of subtending leaf; inflorescences oblong spikes, somewhat rounded, 10-30 cm long, yellowish, 2-ranked, imbricate, bracts nearly orbicular; petals yellow, staminodia usually pale yellow; fruits with orange arillate seeds. Common on trail sides and on creek beds, from coastal Mexico to Peru and Brazil.

Pleiostachya (neotrop. 3, CR 2, GD 2)
A genus of rosulate forest herbs, usually 0,5-1 m tall with broad leaves, usually with obliquely asymmetric apex and markedly flattened inflorescences.

P. pruinosa (Regel) K. Schum., Pl. 30f
Caulescent herb, 2-3 m tall; leaves elliptic-oblong 25-85 cm long, 12-28 cm wide, very oblique and falcate-cuspidate at apex, obtuse at base, petioles 40-85 cm long, pulvinus with raised annular ring 5-7 cm below the lamina; inflorescences 2-3 pedunculate clusters per leaf axils; flowers white, 4-5 cm long; outer staminodium violet-purple, to 1 cm wide, cucullatum pale yellow, staminodium callosum tinged with violet-purple apex. From Belize to Panama.

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HORVITZ, C.C. 1981. Analysis of how ant behaviors affect germination in a tropical myrmecochore *Calathea microcephala* (P. & E.) Koernicke (Marantaceae): Microsite selection and aril removal by neotropical ants, *Odontomachus*, *Pachycondyla*, and *Solenopsis* (Formicidae). - Oecologia (Berl) 51: 47-52.
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KENNEDY, H. 1978. Systematics and pollination of the "closed-flowered" species of *Calathea* (Marantaceae). - Univ. Calif. Publ. Bot. 71: 1-90.
KENNEDY, H. 1983. *Calathea insignis* (Hoja Negra, Hoja de Sal, Bijagua, Rattlesnake Plant). Pp: 204-206. In: D.H. JANZEN (ed.): Costa Rican Natural History. - Chicago: Univ. Chicago Press.
KENNEDY, H., L. ANDERSSON & M. HAGBERG. 1988. Marantaceae. In: G. HARLING & L. ANDERSSON (eds.): Flora of Ecuador 32.

Musaceae

Typical banana-like plants, tall rhizomatous herbs, with well developed stems and large leathery leaves. **Leaves** alternate, spirally arranged, entire, but frequently dissected due to wind action, oblong-elliptic, sheath present, without ligule; **inflorescences** terminal thyrses, bracts leathery, brightly colored, subtending the numerous small flowers, male flowers terminal, female flowers basally on the inflorescence; **flowers** zygomorphic, functionally unisexual, 3-merous, petals 6, 1 free petal, the others fused to a 5-toothed lamina, stamens 6 or mostly 5 and then one staminode present, filaments free, ovary inferior, 3-locular; **fruits** baccate, indehiscent capsules. Native to the Paleotropics, several species cultivated worldwide. Pantrop. 2/ca. 40, CR 1/3, GD 1/2

The paleotropic species of Musaceae with pendent inflorescences are mainly pollinated by macroglossine bats, while the species with erect inflorescences are mainly visited by nectariniid birds (NUR 1976, ITINO et al. 1991).

Commercially the most important member of the family is the banana (*Musa* x *paradisiaca*), which is native to the Paleotropics, but since long cultivated worldwide. It is usually grown in monocultures.

Another useful paleotropic species is *Musa textilis*, whose leaf fibers are used for the production of ropes, fishing nets and clothes.

Musa (paleotrop. ca. 35, CR cultivated 3, GD cultivated 2)
Large herbs with erect stem and large leaves. The erect or pendent inflorescences bearing numerous flowers subtended by variously colored, caducous bracts. Only cultivated species exist in the Neotropics.

Key to the species of *Musaceae*

1	Fruits not edible, bearing seeds	*M. textilis*
1*	Fruits edible, seedless	*M.* x *paradisiaca*

M.* x *paradisiaca L.
Large cultivated herbs; hybrid species with several cultivars, which show a great variety in habit. Cultivated worldwide in the tropics.

M. textilis Née
Large herbs, up to 8 m tall; flowers fertile, fruits up to 8 cm long, seeds numerous. Native to the Philippines, now cultivated worldwide in the tropics.
The two species are similar in habit, *M. textilis* is said to have somewhat narrower leaves than *M.* x *paradisiaca.*

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ANDERSSON, L. 1998. Musaceae. Pp.: 296-301. In: K. KUBITZKI (ed.): The families and genera of vascular plants. Vol IV. Alismatanae and Commelinanae (except Gramineae). - Berlin: Springer Verlag.
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NUR, N. 1976. Studies on pollination in Musaceae. - Ann. Bot. (London) 40: 167-177.

Orchidaceae

The most species-rich family of angiosperms, which is generally very abundant in tropical habitats. Mainly epiphytic herbs with single or densely aggregated stems ("cespitose" habit), sometimes terrestrial, rarely climbing, stem slender or thickened into pseudobulbs comprising single or several internodes. **Leaves** lateral or terminal on pseudobulbs, alternate or distichous, plicate or flat; **inflorescences** racemose or spicate, sometimes single-flowered; **flowers** zygomorphic, sepals 3, petals 3, the sepals and two lateral petals (forming together the "pentas") often similar, the third (median inner) petal ("lip") usually more conspicuous, more elaborate and of different coloration, fertile stamens 1 or 2, fused with the epigynous parts of the gynoeceum into the "column", ovary inferior, 1 or rarely 3-locular; **fruits** capsules, seeds minute, numerous. Cosmopol. ca. 788/18500, CR 163/1044, GD 53/95.

The bulk of orchid species is epiphytic, growing high up on the branches of tall forest trees, and orchids are thus rarely encountered by pedestrian visitors in the Golfo Dulce forests. Additionally, the exploration of the orchid flora is still very incomplete and collections are scanty with many of the collected plants still not identified. Many more genera and species are expected to be found in the Golfo Dulce region in the future. Therefore, the family is treated here only fragmentarily and the selection of epiphytic genera presented is rather arbitrary and is meant to cover some plants of particular biological interest. Due to the enormous number of genera and species and to the often minute differential characters in the flowers, identification of tropical orchids is generally difficult and largely reserved for the specialist. Because of the huge number of genera and lack of detailed information, a key to the genera is not given here. Fortunately, a book by DRESSLER (1993) covering the orchids of Costa Rica is available, and the interested reader is advised to consult it.

The classification and subdivision of Orchidaceae is still a matter of dispute. DRESSLER (1981) sug-

gested a subdivision into 6 subfamilies: (1) Apostasioideae (a primitive Asiatic group with 2 terrestrial genera), (2) Cypripedioideae (terrestrial, flowers with two fertile stamens and a large staminode; though also known from tropical America, none seems to be represented in the area, (3) Spiranthoideae (terrestrial, flowers with a single, dorsal, erect anther that is subequal to the rostellum; pollinia attached to a viscidium at their apex), (4) Orchidoideae (terrestrial, single erect anther projecting beyond the stigma, underground organs in the form of root-stem tuberoids), (5) Epidendroideae (usually epiphytic, the anther bending down during floral ontogeny over the apex of the column and making a right angle to the column axis, or often being placed markedly ventral; opening is apical but topographically basal), and (6) Vandoideae (usually epiphytic, anthers very short, erect, opening basally).

In the evolutionary more advanced groups, the pollen grains are packed together into compact "pollinia" which are glued by a sticky substance to the head or body of a flower visitor. Pollination strategy is enormously diversified and sometimes extremely sophisticated. Pollinators include bees, flies, butterflies, moths and birds.

The only commercially important orchid is vanilla (*V. fragrans*), which is cultivated worldwide throughout the tropics. The extract of the fruit, the so-called Vanilla beans, are used as a flavor for food, but nowadays it is mostly substituted by chemically synthesized vanillin.

The following genera occur in the GD: *Aspasia, Bletia, Brassavola, Campylocentrum, Caularthron, Clowesia, Coccineorchis, Coryanthes, Cryptarrhena, Dichaea, Dimerandra, Dresslerella, Dryadella, Elleanthus, Encyclia, Epidendrum, Erythrodes, Eulophia, Galeottia, Gongora, Habenaria, Hexisea, Jacquiniella, Lepanthes, Lockhartia, Macroclinium, Masdevallia, Maxillaria, Monophyllorchis, Mormodes, Notylia, Oncidium, Ornithocephalus, Palmorchis, Pleurothallis, Polystachya, Prescotia, Psygmorchis, Sarcoglottis, Scaphyglottis, Schiedeella, Sobralia, Stanhopea, Stelis, Stenorhynchos, Trichocentrum, Trichopilia, Trichosalpinx, Trigonidium, Vanilla, Warrea, Wullschlaegelia, Xylobium.*

Elementary ecological groups are: (1) terrestrial orchids, (2) "saprophytic" orchids (terrestrial orchids without green leaves, parasitizing fungi), (3) climbing orchids (*Vanilla*), (4) epiphytic orchids. Because several genera contain species from different ecological groups, the following division of the genera is made upon the preferred life form.

Description of the common genera and species of the GD:

1. Terrestrial orchids

Habenaria (pantrop. + subtrop. ca. 600, CR 11, GD 1) (Orchidoideae)
Terrestrial herbs with thin to fleshy leaves and spicate to racemose inflorescences with few to many flowers. A noteworthy character is the deeply trilobate lip, basally with a long, slender spur.

H. monorrhiza (Sw.) Reichb. f., Pl. 31d
Slender herb, up to 120 cm tall; leaves broadly lanceolate, 3-13 cm long, 1,5-4 cm wide; inflorescences racemose; flowers white, sphingophilous. From Guatemala and the West Indies to Peru and Brazil.

2. Climbing orchids

Vanilla (pantrop. 100, CR 7, GD 2), Pl.32h (Epidendroideae)
The only orchid genus with the habit of a liana, usually with somewhat succulent leaves. The inflorescences are short axillary racemes, bearing rather large, fugaceous flowers.

V. fragrans Andr.
(syn. *V. planifolia* Jacks. ex Andrews)
Plant often climbing high in the canopy; stems thick, often-branched; leaves fleshy, oblanceolate, 10-20 cm long, 2-5 cm wide; inflorescences 5-7 cm long, flowers soon caducous. From Mexico to Panama, cultivated worldwide in the tropics.

3. Epiphytic orchids

Aspasia, Brassavola, Dichaea, Elleanthus, Epidendrum, Encyclia, Gongora, Jacquiniella, Lockhartia, Masdevallia, Maxillaria, Pleurothallis, Scaphyglottis, Sobralia, Stanhopea, Trichosalpinx, Trigonidium

Aspasia (neotrop. 8, CR 1, GD 1)
(Vandoideae)
Herbs with short erect stems, conspicuously thickened above into 1-2-leaved, oblong-elliptic pseudobulbs. The flowers are solitary or mostly arranged in few-flowered racemes with the lip partly united with the column to form a nectar-like tube.

Brassavola (neotrop. 17, CR 1, GD 1)
(Epidendroideae)
Pendent or erect plants with small pseudobulbs and succculent, cylindric leaves. The inflorescences bearing 3-6 greenish, whitish or yellowish flowers, which are fragrant at night.

B. nodosa (L.) Lindl., Pl. 30g,h
Erect or pendent herbs; leaves fleshy, 6-23 cm long; inflorescences terminal, few- to several-flowered; flowers pale yellowish green, lip white with purple spots in throat. From Mexico to Colombia.

Dichaea (neotrop. 55, CR 19, GD 4)
(Vandoideae)
Herbs with slender, erect or pendulous stems, lacking pseudobulbs. The lateral, 1-flowered inflorescences are inserted opposite the leaf axils.

D. morrisii Fawc. & Rendle
Stems erect; leaves broadly oblong-ligular, 3-7 cm long, 8-15 mm wide, lamina articulated to the sheathing bases; sepals and petals green with violet stripes, the lip violet, or flowers sometimes cream-colored. From Nicaragua to Colombia, Venezuela and Ecuador.

D. panamensis Lindl., Pl. 31b
Stems slender, 4-18 cm tall; leaves narrowly linear-lanceolate, up to 4 cm long, up to 6 mm wide, acute to acuminate, lamina articulated to the sheathing bases; flowers pale green or pinkish spotted with violet. From Mexico to Panama.

D. tuerckheimii Schltr.
Small herb; leaves less than 0,6 cm long, lamina not articulated to the sheathing bases; sepals and petals greenish, spotted red-violet, lip white with few spots. From Nicaragua to Panama.

Elleanthus (neotrop. 115, CR 21, GD 2)
(Epidendroideae)
Terrestrial or epiphytic plants with long and slender stems. The small and usually brightly colored flowers are usually clustered into heads.

Key to the species of *Elleanthus* (after DRESSLER 1993)

1	Leaves distinctly pleated, wide or narrow but never strap-like	*E. caricoides*
1*	Leaves conduplicate, usually narrow; bracts always 2-ranked	*E. tillandsoides*

E. caricoides Nash
Capitulae 2-4 cm in diameter; flowers white. From Nicaragua to Panama.

E. tillandsioides Barringer, Pl. 31a
Floral bracts densely clustered; leaves narrowly strap-like, mostly less than 1 mm wide; flowers white. From Costa Rica to Panama.

Encyclia (neotrop. 235, CR 23, GD 1)
(Epidendroideae)
Epiphytic or lithophytic herbs, pseudobulbs present, of various shape, surrounded by sheaths.

E. pygmea (Hook f.) Dressler
Pseudobulbs ellipsoid, to 3 cm long; flowers usually 1-2, cream or pale green, lip white, with 1-3 purple spots or streaks, distinctly trilobate, lateral lobes larger than midlobe. From Nicaragua to Ecuador and Peru.

Epidendrum (neotrop. c. 800, CR 123, GD 8)
(Epidendroideae)
Large and very variable genus, with or without pseudobulbs. A characteristic feature of the genus is the lip united with the column, forming an internal, tube-like nectary.

Hexisea (neotrop. 13, CR 6, GD 2)
(Epidendroideae)
Caespitose herbs with simple or branched stems, sometimes with pseudobulbs. The usually 1-2 leaves arise from the apex of each segment. The

short, few-flowered inflorescences bearing small, variously colored flowers.

H. bidentata Lindl., Pl 31e
Caespitose herbs, up to 40 cm tall, stems segmented; leaves 2,5-16 cm long, 0,3-1 cm wide; inflorescences racemose; flowers usually bright red. From Mexico to Colombia and Venezuela.

Gongora (neotrop. 50, CR 8, GD 1)
(Vandoideae)
Plants with clustered, egg-shaped or pear-shaped pseudobulbs with longitudinal grooves and with 2-3 leaves terminal on the pseudobulbs. The pendent inflorescences bearing 5-30 medium-sized, fragrant, pink, purple or yellow flowers.

G. tricolor (Lindl.) Rchb. f., Pl. 31c
Lip ± conical; flowers yellow, spotted with red-brown. In Costa Rica and Panama.

Jacquiniella (neotrop. 12, CR 5, GD 1)
(Epidendroideae)
Epiphytic herbs with cylindrical or laterally flattened, 2-ranked, flechy leaves. The green or brown flowers are arranged in fascicles.

J. globosa (Jacq.) Schltr.
Leaves cylindrical or subcylindrical, 1-2 cm long; flowers 2-3 mm long, green or bronzy green. From Nicaragua to Peru and Venezuela.

Lockhartia (neotrop. 24, CR 7, GD 5), Pl. 31f
(Vandoideae)
Epiphytic herbs without pseudobulbs, stems linear, undivided, entirely enveloped in the leaves; leaves 2-ranked, laterally flattened; inflorescences upper lateral or terminal, 1-many-flowered.

L. acuta (Lindl.) Rchb. f.
Stems flattened, pendulous, leaves small, triangular, up to 3 cm long and 0,4-1 cm wide; inflorescences paniculate, large and spreading, few- to many-flowered; flowers small, white, lip yellow, with lateral lobes. From Costa Rica to Colombia and Venezuela.

Masdevallia (neotrop. ca. 380, CR 17, GD 1)
(Epidendroideae)
Epiphytic herbs without pseudobulbs, stems unifoliolate. Most characteristic is the fusion of the outer tepals to a funnel-shaped or tubular structure which includes the petals and the lip. The connate sepals bearing conspicuous elongated tails at the apex. Pollination is by flies, sometimes by carrion flies and in species of sect. *Dracula* (with mushroom-mimicking lip) by fungus gnats.

M. calura Rchb. f.
Erect plant; leaves 8-10 cm long; inflorescences surpassing leaves, few-flowered; flowers purple with yellow-green tails. Endemic to Costa Rica.

Maxillaria (neotrop. 420, CR 97, GD 15)
(Vandoideae)
Epiphytic plants with erect, slender stems and usually with pseudobulbs. The leaves are fleshy or at least coriaceous, the inflorescences are consisting of 1-many scapes, each bearing one small to large flower.

M. bicallosa (Rchb. f.) Garay
Plants erect, fan-shaped, stems short, pseudobulbs lacking; leaves papery. From Costa Rica to Ecuador and Peru.

M. uncata Lindl.
Epiphyte, stem creeping or pendulous, pseudobulbs many, ca. 1 cm in diameter, bearing a single 2-5 cm long leaf at the top; leaves linear; flowers whitish with red-brown stripes. On tree branches, high in the canopy, from Honduras to Peru and Brazil.

Pleurothallis (neotrop. 1120, CR 82, GD ?), Pl. 31g, 32a-c
(Epidendroideae)
Small plants, unmistakable by the thin, sometimes densely aggregated stems (cespitose habit) bearing a single apical thickish leaf. From the base of the leaf a long or short inflorescence with small flowers emerges. The flowers are usually greenish or brownish and fly-pollinated.

Psygmorchis (neotrop. 5, CR 3, GD 1)
(Vandoideae)
Small, fan-shaped epiphytes with laterally flattened leaves and without pseudobulbs.
P. glossomystax (Rchb. f.) Dodson & Dressler, Pl. 32d
Corolla yellow with brown spots on bases of petals and lip. From Nicaragua to Panama.

Scaphyglottis (neotrop. 85, CR 32, GD 8)
(Epidendroideae)
Epiphytic herbs, usually with pseudobulbs with terminal, fasciculate or racemose inflorescences. The leaves are of various shape and are usually terminal on the stems.

S. boliviensis (Rolfe) B. R. Adams
Leaves narrow, less than 10 mm wide; inflorescences fasciculate; flowers white to greenish-white, column with tooth-like or acute wings. From Nicaragua to Peru and Brazil.

S. prolifera (R. Br. ex) Lindl. Cogn.
Leaves narrow, less than 10 mm wide; inflorescences fasciculate; flowers white, sometimes violet or flushed with violet, column without wings but with nectary at base. From Honduras to Bolivia and Brazil.

Sobralia (neotrop. 95, CR 16, GD 4) (Epidendroideae)
Epiphytic or terrestrial herbs with reed like habit and with few to many membranaceous leaves. The terminal inflorescences bearing several, membranaceous flowers.

S. decora Batem., Pl. 32e
Slender terrestrial or epiphytic herb, leaves lanceolate or lance-ovate, several on each stem; flowers rose-purple. From Mexico to Costa Rica.

S. fragans Lindl.
Small terrestrial or epiphytic herb; leaves narrowly elliptic to broadly lanceolate, 1 on each stem; flowers small, white or greenish yellow, lip marked with yellow, margin of lip clearly fringed. From Mexico to Venezuela and Ecuador.

Stelis (neotrop. 370, CR 32, GD 1), Pl. 32i (Epidendroideae)
Small to large epiphytes with cespitose or repent stems and oblanceolate, fleshy leaves. The elongate inflorescences bearing several to many flowers with short, fleshy petals.

Stanhopea (neotrop. 55, CR 3, GD 1), Pl. 32f (Vandoideae)
Plants with usually pyriform and longitudinally grooved pseudobulbs and coriaceous leaves. The pendent inflorescences bearing several showy flowers with broadly winged column.

Trichosalpinx (neotrop. 90, CR 9, GD 1) (Epidendroideae)
Epiphytic plants with clustered or superposed shoots and long stems with funnel-like sheaths.

T. blaisdellii (S. Watson) Luer
Leaves ovate or elliptic, 3-6,5 cm long, 1-3 cm wide; inflorescences shorter than the leaves, racemose; flowers red-purple and translucent yellow and cream. From Mexico to Panama.

Trigonidium (neotrop. 14, CR 4, GD 1) (Vandoideae)
Erect or scandent epiphytes with pseudobulbs; leaves linear to elliptic-lanceolate. The axillary inflorescences bearing one, relatively large flower with a small, distinctly trilobate lip.

T. egertonianum Bateman ex Lindl., Pl. 32g
Erect epiphytic herbs, pseudobulbs densely clustered; leaves linear-lanceolate, 20-60 cm long, 0,8-3 cm wide; inflorescences 20-40 cm long, flowers yellow-brown. From Mexico to Colombia and Ecuador.

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Poaceae

The grasses (Poaceae) are one of the most dominant plant families ecologically, consisting of annual or perennial herbs or rarely woody plants (e.g., bamboos), with erect to procumbent culms and usually hollow internodes. **Leaves** alternate, distichous, sessile, usually linear, sometimes lanceolate to ovate, sheath and ligule often present; **inflorescences** terminal, sometimes axillary, paniculate, racemose or spicate with spicate branches (spikelets), with 1-several flowers, each spikelet subtended by 2 sterile bracts (glums); **flowers** mostly bisexual, each flower (floret) enclosed by a bract (lemma) and by a prophyll (palea), glumes and lemmas often awned, lodicules mostly 2, stamens mostly 3, filaments long, slender, ovary superior, 1-locular, styles mostly 2, with long feathery stigmas; **fruit** a caryopsis (grain). Cosmopol. 668/9500, CR 140/473, GD 27/42.

The family is usually subdivided into seven subfamilies: (1) Bambusoideae (*Chusquea, Oryza*), (2) Arundinoideae (*Arunda, Gynerium*), (3) Centostecoideae (*Zeugites*), (4) Chloridoideae (*Eragrostis*), (5) Panicoideae, (*Arundinella, Panicum, Zea*), (6) Stipoideae (*Stipa*) and (7) Pooideae (*Triticum*).

The flowers of Poaceae are usually wind-pollinated. A few exceptions occur: some rainforest understory grasses have evolved towards pollination by small diptera, e.g., in *Pariana* (GAGNÉ 1969, SODERSTROM & CALDERÓN 1971).

Economically, the Poaceae are among the most important plants in the world. They comprise all the cereal crops (including rice and maize), most of the world's sugar, grazing plants for domestic and wild animals, and all bamboos, canes and reeds. Domesticated maize was the basic food for the ancient Mayas in Central America. The stiff, solid stems of *Gynerium sagittatum* are cultivated in large quantities and used for construction (e.g., for ceilings) and as banana props.

Bambusoideae

Usually perennial, woody or herbaceous plants. Leaves usually broadly lanceolate, pseudopetiolate and frequently having an abaxial and adaxial ligule. The tall woody species are largely restricted to the monsoon tropics and the broad-leaved, herbaceous species to the rain forest. Many species are mountain plants, growing at or above the snowline. Widely distributed in the tropics and subtropics.
Genera of the GD: *Cryptochloa*, *Olyra*, *Oryza*, *Pharus*, *Streptochaeta*, *Streptogyna.*

Oryza (pantrop. ca. 18, CR 2, GD 1)
Annual or perennial herbs of wet or inundated areas with paniculate, terminal inflorescences.

O. sativa L.
Widely cultivated grass ("rice") with nearly one thousand cultivars, 40-150 cm tall. Rice is the main cereal crop, providing the basic diet for more than half the world's population. Cultivated throughout the tropics worldwide.

Poaceae-Arundinoideae

Annual or perennial herbs or large reeds, sometimes of bamboo-like habit. Leaves usually linear, ligule mostly ciliate. The species of this subfamily grow in a variety of habitats, from the cool-temperate regions to the tropics.

Arundinella (subtrop. + temp. 47, CR 3, GD 1)
Perennial herbs with short rhizomes, mostly with strong, erect culms and linear, narrow leaves. The inflorescences are open panicles with the spikelets in triads.

A. deppeana Nees ex Steudel
Herb, up to 4 m tall; leaves 25-50 cm long, 0,8-3 cm wide, appressed hispid; inflorescences paniculate, 20-60 cm long. From Mexico and the West Indies to Paraguay and Brazil.

Gynerium (neotrop. 1, CR 1, GD 1)
Monotypic genus. Giant perennial reed, up to 10 m tall, with the leaves clustered at the end of the culm. The solitary, dioecious, paniculate inflorescences are always terminal.

G. sagittatum (Aubl.) P. Beauv., Pl. 33a,b
Common name: caña blanca, caña brava
Large perennial grass, stems becoming woody, forming large clonal colonies; sheaths longer than the internodes, blades to 1 or 2 m long, forming a large fan on the top of the culm; panicles up to 1 (-1,5) m tall. In wet and inundated areas, along rivers, from Mexico and the Antilles to Bolivia and Paraguay.
This species occurs in the GD on the banks of the Rio Bonito, where large lateral runners may extend over considerable distances along the riverside, producing numerous erect branches.

Poaceae-Chloridoideae

Annual or perennial herbs that are tufted or rhizomatous (stoloniferous), sometimes robust. The leaves are mostly narrow, the ligule hair-fringed or reduced to a rim of hairs. This subfamily occurs mainly in tropical and subtropical areas with a markedly seasonal rainfall. Many species are adapted to saline or alkaline soils.
Genera occurring in the GD: *Eragrostis, Muhlenbergia, Uniola.*

Poaceae-Panicoideae

Annual or perennial herbs, either tufted or rhizomatous and sometimes with robust woody culms. The leaves are broad or narrow, the ligule is a ciliate membrane or reduced to a rim of hairs. The subfamily is widely distributed, from the tropics to the warm temperate regions.

Genera occurring in the GD: *Arundinella, Axonopus, Coix, Digitaria, Echinochloa, Homolepis, Hymenanche, Hyparrhenia, Ichnanthus, Isachne, Ischaemum, Lasiacis, Oplismenus, Panicum, Paspalum, Rottboellia, Setaria.*

Hyparrhenia (pantrop. 5, CR 2, GD 2)
Annual or perennial, usually caespitose herbs with tall culms. The inflorescence consists of a pair of racemes, aggregated into a false compound panicle.

H. rufa (Nees) Stapf
Common name: jaraguá
Erect perennial grass, up to 2 m tall, growing in large dense clumps; blades to 35 cm long; inflorescences usually open, 20-40 cm long with paired racemes at the ends of the ultimate branchlets. *H. rufa* is the dominant pasture grass of the Neotropics. Like many other cultivated forage grasses in the American tropics, it is native to Africa, but also cultivated in the Neotropics, from Mexico and the West Indies to Brazil.

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URL: http://biodiversity.uno.edu/delta/grass/index.htm. (12.9.2000).

Pontederiaceae

A small pantropical family of submersed, floating or emergent freshwater aquatics or swamp plants. **Leaves** simple, alternate and distichous or in a basal rosette, linear and sessile or petiolate and lanceolate to orbicular, sheathing at base and enveloping the stem; **inflorescences** terminal, spicate, racemose, umbel-like or flowers paired or solitary, subtended by 2 opposed, spathes, one of them sometimes leaf-like; **flowers** bisexual, zygomorphic or almost actinomorphic, tepals mostly 6, petaloid, basally united into a tube, white, yellow or blue, sometimes with nectar markings, stamens 1, with 2 staminodes, or 3 or 6, inserted on the perianth tube, ovary superior, 3-locular (sometimes only 1 locule fertile), style 1, plants sometimes heterostylous; **fruits** capsules or nutlets, seeds 1 or numerous. Worldwide, mainly in the tropics, but also in temperate zones. Pantrop. + subtrop. + a few temp. 6/32, CR 3/10, GD 3/5.

The flowers of several Pontederiaceae (*Eichhornia* spp., *Pontederia* spp.) are trimorphic (three flower morphs) with short, medium, and long styles - a mechanism for promoting outcrossing. Each style length occurs in a flower with two particular sets of filament lengths: long styles with short and medium filaments, medium styles with short and long filaments, and short styles with medium and long filaments. Other morphological differences between flower morphs in the Pontederiaceae include the pollen grains, associated with a physiological self-incompatibility. Ideally, a legitimate cross resulting in optimum fertility may occur only between flowers with stamens and styles in a corresponding position.

The conspicuously colored flowers of the Pontederiaceae are visited by insects. The flowers of *Eichhornia crassipes* are pollinated by various kinds of nectar and pollen collecting bees, while the flowers of *E. azurea* are pollinated by solitary bees (Anthophoridae and Megachilidae) and by small pollen collecting halictid bees (Barrett 1978, 1980; Cook 1998). *Pontederia cordata* is pollinated mainly by bumble-bees (Price & Barret 1982).

Eichhornia crassipes, the water hyacinth, is one of the world's most aggressive aquatic weeds, clogging waterways. It is used in various countries for water purification, because of its ability to bind heavy metals.

Key to the genera (after Cook 1998)

1	Fruit a 1-seeded nutlet, enclosed by the persistent and hardened base of the perianth tube (anthocarp)	*Pontederia*
1*	Fruit a 3-locular, many-seeded capsule, not enclosed by the base of a persistent or modified perianth tube	2
2	Stamens 6	*Eichhornia*
2*	Stamens 3	*Heteranthera*

Eichhornia (neotrop. 7, CR 4, GD 2)
Annual or perennial, submersed or floating herbs with distinctly zygomorphic flowers with 6 stamens.

Key to the species of *Eichhornia* (after Crow, in prep.)

1	Plants floating (sometimes stranded on mud); vegetative stem very short with leaves in a rosette, somewhat erect to widely spreading, petioles broadly swollen, almost bulbous, filled with aerenchymatous tissue or (when plants growing densely crowded) leaves erect, petioles less swollen; inflorescence glabrous	*E. crassipes*
1*	Plants rooted; vegetative stems very elongate, submersed and typically reaching surface and then floating; petioles not swollen; inflorescence pubescent	*E. azurea*

E. azurea (Sw.) Kunth, Pl. 33c,d
Plants rooted in mud, stems elongate, ascending; submersed leaves alternate, sessile, linear, petiolate leaves orbicular to obovate, 7-17 cm long; inflorescences spicate, many-flowered, densely glandular pubescent; flowers 3,5-5,5 cm long, purplish-blue, sometimes white; fruits ca. 1 cm long. From southern Mexico and the Antilles to Bolivia and Argentina.

E. crassipes (Mart.) Solms-Laub, Pl. 33 e,f
Free floating herb; stems very short with long roots at the base; leaves in a rosette, orbicular, up to 8 cm in diameter, petioles usually short and aerenchymatous or up to 30 cm long; inflorescences spicate, many-flowered, flowers 4-6 cm long, perianth light blue to lavender, upper lobe darker at base and with a yellow spot at center; fruits ca. 1,5 cm long. In lagoons, slow flowing rivers and artificial lakes, from the southern United States to Paraguay, also widely introduced in the tropics worldwide. In the GD in the mouth of the Rio Sierpe, next to the Esquinas Rainforest Lodge.

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BARRETT, S.C.H. 1980. Sexual reproduction in *Eichhornia crassipes* (water hyazinth) II. Seed production in natural populations. - J. Appl. Ecol. 17: 113-127.
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Smilacaceae

A family mostly of tendrillate, woody climbers, rarely herbaceous climbers or erect shrubs, sometimes with spiny stems or leaves. **Leaves** alternate, opposite or verticillate, simple, entire, oblong-ovate to ovate or linear-lanceolate, 3-7(-9)-veined, basally usually bearing a pair of tendrils; **inflorescences** axillary, terminal or leaf-opposed, paniculate, racemose, spicate or umbellate; **flowers** usually small, actinomorphic, dioecious or bisexual, tepals 6, in two whorls, free or united, petaloid, white, cream, green or reddish, stamens (3-)6(-12), in 1-3 whorls, free or united, ovary superior, rarely inferior, 3-locular, female flowers usually with staminodia; **fruits** berries, red, purple or black, seeds 1-3. Pantrop. 3/320, CR 1/17, GD 1/6.

The family is closely related to the Liliaceae, but differs in being dioecious.
Little is known about the pollination biology of the family. The pollination of the flowers of *Smilax* presumably is by small insects such as flies. Nectar is often produced at the base of the stamens or staminodes, at the inner basal surface of the tepals, and/or by septal nectaries. The flowers of some species have a fetid odor, such as *Smilax herbacea*. This species was examined by SAWYER & ANDERSON (1998). They observed that the carrion-like odor attracted various species of coleoptera, hymenoptera and diptera, while andrenid and halictid bees as well as anthomyiid and stratiomyiid flies are supposed to be the main pollinators.

The fruits of *Smilax* are endozoochorous, dispersal probably is by birds and by skillful climbers such as monkeys.

Several species of *Smilax* have medicinal properties and are used as tonics (sarsaparilla against rheumatism) and stimulants.

Smilax (pantrop. + Temp. ca. 300, CR 17, GD 6), Pl. 34 a,b
The only neotropical genus, consisting of woody and herbaceous vines, mostly having tendrils arising in pairs from the petioles and often with prickly stems. It is further characterized by having dioecious flowers with free stamens. The vast majority of the species of this family belong to this genus.

S. lanceolata L.
(syn. *S. domingensis* Willd.)
Glabrous climbers; leaves 5-veined, secondary venation reticulate; inflorescences umbellate; fruits 7-10 mm in diameter, red, purple or black. In wet forests, from Mexico to Panama.

S. panamensis Morong
Glabrous climbers; leaves 7-veined, secondary venation reticulate; inflorescences umbellate; fruits 7-12 mm in diameter, orange to red, rarely black. In wet forests and forest margins in Central America, from Honduras to Panama.

S. spissa Killip & C.V. Morton
Glabrous climbers; leaves 5-veined, secondary venation parallel; inflorescences umbellate; fruits 10-15 mm in diameter, red. In wet forests, from Costa Rica to Panama.

CONRAN, J.G. 1998. Smilacaceae. Pp.: 417-422. In: K. KUBITZKI (ed.): The families and genera of vascular plants. Vol III. Monocotyledons Lilianae (except Orchidaceae). - Berlin: Springer Verlag.
HUFT, M.J. 1994. Smilacaceae. Pp.: 20-25. In: G. DAVIDSE, M. SOUSA S. & A.O. CHATER (eds.): Fl. Mesoamericana Vol. 6. Alismataceae a Cyperaceae. - Universidad Nacional Autónoma de México, Missouri Botanical Garden, Natural History Museum (London).
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SAWYER, N.W. & G.J. ANDERSON. 1998. Reproductive biology of the carrion flower, *Smilax herbacea* (Smilacaceae). - Rhodora 100 (901): 1-24.

Triuridaceae

Small, saprophytic, usually unbranched herbs lacking chlorophyll. Always growing amongst the litter on the forest floor. Stems white to purple, erect, 2-30(-140) cm tall, rhizome erect or creeping; **leaves** spirally arranged, small and scale-like, sessile; **inflorescences** elongate or corymb-like racemes, with the female flowers basal and the male flowers at the upper part in monoecious taxa; **flowers** usually unisexual (monoecious or dioecious), rarely bisexual, 1-8 mm in diameter, tepals 3-6(-8), basally connate, white to purple, sometimes with tail-like or beard-like appendages, stamens 2-3-6, usually epitepalous, filaments short to lacking, free or basally united, ovary apocarpous, unilocular; **fruits** longitudinally dehiscing follicles (e.g., *Sciaphila*) or indehiscent achenes (e.g., *Triuris*). Pantrop. 5/40, CR 1/1, GD 1/1.

The members of the family usually grow in dense lowland forests in leaf-mold as well as at other sites with dense humus layers, e.g., between buttresses and roots of large trees.

The pollination system of Triuridaceae is still little known. MAAS & RÜBSAMEN (1991) report that several kinds of insects, attracted by the tepal appendages, visit the flowers of the Triuridaceae.

Sciaphila (pantrop. 31, CR 1, GD 1)
Small herbs, usually unbranched, with a horizontally creeping rhizome. In flower they can be recognized by the 4-6 papillate and sometimes bearded tepals.

S. picta Miers
Small, reddish herb, up to 25 cm tall, stems unbranched or basally branched; stem leaves 1-4, at least partly amplexicaul; inflorescence terminal, racemose; flowers bisexual, tepals 6, dark red, bearded with reddish hairs, stamens 6, ovaries 10-25, free; fruits follicles, obovoid, longitudinally dehiscent. In Central America and Colombia.

MAAS, P.J.M. & T. RÜBSAMEN. 1986. Triuridaceae. Fl. Neotrop. Monogr. 40: 1-55.
MAAS VAN DE KAMER, H. & T WEUSTENFELD. 1998. Triuridaceae. pp: 452-458. In: K. KUBITZKI (ed.): The families and genera of vascular plants. Vol III. Monocotyledons Lilianae (except Orchidaceae). - Berlin: Springer Verlag.
MARTINEZ, E. & L.D. GOMEZ. 1994. Triuridaceae. Pp.: 18-19. In: G. DAVIDSE, M. SOUSA S. & A.O. CHATER (eds.): Fl. Mesoamericana Vol. 6. Alismataceae a Cyperaceae. - Universidad Nacional Autónoma de México, Missouri Botanical Garden, Natural History Museum (London).
RÜBSAMEN, T. 1991. Morphologische, embryologische und systematische Untersuchungen an Triuridaceae. - Biblioth. Bot. 140: 113p.

Typhaceae

A family of large, erect, perennial herbs, emergent from shallow water or growing on wet soil. **Leaves** basally inserted, linear, base strongly sheathing; **inflorescences** terminal, racemose dense brown cylind-

dric or globose heads with numerous flowers; **flowers** unisexual, plants monoecious, perianth of 1-several inconspicuous tepals, sometimes replaced by hairs or bristles, stamens 2-5, ovary superior, 1-locular; **fruits** small, dry follicles, indehiscent or dehiscing after dispersal. Cosmopol. 1/10-12, CR 1/2, GD 1/1.

The fruits of *Typha* are wind-dispersed, due to their light weight and the presence of hairs instead of petals (KUBITZKI 1998).

Typha (cosmopol. 10-12, CR 2, GD 1)
Perennial herbs with dense, cylindrical, spike-like inflorescences with a female lower part and several male upper parts.

T. domingensis Pers.
Large herb; inflorescence stalks 1-2,5 m tall, female inflorescences in fruit (5-)7-20(-35) cm long, male inflorescences up to 35 cm long; fruits 1-1,5 mm long. In tropical and subtropical regions worldwide.

KUBITZKI, K. 1998. Typhaceae. Pp.: 457-460. In: K. KUBITZKI (ed.): The families and genera of vascular plants. Vol IV. Alismatanae and Commelinanae (except Gramineae). - Berlin: Springer Verlag.

Zingiberaceae

A family of mostly large-sized, perennial, aromatic herbs (essential oils) with rhizomes and poorly developed stems. **Leaves** distichous entire, elliptic, sometimes linear or broadly elliptic, ligule sometimes present, sheath open (vs. closed in Costaceae) venation very fine, strongly ascending parallel; **inflorescences** terminal on a leafy stem, or basal, terminating a separate leafless shoot, arising from the rhizome, usually paniculate, with few- to many-flowered cincinni in the axils of spirally arranged bracts; **flowers** bisexual, zygomorphic, sepals united, calyx tubular, trilobate, petals united, corolla tubular, trilobate, fertile stamen 1, sometimes petaloid, labellum staminodial, often large and showy, lateral staminodes two, usually present, petaloid or very small, free or adnate to the labellum, nectary glands present, ovary inferior, 3-locular; **fruits** capsules, 3-valvate, loculicidally dehiscent, dry or fleshy, seeds many, arillate. Throughout the tropics worldwide, with a concentration in the Old World (especially Southeast Asia). Pantrop. ca. 50/c. 1300, CR 8/22, GD 2/4.

This is the largest family of the order Zingiberales, closely related to the Costaceae. Because of the ephemeral flowers (often lasting only a few hours) the taxonomic study of the family is rather difficult. The family name Zingiberaceae is derived from the Sanskrit word "sringavera", which means horn-shaped, in reference to the rhizomes.

The large, white flowers of *Hedychium coronarium* are reported to be pollinated by hawkmoths, while other species of this genus are pollinated by hawkmoths or butterflies (MÜLLER 1890, KÜNCKEL D'HERCULAIS 1910, LARSEN et al. 1998). Within the genus *Renealmia,* two main floral types can be distinguished: (1) Flowers tubular, with reddish bracts, a tubular and single-colored labellum, yellow anthers and well-developed nectary glands (e.g., *R. cernua*); these flowers are adapted to hummingbird pollination, (2) Exposed flowers with green bracts, the labellum differentiated in a tubular base, a spreading limb with lateral lobes, often purplish veined (nectar guides), and the middle lobe yellow in the center and with the anthers mainly purplish-red and the nectary glands poorly developed. These flowers are adapted to insect-pollination, and pollination is probably by euglossine bees, due to the presence of spreading limbs as landing platforms and nectar guides, e.g., *R. mexicana* (MAAS 1977).

Key to the genera (after MAAS, in prep.)

1	Inflorescence terminal on leafy shoot	2
2	Inflorescence a spike	*Renealmia* p.p.

2*	Inflorescence a raceme or thyrse	*Hedychium*
1*	Inflorescence basal on separate shoot	*Renealmia* p.p.

Hedychium (paleotrop. 50, CR 1, GD 1)
A palaeotropic genus of terrestrial or epiphytic herbs with few to numerous stems and long, robust rhizome. The pendent labellum is usually conspicuously large and bilobate.

H. coronarium J. König, Pl. 34c
Herbs, 1-1,5 m tall; leaves distichous, narrowly lanceolate, sessile, 28-40 cm long, 4-7 cm wide, glabrous above, covered with white appressed hairs beneath; inflorescences terminal, 4-10 cm long, bracts herbaceous, ca. 4-6- cm long, green, persistent, subtending several flowers; flowers aromatic, corolla white, 7-8 mm long, narrow, labellum wider than corolla lobes, white, basally yellow, bilobate; capsule with numerous seeds, aril bright orange. In wet and open habitats, native to the Himalayan region, now also cultivated and naturalized in tropical America.

Renealmia (neotrop. 61, CR 14, GD 3)
A genus of low to tall herbs, easy to recognize by the open leaf sheath, distichous leaves and frequent presence of a ginger-like vegetative odor. The inflorescence is mostly branched, spicate inflorescences may be *Costus*-like with red bracts but these are less coriaceous and less closely appressed.

Key to the species of *Renealmia* (based on MAAS, in prep.)

1	Inflorescence terminal on leafy shoot	*R. cernua*
1*	Inflorescence basal on separate shoot	2
2	Bracts green, caducous	*R. mexicana*
2*	Bracts red, persistent	*R. pluriplicata*

R. cernua (Sw.) J.F. Macbr., Pl. 34d
Plants 0,5-5 m tall, sheaths reticulate; leaves elliptic, (10-)22-43 cm long, (3,5-)5-12 cm wide, glabrous; inflorescences terminal, spicate, 4-14 (-25) cm long, 2-6 cm wide, glabrous or densely covered with appressed hairs, bracts yellow to red, rarely greenish, persistent; calyx same color as the bracts, tubular, corolla yellow, labellum yellow, 7-8 mm long; capsules globose, 6-11(-23) mm in diameter, orange to black at maturity, seeds 8-30, aril orange. In primary and secondary forests, from Central America to western and northwestern South America.

R. mexicana Klotzsch ex Petersen
Plants 1-2(3) m tall, sheaths slightly reticulate; leaves narrowly elliptic, (10-)25-58 cm long, (1,5-)4-11(-14) cm wide, glabrous; inflorescences basally, thyrsoid, 5-25 cm long, covered with furcate hairs, with 3-11 flowered cincinni, bracts green, caducous, narrowly triangular-ovate; calyx red to orange, 3-8 mm long, corolla white to yellow, labellum white to yellow, 8-10 mm long; capsule red to purplish black, globose to ellipsoid, 4-11(-15) mm long,4-6 mm wide, seeds 3-11, aril orange. In very wet forests, from Mexico to northern Venezuela.

R. pluriplicata Maas
Plant 0,5-3,5 m tall, sheaths distinctly reticulate; leaves narrowly elliptic, 25-56 cm long, 7-16 cm wide, glabrous or nearly so above, sparsely to densely covered with simple hairs beneath; inflorescences basal congested thyrses (2,5-)8-22 cm long, cincinni 2-4-flowered, bracts dark to pale red, persistent, ovate-triangular to broadly ovate-triangular; calyx dark to pale red, 4-10 mm long, corolla creamy white to yellow, labellum white with yellow center, 10-14 mm long; capsules ellipsoid to globose, black when mature, 5-10 mm long, seeds 1-7, aril orange. In very wet primary forests, from Nicaragua to Ecuador.

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ANGIOSPERMS - DICOTYLEDONS

Acanthaceae

Prostrate, erect, or rarely climbing herbs, shrubs, or rarely small or regular trees. **Leaves** usually opposite, sometimes alternate or subopposite, simple, usually with cystoliths, margins entire, undulate or serrate, stipules lacking; **inflorescences** axillary or terminal, frequently in the axils of conspicuous bracts and with two bracteoles, spicate, cymose, racemose or flowers solitary; **flowers** zygomorphic to nearly actinomorphic, bisexual, calyx synsepalous at least basally, persistent, the lobes 4 or 5, rarely an entire ring (*Thunbergia*), or 12-20-lobate, corolla sympetalous, the limb 5-lobate or 2-lipped, lobes imbricate or contorted in bud, basally usually divided into a distinct narrow tube and wider throat, stamens 4, usually didynamous, or only 2 fertile and sometimes accompanied by 1 or 2 staminodes, adnate to the corolla tube, filaments free or basally connate in pairs, ovary 2-locular, superior; **fruits**, 2-valved capsules, loculicidally dehiscent, seeds 2-many, usually flattened. In the tropics and subtropics worldwide, sparsely distributed in the temperate zones of both hemispheres. Cosmopol. 229/3450, CR 40/135, GD 15/36.

The main pollinators of the Acanthaceae are bees and hummingbirds. The red-orange flowers of *Aphelandra golfodulcensis* and most other species of the genus are pollinated by hummingbirds (McDade 1984, Endress 1994). Other visitors include perching birds as well as bees (Meliponinae, Xylocopinae) (McDade & Kinsman 1980). Species of *Justicia* are pollinated by bees (Kelbessa 1990) as well as by hummingbirds (McDade & Kinsman 1980, Endress 1994).

The wood of *Bravaisia integerrima* is suitable for cheap construction lumber or box boards. The roots, when cooked in "guarapo" (a fermented beverage made from either sugar cane or pineapples), are used as a pain reliever in some localities.

Key to the genera (after Leonard 1938)

1	Fruit drupaceous; vines	*Mendoncia*
1*	Fruit capsular; herbs, shrubs, small trees, or sometimes vines, usually cultivated (*Thunbergia*)	2
2	Seeds borne on papilliform retinacula	*Thunbergia*
2*	Seeds borne on hook-like retinacula	3
3	Stamens 4	4
4	Anthers 1-celled	*Aphelandra*
4*	Anthers 2-celled or the anterior pair 1-celled	5
5	Anterior stamens with 1-celled anthers	*Chamaeranthemum* p.p., *Herpetacanthus*
5*	Anterior stamens with 2-celled anthers	6
6	Shrubs or small to medium-sized trees	*Bravaisia*
6*	Herbs (sometimes becoming suffrutescent)	7
7	Corolla 2-lipped; flowers solitary or fascicled, axillary (plants sometimes growing on inundated places)	*Hygrophila*
7*	Corolla regular or nearly so; inflorescence various (plants usually growing on well drained places)	8
8	Flowers in dense spikes; bracts closely imbricate	*Blechum*
8*	Flowers borne in loose, terminal or axillary cymes or panicles (rarely in terminal heads); bracts small, not imbricate	9
9	Inflorescence of second racemes; corollas yellow with purplish throat	*Asystasia*
9*	Inflorescence of cymes, heads, panicles, spikes, or else flowers borne axillary; corollas variously colored, not yellowish with purple throat	*Ruellia*
3*	Stamens 2	10

10	Anthers 1-celled	*Razisea*
10*	Anthers 2-celled	11
11	Staminodes present	12
12	Corolla limb 2-lipped	*Odontonema*
12*	Corolla limb equally or subequally 5-lobate	13
13	Pollen marked with straight, longitudinal grooves	*Pseuderanthemum*
13*	Pollen marked with replum-shaped grooves	*Chamaeranthemum* p.p.
11*	Staminodes none	14
14	Inflorescence head-like, the bracts white-hirsute, linear-subulate	*Chaetochlamys*
14*	Inflorescence racemose, paniculate, or spicate, rarely head-like but the bracts then broad and obtuse and not hirsute	*Justicia*

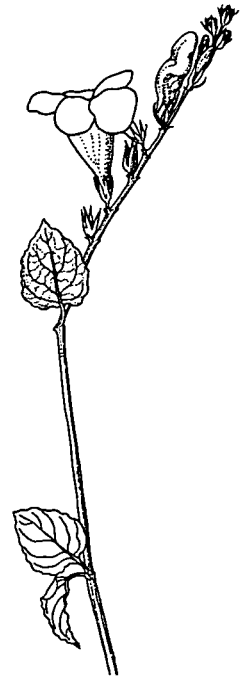
Aphelandra (neotrop. 175, CR 12, GD 4)
Easily recognized by the very characteristic spicate, terminal or axillary inflorescence with conspicuous tightly overlapping, often brightly colored bracts. The capsules are clavate to subglobose, 4-seeded and explosively dehiscent on drying. The strongly bilabiate flowers are mostly red and hummingbird-pollinated.

A. aurantiaca (Scheidw.) Lindl.
Erect herb or shrub, up to 1 m tall; leaves elliptic, 8-30 cm long, 3-12,5 cm wide, undulate to entire, almost glabrous; inflorescences mostly terminal, spicate, to 15 cm long; flowers sessile, calyx 5-merous, apex 3-toothed, corolla orange, red or scarlet, tube to 4 cm long; fruits 1,6 cm long, sparingly puberulous. From Mexico to Bolivia.

A. golfodulcensis McDade, Pl. 35a,b
Shrub or small tree, up to 6 m tall; leaves elliptic to oblanceolate, 25-30(-45) cm long, 12-15 cm wide, entire or slightly undulate, leaves surrounding the inflorescences much smaller, ca. 3-6 cm long; inflorescences terminal, paniculate with spicate branches, 3-15 cm long, bracts rhombic-ovate, entire, 8-13 mm long, green to dull brown-orange; corolla orange to red; fruits clavate, 19-23 mm long, 5-8 mm wide, dark-brown when mature. Endemic to the Golfo Dulce region and adjacent Panama.

Asystasia (paleotrop. 70, CR 1 naturalized, GD 1 naturalized)
This genus occurs in the Old World tropics but it is naturalized in the Neotropics.

A. gangetica (L.) T. Anderson
Erect to ascending shrub to 1,5 m tall; inflorescences unilateral, racemes to 20 cm long, corolla yellow with purplish throat, 30-40 mm long, hirtellous, conspicuously and coarsely reticulate-veined. In disturbed areas near towns, from Honduras and Belize and the Carribean to Colombia and Venezuela, as well as in tropical Africa.



Asystasia gangetica

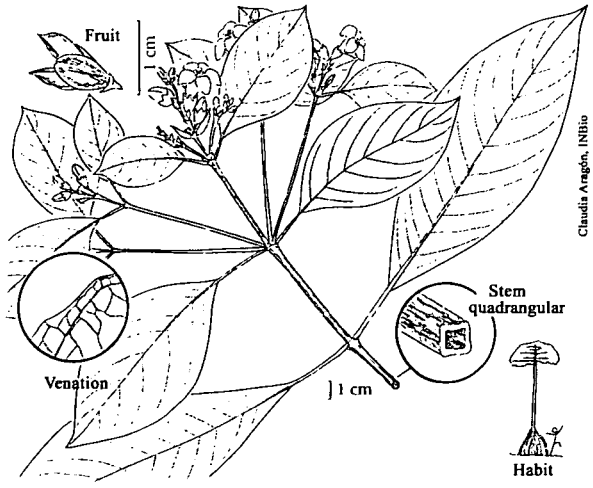
Blechum (neotrop. 6, CR 2, GD 2)
These weedy herbs have inflorescences similar to *Aphelandra* but with loosely appressed, thin, foliaceous, green bracts and small, pale purplish, sessile or short-pedicellate flowers.

B. costaricense Oerst., Pl. 35c,d
Herbaceous or suffrutescent at base, stems pilose or the lower portions glabrescent; corolla pale lavender, 20-25 mm long, finely pubescent, the lower portion of the tube slender, narrowly campanulate above, about 5 mm broad at the throat,

the limb 2 cm broad; capsules ovoid, about 6 mm long and 5 mm wide, puberulent, seeds 4

Bravaisia (neotrop. 3, CR 1, GD 1)
These mostly Central American trees are usually multiple-trunked and the individual trunks are 20 cm or more in diameter. The sessile or short-pedicellate flowers in the axils of two isomorphic bracteoles are very white (Bignoniaceae-like).

B. integerrima (Spreng.) Standl., Pl. 35e,f
Common name (Costa Rica): mangle blanco
Tree to 20 m tall; inflorescences racemose, dichasia 6-10 per raceme; corolla 15-22 mm long, white with brown and yellow markings on inner surface of lower lip; capsule 8-seeded. In semideciduous to evergreen lowland forests, from Mexico to Trinidad and Colombia.



Bravaisia integerrima

Chaetochlamys (neotrop. 7, CR 1, GD 1)
A small genus of herbs, closely related to *Justicia*, with the flowers usually borne in congested, terminal and axillary spikes or heads. The limb is 2-lipped, with the upper lip bilobate and the lower lip trilobate.

C. panamensis Lindau
Herbs, up to 1 m tall, erect or decumbent; leaves oblong-lanceolate, up to 10 cm long and 3 cm wide; inflorescences terminal and axillary, capitate, bracts linear, about 12 mm long and 1 mm wide; corolla pubescent, rose-purple, the tube 15 mm long, 3 mm in diameter, the upper lip 8 mm long and 4 mm wide, the lobes rounded, 2 mm in diameter, the lower lip 11 mm long, the lateral lobes 6 mm long and 7 mm wide, the middle one 8 mm long and 10 mm wide; capsules 10-12 mm long, ca. 4 mm in diameter, narrowed and solid at the base, glabrous. From Costa Rica to Panama.

Chaetochlamys panamensis

Chamaeranthemum (neotrop. 4, CR 2, GD 1)
Herbaceous or suffrutescent plants with terminal, paniculate or spicate inflorescences, bearing small flowers.

C. tonduzii Linsau
Herbs, stems erect, up to 50 cm tall, simple or sparingly branched; leaves oblong-lanceolate, 3-9 cm long, 1-2,5 cm wide, petioles 1-3 mm long; inflorescences sparingly branched panicle of lax spikes, 2-9 cm long, rhachis sparingly puberulent; corolla ca. 10 mm long, minutely pubescent, limb about 1 cm broad, lobes rounded; capsules ca. 15 mm long, the upper portion 2-3 mm broad, finely pubescent.

Hygrophila (pantrop. ca. 25, CR 1, GD 1)
This genus is characterized by the sessile axillary fascicles of small white flowers. Common along streams.

H. costata Nees
Herb with branching, reddish stem to 1 m tall; leaves lanceolate, of various length on the same plant; corolla 7-10 mm long, puberulent, white or lilac. Mostly found on river banks, from Mexico to central Argentina.

Justicia (cosmopol. 600, CR 34, GD 9)
This main genus of the 2-staminate Acanthaceae is characterized by small bracts, strongly bilabiate corollas, often with colored chevron-shaped markings on lower lip, and the absence of staminodes.

J. comata (L.) Lam.
Herb, up to 20 cm tall, stems weak, ascending or nearly erect, leaves sessile or petioled, the blades 3-15 cm long, acuminate or acute; flowers borne in axillary and terminal, peduncled panicles up to 22 cm long; corolla white or purplish, about 6 mm long, tube broad, 2 mm long, upper lip erect, 3 mm long, the lower lip 4-5 mm long, trilobate. In damp thickets and woods, usually on banks of streams. In the West Indies and tropical continental America.

Mendoncia (neotrop. + Trop. Africa and Madag. 60, CR 7, GD 4)
Some species may become high-climbing lianas. This genus has two characteristics which are atypical for the family: the single flowers, borne individually or several together in the leaf axils and partially enclosed by a pair of enlarged bracteole-like foliaceous calyx lobes and the fleshy drupaceous fruit, enclosed by the persistent calyx lobes.

Odontonema (neotrop. 30, CR 1, GD 1)
Shrubs or subshrubs with actinomorphic to weakly bilabiate flowers with red or sometimes yellow or infrequently white, lilac, violet, or pink corolla.

Pseuderanthemum (neotrop. 60, CR 5, GD 2)
Small to medium-sized shrubs or herbs with axillary or terminal paniculate or racemose inflorescences, with the flowers arranged singly, in pairs, or cymes in the axils of opposite bracts, spaced along the rhachis. This genus is very similar to *Justicia* but with staminodes and more or less equal corolla lobes.

P. pittieri Leonard
Herbaceous or suffrutescent plants, stems glabrous or minutely pubescent toward the tip; leaves elliptic, up to 14 cm long and 8 cm wide, glabrous, or the costa and lateral veins beneath sparsely puberulent, with slender, inconspicuous cystoliths above; petioles up to 2 cm long, puberulent; inflorescences loose, narrow terminal racemes; flowers opposite, usually several in a fascicle, corolla 2 cm long, minutely and sparingly pubescent, the tube of fully expanded flowers about 12 mm long, 1 mm in diameter at the base, 3 mm at the mouth, the limb about 2 cm broad, the lobes ovate. Endemic to Costa Rica.

Razisea (neotrop. 3, CR 4, GD 2)
A small Central American genus with 2 stamens and 1-celled anthers.

R. spicata Oerst., Pl. 35g,h
Shrub, up to 3 m tall, stems quadrangular; leaves ovate to oblong-ovate to elliptic, up to 35 cm long and 20 cm wide, acuminate, narrowed at the base; inflorescences spiciform, pedunculate, terminal thyrses, up to 30 cm long; corolla ca. 4 cm long, glabrous, bright red, the upper lip lance-ovate, 8 mm long, the lower lip short, divided at the tip into 3 rounded lobes about 1 mm in diameter; capsules ca. 17 mm long, glabrous, seeds roughened. In wet montane forests in Costa Rica and Panama.

Ruellia (cosmopol. 150, CR 18, GD 4)
Perennial herbs or shrubs usually with regular, but sometimes curved, large and showy flowers. The capsule is oblong or clavate and is exploding violently on exposure to water. The seeds are discoid and glabrous when they are dry, and covered or rimmed with sticky mucilaginous trichomes when they are moistened. *Ruellia* differs from *Aphelandra* in having 2-celled anthers and generally less bilabiate flowers.

Thunbergia (paleotrop. 90, CR 6 naturalized, GD 1 naturalized)
Twining vines, climbers or shrubs with axillary inflorescences with a pair of pedicellate flowers per node (usually these combined into terminal racemes with 2-4 flowers per node). The corolla is contorted in bud, rather actinomorphic to slightly zygomorphic, funnelform or salverform. The capsule is woody, with expanded seed-bearing portion at base and long apical beak, up to 4-seeded.

T. fragrans Roxb., Pl. 35i
A slender vine, up to 2 m long, stem grooved, minutely strigose or glabrate; leaves ovate to ovate-lanceolate, 4-11 cm long, 1,5-6 cm wide,

thin, minutely strigose or glabrate; flowers axillary, peduncles up to 7 cm long, bracts ovate to ovate-lanceolate, 1.5-2 cm long, 6-13 mm wide; flowers pure white; capsules depressed-globose, about 8 mm in diameter, puberulent, tipped by a stout, subulate beak. Along roadsides in thickets, and waste places, native to India but cultivated as an ornamental and sometimes naturalized in tropical America.

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Actinidiaceae

Trees, shrubs or lianas, rather nondescript and closely related to the Dilleniaceae with which they share several characters. Indumentum of simple or stellate hairs; **leaves** simple, alternate, serrate, with numerous parallel secondary veins, stipules lacking; **inflorescences** axillary, thyrsoid, cymose or flowers solitary; **flowers** actinomorphic, bisexual or unisexual (plants then monoecious or dioecious), sepals usually 5, persistent and accrescent in fruit, petals 3-4-5, white, stamens numerous, ovary superior, 3-5-several-locular; **fruits** berries or capsules, seeds numerous, aril lacking. Distributed mainly in tropical Asia with only one genus also occurring in the Neotropics. Pantrop. 3/ 340, CR 1/4, GD 1/2.

Within the family, *Actinidia chinensis*, the Asiatic" kiwifruit", is the best studied species. Its flowers are pollinated mainly by insects, but wind may play a minor role (HOPPING & JERRAM 1979, COSTA et al. 1993). Honey bees are the main pollinators used in kiwifruit vineyards (GOODWIN & STEVEN 1993, VAISSIERE et al. 1996). The flowers of *Saurauia* have nectar secreting tissues and at least a faint sweet scent, which indicates pollination by insects (SOEJARTO 1969). Bees have been observed as visitors. In a study at Monteverde (Costa Rica), CANE (1993) identified females of 15 bee species, foraging for pollen, as pollinators of *Saurauia* sp. nov.

The fruits of *Saurauia* are septicidally dehiscent, with self-dispersal of the seeds being most common, but dispersal of the seeds by birds was also observed (SOEJARTO 1969).

The fruits of *Saurauia* spp. bear numerous seeds covered with an edible sweet tasting pulp, and are sold in local markets in various regions in Central and South America (SOEJARTO 1980). The Asiatic kiwifruit, *Actinidia chinensis*, mainly cultivated in New Zealand, is the only species of commercial importance.

Saurauia (neotrop. 300, CR 4, GD 2)
A large genus, often of higher elevations, but characteristically found in humid or wet habitats (SOEJARTO 1980). Trees and shrubs, usually pubescent with bisexual, but sometimes also functionally unisexual flowers.

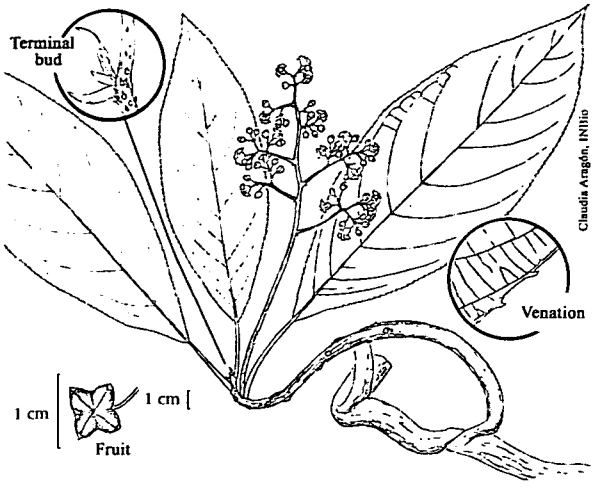
Key to the species of *Saurauia* (after HUNTER 1965)

1 Plants copiously pubescent; leaves with tertiary veins elevated, more prominent than the lesser reticulation; flowers usually 5-merous, more than 12 mm broad, the sepals densely pubescent; ovary and fruit densely pubescent — *S. montana*

1* Plants sparingly pubescent; leaves with tertiary veins immersed, scarcely more prominent than the lesser reticulation; flowers 3-5-merous, sometimes less than 10 mm broad; ovary and fruit glabrous — *S. yasicae*

S. montana Seem.
Tree or shrub, up to 15 m tall, copiously pubescent; leaves narrowly elliptic to obovate, 11-40 cm long, 3-18 cm wide, setaceous-serrulate to serrate; inflorescences few- to many-flowered, 7-30 cm long; flowers 5-merous, white to pinkish; fruits berries, globose, 6-10 mm in diameter, densely pubescent. From Honduras to Panama.

S. yasicae Loes., Pl. 36a
Tree, up to 30 m tall, sparsely pubescent; leaves obovate to elliptic, tertiary veins immersed; inflorescences many-flowered, 5-20 cm long; flowers (3)-4-(5)-merous, white; fruits berries, globose, ca. 8 mm in diameter, glabrous. From southern Mexico to Colombia.



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Aizoaceae

Mostly succulent annual or perennial herbs or occasionally shrubs, usually with succulent and opposite leaves. **Leaves** opposite, sometimes alternate, simple, entire, stipules usually lacking; **inflorescences** mostly terminal, often seemingly axillary, cymose or flowers solitary; **flowers** actinomorphic, bisexual, rarely unisexual, then plants monoecious, perianth of 1 whorl, tepals (3-)5(-8), basally connate and adnate to the filaments forming a tube, lobes often unequal, with subapical appendages, petaloid staminodia often present, stamens (1-)4-5-numerous, free, rarely basally connate, ovary superior or sometimes inferior, 1-5-locular, styles 1-5; **fruits** loculicidal, septicidal or circumscissile capsules, sometimes hard and indehiscent, rarely drupaceous, seeds few to numerous, sometimes arillate. Mainly in

arid habitats, often along beaches in South Africa and Australia, with a few genera elsewhere in the tropics and subtropics. Pantrop. + subtrop. 128/1850, CR 3/3, GD 2/2.

The family description is based on the Aizoaceae s. str. in the sense of BITTRICH & HARTMANN (1988), including the Mesembryanthemaceae and Tetragoniaceae, but excluding the Molluginaceae, which are treated here as a separate family.

The showy flowers of several taxa, and the attractive coloring of the interior of the perianth of some others, suggest that the Aizoaceae are mainly entomophilous (BITTRICH 1986, HARTMANN 1991, 1993). Most of them are pollinated by bees or wasps (VOGEL 1954, GESS & GESS 1989), while others are known to be psychophilous or (rarely) phalenophilous (VOGEL 1954, HARTMANN 1993). Some African species with powdery pollen are at least partly anemophilous (BITTRICH 1986).

The dispersal of the seeds of species with capsular fruits is mainly by hydrochory or autochory (BITTRICH 1986, HARTMANN 1993). An extensive summary of the various dispersal modes in Mesembryanthema (subfamilies Ruschioideae and Mesembryanthemoideae) was presented by HARTMANN (1991). She describes hydrochory as the main dispersal mode and recognized 4 different mechanisms. For example, the seeds of *Sesuvium portulacastrum* are completely unwettable and therefore able to float on seawater (BITTRICH 1990). HARTMANN (1991) mentions anemochory, zoochory (epizoochory by birds as well as endozoochory) and autochory as further ways of dispersal. The seeds of the subfamily Sesuvioideae are sometimes covered by a sticky aril, which suggests epi-ornithochory and long-distance dispersal (BITTRICH 1990).

Some strongly succulent members of the family, such as the "living stones" from South Africa, are used worldwide as ornamentals. Species like the widely cultivated *Tetragonia tetragonioides* (HARTMANN 1993) are consumed as a vegetable, as well as *Tetragonia expansa*, which is locally cultivated in Central America (BURGER 1983).

The two genera of our area belong to subfamily Sesuvioideae, which is characterized by capsular fruits with circumscissile dehiscence and by the seeds always being completely covered by an aril.

Key to the genera (after HARTMANN 1993)

1	Stipules present; style 1	*Trianthema*
1*	Stipules absent; styles 2-5	*Sesuvium*

Sesuvium (pantrop. 12, CR 1, GD 1)
Herbs or subshrubs with more or less equal and usually strongly succulent leaves and often showy flowers.

S. portulacastrum (L.) L., Pl. 36b
Perennial herb, glabrous; leaves linear, elliptic or narrowly obovate; inflorescences axillary; flowers solitary, pink, perianth tube 1,5-3 mm long, stamens numerous, inserted at the orifice of the perianth tube; fruits capsules, ovoid to obovoid, ca. 6,5 mm long, 3 mm in diameter, seeds black. Throughout the tropics worldwide.

Trianthema (pantrop. ca. 17, CR 1, GD 1)
Herbs or subshrubs with strongly unequal leaves. Petiole bases with membranaceous tissue, connecting the opposing leaves.

Trianthema portulacastrum

T. portulacastrum L.
Annual herb, erect or prostrate; leaves obovate to rounded spatulate, the larger one at least twice as large as the smaller one, interpetiolar stipules present; flowers solitary, sessile, perianth tube campanulate, stamens 10, inserted at the orifice of the perianth tube; fruits capsules, almost enclosed in the petiolar sheath, ca. 4,5 mm long, 3,5 mm in diameter, seeds reddish-brown to black. Beach plants, distributed in the tropics and subtropics worldwide.

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Amaranthaceae

A widespread family, closely related to the Chenopodiaceae, mostly of weedy herbs, but also shrubs, lianas or small trees, always with small greenish to whitish inconspicuous flowers in dense inflorescences. **Leaves** simple, alternate or opposite, usually entire or sometimes undulate, rarely crenate or serrate, petiolate or sessile, stipules lacking; **inflorescences** axillary or terminal, of glomerules or spikes, these simple, or often arranged in panicles or compound spikes; **flowers** bisexual or unisexual (plants then monoecious or dioecious), subtended by a ventral bract and two lateral bracteoles, tepals (0-)2-5, usually free, stamens 2-5, mostly epitepal, filaments free or often connate into a tube and then frequently with staminodia-like appendages, alternating with the anthers (pseudostaminodia), ovary superior, 1-locular; **fruits** capsules or berries, circumscissile, irregularly dehiscent or indehiscent, seeds sometimes arillate. Distributed worldwide except in the Arctic regions in nearly all habitats with emphasis on arid and semi-arid zones. Cosmopol. 71/750, CR 11/35, GD 7/9.

Studies on pollination are rare. TOWNSEND (1983) concluded that anemophily is the norm in *Amaranthus* and probably many other genera, but he also suggests that entomophily would play a role in the pollination of Amaranthaceae, due to the fact that insect visits (especially by bees) have been observed in several genera.

Some cultivars of *Amaranthus,* derived from *A. hybridus* from Mexico and Central America, with large inflorescences, have become an important grain crop for their edible seeds (SAUER 1967, cf. BURGER & KUIJT 1983). Some others with colored inflorescences or leaves are used as ornamental plants (BURGER & KUIJT 1983, ELIASSON 1987). The pollen of several species seems to cause allergic reactions and rinitis.

Key to the genera (after NEE 1995)

1	Leaves alternate	2
2	Herbs, erect or spreading	*Amaranthus*
2*	Plants woody, climbing or erect	3
3	Soft-woody clambering vines; fruits dry	*Chamissoa*
3*	Understory shrubs or small trees; fruits fleshy	*Pleuropetalum*

1*	Leaves opposite	4
4	Inflorescence a narrow, elongate spike; flowers or flower clusters burlike, the bracteoles spine-tipped	*Cyathula*
4*	Inflorescence various, but flowers or flower clusters not bur-like; bracteoles not spine-tipped	5
5	Stigma capitate	*Alternanthera*
5*	Stigma bilobate or penicillate	6
6	Filaments fused into a long tube	*Gomphrena*
6*	Filaments fused only at base	*Iresine*

Alternanthera (cosmopol. c. 100, CR 10, GD 2)
A genus of prostrate or decumbent annual or perennial herbs, very variable in shape with opposite, entire to denticulate leaves. The spicate or glomerulate inflorescences bearing bisexual, white to purple flowers, distinct in the flattened filaments which are united to a staminal tube, at least basally.

A. laguroides (Standl.) Standl.
Erect or clambering perennial herb, stem to 4 m long; leaves densely sericeous, lanceolate to narrowly ovate, 2-10 cm long, 1-3,5 cm wide; inflorescences terminal or axillary, capitate; fruits obovoid, to 1 mm long. From Guatemala to Panama.

Amaranthus (cosmopol. 60, CR 6, GD 1)
A cosmopolitan genus of weedy, annual or rarely perennial herbs with rather long petiolate, alternate leaves and spicate or paniculate inflorescences.

A. spinosus L.
Erect herb, usually much-branched; leaves 3-12 cm long, 1,5-5 cm wide, glabrous or almost so, with a pair of spines in each axil, petiole from less than 1 cm long up to the length of the leaf blade; inflorescences axillary and terminal, axillary inflorescences rounded, only with female flowers, terminal inflorescences elongate and spiciform, of densely arranged cymes with male flowers in the upper part and female flowers in the lower part; tepals 5, stamens 5; fruits utricles, with shiny, black seeds. Distributed worldwide from the tropics to temperate zones, usually in disturbed areas, in the Neotropics, reaching from the central United States to Argentina.

Iresine (cosmopol. ca. 80, CR 5, GD 1)
A genus much in need for a revision, consisting of herbs, lianas and small trees with opposite leaves and capitate or spicate inflorescences, arranged in panicles.

I. diffusa H.B.K. ex Willd.
Common names (Central America): adorno de niño, camarón, coyontura de pollo, hierba de gato, siete pellejos, taba de gueguecho, velo de princesa (BURGER & KUIJT 1983).
Vegetatively very variable weedy dioecious herb or subshrub, climbing or erect; leaves opposite or subopposite, broadly ovate to broadly lanceolate, 3-10 cm long, 1,5-6 cm wide, petiole up to 5 cm long; inflorescences terminal, open panicles of numerous minute capitulae or spikes; flowers minute, unisexual, tepals whitish to brownish, stamens 5, fruits indehiscent. Common weed of usually disturbed areas of the Neotropics, from the southern United States, Central America and the West Indies to tropical and subtropical South America.

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Anacardiaceae

A family consisting of trees, shrubs and lianas (not in Costa Rica) which are usually provided with resinous tissues, which release a characteristic terpentinous odor. **Leaves** alternate, simple or pinnately compound, lacking stipules; **flowers** hermaphroditic or sometimes unisexual by reduction, 4-5-merous with 5-10-numerous stamens; intrastaminal disk (between the stamens and the ovary) usually present; ovary superior with 1-5 carpels; **fruit** a 1-seeded drupe. The Anacardiaceae are distributed mainly in the tropics and subtropics with a few representatives in temperate regions. Cosmopol. 70/875, CR 12/17, GD 6/9.

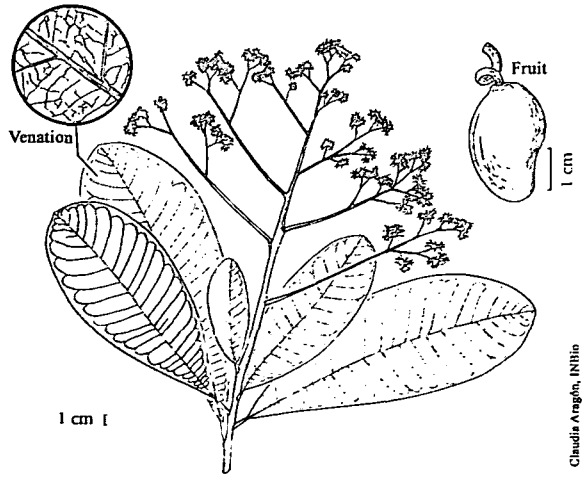
The resinuous sap of several species is used for the production of turpentine or medicines. Several species provide edible fruits or fruit-parts, like edible mesocarp (*Mangifera indica*, *Spondias* spp.), edible seeds (*Anacardium occidentale*, *Pistacia vera*), or edible peduncle (*Anacardium* spp.).

Key to the genera

1	Leaves simple	2
2	Stamens 5, fruit fleshy	*Mangifera*
2*	Stamens 10, fruit hard, more or less nutlike with fleshy hypocarp	*Anacardium*
1*	Leaves compound	3
3	Stamens 5	4
4	Flowers unisexual, calyx accrescent in fruit	*Astronium*
4*	Flowers hermaphroditic, calyx not accrescent in fruit	*Mosquitoxylum*
3*	Stamens (8-)10	5
5	Ovary 4-5-locular	*Spondias*
5*	Ovary unilocular	*Tapirira*

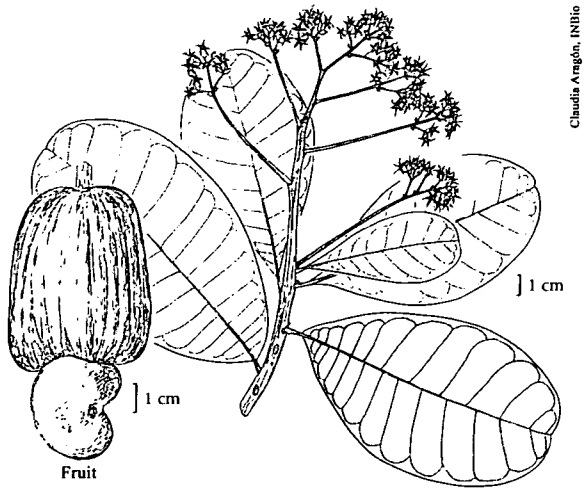
Anacardium (Neotrop. 11, CR 1 + 1 sp. cultivated, GD 1 + 1 sp. cultivated)
A genus of evergreen trees and shrubs, always with simple leaves and (7-)10(-12) stamens.

A. excelsum (Bertero & Balb. Ex Kunth) Skeels, Pl. 36c
Common names (Costa Rica): espavé, espavel, rabito (JIMÉNEZ, in prep.)
Tree 20-25 m tall; leaves clustered at the ends of the branches, entire, 14-31 cm long, 5-12 cm wide; inflorescences terminal, paniculate; flowers cream-white to green, 1-6 mm long, stamens (7-)10(-12); fruits hard, 2,5-3,5 cm long, 1-2 cm broad with a fleshy, 5-20 mm long, edible hypocarp. Growing in forests, from Honduras to northern South America.



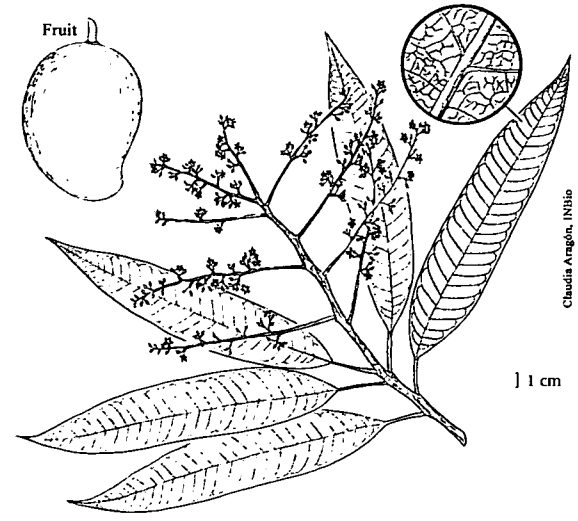
Anacardium excelsum

A. occidentale L., Pl. 36d,e
Tree, ca. 8 m tall; leaves somewhat clustered at the twig ends, broadly oblong-ovate to somewhat obovate, 6-15,5 cm long, 3,5-9 cm wide, glabrous; inflorescences paniculate, 7-16,5 cm long, pubescent; flowers small, greenish-yellow, turning dark red with age; fruits hard, 2-3,2 cm long, 1-2 cm wide, gray, hypocarp to 10 cm long, 5 cm wide, red or yellow. Native to tropical Central and South America, now cultivated worldwide for its edible fruits and hypocarp.



Anacardium occidentale

M. indica L., Pl. 36f-h
Common names (Costa Rica): mango (JIMÉNEZ, in prep.)
Tree to 40 m high; flowers in terminal panicles, 4-5-merous, stamens usually 5, with one large fertile stamen, the other 4 strongly reduced and sterile; drupe 4-25 cm long, 1,5-10 cm in diameter. Cultivated throughout the tropics, occasionally persisting in second growth forests. From this species there exist many varieties, all of them with edible fruits.



Mangifera indica

Astronium (Neotrop. c. 15, CR 1, GD 1)
Trees with strong aromatic resin and wind-dispersed fruits where the accrescent calyx lobes serve as wings.

A. graveolens Jacq.
Common names (Costa Rica): ron ron, jobillo (JIMÉNEZ, in prep.)
Tree, to 35 m high, with smooth bark; leaves odd-pinnate, petiolulate entire or with serrate or serrulate margins; flowers unisexual, 5-merous, calyx enlarging after anthesis, ovary 1-locular; fruit a drupe, fusiform, subtended by the enlarged wing-like calyx. Widely distributed in the Neotropics, from southern Mexico to Paraguay.

Mangifera (Palaeotrop. c. 40-60, CR 1 cultivated, GD 1 cultivated)
Trees with simple, entire leaves which are native in the Palaeotropics, but with one species cultivated worldwide because of its edible fruits.

Spondias (Pantrop. 10, CR 2 + 1 cultivated, cnp 2 + 1 cultivated).
Shrubs or large trees with uneven pinnate leaves. The genus can be distinguished from the other compound-leaved genera by its combination of 8-10 stamens and 4-5-locular ovary.

S. mombin L., Pl. 36j
Common names (Costa Rica): jobo (JIMÉNEZ, in prep.)
Tree, 6-27 m tall; leaves 7-35 cm long, with 5-11 pairs of leaflets, leaflets 4,7-19,6 cm long, 2,1-7 cm wide; inflorescences terminal, paniculate, 10-38 cm long, white to yellowish-white; flowers numerous, hermaphroditic, 5-merous, white or yellow, stamens 10, styles 5; fruits 1,5-4 cm long, 1-2,5 cm wide, yellow to orange when mature, edible. Distributed throughout tropical America, cultivated in Africa.

S. purpurea L., Pl. 36i

Tree, up to 20 m tall; leaves with 5-12 pairs of leaflets, leaflets 1,9-8,2 cm long, 0,9-3,4 cm wide; inflorescences terminal, paniculate, up to 10 cm long, reddish to reddish-purple; flowers small, 5-merous, reddish to pinkish, stamens 10; fruits 1,5-5 cm long, 1-3 cm wide, yellow, orange or red when mature, edible. Widely distributed, from Mexico and the Antilles to South America.

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Annonaceae

The largest family within the order Magnoliales, consisting of trees, shrubs and a few lianas, is characterized by distichous leaf arrangement and a more or less strong Ranalean odor. **Leaves** simple, alternate, entire, glabrous or pubescent, stipules lacking; **inflorescences** usually axillary, sometimes terminal, internodal or cauliflorous, cymose, or flowers in fascicles or solitary; **flowers** bisexual, rarely unisexual (then plants androdioecious), usually white or yellowish-green, sepals (2-)3(-4), free or connate, petals larger than the sepals, (3-)6(-10) in 2 whorls, free or basally connate, stamens usually numerous and spirally arranged, rarely few and whorled, usually free, often with shield-like apical dilatation, carpels 1-numerous, generally free, sometimes basally connate, wholly fused or paracarpous; **fruits** composed of several dry or fleshy, dehiscent or indehiscent monocarps, these totally separate and often long stipitate or syncarpous and connate to an aggregate fruit, seeds often large, sometimes arillate. Worldwide in the tropics and subtropics, with only a few species reaching into temperate zones. Pantrop. 112/2150, CR 16/72, GD 14/39-41.

The Annonaceae are mainly found in lowland rainforests, but also in various savanna types and montane forests, especially in the Neotropics (KESSLER 1993).

In spite of the large variation of flower morphology found within the Annonaceae, most species are pollinated by beetles, which is probably the most primitive pollination mode. The beetles, mostly belonging to the families Nitidulidae and Curculionidae, are attracted by the floral odor of rotten fruits. They use the flowers as breeding and mating place and feed on pollen or special tissues of the petals (GOTTSBERGER 1970, 1989, 1990, MAAS et al. 1992, MURRAY 1993). In most of the genera (e.g. *Anaxagorea*, *Annona*, *Duguetia*, *Guatteria* and *Xylopia*) the petals form a pollination chamber, in which the beetles are enclosed during anthesis. Sometimes small slits between the petals ensure that only small beetles are able to enter the flower, while larger species that would destroy the flowers are restricted (GOTTSBERGER 1970). Exceptions are found. Most species of *Annona*, for example, are pollinated by the quite large dynastid beetles of the genus *Cyclocephala*, where the pollination process is accompanied by flower thermogenesis (GOTTSBERGER & SILBERBAUER-GOTTSBERGER 1988, GOTTSBERGER 1989, 1990). A pollination chamber is lacking in *Guatteria*, which is visited by beetles of the families Staphylinidae

and Nitidulidae (MAAS et al. 1992). Several Annonaceae are cleistogamous and probably completely autogamous (e.g., *Annona muricata*), while others are pollinated by thrips, flies or bats (GOTTSBERGER 1970, KESSLER 1993, WEBBER & GOTTSBERGER 1995).

Annonaceae seeds are mostly dispersed by animals (endozoochorous). Most syncarpous fruits (e.g. *Rollinia* and *Annona*) are preferred by monkeys, while genera with fleshy monocarp (*Guatteria*) are usually eaten by birds and rarely by monkeys (GOTTSBERGER 1970). The dehiscing monocarps of *Xylopia* and *Cymbopetalum* are dispersed by birds, due to the conspicuous colors of the black seeds with reddish or blue aril. *Anaxagorea* shows another mode of seed dispersal, where the slippery seeds are ejected to rather long distances by the pressure of the carpel walls (KESSLER 1993).

Many edible fruits are known in this family. Commercially important are several species of *Annona* (e.g., *A. cherimola, A. muricata, A. purpurea, A. squamosa*) and *Rollinia* (*R. mucosa*). The flowers of *Cananga odorata* have an intense pleasant fragrance and are used for perfume production.

Key to the genera (based on KESSLER 1993)

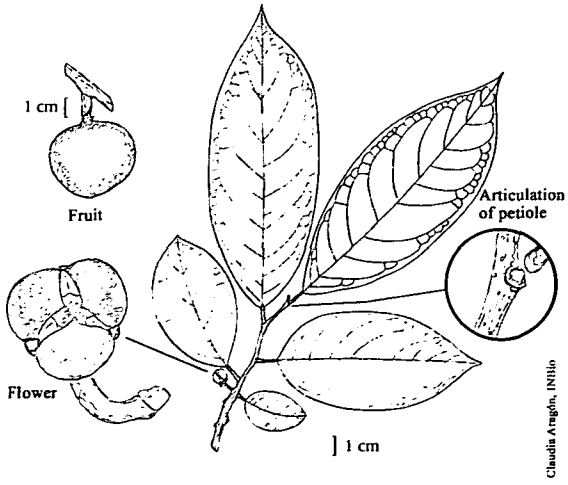
1	Apex of the stamen connective expanded truncate	2
2	Ovules several per carpel, lateral, rarely 1	3
3	Anther cells transversely septate	4
4	Monocarps opening by a lateral slit, inner petals involute boat-shaped	*Cymbopetalum*
4*	Monocarps not opening by a lateral slit, inner petals not involute boat-shaped	*Xylopia*
3*	Anther cells not transversely septate	5
5	Flowers axillary, inner petals concave at the base	*Unonopsis* p.p.
5*	Flowers leaf-opposed, inner petals not concave at the base	*Desmopsis* p.p.
2*	Ovule 1 per carpel, basal or pendulous from the apex	6
6	Fruit wholly syncarpous or monocarps partly connate	7
7	Fruits wholly syncarpous	8
8	Outer petals with a spur or wing on the back	*Rollinia*
8*	Outer petals without a spur or a wing	*Annona*
7*	Monocarps only partly connate	*Duguetia*
6*	Monocarps free	9
9	Petals imbricate	10
10	Sepals valvate	11
11	Petals tomentose, ovule basal	*Guatteria*
11*	Petals glabrous, ovule pendulous from above the middle or near the apex of the carpel	*Cremastosperma*
10*	Sepals imbricate	12
12	Inflorescences leaf opposed, sometimes sub-axillary or supra-axillary or flowers solitary; flowers bisexual	*Malmea*
12*	Inflorescences terminal on a short, axillary shoot; flowers male or bisexual	*Klarobelia*
9*	Petals valvate	13
13	Flowers leaf-opposed, ovules lateral	*Desmopsis* p.p.
13*	Flowers axillary, ovules basal	*Unonopsis* p.p.
1*	Stamens without enlarged connective apex or connective apex tongue-shaped, acute or conical	14
14	Ovules 1, basal	*Oxandra*
14*	Ovules 2 to several	15
15	Plants cultivated	*Cananga*
15*	Plants native, not cultivated	*Anaxagorea*

Anaxagorea (neotrop. 21 + 3 spp. in trop. Asia, CR 5, GD 2)
Small trees and shrubs, distinct in having 2-seeded, dehiscent, pod-like fruits, dehiscing along the ventral suture.

A. crassipetala Hemsl.
Tree or shrub, up to 12(-25) m tall, twigs ferruginous-puberulous; leaves elliptic to (ob)ovate, (11-) 16-40 cm long, 4-14 cm wide, ferruginous puberulous to glabrescent beneath; inflorescences axillary, cauliflorous to ramiflorous, usually clusters of 1-several flowers; petals yellow, orange or brown, densely to sparsely ferruginous-puberulous; fruits consisting of stipitate, beaked follicles, 22-32 cm long, sparsely ferruginous-puberulous, green or greenish-yellow. From Nicaragua to Amazonian Colombia and Peru.

Annona (neotrop. + a few in Africa 137, CR 13, GD 4 + 1 cultivated)
Shrubs, trees and lianas with terminal, internodial or leaf opposite, 1-few-flowered inflorescences and syncarpous, fleshy and often edible fruits.

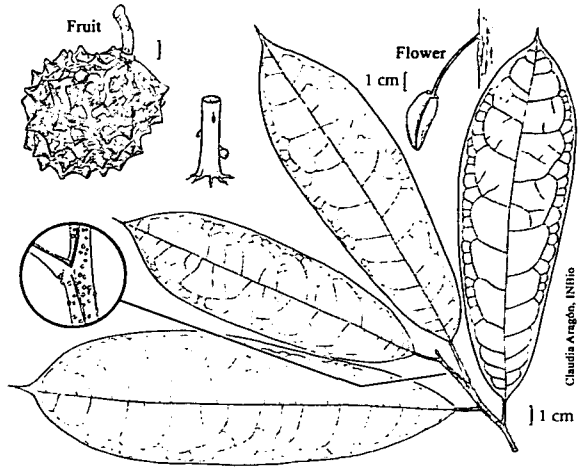
A. amazonica R.E.Fr., Pl. 37a,b
Tree, up to 25 m tall; leaves membranaceous, oblong-lanceolate to oblong-elliptic, 10-14 cm long, 3-5 cm wide, usually glaucous beneath when fresh; inflorescences subsessile, leaf-opposite or cauliflorous. From Costa Rica to Ecuador and Brazil.



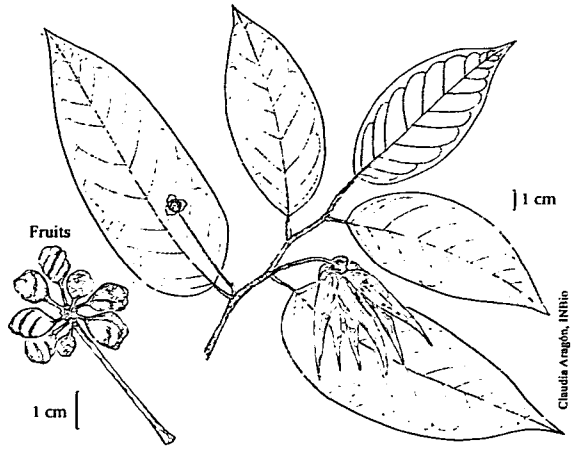
Annona amazonica

A. muricata L., Pl. 37c,d
Common name (Latin America): guanabana
Tree, ca. 8 m tall; leaves ovate-oblong, 6-16 cm long; flowers solitary; fruits 20-35 cm long, ovoid, green, with edible pulp. Native to the Neotropics, but now cultivated worldwide.

A. pittieri Donn. Sm., Pl. 37e,f
Small tree, up to 8 m tall, young twigs with sharp ridges; leaves papyraceous to coriaceous, oblong, 12-18 cm long, 4-5 cm wide; inflorescences cauliflorous or ramiflorous, consisting of 1-5 fasciculate flowers; fruits with hard pericarp, surface covered with conical projections. Costa Rica and Panama.



Annona pittieri



Cananga odorata

Cananga (paleotrop. 2, CR 1, GD 1)
An Old World genus with one species also cultivated in the Neotropics. Trees with rather large flowers and numerous free, stipitate monocarps.

C. odorata (Lam.) Hook. f. & Thomson, Pl. 37g
Common name: ylang-ylang
Medium sized tree, up to 35 m tall; leaves oblong to broadly elliptic, 5-20 cm long; inflorescences of few clustered flowers; flowers greenish with strong, sweet fragrant, petals 3-5(-8) cm long, fruits oblong with 1,5 cm long stalk. Cultivated species, native to the Paleotropics (India to Australia). The flowers are used in perfume production (ylang-ylang oil).

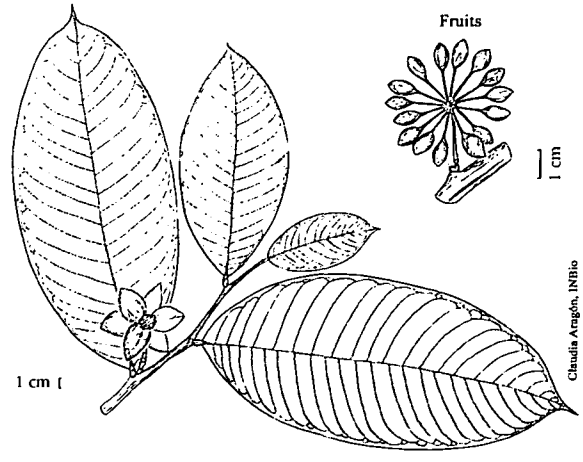
Cymbopetalum (neotrop. 27, CR 3, GD 3)
Shrubs and small trees, characterized by the innermost petals large, chartaceous to carnose and boat-shaped, by the long and pendent pedicels and the seeds with an orange or red aril. The fruits are always apocarpous.

Cymbopetalum lanugipetalum

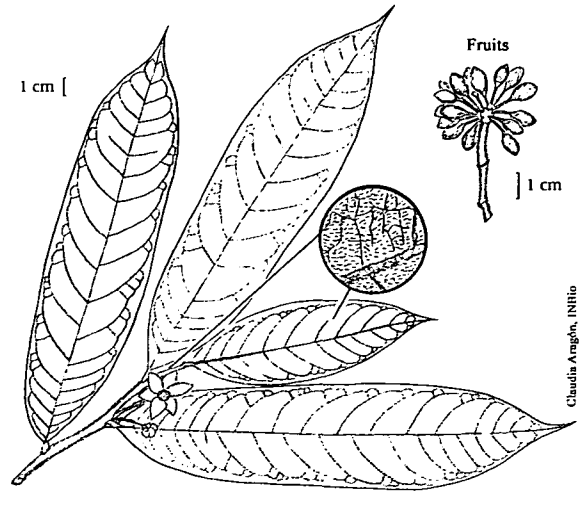
C. lanugipetalum Schery
Treelet, (1-)3-6(-10) m tall; leaves chartaceous to membranaceous, strongly reticulate, lanceolate to elliptic, rarely ovate, petiole shortly winged; inflorescences mostly internodal or terminal, pedicel of flower 6-21(-60) cm long, sepals free, inner petals fleshy, stamens clavate, carpels 28-63; fruits composed of 2-26 monocarps, reddish purple or dark red, seeds 1-6 with orange aril. In lowland wet forests, but also in cloud forests (Coclé, Panama), from southeastern Costa Rica to northwestern Colombia.

Guatteria (neotrop. ca. 279, CR 13, GD 8-10)
The largest neotropical genus with 6 greenish to yellowish, usually slightly spoon-shaped petals. The apocarpous fruit consists of usually long stipitate monocarps.

G. amplifolia Triana & Planch., Pl. 37h
Medium sized tree, up to 12 m tall; leaves membranaceous, elliptic or oblong-elliptic, 20-40 cm long, 7-12 cm wide; flowers axillary, solitary or in pairs, petals ferruginous-tomentellous, 15-18 mm long; monocarps many, ellipsoid, rugose, 8 mm long, 5 mm wide, stipes 10-15 mm long.



Guatteria amplifolia



Guatteria chiriquensis

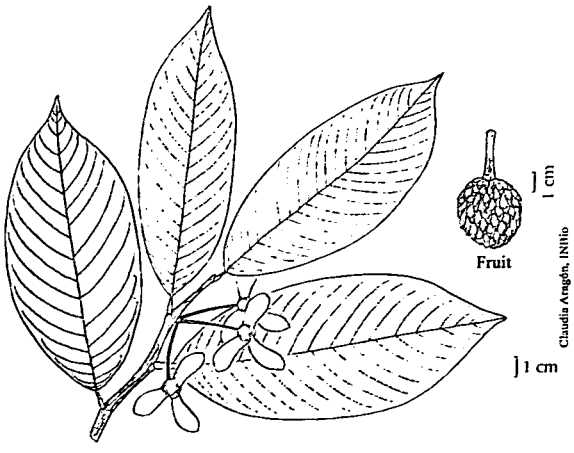
G. chiriquiensis R.E.Fr., Pl. 38a-e
Medium sized tree, up to 15 m tall; leaves glabrous or pubescent, verrucose, linear-oblong; flowers axillary, solitary, petals thick, golden-sericeous on the outer side, glaucous on the inner side; flowers solitary, petals densely golden sericeous outside, subglaucous inside; monocarps black, numerous, narrowly ellipsoid-clavate, 9-10 mm long, 4-5 mm wide, stipes 6-7 mm long.

Rollinia (neotrop. 60, CR 4, GD 3)
A genus with syncarpous, sometimes edible fruits and petals which are conspicuously prolonged abaxially into a broad wing.

Key to the species of *Rollinia* (after MAAS et al. 1992)

1	Sepals flat	*R. mucosa*
1*	Sepals gibbous	2
2	Secondary veins in 15-33 pairs; fruit composed of 100-200 carpels, areoles conical to pyramidal, 3-5 mm high; lamina 15-33 x 7-15 cm; wings 8-15 x 8-10 x 1-2 mm	*R. danforthii*
2*	Secondary veins in 9-25 pairs; fruit composed of 30-150 carpels, areoles not or not strongly protruding	*R. pittieri*

R. mucosa (Jacq.) Baill., Pl. 38f,g
Common name (Costa Rica): anonillo (MAAS et al. 1992)
Tree, up to 20(-25) m tall; leaves narrowly elliptic, (6-)10-25(-35) cm long, (2-)4-8,5(-13) cm wide, sparsely pubescent above, densely covered with white hairs beneath, domatia mostly present; inflorescences supra-axillary to leaf-opposed, few-flowered; flowers yellow, petal wings usually horizontal, 7-15(-20) mm long; fruits globose to depressed ovoid, 2-12(-20) cm long, 2,5-11(-15) cm wide, yellow, densely to sparsely covered with appressed, brownish hairs. In various habitats, widely distributed throughout the Neotropics.



Rollinia pittieri

R. pittieri Saff., Pl. 38h
Common names (Costa Rica): anonillo (MAAS et al. 1992), anón, candelo
Tree, up to 40 m tall; leaves membranaceous to chartaceous, 8-20 cm long, 4,5-8,5 cm wide, both sides covered with whitish hairs, glaucous beneath, domatia sometimes present; inflorescences leaf-opposed, with several flowers; flowers green, suffused with with reddish brown or yellow orange, petal wings recurved, silvery-tomentellous, 1-1,5 cm long.; fruits globose to broadly ovoid, 1,5-3,5(-4) cm long, 1,5-3(-4) cm wide, green, yellowish-green or greenish-brown, densely covered with brownish, crisped hairs. Frequently in secondary forests of low altitude, in Central America, from Honduras southwards to Bolivia and Rondonia (Brazil).

Unonopsis (neotrop. 43, CR 8, GD 3)
Shrubs and small trees, with small and nearly globose flower buds as well as more or less globose and indehiscent monocarps with pitted seeds.

U. panamensis R.E. Fri., Pl. 38i
Small tree, young branches ferruginous pubescent; leaves 15-20 cm long, 4-5 cm wide, glabrous above, hirsute-glabrescent on the midvein beneath; inflorescences axillary. In Costa Rica and Panama.

U. theobromifolia N. Zamora & Poveda, Pl. 38j-l
Small tree, up to 7 m tall; young branches densely ferruginous pubescent; leaves 17,8-43,7 cm long, 6,9-14,5 cm wide, glabrous above, densely pilose beneath; flowers axillary, in fascicles of 2(-3) or flowers solitary, sepals densely ferruginous without, glabrous within; monocarps 5-9, red when mature, seeds 2-4. Endemic to Costa Rica.

Xylopia (pantrop. ca. 160, CR 6, GD 3)
Shrubs and trees with strongly distichous leaves and long and narrow petals. Fruit apocarpous.

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MAAS, P.J.M. & L.Y.T. WESTRA. 1984. Studies in Annonaceae: 2. A monograph of the genus *Anaxagorea* A. St. Hil. - Bot. Jahrb. Syst. 105 (1): 73-134.
MAAS, P.J.M., L.Y.T. WESTRA & COLL. 1992. *Rollinia*. - Fl. Neotrop. Monogr. 57.
MURRAY, N.A. 1993. Revision of *Cymbopetalum* and *Porcelia* (Annonaceae). - Syst. Bot. Monogr. 40:1-121
STEYERMARK, J.A., P.J.M. MAAS, P.E. BERRY, D.M. JOHNSON, N.A. MURRAY & H. RAINER. 1995. Annonaceae. Pp.: 413-469. In: J.A. STEYERMARK, P.E. BERRY & B.K. HOLST (eds.): Flora of the Venezuelan Guayana Vol. 2.
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Apiaceae

Mostly herbs with hollow stems, but also shrubs or small trees with characteristic aromatic odor of essential oils and with simple or compound umbellate inflorescences. **Leaves** alternate, basally inserted or sometimes opposite, compound or variously lobed or deeply incised, rarely simple, often with large petiolar sheaths, sometimes caulinar, stipules sometimes present; **inflorescences** mostly umbellate, sometimes capitate; **flowers** actinomorphic, bisexual or unisexual, small, calyx often reduced, minutely 5-lobate, petals 5, free, stamens 5, inserted on a nectariferous disk, ovary inferior, 2-locular; **fruits** dry schizocarps, composed of 2 connate mericarps, these separating at maturity, seeds 1 per mericarp. Mostly in temperate regions worldwide, with a few representatives in the tropics, where they are restricted to dry areas, savannas or mountainous regions. Cosmopol. 446/3540, CR 20/35, GD 1/1.

The fruits of several members of the Apiaceae are used as spices or flavors, because of the presence of essential oils. The roots or leaves of others are eaten as vegetables or salad. Some of the temperate taxa (e.g., *Daucus carota*, *Petroselinum crispum*) are widely cultivated and have been introduced into tropical America. From the native neotropical species only *Eryngium foetidum* is cultivated worldwide for medicinal use as well as for flavoring food.

Eryngium (cosmopol. 230-250, CR 4, GD 1)
Usually glabrous herbs with spinose leaves and with the inflorescences composed of solitary to numerous involucrate capitulae.

E. foetidum L.
Common names (neotrop.): cilantro, culantro, culantro de monte (BERRY 1995, MATHIAS & CONSTANCE 1971), culantro de coyote (MORALES, in prep.) Strongly aromatic herb, up to 50 cm tall, glabrous; leaves basally inserted, lanceolate to oblanceolate, margin entire to spinose-denticulate; inflorescences trifurcate, capitulae numerous; flowers greenish-white; fruits (sub-)globose, ca. 1,5 mm long, densely papillose. Weedy in cultivated areas and in savannas throughout the Neotropics and also introduced to tropical Asia.

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Apocynaceae

Trees, shrubs, stout lianas, twining or shrubby vines, rarely herbs, generally with milky latex, rarely with clear sap or colored exudate. **Leaves** simple, opposite, whorled, or less often alternate; stipules generally lacking, margins entire, venation pinnate; **inflorescences** terminal and/or axillary, cymose, racemose or flowers solitary, usually branched, of a variety of forms, mostly many-flowered; **flowers** actinomorphic, bisexual, often with the tube slightly curved, often with various corona lobes within the tube, sepals 5, connate basally with lobes imbricate, often with flat glands inside, corolla with 5 contorted lobes usually strongly convolute especially in bud, sometimes with a corona, stamens 5, alternate with the petals, filaments generally adnate to the corolla tube inside, anthers 2-locular, ovary superior, rarely semi-inferior or sunken into the receptacle (*Plumeria*), often with 5 (sometimes 2) disk glands or an annular disk at the base; **fruits** berries, drupes, capsules, or consisting of twin follicles of a leathery or dry consistency, valves rarely becoming woody (*Aspidosperma*), seeds naked, embedded in pulp, winged or comose, with hairs distributed over the surface or in tufts at one or both ends. Widespread in the tropics and subtropics. Pantrop. + a few temp. 163/1850, CR 32/86, GD 17/30.

Key to the genera (by F. MORALES)

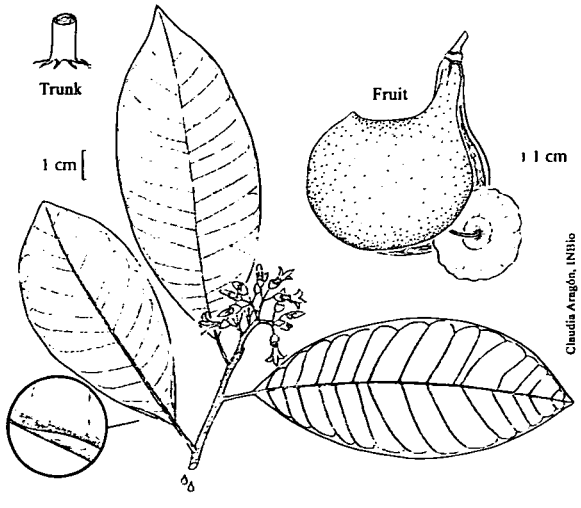
1	Lianas or scandent shrubs	*Allamanda* p.p.
2	Leaves peltate	*Peltastes*
2*	Leaves not peltate	3
3	Leaf blades usually with glands adaxially, disposed along the midrib or basally	4
4	Inflorescence racemose, unbranched	*Mandevilla*
4*	Inflorescence corymbose or variously paniculate, branched	5
5	Flowers more than 1,5 cm long	*Mesechites*
5*	Flowers less than 1 cm long	*Forsteronia* p.p.
3*	Leaf blades eglandular	6
6	Corolla with an annular corona around the mouth, usually with five free corona lobes within	*Prestonia*
6*	Corolla without an annular corona or free corona lobes	7
7	Flowers very small, less than 1 cm long	*Forsteronia* p.p.
7*	Flowers showy, more than 1,5 cm long	8
8	Fruit a dry, spiny capsule	*Allamanda* p.p.
8*	Fruit follicles, without spines	9
9	Sepals eglandular, without colleters within; inflorescence compound by 1 or 2 flowers, plants of mangroves	*Rhabdadenia*
9*	Sepals glandular, with colleters within; inflorescence multiflorous, plants of forests and open areas	*Odontadenia*
1*	Trees or erect shrubs	10
10	Leaves whorled, alternate to densely clustered at the end of the branches	11
11	Fruit consisting of twin, leathery, banana-like follicles becoming dry when mature and containing winged seeds; flowers large and showy, white or pink to reddish; ovary sunken into the receptacle	*Plumeria*
11*	Fruit a single (or paired), woody, compressed follicle, usually containing many seeds with a concentric, papery or rarely thick wing, mature foliage without silvery pubescence, inflorescence axillary or terminal, not originating from stem between leaf-bearing nodes; flowers either relatively small and/or yellow; ovary superior	*Aspidosperma*
10*	Leaves strictly opposite to verticillate	12

12	Fruit consisting of twin leathery follicles with arillate seeds; arils white to brightly colored; trunk sometimes with spines	*Lacmellea*
12*	Fruit consisting of twin leathery follicles with arillate seeds; arils white to brightly colored; trunk never with spines	13
13	Sepals veined, thin, not clasping the corolla base; corolla tube with 5 longitudinal wings inside	*Stemmadenia*
13*	Sepals not veined, relatively thick, usually clasping the corolla base; corolla tube without wings inside	*Tabernaemontana* (incl. *Bonafousia, Stenosolen*)

Allamanda (neotrop. 12, CR 2, GD 1)
Scandent, woody vines with a white latex. The leaves are opposite or alternate in the upper nodes, usually whorled. They are very distinctive in the large campanulate yellow flowers and spiny, syncarpous fruits.

A. cathartica L., Pl. 39a
Edges of evergreen lowland and riparian forests, native to northeastern South America, but widely cultivated and escaped in the tropics of both hemispheres.

Aspidosperma (neotrop. 80, CR 5, GD 3)
Shrubs to large trees with white, creamy, orange or red latex in the branchlets and leaves. The flowers of the axillary, terminal or extra-axillary, compound-cymose to dichasial or thyrsiform inflorescences are mostly small and whitish. The very distinctive fruit is a woody, usually round, sometimes narrowly oblong and compressed follicle. The seeds are thin and round or oval with a membranaceous wing, surrounding the body which has long threadlike stalk from its center.



Aspidosperma megalocarpon

A. megalocarpon Müll. Arg., Pl. 39b,c
Tree, 20-40 m tall, the trunk conspicuously fluted or involute, sap white, copious; leaves alternate, oblong-elliptic to narrowly elliptic, gradually acuminate at apex, acute to cuneate at base, (3,7-) 6-14 cm long, 2,2-7,5 cm wide; flowers fragrant, ca. 1 cm in diameter, calyx grayish-green, tubular, 4-5 mm long, the lobes rounded, 1-1,5 mm long, corolla pale yellow, lobed to about the middle, tube slender, pubescent inside, lobes oblong-elliptic, asymmetrical, stamens 5, inserted at throat of tube; fruits brown, paired, reniform to suborbicular, flattened, 5,5-12 cm long. From Costa Rica to northern South America

Forsteronia (neotrop. ca. 50, CR 5, GD 2)
These woody vines have opposite leaves and terminal and/or lateral inflorescences with a short, rotate or subrotate corolla.

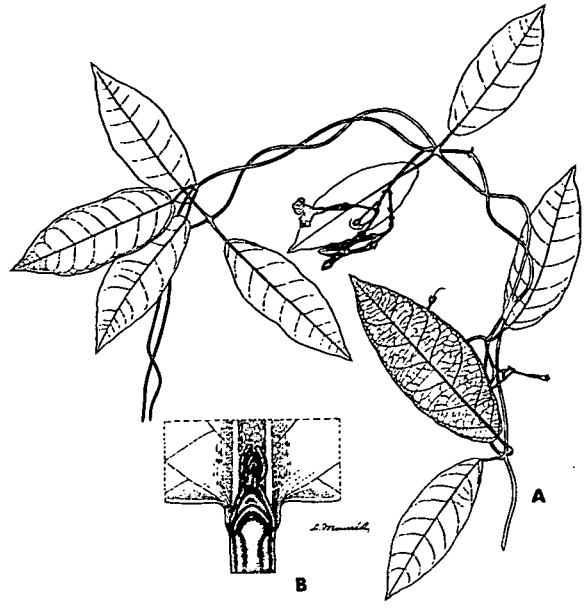
F. myriantha Donn. Smith
Liana, stems puberulent when young; leaves opposite, short-petiolate, elliptic to oval, 5-10 cm long, 2-4,5 cm wide, glabrous or nearly so; inflorescences densely and broadly thyrsiform; flowers numerous, white, calyx 1 mm long, corolla glabrous or minutely papillate, the tube scarcely 1 mm long, the lobes 2,5-3 mm long. From Guatemala to Panama.

Lacmellea (neotrop. ca. 35, CR 3, GD 1)
Medium to large moist- and wet-forest trees, the trunk with milky sap and occasionally with spines. The fruit is indehiscent, fleshy, the leaves are relatively small with acute to acuminate tips, and rather close together secondary veins and mostly a few parallel but usually faint intersecondaries are present. The fruits and latex are sweet and edible, the generic name is therefore derived from "milk and honey".

L. panamensis (Woodson) Markgr., Pl. 39d,e
Tree, to 20 m tall, more or less glabrous, sometimes armed with short and stout spines, sap milky, abundant in trunk, branches, and fruits; leaves opposite, oblong-elliptic, 5-13 cm long, 2-4 cm wide; inflorescences axillary, cymose; flowers congested, calyx lobes 1-1,5 mm long, ciliate, corolla narrowly tubular, white, drying burnt-orange, tube to 3 cm long, the limb to 1,5 cm in diameter; fruits broadly ellipsoid to obovoid, 2-3 cm long, yellow-orange, with a short persistent style to 3 mm long, mesocarp fleshy, sweet and tasty, with copious milky sap, seeds (1-)2(-4). From Nicaragua and Belize to Panama and Colombia.

Mandevilla (neotrop. 114, CR 5, GD 2)
Suffruticose vines, shrubs, or herbs, with white latex. The leaves are always bearing nectaries on the midrib, sometimes also on the upper petiole. The inflorescences are generally axillary, sometimes terminal or subterminal, racemose or cymose, simple or rarely obscurely compound. The corolla is funnelform, salverform, or tubular-salverform, medium-sized to large, with white, yellow, orange, pink, or purple lobes and a throat usually of a different color.
M. villosa (Miers) Woodson
Slender vine, glabrous or pubescent; leaves mostly lance-oblong, sometimes oblong-elliptic, 5-10 cm long, 1,5-3 cm wide, glandular along the costa on the upper surface; calyx 1-1,5 mm long, the lobes narrowly trigonous, corolla salverform, yellow, tube 2-2,5 cm long, lobes 1-1,5 cm long; follicles slender, conspicuously moniliform, 10-20 cm long, glabrous. From Mexico to Panama and northern Colombia.

Mesechites (neotrop. 10, CR 1, GD 1)
Slender weedy vines, closely related to *Mandevilla*, differing in the usually branched inflorescence. The upper part of the corolla tube is narrower and the flower color is different (usually whitish with green center). The leaves are not cordate and nectaries are present only at the base of the blade.
M. trifida (Jacq.) Müll. Arg.
Liana, glabrous or nearly so; leaves opposite, ovate to ovate-oblong, 5-12 cm long; inflorescences branched; calyx lobes 3-5 mm long, corolla greenish white or tinged with red or purple, tube 1,5-2,5 cm long, lobes 7-15 mm long, follicles 15-40 cm long. In semideciduous and evergreen lowland forests, widespread, from southern Mexico to northern South America.



Mesechites trifida
A. Habit. B. Upper surface of leaf with glands at base of midrib

Odontadenia (neotrop. 30, CR 3, GD 2)
Mostly canopy lianas, usually with campanulate, usually yellow, or occasionally red flowers, without annular ring around the mouth of the tube. The leaves usually have a characteristic closely parallel tertiary venation.
O. macrantha (Roem. & Schult.) Markgr.
Lianas, stems hollow, with an interpetiolar ridge, milky sap copious in stems; leaves opposite, sometimes alternate near apex, blades rather elliptic, 7-23(-36) cm long, 4-10(-17) cm wide, somewhat folded along midrib; inflorescences axillary or terminal, thyrsoid; flowers ca. 7 mm long, calyx lobes to 6 mm long, corolla funnelform, ca. 6 cm long, orange-yellow, the lobes ca 3 cm long, spreading, tinged with red-orange inside near throat, the tube orange, bulbous, 5-lobate, ca 1 cm long, markedly constricted above stamens, the throat ca 3 cm long; follicles paired, obovoid to oblong-ellipsoid, up to 22 cm long and 6 cm wide, green tinged with brown, seeds many. In moist forests and forest edges, from Costa Rica to tropical South America.

Peltastes (neotrop. 7, CR 1, GD 1)
More or less woody vines with opposite leaves, lateral inflorescences and few to several flowers, with a large, funnelform corolla. The plants may be recognized readily in the family by the peltate leaves.

P. isthmicus Woodson
Stems ferruginous-lanulous when young; leaves broadly ovate, 10-30 cm long, glabrate above, ferruginous-lanulous beneath when young, calyx lobes 3 cm long, corolla glabrous outside, the tube 2,5 cm long, the throat 2 cm long, the lobes 3,5 cm long; follicles 22-25 cm long. From Costa Rica to Colombia and Venezuela.

Plumeria (neotrop. ca. 17, CR 1, GD 1)
Thick-branched, dry-forest trees with large infundibuliform flowers and tiny inflorescence bracts. The inflorescences are terminal to pseudolateral, cymose and thyrsiform, usually many-flowered. The fruits are woody, banana-shaped prior to opening and flat when dehisced. The seeds have a thickish body and brownish asymmetric wing on one end.

P. rubra L., Pl. 39f,g
Large shrub or small tree, usually up to 9 m tall, deciduous, branchlets usually pubescent; leaves oblong to elliptic, usually 15-30 cm long; corolla 6-7 cm long, white or red, tube slender equal or shorter than the lobes; follicles thick, 10-25 cm long, ca. 4 cm in diameter. From Mexico to South America.

Prestonia (neotrop. 65, CR 8, GD 5)
Suffruticose or slightly herbaceous vines or rarely small trees, with white or translucent latex. The flowers are mostly light yellow and have a thickened annular corona around the corolla mouth and free corona lobes inside the corolla tube. Vegetatively they are characterized by always having toothed nectaries in the leaf axils.

P. portobellensis (Beurl.) Woodson, Pl. 39h
Liana, stems with a prominent interpetiolar ridge, at first coarsely pubescent, minutely lenticellate, milky sap present; leaves opposite, glabrous, elliptic to oblong-elliptic or obovate, 9-20(-30) cm long, 2,5-10(-15) cm wide; inflorescences axillary, corymbose, pedunculate; flowers 5-merous, calyx lobes 10-15 mm long, corolla salverform, constricted just below the lobes, tube greenish, to 18 mm long, pubescent inside at level of stamen attachment, bearing 5 slender appendages above stamens, the tube with a raised yellow rim, the lobes obliquely obovate, white, with orchid lines near margin; follicles paired, often united at apex, 20-40 cm long, 6 mm wide, glabrous. From southern Mexico to Panama.

Rhabdadenia (neotrop. 3, CR 1, GD 1)
Suffruticose vines with terete stems, white latex and opposite leaves. The inflorescences are axillary or subterminal dichasial cymes, but greatly reduced and 1-few-flowered. The corolla is funnelform and its throat conical or tubular. The fruit is apocarpous, and composed of dry, narrowly cylindrical follicles, dehiscing along a ventral suture.

R. biflora (Jacq.) Müll. Arg., Pl. 39i
Glabrous liana, milky sap present; leaves opposite, oblong to oblong-elliptic, 4-10 cm long, 1-5 cm wide; dichasia axillary or subterminal, usually of 1-3 flowers; flowers 5-parted, calyx to 1 cm long, lacking squamellae, corolla white, 5,5-7 cm long, tube 1,5-2 cm long, throat conical, pale yellow basally, 2-3 cm long, lobes somewhat spreading; follicles slender, 10-14 cm long. In sunny places in mangroves and *Mauritia* palm stands, from southern Florida and the West Indies to northern South America.

Stemmadenia (neotrop. 10, CR 10, GD 2)
This genus differs from *Tabernaemontana* by the relatively large calyx lobes and corollas. The flowers are mostly yellow or cream. The fruits are always short and thick, fleshy and of 2 separate mericarps. The seeds have a pulpy aril and a deep hilar groove.
S. donnell-smithii (Rose) Woodson, Pl. 40a,b
Shrub or small tree; leaves, 6-8 cm long, minutely glandular-puberulent or glabrate above, barbate in the axils of the nerves beneath; calyx 2-2,5 cm long, the lobes 1,5-2 cm wide, corolla salverform, yellow, tube 2,5-3 cm long, limb 1,5-2 cm long; follicles 3,5 cm long, 3 cm broad. From Mexico to Panama.

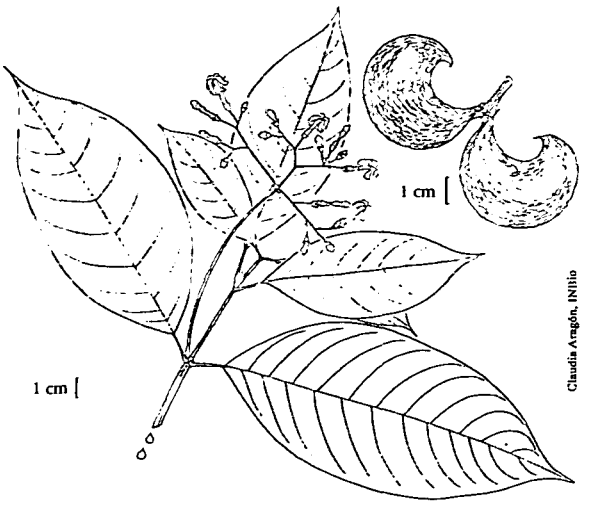
Tabernaemontana (incl. *Bonafousia*, *Stenosolen*) (pantrop. 99, CR 7, GD 6)
Mostly shrubs or trees with white latex. The inflorescences are cymose, axillary, or solitary and usually many-flowered. The corolla lobes are inflexed in bud, convolute to the left and of various colors. The fruit is fleshy, of 2 separate or sometimes partly united mericarps. The seeds have a pulpy aril and a deep hilar groove.

T. arborea Rose ex Donn. Sm.
Tree, up to 25 m tall, glabrous; leaves thin, sometimes unequal, elliptic, obovate to narrowly obo-

vate, 3-19 cm long, 1-7,2 cm wide, entire, glabrous on both sides; inflorescences cymose, many-flowered, peduncle 1-3 mm long; corolla white to yellow, 9-17 mm long; fruits of 2 follicles, follicles sometimes fused, 4,5-7,5 cm long, light brown. From Mexico to Colombia.

T. longipes Donn. Sm., Pl. 40c

Shrub or tree, up to 12 m tall, glabrous; leaves thin, sometimes unequal, obovate-oblong or elliptic-oblong, 1,5-26 cm long, 0,6-9 cm wide, entire, glabrous on both sides; inflorescences cymose, few- or many-flowered, peduncle 1-30 cm long; corolla white to yellow, sometimes with pinkish lobes, 9-20 mm long, somewhat inflated at the base; fruits of 2 free follicles, follicles 2-6,5 cm long, green, yellow or orange. Common understory tree, from Nicaragua to Venezuela.



Tabernaemontana longipes

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Aquifoliaceae

A small family of dioecious or polygamodioecious trees and shrubs, rarely scandent with rather nondescript, simple leaves. **Leaves** alternate, rarely opposite (only in some paleotrop. spp.), entire, serrulate to serrate, rarely spinose, stipules small, early caducous; **inflorescences** axillary, terminal or lateral, mostly diachasial thyrses, but also racemose, paniculate, umbellate or flowers solitary; **flowers** rather small, bisexual or unisexual, mostly 4-5-merous, sepals and petals free or united, staminodia present in female flowers, ovary superior, mostly 3-6-locular; **fruits** berry-like drupes, seeds pendent, surrounded by a stony endocarp. Cosmopol. 4/420, CR 1/16,GD 1/1.

Ilex (Cosmopol. ca 400, CR 16, GD 1)

Trees or shrubs with entire or dentate, sometimes dark punctate leaves. The small, usually white or yellow flowers. The fruits are dark red to black, globose or ellipsoid drupes.

I. skutchii Edwin ex T.R. Dudley & W.J. Hahn

Tree or shrub., up to 40 m tall, leaves elliptic, sometimes obovate, 4-6 cm long, 2-3 cm wide, entire, epunctate, glabrous or almost so; male inflorescences compound dichasia, female inflorescences reduced to 1 flower; flowers small, white; fruits subglobose 2,5-3,5 mm long, 3-4 mm wide, purple. In moist to wet forests, from southeastern Nicaragua to Costa Rica.

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Araliaceae

Trees, shrubs and a few lianas, often with long-petiolate leaves. When present, the stipules are usually adnate to the petiole, or sometimes connate and sheath-like. **Leaves** alternate, simple, palmately, pinnately or ternately compound, entire; **inflorescences** mostly of simple or compound umbels, sometimes capitate, racemose or paniculate; **flowers** actinomorphic, bisexual or unisexual, then plants polygamo-dioecious or -monoecious, usually small, sepals united, petals (4-)5-15, free or connate, deciduous at maturity, stamens usually as many as the petals, rarely more, inserted on the carnose, epigynous disk, ovary inferior, 1-many-locular; **fruits** berries or drupes, exocarp usually carnose, endocarp divided into separate pyrenes, seeds 1 in each pyrene. Widely distributed in the tropics worldwide, with a few representatives in temperate areas. Pantrop. 47/1325, CR 6/45, GD 3/8.

Several species are cultivated as ornamentals in the tropics, especially *Schefflera* spp., which are sometimes also cultivated indoors in temperate zones (N.N., in prep.). The Old World genera *Polyscias* and *Hedera* are frequently cultivated in Central America (N.N., in prep.).

Key to the genera (after N.N., in prep.; FRODIN 1998)

1	Leaves palmately compound	*Schefflera* p.p.
1*	Leaves simple (unifoliolate), sometimes lobed in juvenile plants	2
2	Lateral veins of the lower surface of the leaves when evident 25-60, spaced 2-5 mm apart; stipular ligules present, sometimes conspicuous	*Schefflera* p.p.
2*	Lateral veins of the lower surface of the leaves when evident < 10, spaced > 5 mm apart; stipular ligules absent or nearly so, the petioles sometimes basally dilated	3
3	Flowers polygamo-dioecious or very rarely polygamo-monoecious, in paniculately disposed heads; leaves 3-veined at base with an additional outer pair of basal veins and the auxiliary veins usually extending for at least 1/3 the length of the blade	*Oreopanax*
3*	Flowers bisexual, in once-compound umbels (capitate only in *D. sessiliflorus*); leaves not 3-veined at base or, if so, without subsidiary outer basal veins and the auxiliary veins not usually extending more than 1/3 the length of the blade	*Dendropanax*

Dendropanax (pantrop. 60, CR 12, GD 5)
A large genus of trees or shrubs, sometimes epiphytic, with the leaves always undivided and unlobed (except 3-5-lobate in some juvenile plants) and always lacking stipules. The inflorescences are of 1-20 umbels, compound or arranged in racemes, bearing bisexual, usually 5-merous flowers.

D. arboreus (L.) Decne. & Planch., Pl. 40d
Shrub or tree, up to 30 m tall; leaves elliptic, oblong or obovate, entire, juvenile leaves often 3-5-lobate, petioles up to 40 cm long; inflorescences of 3-many umbels, arranged in a terminal raceme; flowers greenish-white; fruits berries, rounded, 4-8 mm in diameter, purple, seeds 5-7. A very variable species, very common and widespread, in evergreen lowland to montane and elfine forests, also in swampy pastures, from northern Mexico to central South America and the West Indies.

Schefflera (pantrop. ca. 650, CR 13, GD 2)
Unisexual or bisexual trees, shrubs or lianas, sometimes epiphytic with the leaves usually palmately compound or rarely simple (unifoliolate). Stipules always present and forming a conspicuous ligule at the petiole base.

S. systyla (Donn.Sm.) Viguier, Pl. 40e
Common names (Costa Rica): papayillo, papayo de monte (J.F. MORALES pers. comm.)
Shrub or tree, often epiphytic, up to 10 m tall; leaves palmately compound, leaflets oblong-elliptic to lanceolate, 5-9, in 1 whorl, juvenile leaves ferruginous puberulent, ligule up to 8 cm long; inflorescences of 1-10 umbels, arranged in a terminal panicle; fruits subglobose, sharply angled, 2,5-4 mm in diameter, seeds 5-7. A very variable species, distributed in Costa Rica and Panama.

CANNON, M.J. & J.F.M. CANNON. 1989. Central American Araliaceae - a precursory study for the Flora Mesoamericana. - Bull. Brit. Mus. (Nat. Hist.), Bot. 19: 5-61.

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NEVLING, L.I. Jr. 1959. Araliaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 46: 223-242.

Aristolochiaceae

A family consisting mostly of climbing plants with aromatic odor from ethereal oil cells, easily distinguishable from other families by their unique flowers and fruits. **Leaves** alternate, distichous, simple, entire or variously lobed, often palmately veined and cordate, stipules lacking, but often clasping pseudostipules present; **inflorescences** axillary or cauliflorous, racemose or flowers solitary; **flowers** bisexual, radially symmetric or zygomorphic, sepals united, petaloid, usually tubular, petals usually absent or reduced to scales, stamens 5-6-many, free or frequently connate with the style, ovary inferior to half-inferior, 4-6-locular, rarely apocarpous (*Saruma*); **fruits** septicidal capsules, often dehiscing incompletely to form a parachute-like pendent basket, or follicles (*Saruma*), thick-walled, dry berries (*Pararistolochia*) or schizocarps (*Euglypha*), usually pendent, seeds numerous or rarely 1 (*Euglypha*). Distributed worldwide in various habitats, widespread, from the tropics to temperate zones. Cosmopol. ca. 12/475, CR 1/14, GD 1/4.

Most flowers of Aristolochiaceae belong to the myiophilous flower type. The flies are trapped by gliding into the tube along the slippery inner surface of the flower where they are trapped for some time until they pollinate the stigmas and pick up new pollen (DAUMANN 1971, VOGEL 1978, BRANTJES 1980, WOLDA & SABROSKY 1986). Several species have adaptations that attract fungus-gnat diptera (VOGEL 1978). Others, with maroon flowers and an unpleasant odor of rotten meat, are visited by carrion flies. Generally the Aristolochiaceae attract the pollinating flies by a combination of odor (usually produced by osmophores) and visual cues (flower color, perianth appendages). Once entering the flower-tube, the flies are restricted from escaping by an oily surface or trap hairs in the narrowing of the tube, until the flowers wilt.

The incompletely dehiscing fruits of most *Aristolochia* species contain winged seeds, which are wind dispersed. Several other genera (*Asarum*, *Endodeca*, *Holostylis*), but also several herbaceous species of *Aristolochia* have seeds bearing an elaiosome. These are dispersed by ants (HUBER 1993).

Some species of Aristolochiaceae are used medicinally against various diseases. They are applied in modern medicine, because of their stimulating effects on the heart muscle, hypotonic effects and improvement of the immune response (HUBER 1993). Extracts of the stems and roots of *Aristolochia* spp. have been used against snakebite, scorpion stings and to alleviate pain during childbirth (BARRINGER 1983, HUBER 1993, BARRINGER 1998).

Aristolochia (pantrop. + subtrop. 400-500, CR 14, GD 4)
A large genus of mostly woody or herbaceous climbers with zygomorphic flowers and septicidally dehiscent capsular fruits.

A. leuconeura Linden
Woody liana, older stems with corky bark; leaves 13-17 cm long, 13-15 cm wide, deeply cordate, pseudostipules lacking; inflorescences cauliflorous, racemose, densely clustered; limb 2,5-3,5 cm long, yellow with purple marking around the edge; fruits cylindric capsules, 14-20 cm long. Usually in seasonally dry forests, from Costa Rica to Panama.

A. maxima Jacq.
Liana, older stems with corky bark; leaves oblong to obovate, basally truncate, 7-15 cm long, 3-7 cm wide, pseudostipules lacking; inflorescences axillary or cauliflorous, loosely branched rhipidia; flowers 5-7 cm long, limb, 3-5 cm long, purple-brown; fruits ovoid capsules, 10-15 cm long, glabrous, incompletely dehiscent. In thickets and lowland forests in Central America and northern South America to Venezuela and Colombia.

A. tonduzii Schmidt, Pl. 40f,g
Liana, older stems with corky bark; leaves ovate to oblong, 10-16 cm long, 4-8 cm wide, basally cordate, pseudostipules lacking; inflorescences axillary, racemose; flowers 8-13 cm long, limb 4-6 cm long, purple, maculate on inner surface; fruits ovoid capsules, 10 cm long, incompletely dehiscent. In lowland forests in Central America, from Honduras to western South America to Peru and Ecuador.

BARRINGER, K. 1983. Aristolochiaceae. Flora Costaricensis. - Fieldiana Bot. 13, n.s.: 79-87.
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BRANTJES, N.B.M. 1980. Flower morphology of *Aristolochia* species and the consequences for pollination. - Acta Bot. Neerl. 29: 212-213.
DAUMANN, E. 1971. Contribution to the pollination ecology of the species *Aristolochia clematitis* L. - Preslia 43: 105-111.
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VOGEL, S. 1978. Fungus-gnat flowers mimicking fungi. - Flora 167: 329-366.
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Asclepiadaceae

Herbaceous, suffruticose, or shrubby vines, rarely small trees, generally with milky latex. **Leaves** opposite or whorled, rarely alternate or spirally arranged, simple, sometimes much reduced, early caducous or lacking, glabrous or with simple multicellular or glandular trichomes, usually 2-many nectaries borne at the base of upper surface on midvein; **inflorescences** usually subaxillary, sometimes axillary or terminal, usually cymose, cymes umbelliform or racemiform, sometimes paniculate or reduced to one flower; **flowers** actinomorphic, rarely somewhat zygomorphic, bisexual, sepals 5, distinct or basally fused, corolla sympetalous, 5-lobate, rotate, campanulate, urceolate, funnelform, or tubular, the tube short and open to very long and narrow, stamens 5, inserted at or near the base or corolla tube, ovary superior to subinferior, of 2 separated carpels; **fruits** comprising 2 paired follicles or 1 by abortion, seeds few to many per follicle. Distributed worldwide, but mainly in the tropics and subtropics. Pantrop. + subtrop. + a few temp. 248/2800, CR 15/48, GD 6/7.

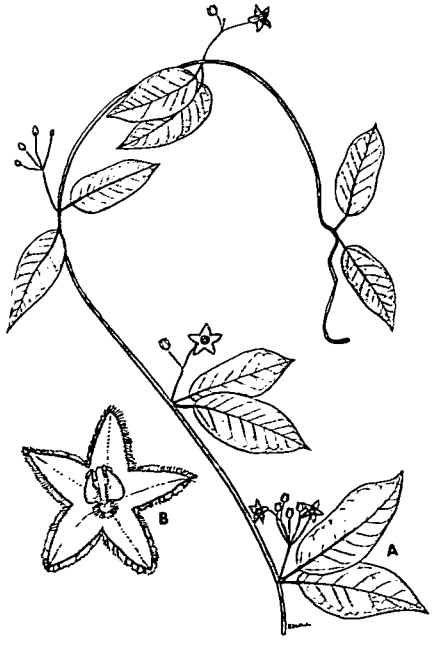
Key to the genera (after MORILLO 1997)

1	Erect or very short twining herbs or subshrubs, stems solitary or several arising from base; pollinia pendulous	*Asclepias*
1*	Twiners or creepers, stems usually simple, several meters long when adult; pollinia pendulous, horizontal, or erect	2
2	Pollinia horizontal or +/- pendulous, at least one surface concave, rarely uniformly rounded, but then with a sterile hyaline margin or zone near the point of attachment of the caudicles, sometimes the hyaline zone not clearly distinct from the caudicles; anthers usually horizontal or almost so, sometimes erect; fruit very often ridged, winged, or with tuberculate projections, or smooth; stem and leaves sometimes with short glandular trichomes mixed with long multicellular ones	3
3	Anthers conspicuously hypertrophied and vesicular throughout; corolla lobes conspicuously crisped on one or both margins; fruit smooth or striate	*Fischeria*
3*	Anthers with laminar, +/- fleshy dorsal appendages; pollinia and anthers generally horizontal; fruit generally winged	*Gonolobus*
2*	Pollinia pendulous, their surface +/- uniformly rounded, uniformly fertile to the	

	point of attachment of the caudicles; anthers +/- erect; fruit smooth; vegetative organs without glandular trichomes	4
4	Coronal segments ovoid or ellipsoid, inflated, vesicular, adnate to base of anthers	5
5	Coronal segments attached separately to back of anthers; gynostegium stipitate; corpusculum ovoid	*Blepharodon* p.p.
5*	Coronal segments basally connate by a ring of tissue; gynostegium sessile or subsessile; corpusculum sagittate	*Sarcostemma*
4*	Coronal segments hooded, 2-horned, bucket-shaped or deeply bilobate with the lobes laminar to filiform	6
6	Coronal segments laminar and simple, disposed in only 1 series	*Tassadia*
6*	Coronal segments hooded, bucket-shaped or 2-horned	*Blepharodon* p.p.

Asclepias (neotrop. 100, CR 5, GD 1)
Perennial herbs, never scandent and often with brightly colored flowers. Most of the species occur in North America and only a few species extend throughout South America.

A. curassavica L., Pl. 40i
Erect, usually simple herb, ca. 1 m tall, glabrous or nearly so; leaves opposite, short-petiolate, oblong to narrowly lanceolate, 5-12 cm long, long-acuminate; flowers showy, corolla lobes red-purple, inner flower parts orange-yellow; follicles glabrous or pubescent, 3-10 cm long. From southern Florida, Mexico and the West Indies to Argentina. A cosmopolitan weed in the tropics, introduced to the Old World as an ornamental. The plant is one of the common weeds of Central America. In Costa Rica the latex is sometimes used to destroy warts.



Blepharodon mucronatum
A. Habit. B. Flower

Blepharodon (neotrop. ca. 45, CR 1, GD 1)
The flowers of these slender vines are small to medium-sized and umbellate with a 5-parted calyx and a 5-lobate corolla.

B. mucronatum (Schltdl.) Decne.
Slender vine with copious milky sap, glabrous except on corolla; leaves opposite, short-petiolate, oblong to elliptic, 3-7 cm long; inflorescences axillary, umbellate, pedunculate, shorter than the leaves; flowers 5-merous, calyx lobes oblong-ovate, corolla greenish-white, gynostegium 3 mm long; follicles fusiform, 7-9 cm long, ca. 2 cm in diameter at widest part, rounded at base, glabrous. From Mexico to South America.
Very similar to *Sarcostemma clausum*, but almost totally glabrous, with interpetiolar ridges and glands, and with fruits rounded at the base and tapered at the apex.

Fischeria (neotrop. 16, CR 4, GD 2)
Usually conspicuously pilose with long brownish multicellular trichomes. The large vines are herbaceous or suffrutescent. The rather large and membranaceous leaves are opposite and are more or less cordate. The cymes are umbelliform or short-racemose, the flowers are rather large and usually dark brown-purple.

Gonolobus (neotrop. 100, CR 6, GD 1)
The leaves of these vines are always membranaceous and cordate, usually somewhat oblong in outline. The flowers are green and completely open (rotate), the fruits are usually longitudinally 5-winged.

G. edulis Hemsl., Pl. 40e
Herbaceous or subwoody vines, leaves lanceolate to narrowly ovate, 4-9 cm long, 2-4 cm wide, basally deeply cordate, puberulent on both sides;

inflorescences racemiform; corolla green, 1,7-2,7 cm in diameter, densely barbellate within, follicles fusiform. In Costa Rica and Panama.

Sarcostemma (pantrop. + subtrop. 30, CR 3, GD 1)
Herbaceous or suffruticose vines, usually with narrowly ovate to oblong leaf blades, which are sometimes reduced to scales and bearing 2-7 nectaries at base. The subaxillary inflorescences are umbelliform or racemiform few- to many-flowered cymes.

S. clausum (Jacq.) Schult.
Trailing or twining herbaceous vine, multi-branched, glabrous or sparsely pubescent with loose white trichomes easily wiped off, copious milky sap present; leaves opposite, linear to elliptic-oblong, 3-7 cm long, 0,5-1,5(-3) cm wide; inflorescences axillary, umbellate, stalked, mostly bearing up to 30 flowers; flowers 1-2 cm long, sepals 5, connate, petals 5, white or pinkish, hoods 5, white, encircling the broad gynostegium; follicles 5-9 cm long, ca. 1,2 cm wide, seeds numerous, flat, brown, bearing a terminal tuft of fine trichomes 2-3 cm long. Usually in deciduous forests or open sunny places, especially on sandy beaches, from the southern USA to Argentina.

Tassadia (neotrop. 17, CR 1, GD 1)
Scandent herbs with a multi-branched, thin stem with small leaves with 2 or 3 nectaries at the base. The axillary or terminal inflorescence is usually a thyrse or a pleiothyrse, sometimes an umbelliform or subumbelliform helicoid cyme. The small flowers have a rotate, campanulate or urceolate corolla, which is erect to reflexed and usually pubescent inside. The follicles are usually in pairs, terete, narrowly fusiform, narrowly ovate, or suborbicular.

T. obovata Decne.
Twining vine; corolla greenish or pale yellow. In evergreen lowland to montane forests, often in riparian vegetation and secondary forests, from Mexico to Peru and Brazil.

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Asteraceae

Annual or perennial herbs, shrubs, trees, or vines, variously pubescent with 1- or 2-seriate trichomes and/or 2-seriate gland, or sometimes glabrous. **Leaves** usually cauline, alternate, opposite, or whorled, simple or less commonly dissected or compound, rarely cordate or amplexicaul; **inflorescences** always capitulescences (the secondary arrangement of capitulae) of 1-many, variously cymose, corymbiform, thyrsoid-paniculate, racemose, or monocephalous, sessile or pedunculate capitulae, generally free from each other, but occasionally fused (syncephalous) or glomerate, capitulae 1-many-flowered, homogamous (with a single flower type) or heterogamous (with 2 flower types), homogamous capitulae discoid (with actinomorphic, bisexual or rarely unisexual disk florets), ligulate (with zygomorphic, bisexual florets), or bilabiate (with bisexual, 2-lipped, zygomorphic florets), heterogamous capitulae radiate (with zygomorphic, pistillate or neuter outer ray florets, and actinomorphic, bisexual or functionally staminate central disk florets), disciform (with pistillate, nonligulate outer florets and bisexual central disk florets), or bilabiate-heteromorphic (with bilabiate outer florets with obvious limbs and bilabiate, bisexual central florets without obvious limbs); **flowers** (florets) bisexual, unisexual (plants then monoecious or less often dioecious), or neuter (perianth remains but both stamens and ovules aborted), epigynous, sympetalous, (3-)5-merous, florets sessile in a compact head (capitulum) on a common, naked or paleate, generally glabrous receptacle that is surrounded by a cylindrical to globose involucre of 1-many generally persistent bracts (phyllaries), these often imbricate and graduate, in 1-several series, corollas

zygomorphic or actinomorphic, zygomorphic corollas with a basal tube and bilaterally symmetric upper portion, either radiate (pistillate or neuter with a single, usually trilobate limb), ligulate (bisexual with a single 5-lobate limb), or bilabiate (bisexual with an outer trilobate limb and an inner 2-forked lip), actinomorphic corollas with a basal tube, generally broadening above at throat into (3-)5 lobes, the lobes usually equal, stamens epipetalous at tube-throat junction, united by the anthers into a tube surrounding the style, gynoecium, ovary inferior, 1-locular; **fruits** achenes, rarely baccate, drupaceous or an utricle, pappus when present, often nearly as long or longer than the corolla, seed 1. Cosmopol. 1528/22750, CR 151/443, GD 34/45.

Key to the tribes and subtribes (after Woodson & Schery 1975)

(this includes the tribes: Cardueae, Mutisieae and Lactuceae, which have no representatives in the GD area).

1	Heads with staminate or perfect florets towards the middle, the corollas tubular, 5-lobate, sometimes with pistillate florets towards the outside, the corollas tubular or ligulate, sap not milky	2
2	Anther tips with sterile, tongue-like, often hyaline appendages	3
3	Florets all alike, perfect, corollas tubular, not yellow, anthers not tailed, receptacle naked	4
4	Leaves alternate; style branches slender, terete, hairy all over, the style shaft apically hairy; anthers auricled; hairs often 1-celled	Tribe ***Vernonieae***
4*	Leaves mostly opposite (except sometimes in the region of the inflorescence); style branches gradually expanded near the tips, papillose or short-hairy, the style shaft often glabrous; anthers obtuse or rounded; hairs multicellular	Tribe ***Eupatorieae***
3*	Florets often not all alike, corollas often yellow; anthers sometimes tailed; receptacle naked or with paleas	5
5	Leaves mostly not spiny, involucral bracts not spiny; anthers tailed or not; style shaft without an apical ring	6
6	Leaves alternate; style branches flattened-fusiform, sometimes apically appendaged or rounded; anthers tailed or not; receptacle mostly naked; pappus mostly of bristles	7
7	Anthers obtuse; style branches often appendaged; achene often compressed; hairs multicellular	Tribe ***Astereae***
7*	Anthers tailed; style branches rounded; achene plump; hairs arachnoid	Tribe ***Inuleae***
6*	Leaves alternate or opposite; style branches flattened-fusiform, sometimes apically appendaged; anthers not tailed; receptacle with paleas or naked; pappus of bristles, awns, or scales	8
8	Pappus of awns, stiff bristles, or scales; style branches often appendaged	9
9	Involucre without transparent margins; leaves mostly opposite, often 3-nerved from the base or trifoliate	10
10	Receptacle mostly with paleas enfolding the achenes; involucral bracts mostly unequal, overlapping; leaves mostly eglandular; hairs often verrucose	Tribe ***Heliantheae***
10*	Receptacle naked; involucral bracts equal, mostly valvate; leaves with oil glands; glabrate	Tribe ***Tageteae***
(9*	Involucre with hyaline, transparent, brownish margins; leaves alternate, with a strong midvein	Tribe *Anthemidae*)
8*	Pappus of soft, silky, hair-like bristles; style branches not appendaged	Tribe ***Senecioneae***
(5*	Leaves and involucral bracts spiny; anthers tailed; style shaft with an apical ring	Tribe *Cardueae*)
(2*	Anther tips sterile but not differentiated into hyaline, tongue-like appendages; anthers mostly tailed	Tribe *Mutisiae*)
(1*	Heads with only perfect florets, the corollas ligulate, 5-denticulate; sap milky	Tribe *Lactuceae*)

Asteraceae-Vernonieae

Elephantopus (incl. *Pseudelephantopus*) (cosmopol. ca. 32, CR 5, GD 2)

Erect, perennial herbs, usually with solitary stems and alternate leaves. The solitary, terminal,

bracteate capitate inflorescences bearing zygomorphic and tubular-funnelform flowers.

Vernonia (pantrop. + subtrop. ca. 500, CR. 15, GD 3)

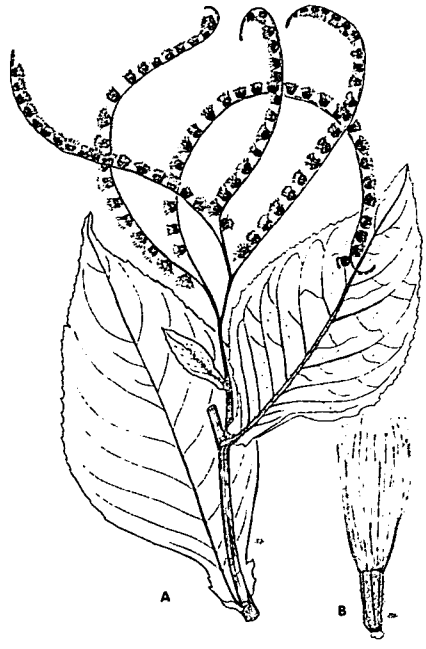
Herbs shrubs or sometimes trees, with the inflorescences mostly of scorpioid cymes, panicles or corymbs. The heads bearing 1-many florets, usually with pink, purple or white corolla.

Key to the species of *Vernonia* (after WOODSON & SCHERY 1975)

1	Heads pedunculate, the peduncles 5-12 mm long; inflorescences corymbose, the axes equal, strongly dichotomizing; achenes ribless; leaves with 2-4 pairs of lateral veins; bristles of the inner pappus deciduous	*V. cinerea*
1*	Heads sessile, subsessile or short pedunculate; inflorescences freely branched cymes; achenes ribbed; leaves with 10-14 pairs of lateral veins, bristles of the inner pappus persistent	2
2	Inflorescence a sparsely or freely branched cyme, leaves broadly elliptic to broadly ovate	*V. brachiata*
2*	Inflorescence a much-branched corymb or panicle; leaves lanceolate	*V. patens*

V. brachiata Benth.

Herb or small shrub to 3 m tall; leaves subsessile, broadly elliptic to broadly obovate, subauriculate at the base, 10-30 cm long, 5-13 cm wide, entire to serrulate, glabrous to glabrescent; inflorescences terminal, leafless, 10-30 cm long, freely branched cymes, heads with 18-22 florets, involucre broadly campanulate, 3-4 mm high; corolla tubular, 4-5 mm long, 5-lobate; achenes narrowly cylindric, 2-3 mm long, faintly ribbed, puberulous, pappus biseriate, the inner bristles filiform, 4-5 mm long, persistent, the outer bristles linear, to 0,3-0,6 mm long, persistent. In Costa Rica and Panama.



Vernonia brachiata
A. Flowering branch. B. Achene

V. cinerea (L.) Less.

Herb to 1 m tall, unbranched to freely branched; leaves narrowly elliptic to deltoid, 2,5(-8) cm long, 0,5-3,0 cm wide, entire to serrate, sparsely hirtellous above, petioles narrowly winged; inflorescences derminal, in dichotomously branched corymbs, heads with 13-23 florets, involucre campanulate; corolla tubular, 3-4 mm long, 5-lobate; achenes subcylindric, 1,4-2,2 mm long, smooth, pappus biseriate, the inner bristles linear, 3-5 mm long, deciduous, the outer bristles subulate, to 0,5 mm long, persistent. In disturbed areas and in lawns, from Mexico and the southern United States to Panama, as well as in Africa and Asia.

Asteraceae-Eupatorieae

Ageratum (neotrop. 44, CR 9, GD 1)

Annual herbs to perennial subshrubs, few to much-branched and often with decumbent base with numerous adventitious roots. The leaves are opposite or alternate with characteristic glandular punctations beneath. The pappus is lacking or coroniform of few awn-like scales.

Chromolaena (neotrop. 165, CR 5, GD 1)
Sparingly to densely branched herbs or subshrubs with opposite, triangular to elliptic, subentire to deeply lobed leaves. The laxly to densely corymbose inflorescences bearing discoid heads with 10-45 florets, Distinct in the pappus which consists of numerous scabrous, capillary bristles.

Critonia (neotrop. 43, CR 5, GD 1)
Sparingly branched, coarse perennial herbs to small trees or woody vines. Inflorescences paniculate, the branches opposite and usually spreading with discoid heads, each with 4-12 florets. The prismatic achenes are 5-ribbed, with a pappus of persistent, scabrous bristles.

Gongrostylus (neotrop. 1, CR 1, GD 1)
Monotypic genus.

G. costaricensis (Kuntze) R.M. King & H. Robinson
Somewhat woody, scandent, slender epiphyte with few branches; leaves opposite, blades ovate, to 9,5 cm long, 4 cm wide, margins with few sharp small teeth; inflorescences terminal and axillary, laxly corymbose, heads 8-10 mm long with ca. 20 florets, involucral bracts ca. 25 subimbricate, in ca. 3 series; corolla 6-6,5 mm long, glabrous, glandular; achenes ca. 2 mm long, prismatic, glabrous, pappus mostly 4-6 mm long with ca. 30-35 bristles. From Costa Rica to Ecuador.

Hebeclinium (neotrop. 20, CR 2, GD 1)
Sparingly branched, erect large herbs or subshrubs, with opposite and usually serrate leaves. The inflorescences are corymbose panicles or lax cymes with discoid heads with 20-80 florets and with an involucre of 25-40 bracts, in 3-5 series. The pappus consists of ca. 30-40 scabrous bristles.

Heterocondylus (neotrop. 13, CR 1, GD 1)
Erect to subscandent perennial herbs or subshrubs with opposite or alternate, entire to serrate leaves. Inflorescences few to much-branched, pyramidal to cymose with heads of ca. 20-80 florets. The 4-5-ribbed achenes are provided with a pappus of 20-30 scabrid, persistent bristles.

H. vitalbae (DC.) R.M. King & H. Rob., Pl. 41c
Scandent woody herbs or shrubs to 6 m tall with few branches, stems finely striate, terete, sparsely puberulous; leaves opposite, blades coriaceous, elliptic-ovate to ovate-lanceolate, to 12 cm long, 7 cm wide, margins serrate; inflorescences loose panicles to 25 cm long, 15 cm wide, heads ca. 1,2 cm long with 60-65 florets, involucral bracts ca. 20; corolla white to pink or purple, ca. 8 mm long; achenes ca. 3,5 mm long, fusiform, 4-5 ribbed, pappus of ca. 20 scabrous deciduous bristles. Widely distributed, from Honduras to Peru and Brazil.

Mikania (pantrop. ca. 430, CR 19, GD 3)
The largest genus of the tribe Eupatorieae, consisting of usually vines or weak shrubs or sometimes perennial herbs. The opposite or verticillate leaves are entire, to toothed or lobed, sometimes with glandular punctations. The paniculate inflorescences bearing sessile or short pedicelled heads, each with 4 florets and 4 involucral bracts.

M. guaco HBK
Coarse sparingly branched vines, stems mostly brownish, terete, striate, glabrate, usually fistular; leaves opposite, blades broadly ovate, to 25 cm long and 15 cm wide, margins entire; inflorescences rather densely corymbose with almost all heads in clusters of 3, heads ca. 8-10 mm long, involucral bracts oblong with rounded tips, 5-6 mm long; corolla whitish, ca. 6 mm long, the tube narrow, 2,5-3 mm long; achenes with 5 ribs or grooves, pappus of ca. 50 slender bristles. Widely distributed in tropical America, from Mexico to Brazil.

Asteraceae-Astereae

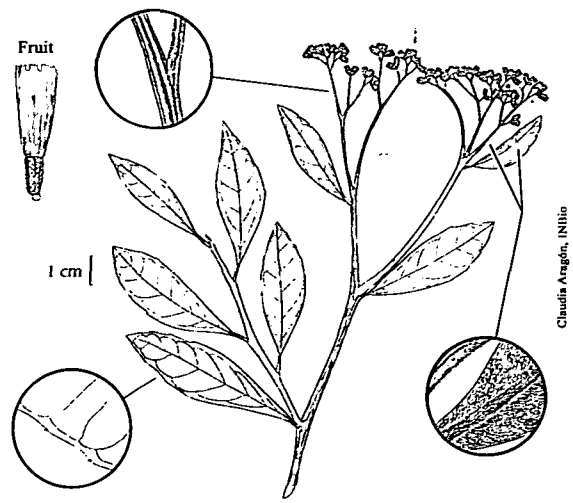
Baccharis (neotrop. ca. 400, CR 3, GD 1)
Dioecious trees, shrubs or rarely herbs usually with alternate coriaceous leaves. The inflorescences are mostly compact panicles, rarely solitary, racemose or spicate, bearing discoid heads with many florets. The staminate heads are always smaller than the pistillate.

B. pedunculata (Miller) Cabr.
Tree or shrub to 4 m tall, minutely puberulent with fine, arachnoid hairs; leaves to 8 cm long, entire, elliptic; inflorescences peduncles to 20 cm long, pistillate heads discoid, hemispherical or globose, staminate heads discoid, smaller than the pistillate heads; corolla white. From Mexico to Peru and northern Argentina.

Asteraceae-Inuleae

Tessaria (neotrop. 4, CR 2, GD 1)
Monotypic genus.

T. integrifolia Ruiz & Pavon
Tree or shrub, up to 10 m tall, twigs drying chocolate brown, puberulent, soon glabrescent; leaves entire or denticulate, oblanceolate or elliptic, mucronulate, to 9 cm long, 2,5 cm wide; inflorescences open cymose panicles, heads disciform, ca. 4 mm long, involucral bracts in 3-5 tightly appressed imbricate series; receptacle conical, ca. 1 mm in diameter, disk floret 1, ray florets many, corolla capillary, ca. 3 mm long. From Costa Rica to Peru and Bolivia.



Tessaria integrifolia

Asteraceae-Heliantheae

Bidens (cosmopol. ca. 240, CR 10, GD 3)
Perennial or annual erect herbs with opposite, and usually serrate, lobed or dissected leaves. The terminal inflorescences consist of solitary, sometimes aggregated heads. Some species are widely naturalized as weeds.

B. pilosa L., Pl. 41a
Erect, branched, annual herb to 1,5 m tall; leaves opposite, 3(-5)-foliolate, the leaflets to 7 cm long, ovate, apically acute, obtuse or acuminate, margin serrate; inflorescences mostly of several loosely aggregated terminal heads; ray florets several, in 1 series or wanting, corolla white or yellow, disk florets numerous, corolla yellowish or greenish; achenes black, 15-22 mm long, linear. Widespread weed of tropical and warm temperate regions in Central and South America as well as in Africa and Asia.

A further species of the GD is *B. cynapiifolia* Kunth., which can be recognized by the usually bipinnate leaves which are not divided into narrow segments. The achenes are dimorphic; the majority of the innermost are glabrous but a few at the margin are densely tomentose.

Calea (neotrop. + subtrop. ca. 110, CR 7, GD 2)
A genus of perennial herbs or shrubs with opposite leaves. The inflorescences are of various shape, ranging from cymose corymbose or umbellate clusters of few to many heads, or the heads solitary.

Key to the species of *Calea*

1	Heads radiate	*C. urticifolia*
1*	Heads discoid	*C. prunifolia*

C. prunifolia Kunth
Dense, bushy to sprawling shrub or vine growing on trees, 1-5 m tall; leaves opposite, elliptic to ovate, nearly entire to serrulate, 1,5-10,5 cm long, 1-6,8 cm wide; inflorescences axillary and terminal, umbellate clusters of heads, heads discoid; corolla yellow, glabrous, 4-6 mm long, 0,5-1,4 mm wide, limb campanulate, lobes 5; achenes narrowly turbinate, subterete to angular, 1,3-3 mm long, antrorsely hirsute to nearly glabrous, black. At forest edges, in open thickets, on roadsides, and along coastal bluffs, from Costa Rica and Panama to South America.

C. urticifolia (Mill.) DC
Weedy shrub, 1,5-3,5 m tall; leaves opposite ovate to lance-ovate, nearly entire to serrate, 3-13 cm

long, 1,4-8 cm wide; inflorescences axillary and terminal, umbellate clusters of heads, heads radiate; corolla yellow; achenes narrowly turbinate, antrorsely hirsute with brownish hairs. In dry savannas, thickets, forests, along roadsides, and cultivated areas, from Mexico through Central America to Panama.

Clibadium (neotrop. 40, CR 12, GD 2)
Shrubs with opposite, lanceolate to cordate leaves, always with serrate or serrulate margins. The inflorescences are racemose, corymbose or capitate panicles with few to numerous, sessile or short pedicellate heads The white flowers lacking a pappus.

C. anceps Greenman
Scandent shrub, 3-6 m tall; leaves ovate to narrowly ovate, 10-15 cm long, 4,5-9 cm wide conspicuously 5-veined from near the base; inflorescences of 55-120 heads in a capitate panicle, with clusters of 3-6 sessile heads terminating all axes, heads radiate; ray florets 3-4, disk florets 6-7; achenes 2 mm long, glabrous. In Costa Rica and Panama.

Eclipta (cosmopol. 4, CR 1, GD 1)
Herbs with opposite, simple, entire or toothed leaves. The genus can be distinguished by the conelike pappus, bristlelike paleas, and sagittate anthers.

E. alba (L.) Hassk
(syn. *E. prostrata* (L.) L.)
Erect or sprawling ephemeral herb, sometimes rooting at the lower nodes; leaves opposite, simple, elliptic to lanceolate, to ca. 7 cm long, margin entire, serrate or shallowly toothed; inflorescences arising terminally but often appearing axillary, a solitary head or a few-headed fascicle, heads 3-9 mm in diameter, radiate, involucral bracts 8-9, imbricate in 2-3 similar series; ray florets in 2-3 series, corolla white, 1-2 mm long, disk florets more numerous than the ray florets, corolla mostly whitish, ca. 1 mm long; achenes dorsiventrally compressed, the angles produced into rudimentary basal wings, apically flared into a ridge, subtending the pappus. Common weed, widely distributed throughout tropical America as well as Africa and Asia.

Melampodium (neotrop. 37, CR 6, GD 1)
The most important morphological feature distinguishing this genus from other genera of the Heliantheae is the fusion of the ray achenes to the inner involucral bracts, which are often ribbed and/or variously sculptured, but never spiny.

M. divaricatum (Rich.) DC., Pl. 41d
Annual herb 15-100 cm tall, stems erect; leaves ovate to rhombic, 1,8-14 cm long, 0,6-8,2 cm wide, margin entire to coarsely dentate-crenate; inflorescences of solitary heads, heads radiate, 5-8 mm tall, 8-15 mm across, ray florets 8-13, ligule yellow-orange, disk florets 40-70, corolla yellow-orange; achenes 2,8-4 mm long, the sides with diagonal striations and enlarged margins. From Mexico throughout Central America to Colombia and Brazil.

Melanthera (pantrop. 20, CR 3, GD 2)
Mostly perennial herbs or vines with opposite, often decussate, sometimes verticillate leaves; The paniculate inflorescences bearing few globose, discoid or radiate heads. The involucral bracts are arranged in several, somewhat unequal imbricate series.

M. aspera (Jacq.) Small
Erect or sprawling herb, up to 80 cm tall; leaves opposite, lanceolate, ovate to oblong, crenate to serrate, basally 3-veined; inflorescences terminal to subterminal with few heads, peduncles to 5-6 cm long, slender, heads discoid, globose, to 12 mm in diameter, whitish; achenes ca. 2 mm long, apex truncate. Frequent along roadsides, fields, and shores, from Florida to Panama and Venezuela.

Milleria (neotrop. 2, CR 1, GD 1)
Tall herbs with erect stems and opposite leaves, the lower leaves always with winged petioles. The inflorescences are terminal racemes or panicles with small radiate heads. This genus is easily distinguishable in fruit from other members of the family by the unusual covering of hard involucral bracts around the single fertile achene.

M. quinqueflora L.
Annual herb, 0,3-1,5 m tall; leaves narrowly ovate or deltoid, 4,5-18 cm long, 2,8-13 cm wide, often auriculate at the base; inflorescences with peduncles 3-9 mm long, stipitate-glandular, heads 3-5 mm long, 2-3 mm wide, involucre of 3 bracts, 2 bracts large, the third bract small ovate; ray floret

1, disk florets 3-5, corolla green; achenes black, 5 mm long, 3 mm in diameter, tightly and completely enclosed by the 3 bracts which become leathery at maturity. From Guatemala and Honduras to Peru and Bolivia.

Neurolaena (neotrop. 13, CR 2, GD 1)
Coarse herbs with alternate subentire to dentate (upper) or sometimes deeply lobed (lower) leaves and with soft stems, covered by an appressed to spreading rough tomentum.

N. lobata (L.) R. Br.
Coarse herb or subshrub, 1,5-3 m tall; stems terete; leaves oblanceolate to narrowly elliptic, pinnately veined, 8-20 cm long, 2-4 cm wide; inflorescence series of loose to dense clusters of bracteate, corymbiform cymes, heads discoid, campanulate, small, involucral bracts imbricate in 3-4 series; florets yellow or occasionally yellow-green or white; achenes ca. 2-4 mm long, black or grayish-brown. Widespread in woody areas, in clearings, as well as on disturbed sites, from Mexico to Ecuador and Peru.

Neurolaena lobata
A. Habit, B. Head. C. Leaf

Sclerocarpus (neotrop. + Africa 8, CR 1, GD 1)
Erect, annual or rarely perennial herbs or sometimes shrubs with alternate or sometimes basally opposite leaves, which are mostly serrate-margined and basally 3-veined. The inflorescence is usually a solitary head with 4-several involucral bracts. The genus can be recognized by its elongate strigose lobes of the disk florets and the elongate anther appendages and in fruit by the distinct urn-shaped utricles.

S. divaricatus (Benth.) Hemsl.
Plants rather slender, erect to prostrate, rarely 1 m tall, rough-pubescent, branched; leaves slender-petiolate, rhombic-ovate, 6 cm long or less; phyllaries green, the outer ones foliaceous, about 7 mm long; disk flowers very slender, corolla 1 cm long. In fields and waste grounds in Mexico and Central America.

Synedrella (neotrop. 2, CR 1, GD 1)
Erect or ascending annual herbs with opposite, petiolate, dentate leaves. The small heads are inserted axillary, usually sessile and glomerate, radiate and yellow.
S. nodiflora (L.) Gaertn.
Plants appressed-pilose, erect or sometimes weak and reclining, much-branched; leaves ovate or elliptic, 3-10 cm long, triplinerved, acute; heads several together in dense, sessile clusters; involucre 8 mm long. On waste grounds or in thickets of the "tierra caliente", widely distributed in tropical America.

Tridax (neotrop. 30, CR 1, GD 1)
Annual or perennial herbs, with opposite, dentate or incised leaves. The radiate heads are long-pedunculate with a flat or convex receptacle; the achenes are sericeous-villous with a pappus of numerous aristate, plumose scales.

T. procumbens L.
Plants hirsute, branched from the base; leaves ovate to ovate-lanceolate, 2-6 cm long, short petiolate, acute or acuminate; involucre campanulate, 6 mm long; rays almost white; achenes 2 mm long. One of the most common weeds in many parts of the Central American "tierra caliente", widely distributed in tropical America.

Verbesina (neotrop. ca. 300, CR 10, GD 1)
Herbs, shrubs, or small trees with opposite or alternate leaves, dentate to pinnate-lobate. The heads are small or medium-sized, radiate or discoid, solitary or numerous and paniculate, yellow, orange, or white. The strongly compressed achenes are 2-winged.

V. turbacensis Kunth
Plants tall and coarse, herbaceous or somewhat woody, commonly 1-3 m tall, the branches densely sordid-tomentose, winged by the decurrent leaf base; leaves alternate, large, deeply pinnate-lobate, rough above, puberulent or tomentose beneath; heads very numerous, white, forming large, corymbose panicles; involucre 3 mm long, rays white, very small. From Mexico to Colombia.

Asteraceae-Tageteae

Pectis (neotrop. ca. 100, CR 11, GD 2)
Glabrous or pubescent annual or perennial herbs, with slender stems, usually much-branched. The leaves are opposite, sessile and 1-nerved. The inflorescences are open to condensed cymose clusters or solitary heads with small, radiate heads. The florets always have a yellow corolla. The genus may be distinguished from the other members of the Tageteae by its slender, entire leaves and short style branches.

Key to the species of *Pectis*

1	Heads subsessile; involucres falling entire; ray florets 5	*P. prostrata*
1*	Heads conspicuously peduncled; involucral bracts falling separately; ray florets 5-8	*P. multifloscullosa*

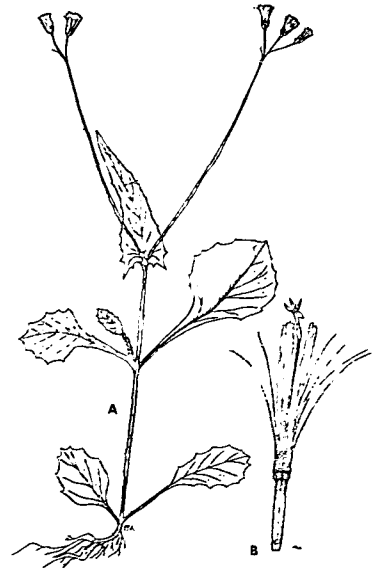
Porophyllum (neotrop. 28, CR 2, GD 1)
Glabrous or pubescent, annual or perennial herbs, usually strong scented with strongly disagreeable odor.

P. ruderale (Jacq.) Cass.
Stout, annual herb, with unpleasant odor, tap-rooted, stems erect, 0,15-1,5 m tall, often much-branched above; leaves opposite or alternate, simple, ovate, elliptic or obovate; inflorescences corymbiform, peduncles 3-5 cm long, heads discoid, 13-22 mm long, 5-10 mm in diameter; florets 30-60, corolla greenish to purplish; achenes cylindric, 7-12 mm long, black or brownish. From the southwestern United States and the West Indies to northern Argentina.

Asteraceae-Senecioneae

Emilia (paleotrop. 100, CR 2, GD 1)
Coarse to frail seasonal herbs with alternate leaves. The inflorescences are terminal or subterminal cymes, bearing several discoid heads.

E. fosbergii Nicolson, Pl. 41b
Erect to weak seasonal herb, up to 40 cm tall; leaves alternate, broadly ovate to oblanceolate; inflorescences in the axils of the upper cauline leaves, one to several corymbiform cymes, few-headed, heads turbinate or sometimes weakly urceolate or becoming weakly campanulate in age, 2-3 times longer than wide; florets 15-30; achenes reddish brown to light tan, 4 mm long, pappus of abundant, white, capillary hairs. Common weed at lower elevations, native to the Old World but now widely distributed in the Neotropics.



Emilia fosbergii
A. Habit. B. Floret

Erechtites (neotrop. 15, CR 2, GD 1)
Herbs with alternate leaves and the inflorescences

varying from a single head to many heads in loose to constricted compound cymes.

E. hieracifolia (L.) Raf. ex DC.
Short-lived herb, 1-3 m tall, stems simple branching above; leaves oblong to linear-lanceolate, 5-15 cm long, 1-4 cm wide, pinnately veined, sessile or nearly so; inflorescences terminal and axillary clusters of corymbiform cymes, with 50 or more heads; ray florets in 1 or 2 series, corollas thin, tubular. Common weed on disturbed sites, especially agricultural lands, widely distributed in the Neotropics, from the southern USA to Paraguay and southern Brazil.

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Avicenniaceae

For the only genus *Avicennia* see Verbenaceae.

Balanophoraceae

A mainly tropical and subtropical family of herbaceous, fleshy, achlorophyllous root parasites arising from an amorphous, subterranean tuber-like structure. **Leaves** alternate, spiral, or whorled, sometimes absent; **inflorescences** dense, often fungus-like, with scaly, triangular or peltate bracts; **flowers** unisexual (plants monoecious or dioecious), male flowers: perianth trilobate, stamens 1-3, opposite the tepals, female flowers: perianth lacking or with 2 greatly reduced tepals, ovary superior or inferior, 1-locular; **fruits** achenes. In the tropics and subtropics of both hemispheres. Pantrop. + subtrop. 18/44, CR 3/3, GD 1/1.

Helosis (neotrop. 1, CR 1, GD 1)
Monotypic genus.

H. cayennensis (Sw.) Spreng., Pl. 41e
Subterranean tubers, 4-5 cm long, 3-4 cm wide; supraterranean, inflorescence-bearing stems 5-15 cm long, basally with 2-6 minute, triangular scales; inflorescences ellipsoid-ovoid, 2-10 cm long, 1-3 cm wide, covered by flattened, early deciduous bracts; flowers embedded in a layer of thin, narrowly clavate hairs, male flowers: perianth tubular below, trilobate with ligulate segments, stamens 3, filaments united into a tubular column inserted in the perianth tube, anthers connate into a 9-locular synandrium; female flowers: perianth adnate to ovary, 2 short and broadly ligulate segments protruding above compressed ovary, styles 2, filiform, appearing above layer hairs; fruits small achenes, 1-seeded. In tropical

rain forests and montane forests, from Mexico throughout Central and tropical southern America to southeastern Brazil.

GÓMEZ, L.D. 1983. Balanophoraceae. Flora Costaricensis. - Fieldiana Bot. 13, n.s.: 93-99.
HANSEN, B. 1980. Balanophoraceae. Fl. Neotrop. Monogr. 23: 1-80.

Begoniaceae

A family of annual or perennial herbs, vines, shrubs or rarely small trees, sometimes climbing, with elongate and succulent or woody stems or stems sometimes reduced to a tuberous rhizome. **Leaves** usually alternate, rarely subverticillate, entire, serrate, lobed or digitately compound, usually asymmetric, sometimes peltate, stipules 2, free, persistent or deciduous; **inflorescences** axillary but sometimes appearing terminal, mostly cymose, sometimes 1-flowered or racemose, commonly dichotomous; **flowers** unisexual or bisexual, plants monoecious, tepals free or connate, stamens 4-numerous, inserted on the receptacle, filaments free or united, ovary inferior; **fruits** usually capsular, usually bearing 3 unequal wings. Widespread in the tropical regions, except for Polynesia and Australia, and is best developed in northern South America. Pantrop. + subtrop. 2/ca. 900, CR 1/32, GD 1/7.

This family is easy to identify because its stems and leaves are often succulent and most of the leaves are serrate or lobate and usually asymmetric. Moreover, the plants are always monoecious, and the fruits are capsules, which generally bear 3 unequal wings.

The family consists of the very large genus *Begonia*, with more than one thousand species, and two smaller genera, *Hillebrandia*, a monotypic genus of Hawaii, and *Symbegonia* with 11 species in New Guinea.

Many species of *Begonia* are cultivated as glasshouse ornamentals and houseplants. Approximately half of the cultivated Begonias are "cultivars", plants that are derived from hybridization, mutation or selection.

Begonia (pantrop. + subtrop. ca. 900, CR 32, GD 7)
The largest genus of the family, consisting of herbs and shrubs, often epiphytic, with conspicuously asymmetric leaves.

B. carletonii Standl.
Acaulescent herb; leaves broadly ovate, cordate at base, 6-16 cm long, sparsely setose-pilose on both surfaces; inflorescences shorter or longer than the leaves, few-flowered; male flowers with 4 tepals, white, female flowers with 3 tepals; capsules 7 mm long, wings very unequal. In Costa Rica and Panama.

B. corredorana C. DC.
Erect herb, the branches villous; leaves ovate, unequal and cordate at the base, serrulate, the teeth setuliferous, densely villous on both surfaces; inflorescences long-pedunculate; pistillate flowers bilobate; capsules 5 mm long, glabrous, the largest wing 15 mm long and 7 mm wide. In Costa Rica and Panama.

B. multinervia Liebm., Pl. 41f
Erect plants, 2-3 m tall; leaves long-petiolate, entire, broadly and obliquely transverse-ovate, mostly 15-20 cm long, shallowly cordate at the base, glabrous, sometimes red on the lower surface; inflorescences equalling or longer than the leaves, usually broad and many-flowered; flowers 6 mm long, pink, sepals 2 petaloid, petals 2; capsules, ca. 7 mm long, the largest wing as much as 13 mm long, broad, rounded at the apex, the 2 others greatly reduced. From Nicaragua to Panama.

SMITH, L.B. & B.G. SCHUBERT. 1958. Begoniaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 45: 41-67.
SMITH, L.B. & D.C. WASSHAUSEN. 1986. Begoniaceae. In: G. HARLING & L. ANDERSSON (eds.): Flora of Ecuador 25.
SMITH, L.B., D.C. WASSHAUSEN, J. GOLDING & C.E. KAREGEANNES 1986. Begoniaceae: part 1. Illustrated key: part 2. Annotated species list. - Smithsonian Contr. Bot. 60: 1-584.

Bignoniaceae

A family usually consisting of lianas, which, with a few exceptions is very distinctive in having opposite and compound leaves. Trees, shrubs or lianas, rarely herbs, the outer scales of the axillar buds often foliaceous and stipule-like; **leaves** opposite, rarely alternate or fasciculate, usually palmately or pinnately compound, rarely simple, the terminal leaflet often replaced by a tendril, interpetiolar glandular fields often present; **inflorescences** axillary, terminal or cauliflorous, paniculate, racemose, fasciculate or flowers solitary; **flowers** 5-merous, calyx usually cupular, variously lobed, entire or spathaceously split, petals connate into a long, 5-lobate, somewhat bilabiate tube, stamens (2-)4(-5), inserted on the corolla tube, usually didynamous, posterior staminode often present, disk usually present, ovary superior, (1-)2-locular; **fruits** capsules, 2-valved, septicidally or loculicidally dehiscent, rarely indehiscent, sometimes berries, seeds numerous, somewhat flattened, often winged. Distributed mainly in the Neotropics but also elsewhere in tropical regions, as well as a few representatives in the temperate zones. Pantrop. 109/750, CR 38/83, GD 22/34.

The Bignoniaceae are among the most important members of tropical forests, especially in the Neotropics. Here they are highly diverse in dry forests, as well as in lowland moist forests (GENTRY 1990). Many Bignoniaceae possess ant attractants, like sugar secreting glands or hollow twigs (e.g., *Tabebuia rosea*, *Jacaranda copaia*), which host ant colonies (GENTRY 1974).

GENTRY (1974, 1980) divided the flowers of Bignoniaceae into 10 morphological types, each related to a specific group of pollinators. The basic flower type, the *Anemopaegma*-type, has a tubular-campanulate corolla with an open mouth adapted to bee-pollination. The others are derived from or modified towards pollination by birds, butterflies, hawkmoths, various groups of bees and bats. Additionally, the several sympatric species with the same pollinators are isolated from each other by phenological specializations, which were divided by GENTRY (1974, 1976, 1980, 1990) into 5 major flowering types: "steady state", "modified steady state", "cornucopia", "big bang", and "multiple bang".

The seeds are mostly wind-dispersed, except in some derived cases, that is species with indehiscent fruits (e.g., *Amphitecna*, *Crescentia*) dispersed by water or mammals (GENTRY 1974, 1980, JANZEN 1982).

Many species are of interest in horticulture because of their showy flowers. The wood of most Bignoniaceae is commercially important because of its durability (GENTRY 1974). Especially some species of *Tabebuia* and related genera, are important lumber trees. The hard pericarp of the fruits of *Crescentia* (especially *C. cujete*) is widely used as a household utensil (GENTRY 1980, 1982, 1998). The fruits of *Amphitecna latifolia* are of local importance, as they are used in medicinal purpose: the seeds are used as a purgative, the pulp as a laxative and remedy in chest infection (GENTRY 1980). The wood of *Jacaranda copaia* is widely used for firewood and timber (GENTRY 1992).

Key to the genera (after MORALES & JIMÉNEZ, in prep.)

1	Trees or shrubs	2
2	Leaves simple	3
3	Leaves fasciculate; fruits ± globose, 13-20 cm in diameter	*Crescentia*
3*	Leaves alternate; leaves globose to ellipsoid	*Amphitecna*
2*	Leaves pinnately compound, often opposite	4
4	Leaves bipinnate; flowers purple	*Jacaranda*
4*	Leaves digitately compound	5
5	Leaves imparipinnate	6
6	Leaflets 3-9, glabrous, lanceolate, margin serrate, base cuneate; flowers yellow	*Tecoma*
6*	Leaflets 9-15, pubescent, elliptic, margin entire, base asymmetric; flowers reddish-orange	*Spathodea*
5*	Leaves digitately compound	*Tabebuia*

1*	Herbaceous or woody lianas	*Amphitecna*
7	Semiherbaceous climbers, inflorescence spicate; apical flowers sterile; fruits densely uncinate-spinose	*Tourretia*
7*	Woody or subwoody lianas, inflorescence never spicate, without sterile flowers	8
8	Branchlets hexagonal	9
9	Calyx double; indumentum of the leaves with dentritic hairs	*Amphilophium*
9*	Calyx simple; leaves always with simple pubescence	*Pithecoctenium*
8*	Branchlets terete or tetragonal	10
10	Leaves bipinnate; branchlets tetragonal, tendrils trifid	*Pleonotoma*
10*	Leaves pinnate; branchlets terete to tetragonal, if tetragonal the tendrils simple	11
11	Twigs hollow; leaves punctate; fruits almost terete	*Stizophyllum*
11*	Twigs not hollow; leaves not punctate; fruits compressed or flat	12
12	Tendrils uncinate-trifid; calyx membranaceous or somewhat foliaceous	13
13	Corolla lilac; stem cross section with 4 phloem arms	*Parabignonia*
13*	Corolla yellow; stem cross section with many irregularly divided phloem arms	*Macfadyena*
12*	Tendrils simple or trifid, not uncinate; calyx more thick and coriaceous, not foliaceous	
14	Leaves with dendroid hairs, at least in the axils of the veins beneath; capsule oblong, woody and smooth; tendrils simple	*Callichlamys*
14*	Leaves glabrous, lepidote or with simple hairs; capsule variable, not oblong; tendrils trifid or simple	15
15	Anthers pubescent, capsule densely pubescent; primary vein conspicuously elevate and pronounced	*Lundia*
15*	Anthers glabrous, or if pubescent, plant with an onion- or garlic-like odor, capsule glabrous, if pubescent, the primary vein neither conspicuous, nor strongly elevate	16
16	Flowers yellow, cream or white, sometimes with red or brown spots; capsules woody or almost so, never membranaceous, never echinate	
17	Branchlets acutely tetragonal, corolla < 2 cm, calyx < 2 mm	*Mussatia*
17*	Branchlets terete or subtetragonal, corolla > 2,5 cm, calyx > 5 mm	*Anemopaegma*
16*	Flowers rose, lilac or purple; capsules membranaceous or somewhat rigid, if woody then densely echinate	18
18	Calyx spathaceous	*Phryganocydia*
18*	Calyx cupular or campanulate, but never spathaceous	19
19	Vegetative parts usually with garlic-like odor; tendrils trifid or if simple, terminating into a peltate disc; petiolar and interpetiolar glandular fields present	*Mansoa*
19*	Vegetative parts with a sweet odor or odorless; tendrils simple, bi- or trifid, never terminating into a peltate disc; petiolar and interpetiolar glandular fields sometimes present, but never at the same time	20
20	Tendril trifid; inflorescence a raceme	*Martinella*
20*	Tendril simple or minutely bifid; inflorescence a panicle	21
21	Interpetiolar glandular fields almost always lacking; petiolar glandular fields present; tendrils minutely bifid	*Paragonia*
21	Interpetiolar glandular fields almost always present; petiolar glandular fields lacking; tendrils simple	*Arrabidaea*

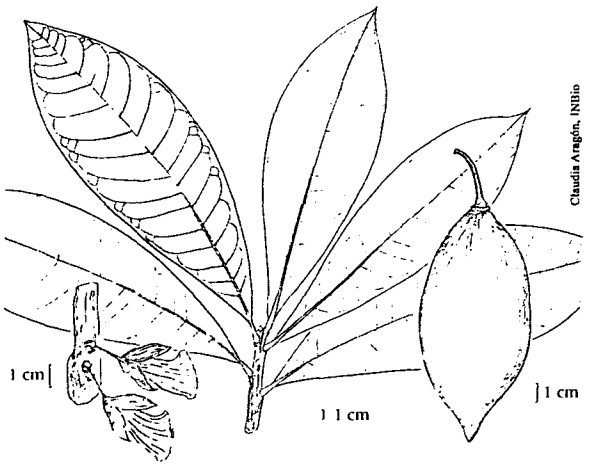
Amphilophium (neotrop. 5, CR 3, GD 2)
Lianas with 2-3-foliolate leaves, the terminal leaflet often replaced by a simply trifid tendril. The corolla is always purple at maturity.

A. paniculatum (L.) H.B.K.
Liana, vegetative parts lepidote to strongly dendroid pubescent; leaves usually 2-foliolate, sometimes with a tendril, leaflets ovate to subrotund, 2,5-16 cm long, 2,1-10,7 cm wide, pseudostipules foliaceous, early deciduous; inflorescences terminal, racemose panicle; flowers 5-merous, calyx double, corolla tubular, yellow-white when young, deep purple when mature, stamens didynamous; capsules slightly flattened, 3,9-9,5 cm long, 2,5-3,8 cm wide, densely lepidote. In tropical dry, moist and wet forests as well as in cloud

forests, from Mexico and the West Indies to Argentina, Paraguay and southern Brazil.

Amphitecna (neotrop. 18, CR 7, GD 4)
A genus difficult to recognize to family, with the outstanding characters of simple and alternate leaves and indehiscent fruits.

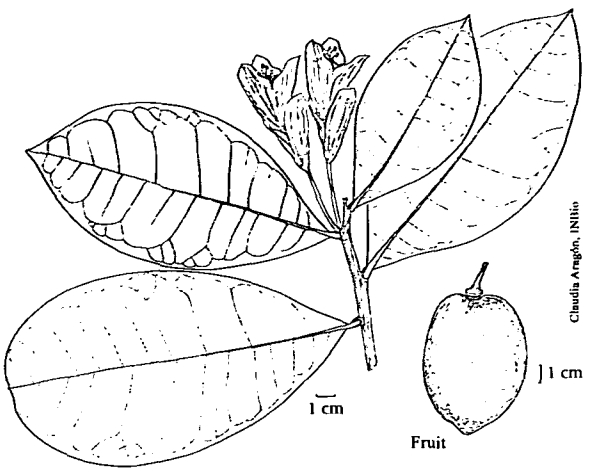
A. kennedyi (A.H. Gentry) A.H. Gentry, Pl. 41i
Tree up to 15 m tall; leaves oblanceolate to ovate, 16-38 cm long, 5-14 cm wide, inflorescences cauliflorous, short shoots with 1 or 2 flowers; calyx bilabiate split, petals greenish-white, corolla tubular, 4,3-4,8 cm long; fruits ellipsoid, apiculate at apex, 11,5-13 cm long, 5,5-7 cm wide, seeds unwinged. In wet forests, from Honduras to Central Panama.



Amphitecna kennedyi

A. latifolia (Mill.) A.H. Gentry, Pl. 41g,h
Common names (Costa Rica): jicaro, jicarita, calabacillo de playa, jicaro de estero (GENTRY 1980)
Small tree up to 10 m tall; leaves obovate, 7-19 cm long, 3,3-10,6 cm wide, with plate-shaped glands especially at the base; inflorescences ramiflorous, fascicles of 2-3 flowers or flowers solitary; calyx bilabiate split, petals greenish-white, corolla tubular, fleshy, 3,8-6,2 cm long; fruits more or less globose, 6-9 cm in diameter, apex rounded, seeds corky, unwinged. Usually in coastal beaches and just behind mangrove associations, from Florida and Mexico to northern Venezuela and on the Pacific coast, from Costa Rica to northern Ecuador.

Crescentia (neotrop. 6, CR 2, GD 1)
Trees with fasciculate and usually entire, rarely 3-



Amphitecna latifolia

foliolate leaves and hard-shelled fruits.

C. cujete L.
Small tree; leaves simple, fasciculate, obovate; flowers solitary, cauliflorous or ramiflorous, petals campanulate, tannish with reddish venation; fruits globose, to 30 cm in diameter, glabrous, indehiscent, pericarp hard, seeds embedded in a pulp. Cultivated throughout the Neotropics.

Jacaranda (neotrop. 34, CR 3, GD 2)
Medium sized to large trees with blue or purple flowers and mostly bipinnate leaves.

J. copaia (Aubl.) D.Don, Pl. 41j,k
Common name (Costa Rica): gallinazo (HOLDRIDGE et al. 1997)
Tree up to 45 m tall; leaves bipinnate, 15-165 cm long, with 5-20 pinnae, each pinna with 5-25 membranaceous leaflets, petiole 3,5-29 cm long; inflorescences terminal, paniculate; calyx cupular with 5 unequal teeth, petals tubular-campanulate, purplish blue outside and on the lobes, whitish inside, stamens didynamous, unithecate, 1 staminode present; fruits capsules, oblong, flattened, 6,2-12,7 cm long, 3,3-6 cm wide. In lowland moist and wet forests, from Belize to Bolivia.

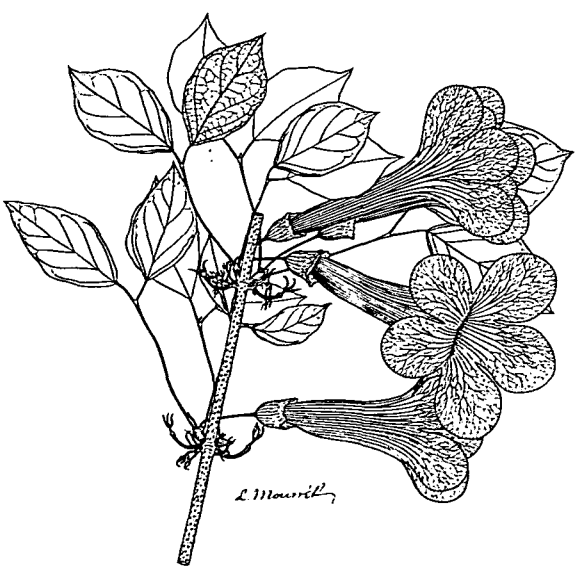
Macfadyena (neotrop. 3-4, CR 2, GD 2)
Small genus of lianas growing closely appressed to a support tree, with yellow flowers and the terminal leaflet of the 2-foliolate leaf transformed into a conspicuous, strongly trifid tendril.

Key to the species of *Macfadyena* (after GENTRY 1973)

1 Calyx subspathaceously split, often with an incurved apicule; leaflets long acuminate; pseudostipules subulate-lanceolate; interpetiolar glandular fields conspicuous; seeds with short wings, shiny and dark blackish brown — *M. uncata*

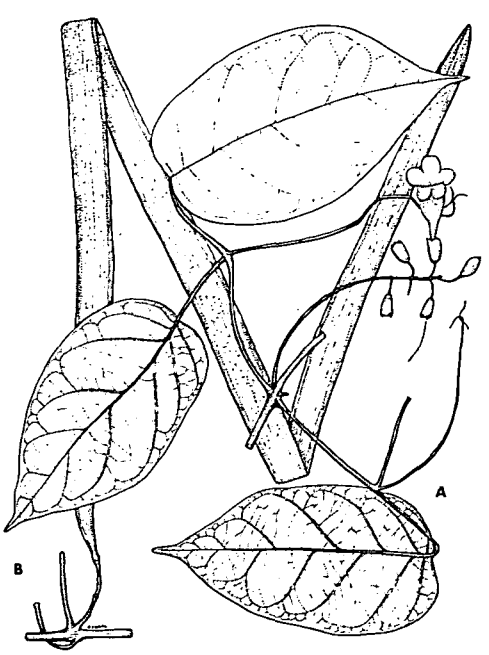
1* Calyx truncate or subtruncate, without an apicule; leaflets acute or short-acuminate; pseudostipules more or less ovate, usually striate; interpetiolar glandular fields absent or small and inconspicuous; seeds with wings longer and irregularly hyaline at tip — *M. unguis-cati*

M. uncata (Andrews) Sprague & Sandw.
Liana, the juvenile plant with small leaflets; leaves membranaceous, tendrils trifid, sometimes lacking, pseudostipules subulate-lanceolate, interpetiolar glandular fields conspicuous; inflorescences axillary, paniculate, few-flowered or reduced to a single flower; calyx subspathaceously split, corolla tubular-campanulate, yellow, 4,2-8,8 cm long, stamens didynamous, staminode present; fruits capsules, linear, acute, compressed, 16-26 cm long, 1,5-1,9 cm wide, seeds winged. In swampy habitats and riverside forests, from southern Mexico to northern Argentina.



Macfadyena unguis-cati

M. unguis-cati (L.) A.H. Gentry, Pl. 42a
Liana, the juvenile plant growing appressed to the host tree and with small leaflets; leaves 2-foliolate, often with a terminal trifid tendril, juvenile leaves narrowly ovate to lanceolate, 1-2 cm long, 4-8 mm wide, mature leaves narrowly-ovate to ovate, 5-16 cm long, 1,2-6,9 cm wide, glabrous or weekly pubescent, scattered lepidote on both sides, a few plate-shaped glands near the midvein beneath, pseudostipules ovate, ca. 5 mm long; inflorescences axillary or terminal, 1-3-flowered dichasia; flowers with lemon odor, corolla tubular-campanulate, 4,5-10 cm long, yellow-orange, stamens didynamous, staminode present; fruits linear, flattened, 26-108 cm long, 1-2 cm wide, dark brown. In tropical dry, wet and moist forests, from Mexico and the West Indies to Argentina.



Martinella obovata
A. Habit. B. Fruit

Martinella (neotrop. 2, CR 1, GD 1)
Lianas with magenta to wine-colored flowers, characterized by conspicuous swollen interpetiolar fields and usually trifid tendrils.
M. obovata (Kunth) Bureau & K. Schum.
Liana, to at least 8 cm in diameter, interpetiolar glands or pseudostipules lacking, interpetiolar

zone conspicuously thickened; leaves 2-foliolate, sometimes with a terminal trifid tendril, leaflets ovate to elliptic, 7,2-21 cm long, chartaceous, small glands irregularly scattered along the midvein beneath; inflorescences terminal, racemose, 1-21 flowered; calyx 2-4-lipped, corolla deep wine-colored, tubulate-campanulate, stamens didynamous, staminode present; fruits capsules, linear, acute, strongly flattened, 55-130 cm long, 1,2-1,8 cm wide, glabrous. Widespread in wet and moist forests, from Honduras to Brazil and Bolivia.

Pithecoctenium (neotrop. 3, CR 1, GD 1)
Lianas with acutely hexagonal branchlets, white flowers and 3-many branched tendrils.

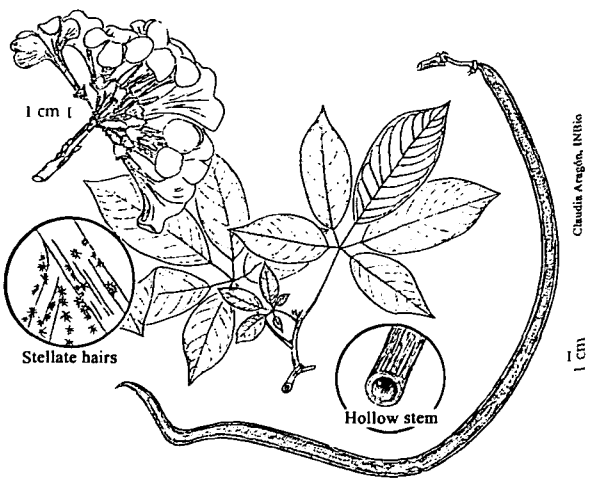
P. crucigerum (L.) A.H. Gentry, Pl. 42c
Liana, to at least 10 cm in diameter, pseudostipules ca. 1 cm long, caducous; leaves 3-foliolate or 2-foliolate with a terminal tendril, leaflets ovate to suborbicular, 3,3-18 cm long, 2-14 cm wide, membranaceous, strongly lepidote and various pubescent on both sides, leaf underside with small glands in the axils of the basal nerves; inflorescences terminal, racemose or paniculate; calyx cupular, truncate or minutely 5-dentate, corolla tubular-campanulate, lobes densely pubescent, stamens didynamous, staminode present; fruits capsules, oblong to elliptic, 12-31 cm long, 5,2-7,5 cm wide, densely covered with small spines. In a wide range of habitats, distributed, from Mexico to the north of Argentina and Uruguay.

Pleonotoma (neotrop. 14, CR 1, GD 1)
Lianas without interpetiolar glandular fields and with acutely tetragonal branchlets. The terminal leaflet is sometimes replaced by a trifid tendril. The pseudostipules are either foliaceous or lacking.

P. variabilis (Jacq.) Miers, Pl.42b
Liana, stem with 4 phloem arms in cross section, stem center hollow; leaves 2-3-ternate, elliptic to elliptic-ovate, 2-16 cm long, 0,8-9,5 cm wide, pseudostipules inconspicuous, often deciduous; inflorescences racemose; corolla campanulate or funnel-shaped, white or yellow. In evergreen lowland forests, from Costa Rica to Bolivia and Brazil.

Tabebuia (neotrop. 100, CR 6, GD 4)
Trees or shrubs with variously colored flowers and leaves ranging from simple to 1-foliolate to digitately 3-7-foliolate.

T. chrysantha (Jacq.) G. Nicholson, Pl. 42d,e
Tree up to 30 m tall, buttresses sometimes present; leaves palmately 5(-7)-foliolate, the leaflets elliptic to oblong-obovate, membranaceous, more or less stellate pubescent on both sides; inflorescences terminal, contracted panicles, almost fascicular; calyx campanulate, 5-lobate, petals 6-11,5 cm long, yellow with reddish pencilling in throat, stamens didynamous; fruits capsules, linear-cylindric, 30-90 cm long, 1,5-2,4 cm wide, seeds thin, winged. In dry and wet forests, from Mexico to northern Venezuela, Trinidad and northern Peru.



Tabebuia chrysantha

T. palustris Hemsl.
Tree or shrub, up to 4 m tall; leaves simple or 3-foliolate, leaflets narrowly elliptic to oblong, lepidote on both sides; inflorescences terminal, cymose, 2-5 flowered, calyx irregularly bilabiate or 3-labiate, petals white with yellow throat ridges, stamens didynamous; fruits capsules, oblong-cylindric, 8-11 cm long, 1,6-2,6 cm wide, densely lepidote with persistent calyx, seeds thick, corky, brown, mostly unwinged. In Pacific coastal mangrove swamps, ranging from Costa Rica to extreme northwestern Ecuador.

T. rosea (Bertol.) DC., Pl. 42f,g
Common name (Costa Rica): roble de sabana (HOLDRIDGE et al. in prep.)
Tree, up to 30 m tall; leaves palmately 5-foliolate, leaflets elliptic to elliptic oblong, subcoriaceous to chartaceous, lepidote on both sides; inflores-

cences terminal, paniculate; calyx cupular, bilabiate, petals pinkish-lavender to magenta or almost white, lobes ciliate, stamens didynamous; fruits capsules, linear-cylindric, 22-38 cm long, 0,9-1,5 cm wide, calyx usually persistent, seeds with hyaline-membranaceous wings. In various habitats, usually in somewhat swampy areas, also cultivated, from southern Mexico to Venezuela and coastal Ecuador.

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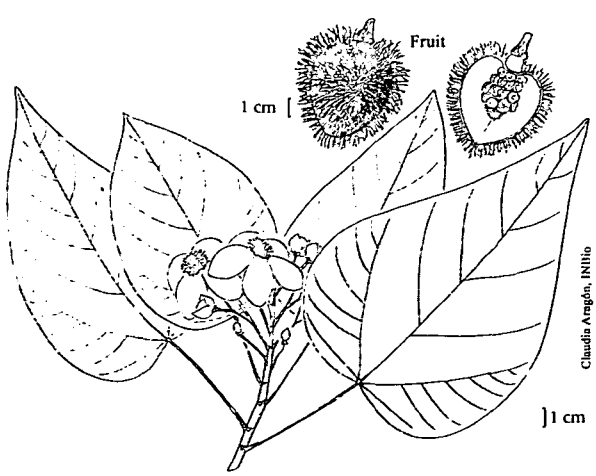
Bixaceae

A small family of trees and shrubs, closely related to the Flacourtiaceae with the common and widely cultivated species *Bixa orellana*. **Leaves** alternate, simple and basally 3(-5)-veined, margins entire, stipules present, deciduous or persistent; **inflorescences** terminal, paniculate; **flowers** actinomorphic, bisexual, 5-merous, sepals free, petals white or pink, free, stamens numerous, free, ovary superior, 1-locular with 1 style, placentation parietal; **fruits** loculizidal capsules, armed with numerous flexible spines or unarmed, seeds numerous with fleshy sarcotesta. Neotrop. 1/3-4, CR 2, GD 1.

The reddish sap of the sarcotesta of *Bixa orellana* is used as a natural dye, especially for coloring food (rice, butter, cheese, margarine), but also for textiles and for body paintings by indigenous tribes (STEYERMARK & HOLST 1998).

Bixa (neotrop. 1, CR 1, GD 1)
Monotypic genus. In the only species *B. orellana* 3 subspecies are distinguished, which are sometimes treated as separate species.

B. orellana L., Pl. 43a-c
Tree or shrub, up to 7 m tall; leaves entire, palmately veined, petioles pulvinate at base and apex, stipules deciduous; inflorescences paniculate; flowers white to pink; fruits 2-valved, spiny capsules. Native to the Neotropics, but nowadays widely cultivated throughout the tropics and subtropics worldwide.
The second (sub-)species of the GD, *B. orucurana*, has usually rounded and more or less lobate fruits, rather than ellipsoid and not lobate in *B. orellana*.



Bixa orellana

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Bombacaceae

A rather small family, consisting of small to large sized trees with very soft wood, for which they have got some commercial importance. The trunk is often columnar and studded with spines, sometimes only in juvenile stages; **leaves** always alternate with caducous stipules, mostly digitately compound, but also simple, but then always palmately veined, which makes them easy to recognize as a member of the order Malvales; **flowers** 5-merous, usually conspicuous and large, glabrous or pubescent, stamens 5 to numerous, connate into a tube, always 1-thecate, ovary superior; **fruit** a loculicidal, 5-valved capsule, seeds often embedded in kapok. Pantrop. 26/250, CR 10/23, GD 9/11.

The Bombacaceae are subdivided into three tribes, the pantropical Bombaceae, the neotropical Matisieae, and the paleotropical Durieae.
Many flowers are of the brush-flower type with long filaments. These are usually pollinated by bats. Observations on bat-pollination were made in several genera, including *Bombacopsis*, *Ceiba* and *Pseudobombax* (ELMQUIST et al. 1992, FISCHER et al. 1992, GRIBEL et al. 1999). Other genera with diurnal flowers are frequently pollinated by birds.
Some species are cultivated for their soft wood, kapok hairs or edible fruits (found only in some Old World species).

Key to the genera

1	Leaves digitately compound	2
2	Stamens few	3
3	Flowers smaller than 1,5 cm long, in unilateral cymes, seeds winged	*Bernoullia*
3*	Flowers more than 1,5 cm long, not arranged in unilateral cymes, seeds not winged	4
4	Anthers elongate, spirally twisted	*Spirotheca*
4*	Anthers not elongate, not spirally twisted	*Ceiba*
2*	Stamens numerous	5
5	Kapok present, flowers less than 24 cm long	6
6	Kapok pale-brown, flowers 13-24 cm long, calyx glabrous without, staminal column 6,5-9 cm long	*Bombacopsis*
6*	Kapok white to grayish, flowers 7-10 cm long, calyx reddish lepidote without, staminal column 0,8-1,8 cm long	*Pseudobombax*
5*	Kapok absent, flowers 17-35 cm long	*Pachira*
1*	Leaves simple	7
7	Leaves entire	8
8	Capsule indehiscent, seeds not winged	*Quararibea*
8*	Capsule dehiscent, seeds winged	*Huberodendron*
7*	Leaves 3-5 sublobate	*Ochroma*

Bernoullia (neotrop. 2, CR 1, GD 1)
Large trees with small, orange, bird-pollinated flowers and 5-valved capsules with distinct winged seeds.

B. flammea Oliv.
Common name (Costa Rica): tallo, yuco (CASCANTE-MARIN 1997)
Large tree, leaves 5-6-foliolate, elliptic-oblanceolate, &-15(-17) cm long, 2,5-5,5(-6) cm wide; inflorescences terminal, paniculate; flowers less than 1,5 cm long, petals orange, to reddish-orange; fruits woody, 5-valved capsules, ca. 20

cm long. In dry and wet forests, from southern Mexico to Panama.

Bombacopsis (neotrop. 22, CR 2, GD 1)
A genus of mostly neotropical shrubs and trees with rather large, hawkmoth pollinated flowers.

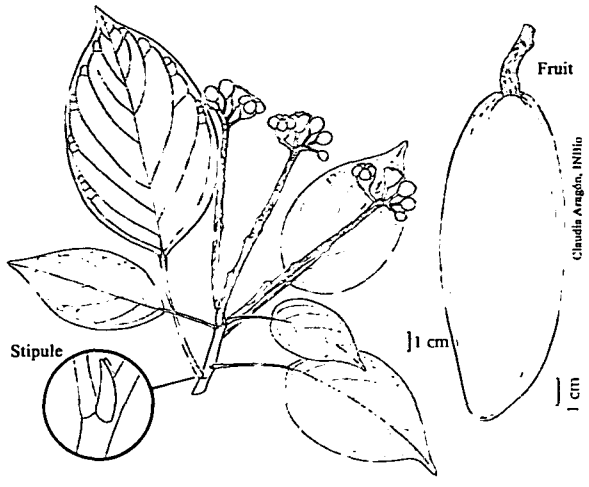
B. sessilis (Benth.) Pittier, Pl. 43d
Medium-sized to tall unarmed tree, up to 20-30 m tall; leaves 5-7-9 foliolate, glabrous, leaflets rounded, sessile to subsessile; flowers white or yellowish, axillary, clustered towards the tip of the branchlets, solitary to 3-nate, 13-24 cm long, stamens numerous, staminal column 6,5-9 cm long; capsule ellipsoid, 5-valvate, 6-12,3 cm long, 3,5-5 cm in diameter, seeds numerous embedded in copious, pale brown kapok. In deciduous and evergreen forests in Costa Rica and Panama.

Ceiba (neotrop. > 11 +1 sp. in Africa, CR 2, GD 1)
A genus consisting mostly of large trees with distinct buttresses, with the most common species occurring in the Golfo Dulce region.

C. pentandra (L.) Gaertn., Pl. 43e,f
Giant tree, 30-60 m tall, the trunk often with strong buttresses, and spiny when young; leaves 5-9-foliolate, petiolate, leaflets with a petiolule, 0,5-1,2 cm long, leaflets oblong-lanceolate, 10-21 cm long and 2,3-4,2 cm wide, entire or sometimes denticulate near the apex; Inflorescences fasciculate, few to many flowered; flowers 2,5-4 cm long, pedicelled, petals light green to yellow, stamens 5, staminar column 5-5,5 mm long; capsule subligneous, ellipsoid or fusiform, acute at both ends, 10-26 cm long, 3-4 cm in diameter, seeds numerous, embedded in copious, grayish kapok. Pantropical tree, usually in secondary forests, sometimes cultivated. The kapok is used for stuffing pillows, mattresses etc, the oil from the seeds is used for lighting and soapmaking (ROBYNS 1964).

Huberodendron (neotrop. 5, CR 1, GD 1)
A genus consisting of trees, characterized by dehiscent capsules with winged seeds.

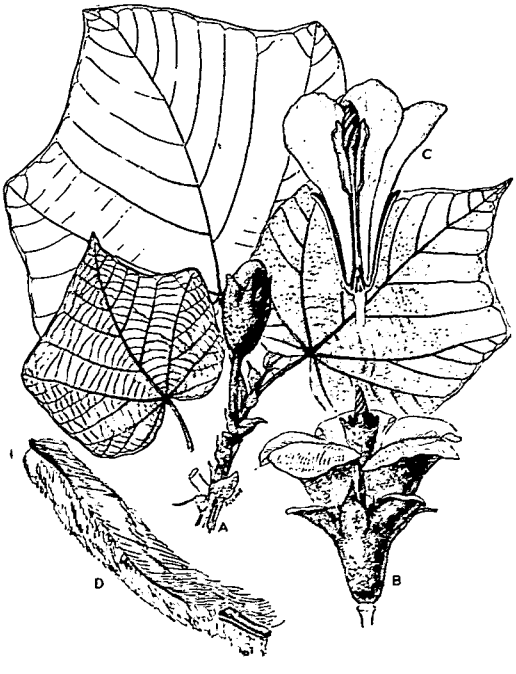
H. allenii Standl. & L.O. Williams, Pl. 43g
Tree, 30-50 m tall; leaves simple, entire, 6-14,5 long, 3,5-8,5 cm wide, long petiolate, sometimes with different length; flowers yellowish; capsule smooth, 18-25 cm long, with winged seeds. Endemic to the Golfo Dulce region.



Huberodendron allenii

Ochroma (neotrop. 1, CR 1, GD 1)
A monotypic genus which is famous for its extremely light wood.

O. pyramidale (Cav. ex Lam.) Urban, Pl. 43h,i
(syn. *Ochroma lagopus* Sw.)
Common name: balsa
Unarmed tree, 10-30 m tall, the trunk sometimes buttressed, with very light wood; leaves simple, 3-5 sublobate, palmatinerved, deeply cordate basally, 30-40 cm long; flowers white, axillary, solitary, grouped at the tips of the branchlets, 4-11 cm long, staminar column 10-12,5 cm long; capsule



Ochroma pyramidale

dehiscent, oblong-fusiform, 16-25 cm long, ca. 2,5 cm in diameter; seeds numerous, embedded in pale brown kapok. Very common in second growth forests. Widespread in tropical America, from southern Mexico to Bolivia. Because of its fast growth and its extremely light wood this tree is often cultivated and its wood used for producing life rafts, insulating equipment, toys, etc. The kapok is suitable for filling pillows and mattresses (Robyns 1964).

Pachira (neotrop. 2, CR 1, GD 1)
Evergreen trees with very large flowers, differing from the rather similar *Bombacopsis* by its fruits lacking kapok.

P. aquatica Aubl., Pl. 44a-c
Tree, 5-23 m tall, sometimes with buttresses; leaves 5-9-foliolate, petioled leaflets usually elliptic to oblong, apically acute or rounded, 5-28 cm long, 2,5-14,5 cm wide; flowers white to rose, solitary in pairs or to three, 17,5-35 cm long, pedicelled, stamens numerous, 16-31 cm long, the staminal column 4,5-12 cm long; capsule ligneous, subglobose, ellipsoid to oblong-ellipsoid, 12,5-30 cm long and 10 cm in diameter, lacking kapok, seeds few. Growing on moist and periodically inundated ground along rivers or lakes. Widespread in tropical America, from southern Mexico to northern Brazil; often cultivated in the tropics worldwide.

Pseudobombax (neotrop. 20, CR 1, GD 1)
Spineless trees with digitately compound leaves, unique in the swollen petiole apex and the petiolule bases not jointed.

P. septenatum (Jacq.) Dugand, Pl. 44d-f
Common names (Costa Rica): barrigón, ceibo verde (CASCANTE-MARIN 1997)
Tree, up to 20 m tall; leaves digitately 5-9-foliolate, leaflets obovate, 6-15 cm long, 3-7 cm wide, entire, sessile to short petiolulate, glabrous or sometimes slightly lepidote beneath; inflorescences cymose, 1-5-flowered; flowers 7-10 cm long, petals carnose, pinkish to cream-colored; fruits ovoid fusiform capsules, 5-valvate, 15-17 cm long, 5-6 cm wide. From Nicaragua to Peru and Brazil.

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Boraginaceae

Trees, shrubs, lianas, vines, or herbs, often conspicuously pubescent, the trichomes often with a basal cystolith. **Leaves** alternate or rarely opposite (*Tournefortia*), simple, stipules lacking; **inflorescences** terminal, subterminal, axillary, or internodal, cymose to paniculate, the branches often scorpioid, helicoid, or reduced and capitate to glomerate, or the flowers rarely solitary in leaf axils; **flowers** actin-

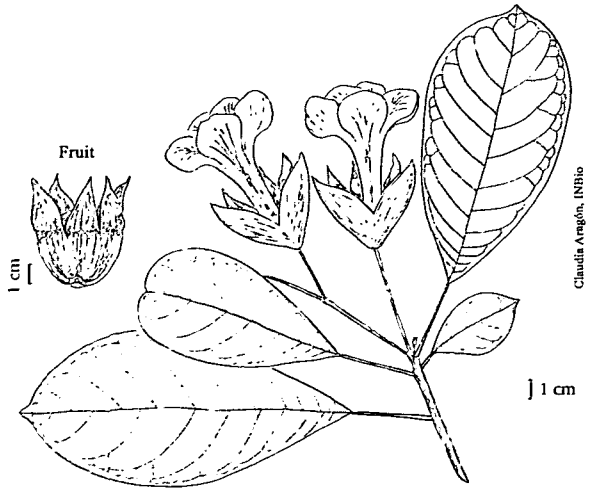
omorphic, bisexual or unisexual, sometimes distylous, usually 5-merous, calyx usually persistent, tubular to campanulate, usually 5-lobate, the lobes connate or free to the base, sepals united, corolla rotate, salverform, campanulate, tubular, or funnelform, usually 5-lobate, sometimes with prominent, often pubescent, appendages in the mouth (faucal appendages), stamens usually as many as the corolla lobes and alternate with them, filaments adnate to the corolla tube, nectariferous disk usually present around base of ovary, ovary superior, usually falsely 4-locular; **fruits** drupaceous, with 1-4 pyrenes, sometimes dry at maturity, or of 4 nutlets, seeds 1-4. Cosmopol. 130/2300, CR 10/63 GD 4/17.

Key to the genera (after MILLER et al. 1997)

1	Style entire, the stigma conical	2
2	Herbs; fruits dry, splitting into 2 or 4 nutlets	*Heliotropium*
2*	Trees, shrubs, or lianas; fruits drupaceous	*Tournefortia*
1*	Style divided, the stigma 2 or 4	3
3	Stigmas 4; cotyledons plicate; endosperm lacking; fruits generally with only a single seed	*Cordia*
3*	Stigmas 2; cotyledons planar; endosperm present; fruits with 2 or 4 seeds	*Bourreria*

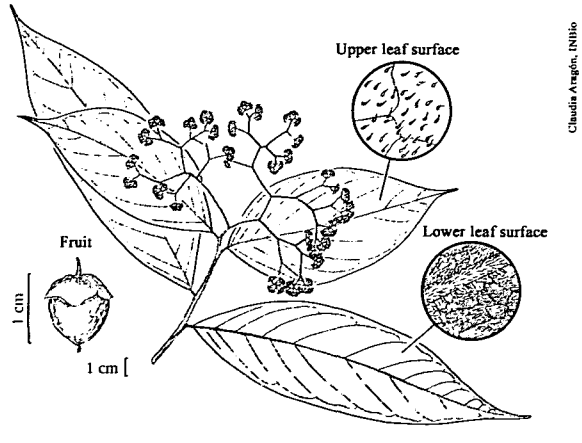
Bourreria (neotrop. + Trop. Africa and Madag. ca. 30, CR 8, GD 1)
Shrubs or trees with entire leaves and small or rather large, white flowers in terminal, corymbiform cymes.

B. grandicalyx J.S. Mill. & Sirot
Tree up to 20 m tall; leaves obovate, 16-20(-25) cm long, 5-7 cm wide, entire, glabrous, inflorescences terminal, cymose, 2-6-flowered; flowers bisexual, calyx accrescent in fruit, corolla tubular, white, stamens 5; fruits drupaceous, transversely ellipsoid, 2,5 cm long, 3 cm wide, completely enclosed in the accrescent calyx at maturity. Endemic to the Osa Peninsula.



Bourreria grandicalyx

Cordia (pantrop. 320, CR 25, GD 10)
A genus consisting of shrubs and large trees. The trees often have tall slender trunks and rather small round crowns. Most tree species have a very characteristic branching, with a leaf arising from each branch dichotomy. Inflorescence of the shrubs often spicate, sometimes even globose, while that of the trees is usually more or less openly cymose-paniculate. The flowers are usually small and white, the fruit is more or less a white or black fleshy drupe, sometimes dry with chartaceous walls, surrounded by the slightly to greatly accrescent calyx.

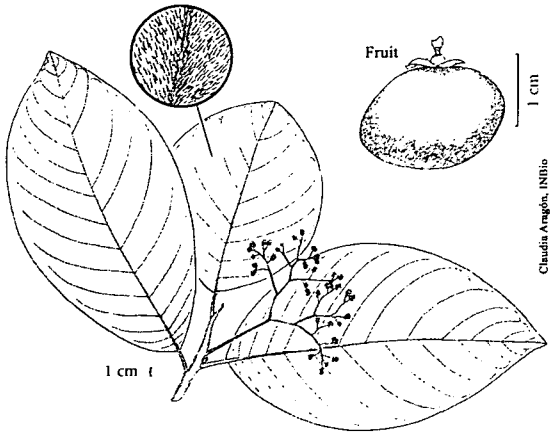


Cordia bicolor

C. bicolor A. DC., Pl. 44g
Tree, usually 8-14(-20) m tall, younger parts appressed-pubescent; leaves alternate, elliptic to ovate, 10-18 cm long, 5-8 cm wide, almost entire, moderately appressed-pubescent above; inflorescences paniculate, with flowers in small cymes;

flowers bisexual, sepals united, calyx tubular-campanulate, persistent in fruit, petals united, corolla white, salverform; fruits drupes, ovoid, ca. 1 cm long, yellow at maturity, with dense, short, appressed trichomes. From Honduras and Belize to Bolivia, Peru and Brazil.

C. cymosa (Donn. Sm.) Standl.
Tree, 5-8 m tall, branchlets ferruginous-tomentose; leaves broadly elliptic or rounded-ovate, 20-28 cm long, 14-23 cm wide, hispidulous above, very densely and softly villosulous-pilose beneath; inflorescences cymose-paniculate, 20-30 cm wide; flowers sessile or subsessile, sepals united, calyx tubular-campanulate, petals united, white, tubular; drupes globose, 8 mm in diameter. From Nicaragua to Ecuador and Peru.



Cordia cymosa

Heliotropium (cosmopol. ca. 250, CR 9, GD 1)
Herbs or shrubs with entire leaves and small, white or blue flowers, mostly in dichotomous, terminal, corymbose cymes.

H. indicum L., Pl. 44h
Common name (Costa Rica): cola de alacran (J. GONZALEZ pers. comm.)
Coarse herb, to 1,5 m tall, stems conspicuously pubescent; leaves ovate, 4-14 cm long, 2-7 cm wide, sparsely pubescent on both sides, margins irregularly sinuate; inflorescences usually terminal, spicate, narrow, to 28 cm long; flowers sessile, sepals 5, petals united, salverform, blue, stamens almost sessile; fruits ovoid, separating into 4 nutlets at maturity, the nutlets 2-3 mm long, angulate. Widely distributed in the Neotropics, from Belize and Honduras to Paraguay and central Brazil.

Tournefortia (pantrop. + subtrop. 100, CR 13, GD 5)
A genus consisting of small trees, shrubs, subshrubs, and sometimes scandent or decumbent, or woody to nearly herbaceous vines. It differs from *Cordia* in the strongly scorpioid inflorescence branches with the flowers all along one side of the branches and in the style, which is not split at the apex. The flowers are white to greenish and are always more or less salverform with reflexed lobes. The fruits are drupaceous, entire or lobed, often with a white fleshy or corky exocarp at maturity, later drying and separating into 2-4 bony nutlets.

T. bicolor Swartz
A small or large, woody vine, branches sparsely pilose or almost glabrous; leaves ovate to lance-ovate or elliptic, mostly 6-14 cm long, sparsely short-pilose to glabrous; inflorescences much-branched, often large; corolla white, the tube 4-5 mm long, strigose, the limb 6-7 mm broad; fruits 8 mm long, glabrous, white; widely distributed in the Neotropics, from southern Mexico to Peru, Bolivia and Brazil.

T. glabra L., Pl. 44i
Scandent shrub or erect tree, up to 6 m tall, with brown or light gray bark and bright yellow wood; leaves thin, lanceolate to ovate, mostly 8-15 cm long, sparsely short-pilose or sericeous or almost glabrous; inflorescences spicate, slender and often greatly elongate; calyx lobes lanceolate, long-acuminate, ca. 2 mm long, petals tubular, pale green or whitish, the tube 4 mm long; fruits white, up to 9 mm long. From southern Mexico and the West Indies to Panama.

Tournefortia glabra
A. Fruiting branch. B. Flowering branch

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Brunelliaceae

Evergreen, large to medium sized trees or occasionally shrubs, with opposite or ternate leaves, which are usually characteristic brown to yellow-brown pubescent. **Leaves** simple to pinnately compound, entire or dentate, stipels and stipules present, small and mostly caducous; **inflorescences**, axillary or terminal, paniculate, dichasially branched; **flowers** bisexual or usually unisexual by abortion (plants then dioecious), mostly small, sepals 4-8, basally connate, persistent in fruit, petals absent, stamens twice as many as the sepals, free, nectariferous disk present, adnate to the ovary, ovary of (2-)5-6(-8) free carpels, alternate with the sepals; **fruits** follicles, ovoid to ellipsoid, apiculate, pubescent, seeds 1-2. Distributed throughout the Neotropics. Neotrop. 1/ca. 66, CR 1/5, GD 1/1.

The Brunelliaceae are usually found in montane forests, most of them occur in the Andean and sub-Andean region. Only *B. hygrothermica* is restricted to sea-level communities (CUATRECASAS 1970). The seeds, which are actively released from the follicles, are eaten and dispersed by birds (PORTER & CUATRECASAS 1975).

Brunellia (neotrop. ca. 66, CR 5, GD 1)
See characters of the family.

B. hygrothermica Cuatr.
Tree or shrub, up to 15 m tall; leaves opposite, very large, 30-75 cm long, leaflets oblong-elliptic, 15-25 cm long, 6-9 cm wide, dentate to serrate; inflorescences axillary or terminal, 30-60 cm long, dense; flowers bisexual, 5-merous; follicles 5, ca. 2 mm in diameter, seed 1. In lowland rain forests, from Costa Rica to Colombia.

CUATRECASAS, J. 1970. Brunelliaceae. - Fl. Neotrop. Monogr. 2.

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Burseraceae

A family of trees and shrubs, vegetatively characterized by the presence of a resinous sap, usually with strong turpentine odor, which is found in nearly all of the vegetative parts like the bark, the twigs and the leaves as well as in the fruits. **Leaves** mostly imparipinnate compound, rarely simple, without stipules, conspicuous pulvini and pulvinuli frequently present; **inflorescences** racemose, paniculate or pseudospicate; **flowers** small, rather inconspicuous, usually functionally unisexual, 3-6-merous, disk always present; **fruits** usually dehiscent or indehiscent drupes, stone often embedded in whitish or brightly colored, sometimes edible pulp. Pantrop. 17/540, CR 5/20, GD 4/14.

Key to the genera (based on DALY 1989)

1	Flowers 3-merous; fruit indehiscent with one plurilocular pyrene	*Trattinickia*
1*	Flowers (3-)4-5(-6)-merous; fruit dehiscent with 1-5 or 10-12 unilocular pyrenes	2

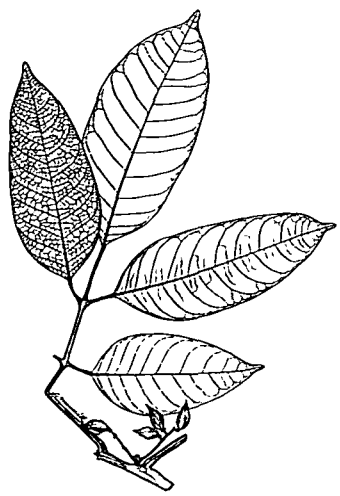
2	Leaves usually deciduous; leaflets all without pulvinuli	*Bursera*
2*	Leaves usually evergreen; terminal leaflets and usually lateral ones with a pulvinulus	3
3	Lateral leaflets with a pulvinulus (sometimes absent in *P. pilosum* but then acumen serrulate)	*Protium* p.p.
3*	Lateral leaflets without a pulvinulus	4
4	Petals connate, fleshy; leaflets entire	*Tetragastris*
4*	Petals free, membranaceous; leaflets irregularly serrate or serrulate	*Protium* p.p.

Bursera (neotrop. ca. 50, CR 9, GD 2)
The largest genus of the family, characterized by its thin, usually serrate margined, usually caducous leaves that are often clustered at the twig ends.
The two species of *Bursera* occurring in the GD both belong to the *Bursera simaruba* Complex, which is known to be an aggregate of rather closely related species, which are very difficult to distinguish from each other (cf. DALY 1993). Furthermore DALY (1993) mentioned that many of the differentiation characters, previously used by taxonomists, can be unreliable. So as long as there is no current revision of this complex (including our two species) available, it seems useful to omit a distinct key. Here we provide a more precise description of *Bursera simaruba* s.l. instead.

B. simaruba s.l. (L.) Sarg. (including *Bursera standleyana* (L.) O. Williams & Cuatrec.), Pl. 45a,b
Trees, up to 20 m tall, with reddish bark, which characteristically peels off in thin, papery sheets; leaves imparipinnate, with 5-7(-9), lanceolate to ovate, entire margined leaflets; inflorescences usually glabrous, reddish; flowers glabrous, male flowers 5-merous, female flowers 3-merous, stamens twice as many as petals; fruits subglobose, reddish-brown, 3-valved. Widespread, from Florida and the Carribean Region throughout Central America to Amazonian Brazil. (*Bursera standleyana* is endemic to Costa Rica).

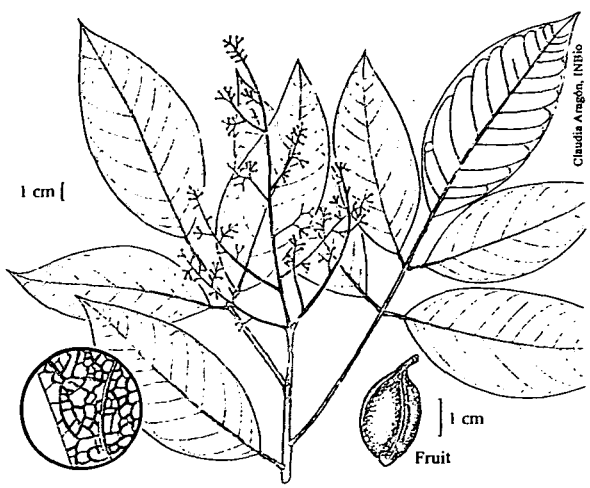
Protium (neotrop. + Africa + Malesia 85, CR 10, GD 10)
This is the most heterogeneous genus of the family, but most of the species can be easily recognized by having conspicuous pulvini and pulvinuli. The inflorescences are always inserted axillary and the fruits are usually red to reddish dehiscent drupes with the stone embedded in a fleshy, white pulp.

P. panamense (Rose) I.M. Johnst.
Trees or shrubs, up to 40 m tall; leaves paripinnate



Protium panamense

with 3-7(-9) leaflets, glabrous, with entire margin; inflorescences axillary panicles, glabrous; flowers yellow, 4(-5)-merous, with 8(-10) stamens; fruits ellipsoid to ovoid, 2-4-valved, reddish capsules. Usually in evergreen lowland forest, from Costa Rica to Colombia.



Protium ravenii

P. ravenii D.Porter, Pl. 45c
Tree, about 15 m tall; leaves paripinnate, with 3-5

leaflets, entire, sparsely appressed puberulent; inflorescences appressed-puberulent; fruits ellipsoid, sparsely appressed-puberulent to glabrate. Endemic to Costa Rica.

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Cabombaceae

Perennial aquatic herbs, with submersed stem. **Leaves** opposite or alternate, the submersed leaves finely lacininate, the emergent leaves undivided, peltate; **flowers** axillary, long pedicellate, solitary, actinomorphic, 3-4-merous, petals white, yellow or purple, stamens 3-36, carpels 1-18, free; **fruits** of indehiscent follicles, seeds 1-3. Distributed throughout the tropics worldwide. Pantrop. 2/6, CR 1/2, GD 1/1.

The family was formerly included in the Nymphaeaceae, from which it differs in having free carpels. The flowers of *Cabomba* are protogynous; anthesis lasts for 2 days, with the female phase on the first day, and the male phase on the second day (ORGAARD 1991). *C. caroliniana* is known to be chiefly pollinated by flies (SCHNEIDER & JETER 1982).
Cabomba caroliniana is a common aquarium plant.

Cabomba (neotrop + subtrop. 5, CR 2, GD 1)
Submersed perennial herbs with the submersed leaves opposite, strongly laciniate and circular to kidney-shaped in outline and the emergent leaves alternate, peltate, bifurcate, linear-elliptic to ovate.

C. furcata Schult. & Schult. f.
Small herb; submersed leaves in whorls of 3-6, emergent leaves narrowly rhombic or linear to lanceolate, occasionally sagittate; flowers tightly clustered beneath the water surface, 6-12 mm in diameter, sepals 3, petals 3, perianth purplish violet to white, basally yellow. From Costa Rica to Peru and Brazil.

DUKE, J.A. 1962. Nymphaeaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 49: 137-143.
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ORGAARD, M., H.W.E. VAN BRUGGEN & P.J. VAN DER VLUGT. 1992. Die Familie Cabombaceae (*Cabomba* und *Brasenia*). - Aqua Planta. Sonderheft no. 3: 43p.
SCHNEIDER, E.L. & J.M. JETER. 1982. Morphological studies of the Nymphaeaceae: 12. The floral biology of *Cabomba caroliniana*. - Amer. J. Bot. 69 (9): 1410-1419.

Cactaceae

A unique family, nearly always lacking typical leaves (except *Pereskia*), terrestrial or epiphytic trees, shrubs, or more or less herbaceous plants. Stems usually photosynthetic, succulent, variously shaped (globose, cylindrical, polygonal etc.) and spiny with axillary multispinate or hairy areas (areoles),

green; **leaves** alternate, simple, entire, usually much reduced, cylindrical and early caducous (*Opuntia*) or lacking; stipules lacking; **inflorescences** rarely 1-few-flowered panicles (only *Pereskia*), mostly flowers solitary; **flowers** actinomorphic, rarely zygomorphic, bisexual or rarely functionally unisexual, usually large and conspicuous, 0,5-40 cm long, usually sessile (pedicellate only in *Pereskia*), perianth spirally arranged, numerous, petaloid, white to red and yellow, stamens usually numerous, ovary inferior to semi-inferior, unilocular; **fruits** berries, dry or fleshy, sometimes dehiscent, seeds numerous. Distributed exclusively in the tropics and subtropics of the New World (except one pantropical species), most abundant in dry areas, but also present in wet habitats. New World + a few spp. in Africa 97/1400, CR 14/45, GD 4/7.

The main centers of diversity of the Cactaceae are the arid areas in Mexico and the southern United States, northeastern Brazil and the Andean region.

Within the Cactaceae there is a high proportion of bat-pollinated species. This mode is restricted to species with tall habit (VOGEL 1968). Other taxa are melittophilous or hawkmoth-pollinated (e.g., *Epiphyllum*) (BARTHLOTT & HUNT 1993).

Fruit dispersal by birds is most common. Other dispersal modes include myrmecochory, as well as a combination of bird and ant dispersal. The rather large and sweet-tasting fruits of some species are eaten by mammals. Wind dispersal of seeds and sometimes also whole fruits (*Neoporteria* spp.) as well as water dispersal is common in several other species (BARTHLOTT & HUNT 1993).
Many species of Cactaceae are of horticultural importance and are therefore cultivated worldwide. Of outstanding commercial value is *Opuntia ficus-indica*, which is cultivated for its acid-sweet edible fruits. It is also used as a natural fence, whereas the spineless variety (var. *inermis*) is used as animal fodder. In South Africa this species is also cultivated as a host plant for the mass rearing of the cochineal insects, which produce a red dye (BRÜCHER 1989). *Lophophora williamsi*, the peyote cactus, is native to Mexico, where it has been cultivated since pre-columbian times as a source of the hallucinogenic narcotic "mescalin".

Key to the genera (based on MADSEN 1989)

1	Branching with new stem-joints appearing from apex of previous ones; pericarpel and fruit naked or rarely with a single bract; seeds narrowly oblong, 0,5-0,7 mm wide; flowers 0,5-1 cm long	*Rhipsalis*
1*	Branching with new stem-joints appearing at base to the middle of previous ones; pericarpel and fruit with minute bracts; seeds and flowers larger	2
2	Flowers less than 4 cm long; fruits less than 2 cm long	*Disocactus*
2*	Flowers longer than 5,5 cm; fruits longer than 2,5 cm	3
3	Flowers funnel shaped (tube shorter than or = lobes); fruits tuberculate	*Weberocereus*
3*	Flowers trumpet shaped (tube longer than lobes); fruits not tuberculate	*Epiphyllum*

Disocactus (neotrop. 16, CR 7, GD 2)
Pendulous epiphytes, lacking spines with flat stems and rather small flowers. The flower tube is clearly visible, and in difference to *Epiphyllum* always shorter or as long as the lobes.

D. himantocladus (Rol.-Goss.) Kimnach
Epiphyte; cladodes 20-45(-60) cm long, (1,5-)3-4,5 cm wide, margins crenate; flowers 1,5-2,5 (-3,3) cm long, yellowish pink to white; fruits globose, ca. 1 cm in diameter, reddish. Usually in wet forest, from Costa Rica to Panama.

Epiphyllum (neotrop. 15, CR 5, GD 2), Pl. 45f
Mostly woody epiphytes with cylindrical primary stem and flat branches, in adult stages usually without spines. The conspicuous large, tubular pink to yellow-colored, usually hawkmoth-pollinated flowers open during night.

E. grandilobum (F.A.C. Weber) Britton & Rose
Epiphytic plant; branches very large, up to 25 cm broad, with deeply lobed margins and especially the relatively large aereolar bracts; flowers 28-38 cm long, white; fruits ovoid ca. 5 cm in diameter, reddish. From Nicaragua to Panama.

Weberocereus (Neotrop. 9, CR 4, GD 2)
Epiphytic or epilithic plants with terete or flattened stems and aerial roots. The sessile, nocturnal flowers are rather large and narrowly funnel-shaped.

W. bradei (Britton & Rose) G.D. Rowley
Scandent epiphytic plant, stems flattened with obovoid lobes (cladoces); areoles with dense wool and often with orange spines up to 1 cm; flowers 5-8 cm, white to pink; fruits ovoid, 3,5 cm in diameter, browinsh red, pulp reddish. In seasonal wet forests, endemic to the Golfo Dulce region.

W. imitans (Kimnach & Hutchison) Buxb., Pl. 45g
Scandent epiphytic plant, stems flattened with long ovate lobes (cladoces); areoles woolly, rarely with spines; flowers 5,5-7 cm long, yellow to cream, receptacle lacking spines or with hairlike spines only; fruits ca. 3,5 cm in diameter, green to red berries. Endemic to the Golfo Dulce region.

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HAMMEL, B.E. 2000. Cactaceae. In: Family treatments for the Manual to the Plants of Costa Rica. (WWW document) URL: http://www.mobot.org/MOBOT/research/treat/cactaceae.html (12.9.2000).
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HUNT, D.R. & N. TAYLOR. 1986. The genera of the Cactaceae: towards a new consensus. - Bradleya 4: 65-78.
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KIMNACH, M. 1965. *Epiphyllum grandilobum*. - Cactus and Succulent Journal (U.S.) 37 (1): 15-20.
MADSEN, J.E. 1989. Cactaceae. In: G. HARLING & L. ANDERSSON (eds.): Flora of Ecuador 35: 1-79.
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Caesalpiniaceae, see Fabaceae-Caesalpinioideae

Campanulaceae

Herbs, shrubs or vines, usually with milky latex. **Leaves** alternate, rarely opposite or verticillate, simple, entire to serrate or crenate, rarely deeply lacinate or pinnatifid, stipules lacking; **inflorescences** terminal, racemose, or flowers solitary and axillary; **flowers** actinomorphic or zygomorphic, calyx with 5 free lobes, rarely synsepalous and tubular, corolla sympetalous, campanulate to tubular, stamens 5, filaments at least partially connate, ovary inferior, rarely semi-inferior, 2-3-locular; **fruits** capsules, apically dehiscent or circumscissile, or fleshy to dry berries. Cosmopolitan, except tropical Africa. Cosmopol. 82/2000, CR 10/39, GD 3/3.

Key to the genera (after WILBUR 1976b)

1	Leaves entire; flowers borne in a compact spike, the flowers contiguous	*Sphenoclea*
1*	Leaves coarsely toothed, serrulate or denticulate; flowers not borne in a dense spike, the flowers not contiguous	2
2	Fruit a capsule, dehiscing by apical valves; corolla white, salverform	*Hippobroma*
2*	Fruit a dry or fleshy berry, indehiscent; corolla not white, never salverform	*Centropogon*

Centropogon (neotrop. 230, CR 16, GD 1)
Plants herbaceous or suffrutescent, sometimes more or less scandent; leaves membranaceous, small or large, usually dentate; flowers pedicellate, axillary or grouped in terminal, usually umbelliform racemes, large and showy, red or

purple; anthers not barbate, fruit baccate, not inflated. The genus contains some of the most showy and brilliant flower plants of Costa Rica, notable for their abundant flowers, which often are of an intense, bright red color.

C. granulosus Presl.
More or less scandent subshrub; stems granulose-scabrous towards the top; leaves not decreasing much in size towards the top, widely ovate or widely elliptic to oblong-elliptic, 10-30 cm long, 5-14 cm wide, almost entire to callose, crenulate or denticulate; inflorescences pendent, racemose, 4-20 cm long, usually curved, long-pedunculate; petals much curved, sometimes sigmoid, yellow to red, limb usually tipped with some shade of yellow, tube usually with 5 deep depressions; fruits almost dry berries, depressed-globose, up to 1,5 cm wide. From Costa Rica to Colombia and Peru.

Hippobroma (neotrop. 1, CR 1, GD 1)
Monotypic genus.

H. longiflora (L.) G.Don, Pl. 46a
Perennial herb, erect or decumbent, up to 50(-90) cm tall, leaves sessile, elliptic to oblanceolate, (5-) 10-20 cm long, (1-)2-5 cm wide, dentate with large and small teeth; flowers solitary, corolla white, sometimes with greenish veins, corolla tube 5-13,5 cm long, glabrous; fruits capsules, 1,2-2 cm long, pendent. Very common and probably native to the West Indies, but also found from Mexico to Peru and Brazil.

Sphenoclea (pantrop. 2, CR 1, GD 1)
This genus is sometimes segregated in an own family Sphenocleaceae. It consists of succulent semiaquatic herbs with minute white flowers, which are congested into a thick, densely spicate, fleshy inflorescence.

S. zeylanica Gaertn.
Coarse, erect, glabrous, annual herb, 0,4-1(-1,3) m tall; stems green, usually fistulous towards the top; leaves ovate to elliptic, 3-12 cm long, 1-3,5 cm wide; inflorescences spicate, cylindric, usually 2,5-8 cm long, 0,5-11 cm wide, with up to about 100 flowers; flowers sessile, sepals persistent, covering the capsule at maturity, petals tubular, whitish; fruits capsules, 3-5 mm in diameter, dehiscing below the sepals.

Sphenoclea zeylandica

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WILBUR, R.L. 1976b. Campanulaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 63: 593-655.

Canellaceae

Glabrous trees or shrubs with highly aromatic leaves due to essential oil cells in the parenchyma. **Leaves** alternate, simple, entire, usually pellucid punctate; **inflorescences** axillary or terminal, racemose, paniculate or flowers solitary; **flowers** bisexual, stamens numerous, ovary superior, unilocular; **fruits** berries. Neotrop. + Africa 5/13, CR 1/1, GD 1/1.

Pleodendron (Neotrop. 1-2?, CR 1-2?, GD 1)
Until now only one species, *P. macranthum*, was described for this genus. Recently a further species with some aberrant features was found in the Golfo Dulce region.

Capparidaceae

Trees, shrubs and herbs, often with lepidote hairs and often having a strong and somewhat fetid odor. Indumentum sometimes glandular or stellate, plants occasionally spiny. **Leaves** alternate, simple (unifoliolate), palmately compound or trifoliolate, usually entire, rarely minutely serrate, stipules present, but minute or lacking; **inflorescences** terminal or axillary, simple or compound, racemose to corymbose, or flowers solitary; **flowers** actinomorphic or frequently zygomorphic, bisexual or unisexual, plants then monoecious, sepals usually 4, mostly free, petals usually 4, free, equal or the posterior pair larger, often clawed, receptacle often elongated into a prominent gynophore or androgynophore, often with a nectariferous disk, stamens 4-numerous, equal or unequal, ovary superior, unilocular; **fruits** dry, silique-like, 2-valved capsules, berries or drupes, seeds few to many, sometimes arillate. Distributed mostly in dry areas of tropical to temperate and arid habitats worldwide. Cosmopol. 39/650, CR 7/33, GD 4/8.

Capparidaceae with diurnal flowers are usually melittophilous, like several *Cleome* spp. which are buzz-pollinated (ENDRESS 1994). Several species have nocturnal flowers and are mainly pollinated by sphingids (VOGEL 1954). Some *Capparis* spp. as well as *Cleome anomala* have evolved towards chiropterophily, which can be seen in several adaptations, such as the reduction of the perianth, the lack of fragrance, the rigid flower parts, etc. (VOGEL 1958, 1968).
Capers are produced from the flower buds of *Capparis spinosa*, originating from the Mediterranean area. They are used as spices. A few species of *Cleome* are used as ornamentals (WOODSON & SCHERY 1948).

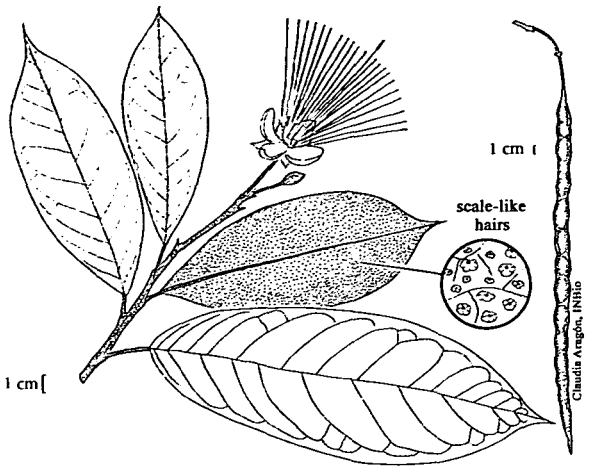
Key to the genera (after WOODSON & SCHERY 1948)

1	Herbs, sometimes suffrutescent; fruit a dry, thin-walled silique, dehiscing from a distinct, double replum	2
2	Flowers hermaphrodite; replum straight and persistently joined at the apex after dehiscence of the silique; seeds without an aril	*Cleome*
2*	Flowers monoecious; replum separating at the apex and contorting after dehiscence of the silique; seeds arillate	*Podandrogyne*
1*	Shrubs and trees; fruit fleshy and tardily dehiscent or indehiscent, without a distinct replum	3
3	Leaves compound, 3-foliolate; flowers hermaphrodite or unisexual by abortion; disk thick and conspicuous	*Crateva*
3*	Leaves apparently simple, 1-foliolate; flowers hermaphrodite; disk thin and inconspicuous	*Capparis*

Capparis (pantrop. + subtrop. 250, CR 15, GD 5)
The largest genus of the family, consisting of trees and shrubs with simple leaves and often with petioles of different length. The species often have an indumentum of lepidote hairs, the stipules are sometimes lacking. The white to yellowish flowers, usually having numerous stamens are mostly borne on racemose or corymbose inflorescences.

C. cynophallophora L., Pl. 46b
Shrub or small tree, up to 6 m tall; branches densely lepidote to glabrate; leaves coriaceous, glabrous above, densely lepidote beneath; inflorescences axillary and terminal, corymbose, densely lepidote, few to several flowered; petals white to purplish or brownish, densely lepidote throughout, ovary borne on a 12 mm long gynophore, which elongates into the fruit;

fruits linear-fusiform, 15-40 cm long, ca. 1,0 cm wide, densely brown lepidote. From southern Florida throughout Central America and the Antilles to Venezuela.



Capparis cynophallophora

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RUIZ-ZAPATA, T. & H.H. ILTIS. 1998. Capparidaceae. Pp.: 132-157. In: J.A. STEYERMARK, P.E. BERRY & B.K. HOLST (eds.): Flora of the Venezuelan Guayana Vol. 4.
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Caprifoliaceae

Shrubs or small trees, or sometimes lianas or herbs, usually pubescent, usually with a strong interpetiolar ridge. **Leaves** opposite, simple or rarely pinnate (*Sambucus*), margin mostly serrate or dentate, sometimes with glands on the teeth, stipules minute or lacking; **inflorescences** axillary or terminal, cymose, or sometimes paniculate, often several or many-flowered and distinct flat-topped, or the flowers arranged in pairs; **flowers** actinomorphic to strongly zygomorphic, bisexual, calyx small, (4-)5-merous, somewhat accrescent in fruit, sometimes glandular, corolla tubular, (4-)5-lobed, stamens 4-5, sometimes reduced to 2, ovary inferior to semi-inferior, 2-5(-8)-locular; **fruits** berries, drupes or sometimes longitudinally dehiscent capsules, seeds 1-several. Mostly plants of temperate areas of the northern hemisphere, but also extending into the tropics and subtropics. Cosmopol. 15/420, CR 3/6, GD 1/1.

The flowers of the Caprifoliaceae are entomophilous. KRANNITZ & MAUN (1991) and ENGLUND (1993), studied the pollination ecology of the temperate species *Viburnum opulus* and found it to be visited by a large variety of insects, mainly beetles, bees and flies.

Viburnum (cosmopol. 150, CR 3, GD 1)
Trees or shrubs, sometimes scandent, with entire leaves and with white or rose fragrant flowers, usually arranged in compound flat-topped cymes.

V. costaricanum (Oerst.) Hemsl.
Shrub or tree, up to 15 m tall, the twigs sparsely to densely appressed-pubescent with simple and stellate hairs; leaves ovate, 5-9 cm long, entire or apically toothed, often with 1-2 pairs of glands near the base, glabrate, stipules absent; inflorescences terminal, compound cymes, 4-8 cm in diameter; flowers white, corolla campanulate, glabrate, stamens excerted; fruits dark purple. In Costa Rica and Panama.

D'ARCY, W.G. 1973. Caprifoliaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 60: 155-167.

ENGLUND, R. 1993. Movement patterns of *Cetonia* beetles (Scarabaeidae) among flowering *Viburnum opulus* (Caprifoliaceae): Option for long-distance pollen dispersal in a temperate shrub. - Oecologia 94 (2): 295-302.
KRANNITZ, P.G. 1991. Insect visitors to the Guelder Rose, *Vibernum opulus* var. *opulus* (Caprifoliaceae), in London, Ontario (Canada). - Canad. Field-Naturalist 105 (1): 13-17.
MORTON, C.V. 1933. The Mexican and Central American species of *Viburnum*. - Contr. U.S. Natl. Herb. 26: 339-366.

Caricaceae

Small trees or shrubs, stems with milky latex, often unbranched with a terminal cluster of leaves. **Leaves** alternate, palmately lobed, palmately compound, or rarely simple and palmately veined; **inflorescences** axillary, racemose, paniculate, or cymose; **flowers** actinomorphic, unisexual (plants dioecious or sometimes monoecious), calyx tubular or campanulate, 5-lobate, petals 5, basally connate, forming an elongate tube in staminate flowers or a short tube in pistillate flowers, stamens 10 in 2 whorls, less commonly 5, alternate with the corolla lobes, filaments adnate to the corolla tube, ovary superior, 1-locular or rarely 5-locular by intrusion; **fruits** fleshy berries. In tropical and subtropical America as well as in tropical Africa. Neotrop. + subtrop. + trop. Africa 4/33, CR 2/6, GD 2/3.

A recent study in Australia on cultivated papaya (*Carica papaya*) which is cultivated worldwide in the tropics for its edible fruits, has shown that the only significant method of pollination is by hawkmoths (MORRISEN et al. 2000).

Key to the genera

1	Leaves digitate; plants often armed with thorns on stem and petioles; calyx lobes opposite to those of the corolla	*Jacaratia*
1*	Leaves simple, palmately lobed; plants unarmed, calyx lobes alternate to those of the corolla, rarely opposite, but then the leaves simple	*Carica*

Carica (neotrop. 23, CR 4, GD 1)
A mainly tropical genus consisting of monoecious, dioecious or polygamous arborescent, shrubby, or herbaceous plants with soft stems. The flowers have a usually small, 5-lobate calyx and a tubular corolla, which is often widened distally.

C. cauliflora Jacq., Pl. 46c,d
Unbranched dioecious tree, 3-6 m tall, mostly glabrous; leaves in a dense terminal crown, ovate, shallowly 5-lobate when mature, 30-70 cm long, petioles mostly more than 50 cm long, hollow, with few milky sap; male inflorescences dichotomously branched, ca. 30 cm long, many-flowered, female inflorescences contracted, 2,5-5 cm long, ca. 7-flowered; flowers ca. 3 cm long, calyx deeply 5-lobate, green, petals united, 5-lobate, white to yellowish, anthers 10; fruits berries obovate, ca. 8 cm long and 6 cm wide, minutely apiculate, becoming orange at maturity. From southern Mexico to Colombia, Trinidad and Venezuela.

Jacaratia (neotrop. 7, CR 2, GD 2)
Medium to large, sometimes spiny trees with milky latex and compound leaves. The male flowers have a small 5-lobate calyx and a tubular corolla which is never widened distally. The corolla of the female flowers is usually short-tubed and the lobes are narrowly triangular.
The fruit is ovoid to ellipsoid, sometimes with short and wide basal lobes.

Jacaratia dolichaula

J. dolichaula (Donn. Sm.) Woodson
Branching shrub, or often a tall and corpulent tree, glabrous throughout; leaves digitately compound, the 3-5 leaflets short-petiolate, ovate-oblong, narrow-acuminate, entire or sometimes lobulate; flowers white, the pistillate flowers 5-7 cm long, very narrow; fruit ca. 5-10 cm long. From Belize and Honduras to Panama.

J. spinosa (Aubl.) DC., Pl. 46e-g
Trees up to 40 m tall, trunk grayish, large individuals without thorns, small individuals with conical, laterally compressed thorns up to 5 mm long; leaves digitately compound, glabrous; male inflorescences axillary, erect, subracemose or laxly cymose, 7-9 cm long and 4-6 cm wide, female inflorescences erect, usually uniflorous; sepals and petals united, corolla tubular, green to whitish-green or white; fruits ellipsoid, narrowly ellipsoid, or sometimes ovoid, 2-12 cm long, 1-3,5 cm wide, yellowish. From Costa Rica to Bolivia, Paraguay and Brazil.

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WOODSON, R.E. & R.W. SCHERY. 1958. Caricaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 45: 22-31.

Caryocaraceae

The Caryocaraceae is a small Amazonian centered family, usually of large canopy trees, with only two species reaching into Central America. **Leaves** opposite or alternate, always trifoliolate, the margin usually serrate, crenate or dentate, rarely entire, frequently stipellate, stipules sometimes present and then early caducous; **inflorescences** of terminal racemes; **flowers** bisexual, medium-sized to large, 5(-6)-merous, stamens numerous, the filaments rather long and usually basally united, ovary superior, 4-18-locular, styles 4-20, free; **fruits** drupes, endocarp muricate, tuberculate or spinulose outside, seeds 1-4 (*Caryocar*) or 8-20 (*Anthodiscus*). Confined to the Neotropics, reaching from Costa Rica to southern Brazil. Neotrop. 2/25, CR 2/2, GD 2/2.

The name of the family is derived from the Greek word "caryon" (= nut) and the Latin word "caro" (= flesh), because of the large fruit with fleshy mesocarp and woody endocarp of the type species *Caryocar nuciferum*.

Pollination studies on *Caryocar* were made by VOGEL (1968) in the Brazilian species *C. villosum*, which proved visited and pollinated by bats. Because most of the species of this genus display a similar morphology and flowering habit they are also supposed to be bat-pollinated (VOGEL 1968, PRANCE & DA SILVA 1973). Little is known about the pollination mode of *Anthodiscus*, but its flowers (medium sized, yellow petals) suggest pollination by insects rather than by bats (PRANCE & DA SILVA 1973).

Key to the genera (after PRANCE 1998)

1	Leaves alternate; calyx truncately dentate and reduced; ovary and fruit 8-20-locular; styles 8-20; radicle of embryo spirally twisted	*Anthodiscus*
1*	Leaves opposite; calyx deeply lobed; ovary and fruit 4(-6)-locular; styles 4; radicle of embryo straight	*Caryocar*

Anthodiscus (neotrop. 10, CR 1, GD 1)
Trees and shrubs with alternate, long petiolate, 3-foliolate leaves, the leaflets usually with crenate or entire margin. The terminal, elongate racemes bearing medium sized, usually white flowers with the petals apically fused, forming a conspicuous caducous calyptra.

A. chocoensis Prance
Tree, up to 40 m tall; leaflets elliptic, crenate, glabrous, except a few appressed hairs on the midrib beneath, terminal leaflet 12-15 cm long, 6-7 cm wide, lateral leaflets smaller; inflorescences elongate racemes, rhachis 5-6 cm long; calyx broadly cupuliform, corolla yellow, stamens numerous, ovary 12-locular; fruits flattened drupes, 1 cm long, 1,8-2 cm wide, upper part brown, lower part green. From Costa Rica to northwestern Colombia.

Caryocar (neotrop. 15, CR 1, GD 1)
Mostly large trees, but also shrubs or subshrubs with multistaminate, whitish or yellow flowers and with unique fruits having a spiny endocarp.

C. costaricense Donn. Sm., Pl. 46h,i
Common names (Costa Rica): ajo, ají, ajillo, caballo-kup (PRANCE & DA SILVA 1973).
Large tree, up to 50 m tall; leaves opposite, shortly petiolate, leaflets slightly asymmetrical, serrate, apex acuminate, stipels present; inflorescences clustered racemes with many flowers; flowers yellow, 5-merous, with numerous stamens with long filaments and with a conspicuous fragrance of garlic; immature fruits green, mature fruits yellow. In tropical lowland forests, from Costa Rica to northern South America.

DICKISON, W.C. 1990. A study of the floral morphology and anatomy of the Caryocaraceae. - Bull. Torrey Bot. Club 117 (2): 123-137.
PRANCE, G.T. 1987. An update on the taxonomy and distribution of the Caryocaraceae. - Opera Bot. 92: 179-183.
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VOGEL, S. 1968. Chiropterophilie in der neotropischen Flora. Neue Mitteilungen I. - Flora, Abt. B. 157: 565-569.

Caryophyllaceae

Annual or perennial herbs or subshrubs, often with swollen nodes and the bases of the opposite or verticillate leaves often connected across the stem. **Leaves** simple, entire, mostly opposite, sometimes succulent, stipules sometimes present; **inflorescences** terminal, dichasial cymes, sometimes compact and capitate, or flowers solitary in the axils or terminal; **flowers** actinomorphic, bisexual, rarely unisexual, sepals 4-5, free or united, persisting in fruit, sometimes subtended by calyx-like bracts (epicalyx), petals (0-)4-5, free, entire to deeply lobed or serrate at the apex, sometimes clawed, usually white, pink or red, stamens usually 5 or 10, often basally united, ovary superior, 1-locular; **fruits** usually longitudinally dehiscent capsules or achenes, rarely berries, seeds 1-numerous. Mainly in temperate regions of the northern hemisphere worldwide, with a few members in the tropical zone. Cosmopol. 87/2300, CR 9/18, GD 2/2.

Most species of Caryophyllaceae are pollinated by insects, mainly by lepidoptera, diptera and hymenoptera (BITTRICH 1993).

Only a few members of this family are of economic importance, e.g. some species of *Dianthus* or *Lychnis* which are used as ornamentals in horticulture. Several species of *Drymaria* are used in traditional medicine in Mexico and Ecuador (DUKE 1961b).

Key to the genera (after BAKER & BURGER 1983)

1	Stipules present at the leaf base (sometimes falling off early), leaf bases not clasping or sheathing the stem, interpetiolar lines often present	*Drymaria*
1*	Stipules absent, leaf base often clasping or sheathing the stem, an interpetiolar line or sheath often present	*Stellaria*

Drymaria (neotrop. + subtrop. 48 + 1 sp. pantrop., CR 3, GD 1)
Annual and perennial herbs, mainly of the New World, with only one widespread cosmopolitan species (*D. cordata*). They are characterized by the presence of usually minute stipules and with solitary or fasciculate flowers in the axils of the opposite leaves or in terminal cymes.
D. cordata (L.) Willd. ex Roem. & Schult.
Annual herb, prostrate to erect, glandular-puberulent to glabrate, often rooting at the nodes, leaves orbiculate to reniform, glabrous to scantily pubescent, stipules up to 2 mm long; inflorescences axillary or terminal, dichasial cymes or rarely flowers solitary in the leaf axils; flowers 5-merous, petals deeply bifid, stamens 2-3(-5); fruits ovoid, 3-valved capsules,1,5-2,5 mm long. Usually in weedy areas, from Florida and the West Indies and Central America to Paraguay and Argentina, as well as in the Old World in Africa, Asia and Oceania.

Stellaria (cosmopol. 150-200, CR 5, GD 1)
Annual or perennial herbs with erect or procumbent stems. The glabrous or rarely somewhat pubescent leaves are distinct in lacking stipules. The flowers are white and usually 5-merous.
S. irazuensis Donn.Sm.
Perennial, decumbent herbs; leaves broadly ovate to orbicular, 6-24 mm long, 4-18 mm wide, basally cordate, glabrous; inflorescences terminal, cymose, usually with 10-20 flowers; sepals 4, petals 2-4, minute; capsules ellipsoid, 4-valvate, dehiscent. From southern Mexico to Panama.

AYMARD, G.A. & N.L. CUELLO. 1998. Caryophyllaceae. In: J.A. Steyermark, P.E. Berry & B.K. Holst (eds.): Flora of the Venezuelan Guayana Vol. 4.
BAKER, R.A. & W. BURGER 1983. Caryophyllaceae. Pp.: 171-174. Flora Costaricensis. - Fieldiana Bot. 13, n.s.: 227-247.
BITTRICH, V. 1993. Caryophyllaceae. Pp: 206-236. In: K. KUBITZKI (ed.): The families and genera of vascular plants. Vol II. Magnoliid, Hamamelid and Caryophyllid families. Berlin: Springer Verlag.
DUKE, J.A. 1961a. Caryophyllaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 48: 90-106.
DUKE, J.A. 1961b. Preliminary revision of the genus *Drymaria*. - Ann. Missouri Bot. Gard. 48: 173-268.

Cecropiaceae

A family of terrestrial and hemiepiphytic trees and shrubs with watery or black sap in the vegetative structures. **Leaves** spirally arranged, entire to palmately incised, sometimes peltate, stipules present, connate, usually amplexicaul; **inflorescences** axillary, unisexual (plants dioecious), cymosely branched or unbranched, flowers clustered in heads or spikes or flowers solitary, bracteate or ebracteate; staminate **flowers** with 2-4 tepals, free or connate, stamens 1-4, free or connate, pistillate flowers with 2-4 tepals, connate, ovary superior, 1-locular; **fruits** achenes or more or less drupaceous (*Coussapoa*), free or enveloped by a more or less fleshy perianth, seeds small and with endosperm or large and lacking endosperm. Frequently in light areas, like open places or gaps or in secondary vegetation in the tropical lowland forests as well as up to 2000 m alt. in the Neotropics (*Cecropia*, *Coussapoa*, *Pourouma*), tropical Africa (*Musanga*, *Myrianthus*) and South East Asia (*Poikilospermum*). Pantrop. 6/180, CR 3/15, GD 3/8.

The family Cecropiaceae was formerly included in the Moraceae, until BERG (1978) classified it into its own family. Due to the presence of several urticaceous characters it is probably more closely related to the Urticaceae than to the Moraceae (CORNER 1962, BERG 1990).

Many species of *Cecropia* live in close association with the heavily stinging *Azteca* ants. These animals inhabit the hollow stems of the trees, which are subdivided by thin transverse walls at each node (ZIZKA 1990). Inside, the ants keep aphids to feed on their sugary secretions. Other important food sources are the "Müllerian bodies" (transformed hairs growing on a trichilium on the petiole base) and the "pearl bodies", which emerge from the petioles and the leaf surface. While the Müllerian bodies contain mainly glycogen, the main constituents of the pearl bodies are lipids (O'DOWD 1982). By providing food and

living space, *Cecropia* trees are defended by the ants against herbivores and overgrowing climbers and lianas.

Pollination studies on Cecropiaceae are lacking, but anemophily is assumed to be the pollination mode in *Cecropia* (KUBITZKI 1993).

Key to the genera (after BERG 1998)

1	Leaf blades peltate, radially incised	*Cecropia*
1*	Leaf blades basally attached, entire or palmately incised	2
2	Staminate flowers with 1 stamen or with 2 or 3 connate stamens; pistillate flowers sessile in globose (to ellipsoid) heads; fruits < 5 mm long; stipule scars usually ascending; leaves entire, usually with pinnate venation	*Coussapoa*
2*	Staminate flowers with (2-)4 free stamens; pistillate flowers pedicellate (to subsessile), solitary or in noncapitate clusters; fruits > 10 mm long; stipule scars horizontal; leaves entire to palmately lobed or parted, venation pinnate to subpalmate	*Pourouma*

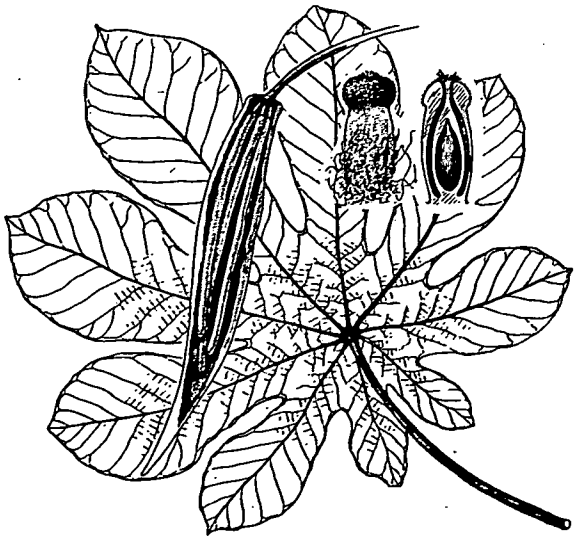
Cecropia (neotrop. ca. 75, CR 5, GD 3)
Common names (Costa Rica): guarumo (BURGER 1977, HOLDRIDGE et al.1997)

Trees with peltate palmately lobed leaves, with stems and branches having hollow internodes, which are often inhabited by *Azteca* ants.

Key to the species of *Cecropia* (after GONZÁLEZ, in prep.)

1	Upper surface of leaves smooth; pistillate inflorescences usually in groups of 6-7	*C. insignis*
1*	Upper surface of leaves coarse; pistillate inflorescences usually in groups of 4	2
2	Lamina with 11-13 lobes; pistillate spikes 18-50 cm long, staminate spikes 8-22 cm long	*C. obtusifolia*
2*	Lamina with 7-11 lobes; spikes much shorter	*C. peltata*

C. insignis Liebm., Pl. 47a,b
Tree up to 40 m tall; leaves deeply lobed, lobes usually 8-10, surface of lamina rough, stipules 18-34 cm long, pink or reddish; staminate inflorescences clusters of 5-7 spikes, these about 6 cm long, pistillate inflorescences clusters of 5-7 spikes, these (6-)8-12 cm long, accrescent in fruit; fruits small achenes. In wet forests, in primary and secondary vegetation, from Costa Rica to Colombia.



Cecropia obtusifolia

C. obtusifolia Bertol., Pl. 47c,d
Tree, up to 15 m tall; leaves deeply lobed, lobes usually 11-13, stipules fully amplexicaul, 5-12 cm long; staminate inflorescences pedunculate clusters of 12-18 spikes, these 8-22 cm long, subsessile or up to 5 mm stipitate, pistillate inflorescences pedunculate clusters of usually 4 spikes, these 18-50 cm long, sessile or shortly stipitate, accrescent in fruit; fruits small achenes, 2 mm long, 1,2 mm wide, usually flattened. On wet sites in clearings and secondary forest, from southern Mexico to Ecuador.

C. peltata L., Pl. 47e
Tree 6-20 m tall; leaves lobed to about the middle of the blade, lobes usually 7-11, stipules 6-9 cm long; staminate inflorescences clusters of 12-30 spikes, these 3-5 cm long with short, 3-5 mm long stipes, pistillate inflorescences clusters of 4-6 spikes, these 4-5 cm long, accrescent in fruit to 5-10 cm in length and 1 cm in diameter; fruits achenes. In clearings and thickets, from southern Mexico to northern South America and in the Greater Antilles.

Cecropia peltata

Coussapoa (neotrop. 50, CR 7, GD 5), Pl. 47g
Hemiepiphytic or terrestrial trees and shrubs with entire leaves and frequently having either stilt roots or aerial roots.
C. glaberrima W.C. Burger
Small hemiepiphytic or terrestrial tree; leaves obovate to narrow elliptic, subcoriaceous, glabrous, stipules ca. 1,2 cm long, caducous; inflorescences pedunculate, of several globose capitate clusters, staminate inflorescences of 10-12 pedunculate capitae, these ca. 2 mm in diameter; flowers with 2 stamens, pistillate inflorescences of 2-3 pedunculate capitae, these ca. 6 mm in diameter, accrescent in fruit; fruits achenes, enclosed in the fleshy perianth. In wet forests in Central America, from Nicaragua to Panama.

Pourouma (neotrop. > 25, CR 3, GD 1)
Usually epiphytic dioecious trees, frequently with stout and hollow branches, and with entire to lobed leaves.
P. bicolor Mart., Pl. 47f
Common names (Costa Rica): chumico, guarumo de montaña, lija (BERG et al. 1990)
Tree up to 15 m tall; leaves entire and 5-25 cm long, 3-18 cm wide to 3-5-lobed and 13-30(-42) cm long, 13-30(-40) cm wide, basally truncate to deeply cordate, glabrate to sparsely pubescent along the veins above, glabrate to yellowish-puberulous along the veins beneath, stipules 2-13,5(-25) cm long, white puberulous, caducous; staminate inflorescences up to 17 cm long, peduncle 2,5-7 cm long, pistillate inflorescences up to 26 cm long in fruit, branched, peduncle 1,5-14 cm long; flowers usually sessile, somewhat clustered; fruits small achenes. From Honduras and Belize to Amazonian Peru and Brazil.
This is a variable species, which can be subdivided into 5 subspecies, one of them, *P. bicolor* ssp. *scobina* is present in the Golfo Dulce region.

BERG, C.C. 1978. Cecropiaceae, a new family of the Urticales. - Taxon 27: 39-44.
BERG, C.C. 1998. Cecropiaceae. Pp.: 174-190. In: J.A. STEYERMARK, P.E. BERRY & B.K. HOLST (eds.): Flora of the Venezuelan Guayana Vol 4.
BERG, C.C., R.W.A. AKKERMANS & E.C.H. VAN HEUSDEN. 1990. Cecropiaceae: *Coussapoa* and *Pourouma*. - Fl. Neotrop. Monogr. 51.
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GONZÁLEZ, J. In prep. Cecropiaceae. Manuál de las plantas de Costa Rica. Missouri Botanical Garden. Instituto Nacional de Biodiversidad. Museo Nacional de Costa Rica.
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ZIZKA, G. 1990. Pflanzen und Ameisen, Partnerschaft fürs Überleben. - Palmengarten, Sonderheft 15.

Celastraceae

A family of trees and shrubs and a few lianas, rather nondescript, with opposite or alternate leaves, often with lenticellate twigs and with small, inconspicuous flowers. Plants frequently glabrous; **leaves** simple, rarely reduced, entire or dentate, stipules minute and early caducous or lacking; **inflorescences** terminal or axillary, mostly cymose, sometimes racemose, or flowers solitary and fasciculate; **flowers** bisexual or sometimes unisexual (then plants dioecious), usually greenish or greenish white, sepals 4-5, free or basally connate, petals 4-5, disk present, stamens 4-5, attached at the margin of the disk, ovary superior or half-inferior, 2-5-locular, style 1, rarely 5; **fruits** capsules, berries, drupes or samaras, seeds usually white or orange arillate. Mostly in the tropics but also in temperate regions worldwide. Cosmopol. ca. 40/ ca. 500, CR 11/25, GD 3/4.

Although the family is rather nondescript, it can be characterized vegetatively by several common features: twigs often irregularly angled from the decurrent petioles and looking somewhat zig-zag when young; twigs often lenticellate; inner bark often bright yellow.
The Hippocrateaceae are often included in the Celastraceae, from which they differ by having only 3 stamens, which arise from the center of the disk (HAMMEL, in prep.).
The only economically important species of Celastraceae is the South American *Goupia glabra*, which is an important timber tree.

Key to the genera (after HAMMEL, in prep.)

1	Leaves opposite	*Crossopetalum*
1*	Leaves strictly alternate	2
2	Inflorescences much-branched, generally wider than the leaves; fruits berries	*Perrottetia*
2*	Inflorescences little branched, usually narrower than the leaves, flowers sometimes solitary	*Maytenus*

Crossopetalum (neotrop. 30-36, CR 5, GD 2)
Shrubs or small trees with opposite, serrate leaves and 1-seeded drupaceous fruits.

Key to the species of *Crossopetalum* (after HAMMEL, in prep)

1	Inflorescences pubescent, much-branched; largest leaves mostly 10(-13) cm long, drying brownish; filaments nearly 1/2 the length of the petals	*C. parviflorum*
1*	Inflorescences glabrous, little branched, appearing almost umbellate; largest leaves, (12-)15 cm long or more, drying gray; filaments much shorter	*C. gomezii*

C. gomezii Lundell
Small shrub, up to 2 m tall; leaves elliptic, (12-) 16-18 cm long, (4,5)-7-8 cm wide, glabrous, inconspicuously dentate; inflorescences few-branched, few-flowered, glabrous; fruits obovoid, ca. 1 cm long, red. In wet lowland forests, endemic to southern Costa Rica.

C. parviflorum (Hemsl.) Lundell
(syn. *C. eucymosum* (Loes. & Pittier) Lundell)
Tree or shrub, up to 7 m tall; leaves elliptic, (6,5-) 9-12(-13) cm long, (2,5-)3-5(-6) cm wide, glabrous, inconspicuously dentate; inflorescences much-branched, many-flowered, pubescent; fruits obovoid, 1-2,5 cm long, red to purple. Usually in very wet lowland forests, from Mexico to Panama.

Maytenus (pantrop. ca. 225, CR 6, GD 1)
Small trees and shrubs, rather nondescript, with alternate, entire or serrate leaves and capsular fruits.

Perrottetia (pantrop ca. 25, CR 3, GD 1)
Dioecious trees and shrubs with alternate and serrate or rarely entire leaves. Distinct in having large paniculate inflorescences of pyramidal shape, bearing inconspicuous greenish flowers.

P. sessiliflora Lundell
Tree, up to 15 m tall; leaves oblong-elliptic, entire; inflorescences ca. 6 cm long, yellowish pubescent; flowers sessile. In wet forests up to 800 m ranging from Costa Rica to Ecuador and Peru.

EDWIN, G. & D. HOU. 1975. Celastraceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 62: 45-56.

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KEARNS, D.M. 1998. Celastraceae. Pp.: 190-197. In: J.A. STEYERMARK, P.E. BERRY & B.K. HOLST (eds.): Flora of the Venezuelan Guayana Vol. 4.

LUNDELL, C.L. 1985. Neotropical species of the genus *Perrottetia* (Celastraceae). - Phytologia 57 (3): 231-238.

Chloranthaceae

Trees and shrubs with aromatic odor, vegetatively well characterized by the petioles of the opposite leaves often being connate, forming a sheathlike structure. **Leaves** opposite, simple, usually glabrous, margins serrate or dentate, stipules present; **inflorescences** axillary or terminal, racemes or panicles; **flowers** bisexual or unisexual (then plants monoecious or dioecious), small, inconspicuous, usually greenish, perianth of three tepals, sometimes lacking, sometimes subtended by 1-3 bracts, stamens 1-3, adnate to the ovary in perfect flowers, ovary inferior, 1-locular, stigma sessile; **fruits** drupes, seed 1. Pantrop. + subtrop. 4/75, CR 1/6, GD 1/2.

The Chlorantaceae are one of the oldest angiosperm families, with the first fossil records dating from the early Cretaceous (CRANE et al. 1989, 1995, HERENDEEN et al. 1993, ZHOU 1993, EKLUND et al. 1997). The genus *Sarcandra* is one of very few woody angiosperm genera lacking vessels in the xylem (BURGER 1977).

Systematically and biologically the family can be divided into two groups, the one with the more primitive genera *Sarcandra* and *Chloranthus,* the other with the more advanced genera *Ascarina* and *Hedyosmum* (ENDRESS 1987).

Field observations on the pollination of the Chloranthaceae are rare, but the floral morphology suggests that the clossely related genera *Sarcandra* and *Chloranthus* are probably pollinated by insects (coleoptera, diptera), while *Ascarina* and *Hedyosmum* are probably wind-pollinated (ENDRESS 1987, 1990). YI-BO & ZHEN-YU (1999) found that thrips are the exclusive pollinators of two species of *Chloranthus*.

The berry-like fleshy fruits of Chloranthaceae are mainly eaten by birds (ENDRESS 1990).

Hedyosmum (neotrop. 45, CR 6, GD 2)
This is the only neotropical genus. It is characterized by conspicuous leaf sheaths, formed by the petiole bases and with the male flowers reduced to a single stamen. Mostly growing in wet habitats in the cloud forests of the Neotropics. Only one species is found in southeast Asia.

H. brenesii Standl.
Monoecious erect or scandent shrub, up to 2,5(-5) m tall; leaves usually linear-lanceolate, subsessile; inflorescences unisexual, male inflorescences single spikes, 1,4-2 cm long, female inflorescences short panicles, 1,5-3,5 cm long, with several greenish flowers; fruits purple to black, 3-4 mm long, 2-3 mm wide. In lower montane or premontane rainforests in Central America, from Honduras to Panama.

H. scaberrimum Standl., Pl. 48a
Monoecious or dioecious shrubs or treelets, up to 10 m tall; leaves acuminate, petiolate, margin serrulate; inflorescences unisexual, male inflorescences of solitary spikes (on unisexual plants) or of 3-4 spikes on a common axis (on bisexual plants), female inflorescences axillary or terminal racemes or panicles with several cymules of (1-) 2(-4) greenish flowers; fruits white, 8-12 mm long, 6-10 mm wide. In primary and secondary forests, from southeastern Costa Rica to northern Colombia and Ecuador.

BURGER, W.C. 1977. Chloranthaceae. Flora Costaricensis. - Fieldiana Bot.40.

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D'ARCY, W.G. & R.L. LIESNER. 1981. *Hedyosmum* (Chloranthaceae) in Panama. - Syst. Bot. 6 (1): 74-86.
EKLUND, H., E.M. FRIIS & K.R. PEDERSEN. 1997. Chloranthaceous floral structures from the Late Cretaceous of Sweden. - Pl. Syst. Evol. 207: 13-42.
ENDRESS, P.K. 1987. The Chloranthaceae: reproductive structures and phylogenetic position. - Bot. Jahrb. Syst. 109: 153-226.
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HERENDEEN, P.S., W.L. CREPET & K.C. NIXON. 1993. *Chloranthus*-like stamens from the Upper Cretaceous of New Jersey. - Amer. J. Bot. 80: 865-871.
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ZHOU, Z.K. 1993. Origin, systematics and distribution of Chloranthaceae. - Acta Bot. Yunnanica 15 (4): 321-331.

Chrysobalanaceae

A pantropical family, closely related to the temperate centered Rosaceae, from which it was recently separated. Trees, shrubs or subshrubs, usually with reddish inner bark; **leaves** simple, alternate, entire, glabrous or pubescent beneath, always with 2 persistent or caducous stipules of various shape, glands sometimes present on leaves; **inflorescences** racemose, paniculate or cymose; **flowers** actinomorphic or zygomorphic, usually bisexual, disk always present, sepals 5, petals (4-)5, sometimes lacking (in some *Licania*), stamens 2-200, all of them fertile, or sometimes a few of them reduced to staminodes, ovary superior, 3-locular, usually 2 of them reduced; **fruits** 1-seeded, dry or fleshy drupes of various size. Distributed in all lowland tropical regions on both hemispheres. Pantrop. 17/460, CR 6/32, GD 6/22.

Key to the genera (after PRANCE, in prep.)

1	Ovary inserted at base of receptacle	2
2	Fruit costate; stamens united for half length, exserted; inflorescences of cymules	*Chrysobalanus*
2*	Fruit not costate; stamens free to base, or if united then included; inflorescences panicles or racemose panicles	*Licania*
1*	Ovary inserted at mouth of receptacle	3
3	Ovary bilocular	4
4	Leaf underside lanate, with stomatal cavities; stamens 7-8, included; fruit exterior lenticellate	*Parinari*
4*	Leaf underside glabrous without cavities; stamens 17-20, exserted; fruit exterior smooth	*Maranthes*
3*	Ovary unilocular	5
5	Leaf underside lanate pubescent, stamens 11-21; fruits obovoid, 5-7 x 3-4,5 cm	*Couepia*
5	Leaf underside glabrous or hirsute; stamens 3-7; fruits ellipsoid, not exceeding 3,5 cm long	*Hirtella*

Chrysobalanus (pantrop. 2, CR 1, GD 1)
A small genus of shrubs and small trees with glabrous leaves and terminal or axillary cymules. The fruits are small, fleshy drupes.

C. icaco L.
Common name (Costa Rica): icaco (PRANCE, in prep.)
Small shrub or tree up to 5 m tall; leaves orbicular to ovate elliptic, 2-8 cm long, 1,2-6 cm wide, glabrous, stipules deciduous; inflorescences axillary and terminal, small; flowers white; fruits 1,8-5 cm long, edible. In coastal areas on sandy beaches, from Mexico to Venezuela, the Guianas and coastal Brazil, cultivated in the Paleotropics.

Hirtella (cosmopol. 103, CR 9, GD 8)
A genus of understory shrubs and small trees with zygomorphic and usually small flowers in racemose or paniculate inflorescences.

H. racemosa Lam., Pl. 48b
Shrub or small tree; leaves elliptic to oblong, 3,5-

16,5(-19,5) cm long, 1,5-7 cm wide, glabrous or sparsely pubescent beneath, stipules linear, persistent; inflorescences axillary and terminal, racemose, bracts and bracteoles persistent, usually with sessile glands mostly towards the base or with a single large gland; petals 5, pink, stamens 5-7; fruits ellipsoid. Widely distributed from Mexico to Peru and Brazil.

H. triandra Sw.
Tree, up to 15 m tall; leaves oblong to elliptic, 4-14,5 cm long, 2-5,5 cm wide, with stiff appressed hairs beneath, stipules linear, persistent; inflorescences axillary and terminal, paniculate, bracts and bracteoles persistent, eglandular; petals 5, stamens 3; fruits ellipsoid, berry-like. Growing in a wide range of habitats, from Mexico through Central America and the Lesser Antilles to Bolivia and Brazil.
This species can be subdivided into three subspecies. Only the most common one, *H. triandra* ssp. *triandra* can be found in Costa Rica.

Licania (neotrop. 193, CR 17, GD 10)
Trees and shrubs largely neotropical but with one widespread Asian species. Very variable genus with the flowers usually in racemose panicles and the dry or fleshy drupaceous fruit often very large, with a smooth or verrucose surface, glabrous or covered with tomentellous hairs. The species are usually hard to recognize, but several of them can be identified by at least one of the following characteristic features: whitish or gryish leaf undersurface, the lack of petals or petioles, or the leaf base usually with two or more sessile glands.

L. platypus (Hemsl.) Fritsch
Medium to large tree, leaves oblong to oblong-lanceolate, glabrous with 2 glands at the base beneath, petiole glands lacking, stipules persistent; flowers 3-4 mm long, petals 5, glabrous, stamens 15-20; fruits ellipsoid to ovoid, up to 15 cm long. Usually found in riverine forests, but also away from rivers, from southern Mexico to northern Colombia.

L. sparsipilis Blake
Medium sized tree; leaves elliptic to oblong, glabrous, petiole with 2 sessile glands, stipules caducous; flowers small, sessile, petals lacking, stamens 8-10. In lowland rainforests, sometimes common on hilly terrain in Central America, from Honduras to Panama.

PRANCE, G.T. 1972. Chrysobalanaceae. Fl. Neotrop. Monogr. 9.
PRANCE, G.T. 1986. Chrysobalanaceae. In: GORTS VAN RIJN (ed.): Flora of the Guianas, ser. A, Nr. 85. Koeltz Scientific Books.
PRANCE, G.T. 1989. Chrysobalanaceae. Fl. Neotrop. Monogr. 9 S.
PRANCE, G.T. In prep. Chrysobalanaceae. Manuál de las plantas de Costa Rica. Missouri Botanical Garden. Instituto Nacional de Biodiversidad. Museo Nacional de Costa Rica.

Clethraceae

A small monogeneric family of small trees and shrubs, characterized by the usually white or grayish leaf underside, as a result of the dense pubescence of stellate trichomes (lacking only in a few species). **Leaves** simple, alternate, often clustered at the twig ends, margin often serrate or dentate, rarely entire, stipules lacking; **inflorescences** terminal, sometimes axillary, racemose or paniculate, dense-flowered; **flowers** actinomorphic, bisexual, rarely unisexual (then plants gynodioecious), white or pinkish, sepals 5(-6), basally connate, petals 5(-6), basally connate, stamens 10(-12), free or basally adnate to the petals, ovary superior, 3-locular, style 1; **fruits** trilobate capsules, subglobose, loculicidally 3-valvate, calyx and style persistent, seeds few to numerous. In tropical and subtropical Asia, America and the Madeira Islands. Pantrop. 1/64, CR 1/5, GD 1/1.

The species of *Clethra* are usually light-demanding and therefore mostly found in open habitats, e.g. open or secondary forests, forest edges, thickets, etc. (SLEUMER 1967). While temperate species are mainly found in the lowlands, the tropical and subtropical taxa are mostly mountain plants, except in Central America and New Guinea, where they also occur down to sea level (SLEUMER 1967).

Temperate species of *Clethra* are cultivated as ornamentals for their fragrance and for their showy flowers (SLEUMER 1967). The wood of *C. mexicana* is used locally for making furniture (SLEUMER 1971).

Clethra (neotrop. + trop. Asia 64, CR 5, GD 1)
See characters of the family.

C. mexicana A.DC.
Small tree or shrub, up to 30 m tall, buttresses sometimes present; leaves clustered at the twig ends, 7-18 cm long, 3-9 cm wide, chartaceous to subcoriaceous, entire to slightly denticulate, stellate pubescent; inflorescences racemose, 4-10, (sub-)fasciculate, 8-26 cm long; flowers white, sweetly aromatic, 5-merous; fruits transversely-elliptic, up to 6 mm in diameter, seeds 3. Widely distributed, from Mexico to Panama and northern South America (Colombia, Venezuela and Trinidad).

GUSTAFSSON, C. 1992. Clethraceae. In: G. HARLING & L. ANDERSSON (eds.): Flora of Ecuador No. 45.
MILLER, J.S. & P. BERRY. 1998. Clethraceae. Pp.: 246-247. In: J.A. STEYERMARK, P.E. BERRY & B.K. HOLST (eds.): Flora of the Venezuelan Guayana Vol. 4.
ROBERTSON, K.R. 1967. Clethraceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 54 (3): 389-392.
SLEUMER, H.O. 1967. Monographia Clethracearum Part I. - Bot. Jahrb. Syst. 87 (1): 36-116.
SLEUMER, H.O. 1971. Clethraceae. Pp.: 171-183. In: T. LASSER (ed.), Flora de Venezuela. Vol III. Primera Parte.

Clusiaceae

The Clusiaceae is a large cosmopolitan family. Many species are used in the production of timber, drugs, dyes and fruits. Glandular secretions are produced in all members of the family in canals or lacunae within stems, leaves and floral parts. The plants are trees, shrubs, herbs, often epiphytes or hemiepiphytes with white, yellow, orange or sometimes colorless latex; **leaves** opposite, often leathery; **inflorescences** paniculate or racemose, or flowers solitary; **flowers** bisexual or unisexual, then plants dioecious, sepals 2-5, free or basally connate, petals 2-6 free, imbricate or contorted, male flowers: stamens numerous, free or united in fascicles, female flowers: ovary superior, 1-pluri-locular; **fruits** capsules, drupes or berries, seeds often arillate (Clusia, lat. clusus = closed, the presence of a aril). Cosmopol. (predominantly in the tropics) ca. 40/ca. 1,000, CR 14/72, GD 8-9/31.

The subdivision of the Clusiaceae into five subfamilies is based primarily on sex distribution, androecium, ovary, fruit and seed characters. The five subfamilies are: Hypericoideae (sometimes treated as a separate family; *Vismia*), mostly consisting of shrubs or herbs at high altitudes, Kielmeyeroideae and Moronobeoideae (*Symphonia*) with bisexual flowers, Calophylloideae (*Calophyllum*), and Clusioideae (*Clusia* incl. *Garcinia, Tovomita, Chrysochlamys*) with mostly unisexual flowers.

Preliminary observations indicate that the various groups within the genus *Clusia* have somewhat different pollination syndromes. *C. flava* appears to attract only small weevils, but members of the other groups attract bees. The resin produced in flowers of *C. minor* is gathered by bees for nest building (SKUTCH 1971). Additionally, apomixis is found in some species (MAGUIRE 1976). The pollination biology of *Symphonia globulifera* was studied in central Amazonia, Brazil (BITTRICH & AMARAL 1996). As suggested by the ornithophilous syndrome, the flowers are mainly pollinated by hummingbirds.

Key to the genera (after WOODSON & al 1980)

1	Inflorescences elongate, unbranched racemes; fruit linear with a narrow beak terminated by the globose stigma	*Marila*
1*	Inflorescences cymose, if racemose then short; fruit ovoid to ellipsoid, if narrow then unbeaked and with 5 or more stigmas	2
2	Leaves stellate pubescent and pellucid punctate below, the hairs rusty brown; petals densely woolly inside	*Vismia*
2*	Leaves without stellate hairs, essentially glabrous	3
3	Leaves with many straight, closely parallel (< 1 mm apart) lateral veins	4
4	Fruits indehiscent, single-seeded; leaves basally obtuse to rounded and with an obvious petiole	*Calophyllum*

4*	Fruits dehiscent, seeds one per locule; leaves basally narrowed and abruptly narrowed, essentially without petiole	*Tovomita weddelliana*
3*	Leaves with lateral veins often arcuate and forking, more distant if parallel	5
5	Fruits indehiscent; styles mostly united or obsolete	6
6	Petiole with a margined pit adaxially at the base; stamens free; young twigs without stipule-like structures	*Garcinia*
6*	Petiole without a margined pit adaxially at the base; stamens united into a column; young twigs with small, paired, black, interpetiolar, stipule-like structures	*Symphonia*
5*	Fruits dehiscent; styles mostly divaricate or obsolete	7
7	Ovules 2 to many per carpel; seeds numerous, ca. 3 mm; plants usually hemi- or epiphytic	*Clusia*
7*	Ovules 1-2 per carpel; seeds few, ca. 10 mm; plants mostly free standing	8
8	Outer perianth partly or completely fused in bud; usually with conspicuous stilt roots; leaves clustered on short shoots	*Tovomita* p.p.
8*	Perianth members all free, often imbricate; leaves never clustered on short shoots	*Chrysochlamys*

Alternative key to the genera (after HAMMEL 1986b)

1	Flowers in racemes more than 10 cm long; stamens with linear appendages ca. 1/2 the length of the anther; ovary with a single style and stigma; fruit slender dry capsule, the valves often twisting; seeds comose at each end; lower leaf surface with very prominent secondary veins, conspicuously loop-connected near the margin, and with numerous perpendicular cross veins	*Marila*
1*	Flowers in panicles, fascicles or, if racemes, then less than 5 cm long, stamens without appendages; ovary with 3 or more stigmas (except 1 in *Calophyllum*); fruit a berry, drupe or fleshy capsule; seeds not comose; leaves lacking numerous perpendicular cross veins	2
2	Leaves stellate pubescent and pellucid punctate below, the hairs rusty brown; petals wholly pubescent within	*Vismia*
2*	Leaves glabrous or minutely puberulent with simple hairs, not pellucid punctate; petals glabrous within	3
3	Plants epiphytic	*Clusia*
3*	Plants terrestrial	5
5	Flowers in panicles; fruits fleshy capsule	6
6	Outer pair of sepals imbricate, not fused in bud, petaloid in color and texture but smaller, deciduous in fruit; leaves with a definite petiole, the blade elliptic to oblong	*Chrysochlamys*
6*	Outer pair of sepals valvate or fused in bud, much different from the petals in color and texture but similar in size, persistent, clasping the base of the fruit; mature flower buds ca. 1 cm in diameter; leaves gradually narrowed to the base, petiole lacking, the blade spatulate	*Tovomita*
5*	Flowers in fascicles or racemes; fruits drupes	7
7	Secondary veins less than 1 mm distant, and very straight; sap resinous or whitish; canopy trees 25-35 m tall	*Calophyllum*
7*	Secondary veins 3 mm or more distant, curving and often reticulate near the margin; sap yellow; understory trees less than 15 m tall	8
8	Flowers showy, corolla globose in bud, the petals contorted, later depressed to form a red and white pinwheel about 2 cm in diameter; midrib plane above; secondary veins barely visible in fresh material; very striking stilt roots	*Symphonia*
8*	Flowers inconspicuous, yellow green, 2-3 mm in diameter; midrib prominent above; secondary veins also slightly prominent above and below in fresh material	*Garcinia*

Calophyllum (pantrop. ca. 100, CR 3, GD 2)
Dioecious or hermaphroditic trees with a sulfur yellow latex. Leaves with very fine, close spaced and undifferentiable secondary and intersecondary veins. *Colophyllum* and *Mammea* are the only New World members of subfamily Calophylloideae. Both have more species in the Old World, especially in the Indo-Malesian region.

Key to the species of *Calophyllum* (after HAMMEL, in prep.)

1 Leaf apex mostly acute to acuminate, leaves mostly < 5(-7) cm wide; midrib adaxially sulcate only at base, if at all — *C. brasiliense*

1* Leaf apex mostly rounded, leaves > 7 cm wide — *C. longifolium*

C. brasiliense Cambess., Pl. 48d
Subcanopy tree, 20-25 m tall, trunk distinctly furrowed with shallow vertical reticulating lines, sap creamy; leaves elliptic, 3-22 cm long, 1,5-6 cm wide, base acute; inflorescences axillary, short racemes, mostly 3-7 flowered; flowers with tepals greenish to white, male flowers with a small ovary, female flowers with numerous fertile stamens; fruits drupes, globose, apiculate, ca. 1,5 cm in diameter, green. From Mexico to Costa Rica.

C. longifolium Willd., Pl. 48c
Tree, up to 30 m tall; leaves elongate-elliptic, 20-25 cm long, 7-9 cm wide, base acute to rounded; inflorescences ca. 4 cm long, finely rufous pubescent, fruits globose. In wet forests, from Costa Rica to northern South America.

Chrysochlamys (neotrop. 20, CR 8, GD 7)
Trees or shrubs with white or yellow sap and with opposite and later often alternate, simple and entire leaves. The fruits are always leathery or fleshy capsules.

C. myrcioides Triana & Planch.
Tree to 15 m tall; leaves elliptic, coriaceous, to 25 cm long, 15 cm wide, glabrous, sometimes drying pinkish; inflorescences terminal, to 15 cm long, cymose, pyramidal panicle; flowers unisexual; fruits ovoid to obovoid, 3,5 cm long, ca. 2 cm in diameter, dark red, seeds enveloped by a large aril. From Costa Rica to Colombia.

Clusia (neotrop. ca. 150, CR 31, GD 9)
Common name (Costa Rica): matapalo
Together with *Ficus,* this genus is the main constituent of hemiepiphytic shrubs or trees in the Neotropics. The dioecious plants contain a milky colored sap and often have long, straight, woody free-hanging roots, reaching to the ground. The leaves are thick, leathery and rigid and many of them use the CAM-photosynthetic pathway.

C. rosea Jacq.
Epiphytic or free standing tree, up to 30 m tall, sometimes strangling, sap yellow; leaves spatulate, 9-14 cm long, 7-11 cm wide, inflorescences 1-2-flowered, flowers white to pink; fruits globose, usually 4-5 cm in diameter, greenish-white. In moist to wet forests and pastures, from the southern U.S. to northern South America.

C. osaensis Hammel ined., Pl. 48g
Epiphytic or rarely free-standing shrub or tree, 3-7 m tall, sometimes strangling, sap clear; leaves broadly obovate-elliptic, 11-16 cm long, 5-9 cm wide, inflorescences open few-flowered, flowers cream-colored; fruits ovoid-elongate, usually 6 x 3 cm, greenish, seeds elongate with orange arils. In wet to very wet forests, from San Vito to Golfito and the Osa Peninsula.

C. valerii Standl., Pl. 48e, f
Large epiphytic shrubs, rarely terrestrial, sap thick, white; leaves obovate-elliptic, 10-24 cm long, 5-12 cm wide, leathery; male inflorescences 5-7 cm long, 5-7 cm wide, 3-7 flowered, female inflorescences 5-7 cm long, 5-7 cm wide, 1-3 flowered; male flowers large and showy, sepals white, petals 5-7, fleshy, white abaxially, reddish pink within, stamens numerous, becoming fused by a resinous exudate that covers the surface of the androecium, both of the female flowers and the male ones, but the ovary subtended by a 5-7 mm high staminodial ring or cup, which also exudes a sticky resin; fruits capsules, ovoid, 3,5-5 cm long, 2,5-3,5 cm wide, reddish pink, inner wall of the fruit valves forming a thick, white bony endocarp. From Costa Rica to Colombia.

Garcinia (pantrop. 200, CR 5, GD 4)
Dioecious trees and shrubs with bright yellow sap and usually with nocturnal flowers. The inflorescences are axillary fascicles of flowers.

G. madruno (Kunth) Hammel, Pl. 48h
Tree up to 20 m tall; leaves elliptic, 12-22 cm long, 5-10 cm wide; fruits ovoid, 3-5 cm long, green to yellow, seeds surrounded by a sweet, edible aril. In very wet forests, from Nicaragua to Paraguay.

Marila (neotrop. 15, CR 4, GD 2)
Shrubs or trees with clear or brownish-orange sap. The racemose, often pendent inflorescences bearing many flowers. A distinct feature is the venation with very prominent secondary veins and finely parallel tertiary veins.

M. laxiflora Rusby, Pl. 48i
Trees up to 15(-25) m tall, younger branches densely glandular pubescent, latex yellow-brown; leaves 10-22(-27) cm long, 5-10 cm wide; inflorescences axillary, often in the axils of fallen leaves, 10-30 cm long; flowers green, fragrant; fruits linear capsules, 2,5-7 cm long, yellow-brown. In wet to very wet forests, from Mexico to Bolivia.

Symphonia (neotrop., Africa and Madag. ca. 18, CR 1, GD 1)
Trees and shrubs, usually with large stilt roots and a characteristic pagoda-style branching. The latex is always bright yellow.

S. globulifera L.f., Pl. 49a-c
Large trees, to 30 m tall; leaves elliptic to oblong elliptic, 8-13,5 cm long, 3,5-5,5 cm wide; inflorescences few- to many-(5-20) flowered; flowers bisexual, sepals 5, pink, petals 5, brightly bi-colored, pinwheel red and white, the anthers borne on the outer surface of the flaring segments of the staminal column; fruits globose berries with a thin exocarp, green at maturity, seeds 1-2 without an aril. The most wide-ranging species of Clusiaceae and perhaps one of the most wide-ranging native species within the Costa Rican flora, ranging from Central America and the West Indies to South America, as well as in Africa and Madagascar.

Tovomita (neotrop. ca. 60, CR 4, GD 3)
Terrestrial trees with capsular fruits like *Clusia*, but the seeds relatively large and only one or two per locule. The seeds are covered by a fleshy, usually orange "arilloid" (from the integument). The combination of conspicuous stilt roots and a characteristic branching with the leaves clustered on short shoots separated by longer internodes is very typical of the genus. The fruits are warty and brown, with the carpels completely reflexed to expose a red to purplish placenta and inner fruit wall.

T. weddelliana Planch. & Triana, Pl. 49d,e
Trees, dioecious, or sometimes hermaphroditic, 4-20 m tall, often with a few stout adventitious roots, sap resinous and clear to somewhat milky; leaves spatulate 14-47 cm long, 3-8 cm wide, base gradually narrowed to a winged petiolar region; inflorescences terminal, few flowered cymes; flowers unisexual, seemingly bisexual, with numerous staminodia, sepals, green, accrescent in fruit, petals membranaceous, translucent white; fruits pyriform capsules, 3-3,5 cm long, topped by 4-6 small, sessile stigmas, green or reddish, splitting at maturity with the valves reflexed, fruit wall (inside) and axis dark red, seeds with orange arilloid. From Costa Rica to Bolivia.

Vismia (neotrop. + Africa 54, CR 6, GD 3)
Mostly second-growth trees or shrubs with resinous yellow to orange latex and perfect flowers. The leaf surfaces are usually stellate pubescent and pellucid punctate beneath. The fruit is a smooth fleshy berry or rarely 5-lobate with a thin pericarp and apparently dehiscent when dry and contain many seeds without an aril. The flowers are visited by bees and the fruits are eaten by birds and possibly bats.

Key to the species of *Vismia* (after ROBSON 1998)

1	Stamen fascicles persisting after petals fall	*V. macrophylla*
1*	Stamen fascicles deciduous with petals	*V. baccifera*

V. baccifera (L) Triana & Planch., Pl. 49g,h
Shrub or tree, to 25 m tall, young twigs brown to ferruginous pubescent; leaves usually ovate to elliptic, 7-17 cm long, 2,5-10 cm wide, reddish pellucid-punctate; inflorescences terminal to 8 cm long; flowers bisexual, ca. 1 cm long. Fruits ovoid berries, ca. 1,5 cm long, green, seeds many. In older clearings, from Mexico to Colombia, Venezuela and Brazil.

V. macrophylla Kunth, Pl. 49f
Tree, 4-25 m tall, branchlets densely ferruginous pubescent; leaves with 18-31 pairs of parallel, rather widely spaced lateral veins; inflorescences terminal, many flowered; flowers heterostylous, sepals stellate-dendroid pubescent, persistent in fruit, petals distally glandular punctate, greenish white to cream, stamen fascicled, persistent in fruits, fruits globose to ovoid capsules, 1-1,5 cm in diameter, green to olive brown or reddish. From Mexico to central Brazil.

BITTRICH, V. & M.C.E. AMARAL. 1996. Pollination biology of *Symphonia globulifera* (Clusiaceae). - Pl. Syst. Evol. 200: 101-110.

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D'ARCY, W.G. 1980. Guttiferae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. Ann. Missouri Bot. Gard. 67: 969-1043.

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HAMMEL, B.E. In prep. Clusiaceae. Manuál de las plantas de Costa Rica. Missouri Botanical Garden. Instituto Nacional de Biodiversidad. Museo Nacional de Costa Rica.

MAGUIRE, B. 1976. Apomixis in the genus *Clusia* (Clusiaceae) - A preliminary report. - Taxon 25 (2/3): 241-244.

ROBSON, K.B. 1998. *Vismia*. Pp.: 322-329. In: J.A. STEYERMARK, P.E. BERRY & B.K. HOLST (eds.): Flora of the Venezuelan Guayana Vol. 4.

SKUTCH, A.F. 1971. A naturalist in Costa Rica. - Gainsville: Univ. Florida Press.

Cochlospermaceae

Trees, shrubs and herbs, well characterized by the presence of usually red or yellow-colored sap, even in the perianth parts. **Leaves** alternate, simple or palmately lobed or -compound, entire to serrate, stipules present, caducous, sometimes persistent; **inflorescences** terminal, racemose or paniculate, usually flowering when leafless; **flowers** actinomorphic or slightly zygomorphic, bisexual, large and conspicuous, sepals 5, free, petals 5, free, yellow, stamens numerous, free, ovary superior, 1-locular; **fruits** loculicidal capsules, dehiscing by 3-5 valves, seeds numerous, glabrous, short tomentose or sometimes embedded in dense, kapok-like indumentum. Pantrop. 2/ca. 15, CR 1/1, GD 1/1.

Little is known about the pollination of Cochlospermaceae. *C. vitifolium* was investigated by ROUBIK et al (1982) in the forests of Panama, where they observed anthophorid bees of the genera *Centris* and *Xylocopa* as the main pollinators.

Species of *Cochlospermum* are locally cultivated for their seed hairs, which are used as a substitute for cotton. The roots as well as the fruits and seeds of *Cochlospermum* spp. are eaten by some indigenous tribes. In some cases, species of *Cochlospermum* are used in local medicine (e.g., against stomach troubles, jaundice etc.) (POPPENDIECK 1980).

Cochlospermum (pantrop. ca. 12, CR 1, GD 1)
Trees and shrubs with entire, palmately lobed or -divided leaves and the seeds always embedded in white, kapok-like indumentum.

C. vitifolium (Willd.) Spreng., Pl. 50a-c
Common name (Central America): poro poro (POPPENDIECK 1980)
Tree up to 20 m tall, few-branched; leaves simple, 3-5(-7)-lobate, ca. 30 cm in diameter, margin serrate, stipules small, early caducous; inflorescences terminal, paniculate, 10-25 cm long; capsules obovate, 5-valved, 5-8 cm long, 4-6 cm wide, grayish to brownish tomentellous. Widely distributed in Central America and northern South America and sometimes also cultivated in Africa and South East Asia.

MOLAU, U. 1983. Cochlospermaceae. In: G. HARLING & L. ANDERSSON (eds.): Flora of Ecuador 20: 11-13.

POPPENDIECK, H.H. 1980. A monograph of the Cochlospermaceae. - Bot. Jahrb. Syst. 101 (2): 191-265.

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ROUBIK, D.W., J.D. ACKERMAN, C. COPENHAVER & B.H. SMITH. 1982. Stratum tree and flower selection by tropical bees: implications for the reproductive biology of outcrossing *Cochlospermum vitifolium* in Panama. - Ecology 63 (3): 712-720.

Combretaceae

Trees, shrubs, subshrubs, or frequently lianas, sometimes in mangroves, rarely spiny. **Leaves** alternate or opposite, spirally arranged, simple, entire, glandular trichomes sometimes present, of 2 types: short,

capitate stalked glands and subsessile peltate scales, stipules absent; **inflorescences** axillary or terminal, capitate to expanded spikes or panicles bearing the same glandular trichomes as the leaves; **flowers** actinomorphic or sometimes weakly zygomorphic, bisexual or unisexual (plants then dioecious), 4- or 5-merous, hypanthium (receptacle) surrounding the ovary (lower hypanthium) and extended beyond into a saucer- to tube-shaped upper hypanthium bearing the stamens and perianth, sepals 4-5(-8), usually small, rarely accrescent, petals 4-5, usually borne at or near the top of the upper hypanthium, often small or lacking, sometimes conspicuous, stamens usually twice as many as the sepals, borne inside the upper hypanthium usually at two levels, nectariferous disk often present at base of upper hypanthium, ovary 1-locular; **fruits** indehiscent, pericarp dry or succulent, often with 2-5 papery to leathery wings, seed 1. Pantrop. + subtrop. 20/500, CR 6/16, GD 5/13.

The flowers of *Combretum fruticosum* produce copious nectar and are visited mainly by hummingbirds and perching birds, and to some extent also by insects (SCHEMSKE 1975, 1980; GRYJ et al. 1990; BERNARDELLO 1994). *C. lanceolatum*, a species of the Brazilean cerrado, displays the bat-pollination syndrome with white flowers and copious nectar. PRANCE (1980) observed *Cebus* monkeys foraging on the nectar of this species and suggested them to be probable secondary pollinators. The pollination of some Indian species of *Terminalia* was investigated by SRIVASTAVA (1993). The entomophilous flowers of these species were visited by a wide range of insects, among them butterflies, flies, and various bees. The wood of *Conocarpus erectus* is fine-grained, heavy, and strong. In some regions it is employed for construction and for the production of charcoal. It is said that the bark is rich in tannin. *Terminalia catappa* provides edible seeds. Its wood is hard, fine-grained, and reddish brown. Its roots, bark, and fruits also contain high concentrations of tannin and are utilized for tannin skins.

Key to the genera (after JIMÉNEZ, in prep.)

1	Trees or shrubs	2
2	Leaves opposite	*Laguncularia*
2*	Leaves alternate or spirally arranged	3
3	Lamina of the leaves usually with domatia; flowers on globose heads	*Conocarpus*
3*	Lamina of the leaves without domatia; flowers in spikes or racemes	4
4	Fruits winged (except in *T. catappa*); stamens with versatile anthers	*Terminalia*
4*	Fruits drupaceous; stamens with basifixed anthers	*Buchenavia*
1*	Climbers or lianas, rarely with spines	*Combretum*

Buchenavia (neotrop. 20, CR 2, GD 2)
Trees without glandular hairs, and with the leaves usually clustered at the branchlet tips. The bisexual, 5-merous flowers lack petals and are arranged in simple, axillary, capitate or elongated spikes. This genus can be distinguished from the New World species of *Terminalia* by its non-winged, succulent pseudodrupaceous fruits.

B. costaricensis Stace
Tree, up to 40 m tall; leaves obovate, 2,5-14,2 cm long, 1,5-5,6 cm wide, glabrous, with domatia in the angles between the secondary veins and the midvein beneath, petioles 1,2-3,5 cm long; inflorescences spicate, 6-12 cm long, puberulent; flowers greenish-yellow; fruits drupes, ellipsoid to obovoid, 1,5-3 cm long, 1,2-1,9 cm wide, glabrous. Endemic to the Golfo Dulce region.

Combretum (pantrop. 250, CR 7, GD 5)
Scandent shrubs, sometimes armed with spines. The flowers are polygamo-dioecious, spicate or racemose and the racemes are often one-sided. The coriaceous, 1-seeded fruit has 4-6 longitudinal wings.

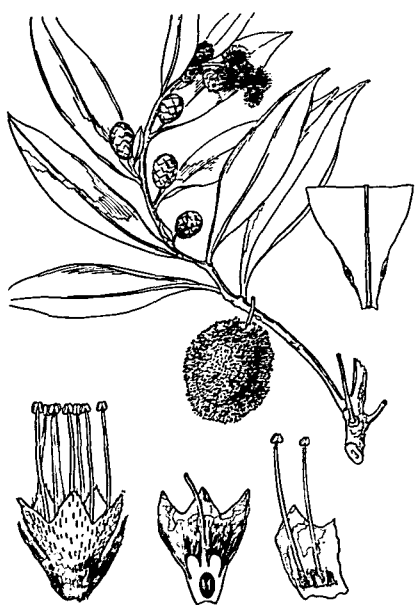
C. assimile Eichler
Liana; glandular trichomes peltate, red; flowers (from rhachis to sepal apex) 12-20 mm long, filaments exserted 20-30 mm long. In riparian forests, from Costa Rica and Panama to Peru, Bolivia and Brazil.

C. fruticosum (Loefl.) Stuntz
Liana; leaves, rhachis, and calyx bearing somewhat sunken scales; leaves opposite, somewhat elliptic, acuminate and mostly falcate at apex, cuneate or rounded at base, 6-12 cm long, 2-6 cm

wide, yellowish beneath due to golden scales; inflorescences terminal or in the axils of the upper leaves, paniculate; flowers actinomorphic, 4-merous, yellowish green or yellow, sessile or subsessile, densely arranged along branches, mostly 9-12 cm long, hypanthium ca. 1 cm long, stamens 8, yellowish, 15-20 mm long; fruits more or less orbicular, rounded to emarginate at apex, obtuse to subcordate at base, 12-18 mm long, 13-25 mm wide, wings 4, flexible, to 9 mm wide, reddish-brown to purplish, sparsely covered with dark brown scales. In semideciduous to evergreen lowland forests, from Mexico to Argentina.

Conocarpus (neotrop. + Africa. 1, CR 1, GD 1)
Monotypic genus.

C. erectus L., Pl. 50d
Shrub or small tree; leaves alternate, ovate to lanceolate, 3-10 cm long, glabrous or nearly so, with 2 glands at the base; inflorescences terminal or in the upper leaf axils, dense heads, 1 cm in diameter arranged in racemes; flowers very small. Widely distributed throughout Central America.



Conocarpus erectus

Laguncularia (neotrop. + West Africa 1, CR 1, GD 1)
Monotypic genus.

L. racemosa (L.) Gaertn., Pl. 50e,f
Shrub or small tree, bark reddish brown; leaves opposite, oblong or ovate, 3-7 cm long, coriaceous, glabrous, petiole with 2 large glands; inflorescences spicate, clustered; flowers small, actinomorphic, 5-merous, calyx 2-3 mm long, sericeous; stamens 10; fruits drupes, coriaceous, ca. 1,5 mm long, 10-costate. A characteristic tree of mangrove swamps ("white mangrove"), widely distributed from USA and Central America to northern South America and the west coast of Africa.

Laguncularia racemosa

Terminalia (pantrop. 150, CR 4, GD 4)
Tall or medium-sized trees with leaves often clustered at the tips of the branches. The fruit is drupaceous and compressed, or coriaceous and longitudinally winged.

T. amazonia (J.F. Gmel.) Exell
Tree up to 50 m tall; leaves alternate, clustered at the ends of the branchlets, obovate, to 10 cm long, 5 cm wide; flowers 5-merous, greenish-white, petals lacking, stamens 10; fruits 5-7(-10) mm long, 8-18(-22) mm wide, with five thin wings of which two are much larger (5-10 mm wide) than the others. Common in evergreen lowland to montane forests, from Mexico and Trinidad to Peru and Brazil.

T. catappa L., Pl. 50g,h
Medium-sized tree, branches verticillate; leaves obovate, 10-30 cm long; drupes obovoid, 4-7 cm long. Native to the East Indies, but naturalized throughout the tropics worldwide.

T. oblonga (Ruiz & Pav.) Steud., Pl. 50i
Tree up to 50 m tall; leaves to 20 cm long, 7 cm wide; fruits 12-20(-30) mm long, 20-40(-55) mm wide, with 2 wings, 8-25 mm wide. In evergreen lowland forests, from Mexico, to Ecuador, Peru, Bolivia and Brazil.

BERNARDELLO, L., L. GALETTO & I.G. RODRIGUEZ. 1994. Reproductive biology, variability of nectar features and pollination of *Combretum fruticosum* (Combretaceae) in Argentina. - Bot. J. Linn. Soc. 114 (3): 293-308.
EXELL, A.W. 1953. The *Combretum* species of the New World. - Bot. J. Linn Soc. 55: 103-141.
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EXELL, A.W. & C.A. STACE. 1963. Revision of the genera *Buchenavia* and *Ramatuella*. - Bull. Brit. Mus. (Nat. Hist.), Bot. 3: 3-46.
GRYJ, E., C. MARTINEZ DEL RIO & I. BAKER. 1990. Avian pollination and nectar use in *Combretum fruticosum* (Loefl.). - Biotropica 22: 169-171.
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PRANCE, G.T. 1980. A note on the probable pollination of *Combretum* by *Cebus* monkeys. - Biotropica 12 (3): 239.
SCHEMSKE, D.W. 1975. Time budget and foraging site preference of the Cinnamon hummingbird in Costa Rica. - Condor 77: 216-217.
SCHEMSKE, D.W. 1980. Floral ecology and hummingbird pollination of *Combretum farinosum* in Costa Rica. - Biotropica 12 (3): 169-181.
SRIVASTAVA, P.K. 1993. Pollination mechanisms in genus *Terminalia* L. - Indian Forester 119 (2): 147-150.

Connaraceae

Mostly scandent woody plants, but also trees and shrubs with pinnately compound or 3-foliolate leaves and distinct follicular fruits. **Leaves** alternate, sometimes simple by reduction, entire, pulvinus and pulvinuli present; **inflorescences** axillary or terminal, panicles, racemes or rarely spikes; **flowers** white, yellow or pink, 5-merous, calyx sometimes accrescent in fruit, stamens 10, the outer whorl longer than the inner whorl, ovary superior, 1-5-locular; **fruits** consisting of 1 to several follicles, seed 1, arillate. Distributed in the tropics worldwide. They can be found in the Neotropics in various habitats: humid forests, savannas, cerrados, river margins etc. Pantrop. 12/180, CR 3/8, GD 3/5.

Little is known about the pollination of this family, which is assumed to be pollinated by insects (possibly bees) (FORERO 1983).
Because of the red color of the fruits and the usually black seed with a yellow, white or orange aril the seeds are probably dispersed by birds (FORERO 1983).

Key to the genera (after FORERO & SANTANA 1998)

1	Flowers 1-carpellate; glandular dots present on petals and sepals; fruit stipitate	*Connarus*
1*	Flowers 5-carpellate; glandular dots absent on petals and sepals; fruit sessile	2
2	Endosperm scanty; calyx not accrescent in fruit; sepals valvate or only narrowly imbricate, inflorescence (and fruit) densely pilose	*Cnestidium*
2*	Endosperm absent; calyx accrescent in fruit; sepals imbricate; inflorescence (and fruit) usually glabrous or villous, but never densely pilose	*Rourea*

Cnestidium (neotrop. 3, CR 1, GD 1)
Liana, vegetative parts densely pubescent, often with ferruginous hairs and with 5-9-foliolate leaves.

C. rufescens Planch.
Liana, vegetative parts ferruginous pubescent; leaves imparipinnate, 7-9-foliolate, leaflets elliptic, oblong or obovate-oblong, 3-10(-16) cm long, 1,5-4,8(-7,5) cm wide, entire, glabrous above, densely ferruginous tomentose beneath; inflorescences axillary or pseudoterminal, paniculate, to 20 cm long; flowers (sub-)sessile; fruits curved, 1,3-1,5 cm long, 7-8 mm wide, densely ferruginous tomentose. From Mexico to Colombia, Ecuador and Venezuela.

Connarus (pantrop. 77, CR 3, GD 2)
The largest genus, consisting of trees shrubs as well as lianas, is well characterized when in flower by the glandular petals and the presence of a single carpel.

C. lambertii (DC.) Sagot
Shrub or liana, up to 3 m tall; leaves 3-foliolate, chartaceous, indumentum of simple hairs; inflorescences axillary or pseudoterminal panicles; flowers short pedicellate; fruits stipitate, 2 cm long, 1,3 cm wide, glabrous, with persistent calyx. Distributed from Belize and Guatemala to Colombia, Venezuela and Guyana.

C. panamensis Griseb.
Subscandent treelet or liana, up to 10 m tall; indumentum of simple hairs; leaves usually (1-)3(-5)-foliolate; inflorescences axillary or pseudoterminal panicles; flowers sessile; fruits tomentose, up to 2 cm long, 1,5 cm wide, with persistent calyx. Widespread in Central America and northern South America, reaching from Guatemala to Colombia and Venezuela.

FORERO, E. 1976. A revision of the American species of *Rourea* subgenus *Rourea* (Connaraceae). - Mem. New York Bot. Gard. 26: 1-119.
FORERO, E. 1983. Connaraceae. - Fl. Neotrop. Monogr. 36.
FORERO, E. & E. SANTANA. 1998. Connaraceae. Pp.: 365-376. In: J.A. STEYERMARK, P.E. BERRY & B.K. HOLST (eds.): Flora of the Venezuelan Guayana Vol. 4.

Convolvulaceae

Herbs, vines, lianas, shrubs or trees, sometimes with milky sap. **Leaves** mostly simple, pinnately lobed or pectinate, compound in some species; **inflorescences** axillary, racemose or paniculate, dichasial, solitary; **flowers** actinomorphic or slightly zygomorphic, small and inconspicuous to large and showy, but mostly evanescent, sepals 5, free, sometimes unequal, persistent, occasionally accrescent in fruit, petals united, tubular, funnelform, campanulate, urceolate, rotate or salverform, the limb with 5 lobes or teeth or almost entire, stamens 5, inserted on the base of the corolla tube, ovary superior, usually 2-3-locular; **fruits** capsules dehiscent or indehiscent, seeds 1-4. In the tropics as well as in temperate zones. Cosmopol. 56/1600, CR 17/87, GD 5/14.

The flowers of *Dicranostyles* and *Maripa* are pollinated by bees, while those of *Ipomoea* are pollinated by bees, birds and moths.

Ipomoea batatas, the sweet potato, is an important Asian crop and is widely cultivated for its starchy, edible tubers. *Ipomoea alba* is widely cultivated as an ornamental for its showy flowers. The sweet pulp around the seeds of *Maripa* is eaten by humans and animals.

Key to the genera (B. HAMMEL)

1	Flowers bright yellow or white; leaves often palmately compound to deeply digitately dissected, or simple and entire (both spp. in GD); anthers spirally twisted	*Merremia*
1*	Flowers mostly pink, blue, red or white, rarely bright yellow; leaves never palmately compound; anthers not twisted	2
2	Leaves basally acute to truncate; flowers usually pubescent; woody, forest or forest edge lianas	3
3	Flowers large (30-45 mm), pink to lavender; fruits more or less woody; seeds coated in gummy, black substance	*Maripa*
3*	Flowers small (ca. 2 mm), white; fruits leathery; seeds in gelatinous, clear perisperm	*Dicranostyles*
2*	Leaves basally cordate to sagittate, rarely truncate (but often lobed in *Ipomoea*, never lobed in other genera); flowers usually glabrous; mostly herbaceous vines of open, disturbed areas	4
4	Corolla never gland-dotted, the leaves rarely; fruits dehiscent	*Ipomoea*
4*	Corolla and leaves gland-dotted (black); fruits indehiscent	*Stictocardia*

Dicranostyles (neotrop. 15, CR 1, GD 1)
Rather tall lianas, reaching over 30 m in height with minute, usually greenish or greenish-white flowers, borne in axillary racemose or paniculate inflorescences.

D. ampla Ducke
Liana, stems brown to reddish brown, glabrescent; leaves oblong, elliptic-oblong, ovate, or obovate, subcoriaceous, glabrescent, flowers mostly smaller than 10 mm long, white. In evergreen lowland to lower montane forests, from Costa Rica to Ecuador, Peru and Brazil.

Ipomoea (pantrop. + warm temp. ca. 650, CR 49, GD 9)
The largest genus in the family consisting of vines and shrubs often having a cordate leaf base.

I. alba L.
Vine, stems herbaceous, at least near tips, often to 6 m or more, smooth or with short fleshy prickles, occasionally rooting near the nodes, glabrous; leaves membranaceous, entire to 3-7-lobate, rounded ovate, glabrous; flowers white. In thickets and on other disturbed sites near evergreen lowland forests in the tropics worldwide.

I. batatas (L.) Lam.
Vine, stems usually somewhat succulent but sometimes slender and herbaceous, erect, procumbent, or twining, glabrous or pubescent; leaves variable, entire to often deeply (3-)5-7-lobate, chartaceous to fleshy, cordate to ovate, dentate, glabrous or pubescent; flowers lavender to purple. Near villages and towns in disturbed and cultivated areas, throughout the Neotropics, cultivated in most temperate and tropical parts of the world.

I. nil (L.) Roth, Pl. 51b
Annual vine, stems with large trichomes, densely to scattered-pubescent throughout; leaves entire to 3-5-lobate, ovate to suborbicular; flowers of wild individuals usually blue on the limb with a white tube, flowers of cultivated individuals or of those escaped from cultivation varying to purple, with or without white spots and stripes to nearly red. Widespread in the tropics and subtropics worldwide, and even into temperate regions due to cultivation.

I. pes-caprae (L.) R. Br., Pl. 51a
Vine with long-creeping stems, rooting at the internodes; leaves often unilateral, ovate, elliptic, orbicular, or reniform; flowers usually solitary, glabrous, lavender to purple. On sandy saltwater beaches, near sea level, distributed throughout the tropics worldwide.

Maripa (neotrop. + subtrop. 19, CR 1, GD 1)
Lianas, larger stems fluted, reaching over 30 m long and to 30 cm diameter. The leaves are mostly elliptic, ovate or obovate to oblong, with canaliculate petioles.

Merremia (pantrop. ca. 70, CR 7, GD 3)
Vines with flowers campanulate, white or yellow, some with a purple center, or rarely of other colors.

M. umbellata (L.) Hallier f.
Vine, stems herbaceous toward tips, woody near base, twining or prostrate and rooting at and between nodes, glabrous or softly puberulent; leaves variable, ovate, ovate-oblong, oblong to sagittate, entire; flowers yellow. In the margins of lowland forests, throughout the tropics worldwide.
This species is easy to distinguish from other Costa Rican Convolvulaceae due to the pair of stipule-like protuberances at the base of the petioles.

Stictocardia (pantrop. 9, CR 1, GD 1)
Woody vines with the leaves often large and broad and long-petiolate. The flowers are usually large and showy.

AUSTIN, D.F. 1973. The American Erycibeae (Convolvulaceae): *Maripa*, *Dicranostyles* and *Lysiostyles*: 1. Systematics. - Ann. Missouri Bot. Gard. 60 (2): 306-412.
AUSTIN, D.F. 1975. Convolvulaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 62: 157-224.
AUSTIN, D.F. 1982. Convolvulaceae. In: G. HARLING & L. ANDERSSON (eds.): Flora of Ecuador 15.
AUSTIN, D.F. & R.S. BIANCHINI. 1998. Additions and corrections in American *Ipomoea* (Convolvulaceae). - Taxon 47 (4): 833-838.
AUSTIN, D.F. & Z. HUAMAN. 1996. A synopsis of *Ipomoea* (Convolvulaceae) in the Americas. - Taxon 45 (1): 3-38.

Crassulaceae

Usually succulent herbs or small shrubs or subshrubs, characterized by succulent leaves and usually thick stems. **Leaves** alternate, opposite, sometimes whorled, simple to pinnately compound, entire or crenulate, stipules lacking, sometimes capable of producing plantlets from the marginal dilatations; **inflorescences** cymose, frequently a dichasial corymb, or flowers solitary; **flowers** actinomorphic, usually bisexual, (3-)5(-6)-merous, sepals free or connate, petals free or connate, usually persistent, stamens twice as many as the petals, filaments mostly free, carpels free, as many as the petals, free or basally united; **fruits** of separate follicles, rarely capsules, seeds small. Distributed worldwide, most abundant in Africa. Cosmopol. 33/1100, CR 3/4, GD 1/1.

Many species of Crassulaceae are cultivated ornamentals (e.g., *Kalanchoe blossfeldiana*).

Kalanchoe (paleotrop. 125 + 1 sp. neotrop., CR 2, GD 1)
Erect succulent herbs, sometimes slightly woody at the base, with opposite and serrate leaves. The leaf blade ranges from simple to variously pinnate compound.

K. pinnata (Lam.) Pers.
Perennial succulent herb; leaves simple to 3-5-pinnate; inflorescences terminal, paniculate, ca. 50 cm long; flowers large, 4-merous, calyx tubular, greenish, petals reddish. Native to South Africa, but escaped from cultivation worldwide, sometimes common along wet areas close to rivers or creeks.

HART, H. & U. EGGLI. 1995. Evolution and systematics of the Crassulaceae. - Leiden: Backhuys Publ.
KEARNS, D.M. 1998. Crassulaceae. Pp.: 430-431. In: J.A. STEYERMARK, P.E. BERRY & B.K. HOLST (eds.): Flora of the Venezuelan Guayana. Vol. 4.
WOODSON, R.E. & R.W. SCHERY. 1950. Crassulaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 37: 121-124.

Cucurbitaceae

Annual or perennial, mostly scandent vines and lianas and only a few shrubs and small trees. The main family characters are the palmate venation of the leaves and the presence of coiling lateral tendrils in the scandent species. **Leaves** alternate, simple, entire to palmately compound and pedately lobed, sometimes glandular beneath, stipules lacking; **inflorescences** axillary, racemose, spicate, paniculate or flowers variously clustered or solitary; **flowers** actinomorphic, unisexual or rarely bisexual, sepals united, (3-)5(-6)-lobate, petals mostly united, (3-)5(-6), stamens 5, free or variously fused, appearing as 1-3 single stamens, staminodia often present in pistillate flowers, nectariferous disk sometimes present, ovary inferior; **fruits** drupes or fleshy berries, dehiscent or indehiscent, pericarp soft or woody, sometimes spiny, seeds 1-many, often compressed, sometimes winged. Mainly in the tropics and subtropics, but also in temperate areas worldwide. Cosmopol. 120/775, CR 24/66, GD 10/14.

The flowers of *Gurania* and *Psiguria* are visited by hummingbirds as well as by butterflies (*Heliconius*) foraging for nectar and pollen (KEARNS 1998). The flowers of *Rytidostylis* are fragrant at night and pollinated by small moths (KEARNS 1998). Chiropterophily occurs in some Cucurbitaceae with nocturnal flowers (e.g., *Cayaponia* sp.) (VOGEL 1957, 1969b).

The seeds of *Gurania* and *Psiguria* are dispersed by fruit eating bats (KEARNS 1998).
Many cucurbitaceous species, especially of the genera *Cucumis* (e.g., *C. sativus*) and *Cucurbita* (e.g., *C. pepo*, *C. maxima*) are cultivated worldwide for their fruits. In Central America, *Sechium edule* has also become important as a vegetable, because of its edible fruits and its root-tubers containing high amounts of starch. The fleshy fruits of *Momordica charantia* are cooked and eaten as a vegetable in

some countries, especially in India. The seeds of *Fevillea cordifolia* are used as a source of oil and can be burned like candles (GENTRY & WETTACH 1986, KEARNS 1998). Moreover, they are sometimes used against snake bites.

The fibrous fruits of *Luffa cylindrica* are used as bath sponges and are also cooked and eaten as a vegetable (WUNDERLIN 1978, KEARNS 1998). *Momordica charantia* is medicinally used as a purgative and against hypertension. The arils of *Rytidostylis carthaginensis* are edible.

Key to the genera - valid only for the Costa Rican taxa (after GONZALEZ & POVEDA, in prep.)

1	Leaves compound	2
2	Sessile glands usually present near the base of the lamina beneath	*Cayaponia* p.p.
2*	Glands lacking	3
3	Calyx reddish-orange, its lobes much larger than the corolla lobes	*Gurania* p.p.
3*	Calyx green or grayish, its lobes much shorter than the corolla lobes	*Psiguria* p.p.
1*	Leaves simple	4
4	Sessile glands present on the lamina	5
5	Fruits red when mature, seeds triangular	*Selysia*
5*	Fruits green to yellow when mature, seeds ovate to elliptic	*Cayaponia* p.p.
4*	Glands lacking on the lamina	6
6	Stamens totally or partially connate	7
7	Stamens partially connate, anthers free; fruits 1-seeded	*Sechium*
7*	Stamens completely connate, anthers united; fruits with more than 1 seed	*Rytidostylis*
6*	Stamens free	8
8	Stamens 5	*Fevillea*
8*	Stamens 2-3	9
9	Stamens with the anthers conduplicate or flexuous	10
10	Petals basally free	*Luffa*
10*	Petals at least basally united	*Momordica*
9*	Stamens with the anthers erect or curved	11
11	Stamens 2	12
12	Calyx reddish-orange, its lobes much longer than the corolla lobes	*Gurania* p.p.
12*	Calyx green or grayish, its lobes much shorter than the corolla lobes	*Psiguria* p.p.
11*	Stamens 3	13
13	Male flowers arranged in panicles	*Sicydium*
13*	Flowers solitary or fasciculate	*Melothria*

Cayaponia (neotrop. 45 + 1 sp. in Africa, CR 7, GD 1)

Monoecious or dioecious herbaceous vines with the leaves varying from entire to deeply lobed to 3-5-foliolate. The fruit is always a globose to ellipsoid, smooth and leathery berry.

C. granatensis Cogn.

Dioecious vine; leaves trifoliolate (except young leaves often simple), glabrous, entire; inflorescences fasciculate racemes, petals white to yellowish green; fruits globose, 1,5-3 cm in diameter, glabrous, reddish orange to dark red, seeds 3. In tropical lowland moist forests, from Costa Rica to Peru and Brazil.

Fevillea (neotrop. 7, CR 1, GD 1)

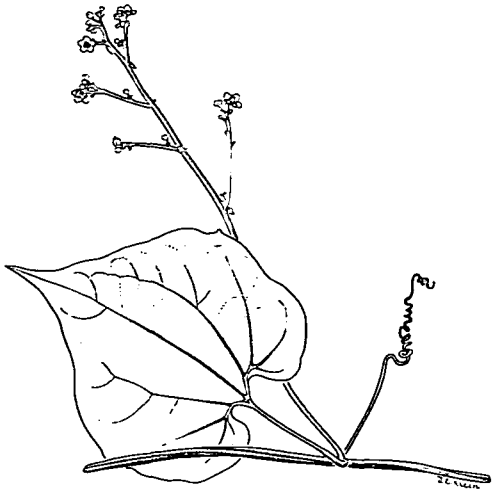
Perennial, dioecious woody lianas with simple, palmately lobed or 3-5-foliolate leaves and yellowish to brownish flowers. Distinct in having very large, globose, gourd-like and almost always apically dehiscing fruits.

F. cordifolia L., Pl. 51c

Common name (Costa Rica): cabalonga (J. GONZALEZ pers. comm.)

High climbing liana; leaves simple, entire or 3-5-lobate, tendrils 2-branched; inflorescences axillary, paniculate, 10-50 cm long; calyx greenish-yellow, 5-lobate, corolla greenish-yellow; fruits globose, 7-12 cm in diameter, indehiscent, seeds numerous. In evergreen lowland forests, often

along rivers, ranging from Central America and the West Indies to Amazonian Peru and Brazil.



Fevillea cordifolia

Gurania (neotrop. ca. 75, CR 8, GD 2)
Dioecious or rarely monoecious vines or lianas with simple and variously lobed or 3-5-foliolate leaves. The pendulous, many-seeded fruits vary in shape from oblong fusiform to cylindric.

G. makoyana (Lem.) Cogn., Pl. 51e,f
Dioecious vine; leaves simple, entire to deeply 3-7-lobate, margin denticulate; male inflorescences axillary, racemose, 9-50 cm long, long pedunculate, female inflorescences of 1-several flowers at leafless nodes in the upper part of the stem; sessile to subsessile, calyx orange, corolla yellow, smaller than the calyx, anthers 2; fruits cylindric fusiform, 4-6 cm long, 2-2,5 cm in diameter, green, seeds numerous. On open sites and in tropical moist forests, ranging from Guatemala to Colombia.

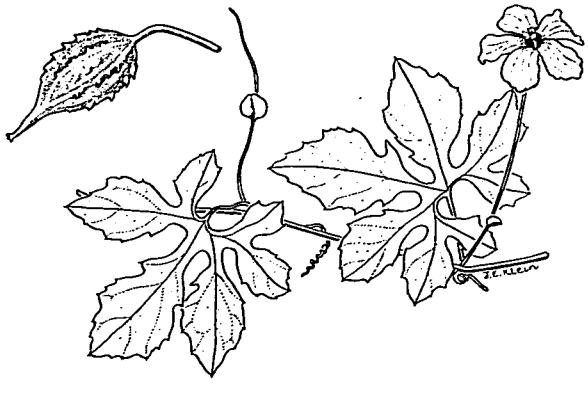
Luffa (pantrop. 7, CR 4, GD 2)
Monoecious vines with simple, palmately lobed leaves. Distinct in the globose fruits dehiscing by an apical operculum.

L. cylindrica (L.) A. Roem.
Common names (Costa Rica): paste, estopa (J. GONZÀLEZ pers. comm.)
Leaves simple, entire to 3-5-lobate, suborbicular, 10-25 cm long, denticulate; male inflorescences axillary, racemose, 10-35 cm long; male flowers yellow, stamens 3, free, female flowers axillary, solitary, yellow, staminodia 5; fruits cylindrical or fusiform, longitudinally striate, ecostate, 10-40 cm long, green. Usually in disturbed areas, native to the Paleotropics, but cultivated and sometimes escaped throughout the tropics worldwide.

Melothria (neotrop. 10, CR 4, GD 2)
Slender monoecious vines with simple and entire or lobate leaves and smooth, indehiscent berry fruits. They are easy to recognize in flower by the long pedunculate male inflorescences.
M. dulcis Wunderlin, Pl. 51g
Leaves simple, entire, ovate, 6-12 cm long and 5-11 cm wide; male inflorescences racemose, ca. 2 cm long; female solitary; fruits ellipsoid, 5-8 cm long. In wet forests of Costa Rica (Golfo Dulce region) to Panama.

Momordica (paleotrop. 45, CR 1, GD 1)
Slender monoecious or rarely dioecious vines, vegetatively rather similar to *Melothria*. Leaves simple and usually deeply lobed or sometimes 3-9-foliolate. The fruits are usually dehiscent and sometimes adorned with spines, tubercles or ridges.

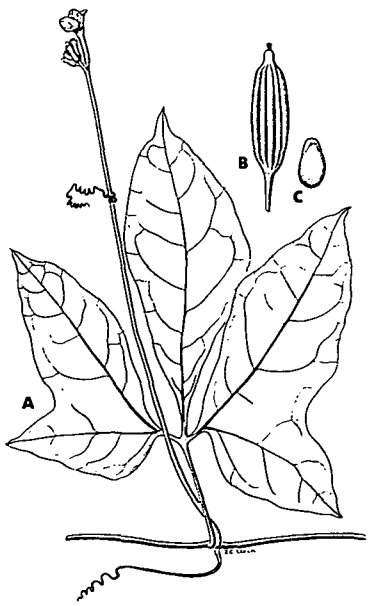
M. charantia L.
Common names (Costa Rica): sorosi, pepinillo (GONZALEZ & POVEDA, in prep.)
Leaves simple, deeply 5-9-lobate, margin dentate; male inflorescences axillary, racemose, corymbose or flowers solitary; male flowers yellow, 5-lobate, stamens(2-)3; female flowers axillary, solitary, 5-lobate; fruits bright orange red, oblong, fusiform to cylindric, 4-8 cm long, 3-valvate, with tubercles on the surface. In forests and on disturbed sites, native to tropical Africa, but now a widespread weed in the tropics worldwide.



Momordica charantia

Psiguria (neotrop. 15, CR 4, GD 2)
Perennial, herbaceous or soft-wooded monoecious vines with simple or 3-5-foliolate leaves and orange flowers. The male flowers are arranged in long pedunculate fascicles, while the female flowers, which are spatially and temporally separate from them, are arranged in groups of 1-5 in short pedunculate fascicles. The fruits are greenish, pendulous and indehiscent berries.

P. warscewiczii (Hook. f.) Wunderlin
Leaves 3-foliolate, the lateral leaflets strongly asymmetric; male inflorescences axillary, racemose, with subcapitate clusters of flowers, female inflorescences axillary, of 1-3 flowers; flowers reddish-orange; fruits cylindric to oblong, green with whitish stripes, 5,5-7 cm long. A rather common and variable species of open sites as well as of wet forests, ranging from southern Mexico to Peru.



Psiguria warscewiczii
A. Habit. B. Fruit. C. Seed

Rytidostylis (neotrop. 5, CR 2, GD 1)
Weedy monoecious vines with conspicuously yellow to whitish, long tubular flowers. The simple leaves vary from entire to palmately lobed. The soft-spiny fruits are distinct in dehiscing elastically.

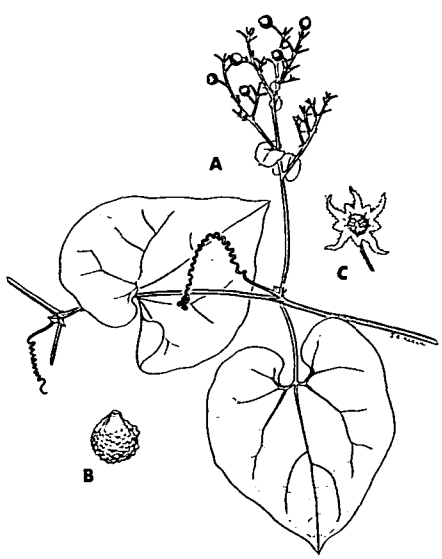
R. carthaginensis (Jacq.) Kuntze
Common name (Costa Rica): chanchitos (J. GONZALEZ pers. comm.)
Leaves entire to 3-5-lobate, dentate, tendrils usually 2-3-branched; male inflorescences axillary, subumbelloid racemes; male flowers yellowish-green, female flowers axillary, solitary, yellowish green; fruits obliquely ovoid, 2-4 cm long, 1,2-2 cm wide, green. On open and disturbed sites, ranging from Mexico to Ecuador, Peru and Brazil.

Selysia (neotrop. 4, CR 1, GD 1)
Monoecious vines with simple, entire to trilobate leaves. This genus is closely related to *Cayaponia*, but can be distinguished from it by the inflorescences (fascicles or reduced to 1-2 flowers).

S. prunifera (Poepp. & Endl.) Cogn., Pl. 51g
Leaves trilobate, denticulate, the venation pubescent on both sides; male inflorescences axillary, of 1-3 fasciculate flowers; male flowers 5-merous, petals white, stamens 3, female flowers axillary, solitary, 5-merous, white; fruits berries, subglobose, 2-4 cm long, red to orange. From Costa Rica to Ecuador and Peru.

Sicydium (neotrop. ca. 6, CR 3, GD 1)
Dioecious vines, with simple, entire, cordate leaves. The flowers are always arranged in panicles and the fruits are characteristic small, 1-seeded berries.

S. tamnifolium (Kunth) Cogn.
Leaves, stems and inflorescences densely pubescent, indumentum mostly of glandular hairs; leaves ovate, elliptic-ovate to broadly triangular, tendrils 2-branched; inflorescences axillary, 5-20 cm long; flowers green to yellowish-green; fruits globose, 5-8 mm in diameter, black. In forests and on open sites, from Mexico to Peru.



Sicydium tamnifolium
A. Habit. B. Seed. C. Flower

BATES, D.M., R.W. ROBINSON & C. JEFFREY (eds.). 1990. Biology and utilization of the Cucurbitaceae. - Ithaca: Cornell Univ. Press.

GENTRY, A.H. & R.H. WETTACH. 1986. *Fevillea*, a new oil seed from Amazonian Peru. - Econ.Bot. 40: 177-185.

GONZÁLEZ, J. & L.J. POVEDA. In prep. Cucurbitaceae. Manuál de las plantas de Costa Rica. Missouri Botanical Garden. Instituto Nacional de Biodiversidad. Museo Nacional de Costa Rica.

HEISER, C.B., JR., E.E. SCHILLING & B. DUTT. 1988. The American species of *Luffa* (Cucurbitaceae). - Syst. Bot. 13 (1): 138-145.

JEFFREY, C. & B. TRUJILLO. 1992. Cucurbitaceae. In: T.LASSER (ed.): Flora de Venezuela. Vol V (1).

KEARNS, D.M. 1998. Cucurbitaceae. Pp.: 431-461. In: J.A. STEYERMARK, P.E. BERRY & B.K. HOLST (eds.): Flora of the Venezuelan Guayana. Vol. 4.

VOGEL, S. 1957. Fledermausblumen in Südamerika. - Österr. Bot. Z. 104: 492-530.

VOGEL, S. 1969b. Chiropterophilie in der neotropischen - Flora. Neue Mitteilungen III. Flora, Abt. B. 158: 289-323.

WUNDERLIN, R.P. 1978. Cucurbitaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 65: 285-368.

Dichapetalaceae

A family consisting of trees, shrubs and lianas, with the characteristic feature of the inflorescence often arising from the petiole or even from the midvein of the leaves. Vegetatively they can be recognized by the presence of sometimes conspicuous, but usually early caducous stipules. **Leaves** simple, alternate, entire; **inflorescences** axillary or more frequently attached to the petiole, corymbose-cymose or subcapitate or fascicles of flowers; **flowers** small, actinomorphic, sometimes weekly zygomorphic, bisexual or rarely unisexual, sepals 5, free or basally connate, petals 5, free or connate into a tube, with the lobes usually bifid at the tips and frequently cucullate, stamens 5, sometimes only 3 fertile, free or adnate to the corolla tube, disk of 5 glands, alternating with the stamens, ovary superior, 2-3-locular; **fruits** dry or rarely fleshy drupes, seeds 1-2(-3). Pantrop. 3/160, CR 3/15, GD 2/4.

Key to the genera (after PRANCE, in prep.)

1	Petals free and regular; stamens free; inflorescence with a long distinct peduncle	*Dichapetalum*
1*	Petals connate; stamens united to corolla tube; inflorescence a sessile cluster inserted on petioles	*Stephanopodium*

Dichapetalum (pantrop. 124, CR 14, GD 3)
Trees, shrubs or lianas with small stipules and conspicuous, usually long pedunculate and strongly dichotomous inflorescences.

Stephanopodium (neotrop. 9, CR 1, GD 1)
Small to medium sized trees with small stipules and rather inconspicuous inflorescences of small (sub-)sessile glomerules, which are borne on the petioles.

S. costaricense Prance
Tree up to 20 m tall; leaves oblong, coriaceous, apex acuminate, glabrous; inflorescences of dense, sessile glomerules; flowers polygamous, pedicellate, corolla tube short with 5 equal lobes, fertile stamens 5. In lowland rainforests, endemic to Costa Rica.
The species is easy to recognize vegetatively, because of the very characteristic canaliculate stem.

LEWIS, W.H. 1967. Dichapetalaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 54 (1): 9-12.

PRANCE, G.T. 1972. Dichapetalaceae. - Fl. Neotrop. Monogr. 10.

PRANCE, G.T. 1980. Dichapetalaceae. In: G. HARLING & L. ANDERSSON (eds.): Flora of Ecuador 12.

PRANCE, G.T. 1995. A synopsis of *Stephanopodium* (Dichapetalaceae). - Kew Bull. 50 (2): 295-305.

PRANCE, G.T. 1998. Dichapetalaceae. Pp.: 666-671. In: J.A. STEYERMARK, P.E. BERRY & B.K. HOLST (eds.): Flora of the Venezuelan Guayana Vol. 4.

PRANCE, G.T. In prep. Dichapetalaceae. Manuál de las plantas de Costa Rica. Missouri Botanical Garden. Instituto Nacional de Biodiversidad. Museo Nacional de Costa Rica.

Dilleniaceae

Lianas, shrubs, trees or rarely herbs, frequently with rough and coriaceous leaves, from the silicified or sclerified indumentum. Hairs simple, fasciculate, or sometimes stellate (*Tetracera*); **leaves** alternate, rarely opposite, simple, entire or dentate, stipules rarely present, and then soon caducous; **inflorescences** terminal, axillary or ramiflorous, racemose, paniculate, cymose, glomerulate, fasciculate or flowers solitary; **flowers** actinomorphic, bisexual or unisexual, then plants androdioecious (*Tetracera*), sepals (3-)5-7(-12), petals 2-6, free or basally connate, yellow to white, rarely pinkish, stamens numerous, free or basally connate, ovary of 1-numerous, free or ventrally connate carpels; **fruits** follicles, capsules or berries, seeds 1-numerous, arillate. Pantrop. + subtrop. 12/300, CR 6/18, GD 4/11.

The genus *Dillenia* is pollinated by pollen-collecting *Xylocopa* bees (ENDRESS 1994, 1997). GOTTSBERGER (1977) found that some species of *Davilla* and *Doliocarpus*, usually pollinated by bees, are also visited by fruit-eating beetles attracted by the floral odor. They lay their eggs inside the flower and in so doing effect pollination.

Key to the genera (after AYMARD & MILLER 1994, AYMARD 1997)

1	Carpel 1 per flower	2
2	Sepals unequal in size, the 2 inner ones larger, covering the fruit entirely; inflorescences in terminal or lateral panicles	*Davilla*
2*	Sepals more or less equal in size, never covering the fruit; inflorescence ramiflorous, fasciculate, glomerate, or flowers solitary	*Doliocarpus*
1*	Carpels 2-5 per flower	3
3	Carpels 3-5 per flower; fruit a follicle	*Tetracera*
3*	Carpels 2 per flower; fruit a capsule	*Pinzona*

Davilla (neotrop. 20, CR 3, GD 3)
Lianas or small shrubs and trees, mostly in secondary growth, with an indumentum of simple hairs. Further characteristics are paniculate inflorescences and indehiscent, globose, 1-seeded fruits.

D. kunthii A.St.-Hil.
Liana, densely to sparsely pubescent; leaves usually coriaceous, elliptic to orbicular, 6-22 cm long, 4-11 cm wide, subentire or slightly serrate, margin revolute; inflorescences paniculate, 4-10 cm long; fruits ca. 6 mm long, orange to brownish. From Mexico to Peru, Bolivia and Brazil.

D. nitida (Vahl) Kubitzki, Pl. 51h
Scandent shrub or liana, glabrous or with few scabrous hairs; leaves (sub-)coriaceous, usually elliptic to oblong, 3,5-15 cm long, 2-8 cm wide, mostly entire to slightly serrate; inflorescences paniculate, 7-20 cm long; fruits 3-5 mm long, orange. In primary and secondary forests, also in gallery forests and savannas, ranging from southern Mexico and the Antilles to Bolivia and Brazil.

Doliocarpus (neotrop. 40, CR 7, GD 4), Pl. 52b
Lianas or scandent shrubs, with glomerulate or fasciculate inflorescences and follicular or berry-like, reddish fruits, dehiscing along the ventral suture with 1-2 white, arillate seeds.

D. hispidus Standl. & L.O. Williams
Liana, the branches densely pilose, glabrescent; leaves chartaceous, usually dentate above the middle, hispid beneath; inflorescences fascicles of solitary flowers; flowers hispid, sepals 4-5, stamens 30-40; fruits 0,8-1 cm in diameter, densely hispid. In wet evergreen forests, from Costa Rica to Ecuador and Brazil.

D. multiflorus Standl., Pl. 52a
Liana, the branches densely pilose, glabrescent; leaves subcoriaceous, usually entire; inflorescences fasciculate, 2-10 flowers on a short, common peduncle; sepals 4-5, petals 2, white, stamens 30-40; fruits 1-1,5 cm in diameter, red. In evergreen lowland forests, from Belize and Guatemala and the Antilles to Bolivia and Brazil.

AYMARD, C.G.A. 1997. Dilleniaceae novae neotropicae: 5. El genero *Doliocarpus* en Colombia. - Anales Jard. Bot. Madrid 55 (1): 17-30.

AYMARD, C.G.A. 1998. Dilleniaceae. Pp.: 671-685. In: J.A. STEYERMARK, P.E. BERRY & B.K. HOLST (eds.): Flora of the Venezuelan Guayana. Vol 4.
AYMARD, C.G.A. & J. MILLER. 1994. Dilleniaceae novae neotropicae: 3. Sinopsis y adiciónes a las Dilleniaceae del Peru. - Candollea 49 (1): 169-182.
ENDRESS, P.K. 1994. Diversity and evolutionary biology of tropical flowers. Cambridge: Cambridge University Press.
ENDRESS, P.K. 1997. Relationships between floral organization, architecture and pollination mode in *Dillenia* (Dilleniaceae). - Pl. Syst. Evol. 206 (1-4): 99-118.
GONZÁLEZ, J. In prep. Dilleniaceae. Manuál de las plantas de Costa Rica. Missouri Botanical Garden. Instituto Nacional de Biodiversidad. Museo Nacional de Costa Rica.
GOTTSBERGER, G. 1977. Some aspects of beetle pollination in the evolution of flowering plants. In: K. KUBITZKI (ed.): Flowering plants: Evolution and classification of higher categories. - Plant Syst. Evol. Suppl. 1: 211-226.
HUNTER, G.E. 1965. Dilleniaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 52: 579-598.
KEIGHERY, G.J. 1991. Pollination of *Hibbertia conspicua* (Dilleniaceae). - W. Austral. Naturalist 18 (6): 163-165.
KUBITZKI, K. 1971. *Doliocarpus*, *Davilla* und verwandte Gattungen (Dilleniaceae). - Mitt. Bot. Staatsamml. München 9: 1-105.
KUBITZKI, K. 1973. Neue und bemerkenswerte neotropische Dilleniaceen. - Mitt. Bot. München 9: 707-720.

Ebenaceae

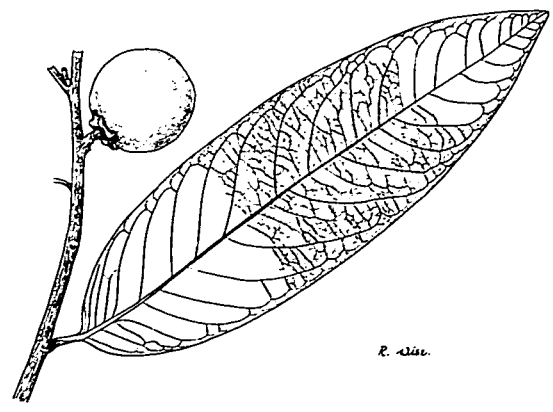
Trees and shrubs, sometimes with dark red to black heartwood, sometimes with a disagreeable odor and without milky latex. **Leaves** alternate, rarely opposite, simple, entire, stipules lacking; **inflorescences** axillary, sometimes cauliflorous, usually cymose or fasciculate, sometimes in false racemes or panicles, or flowers solitary; **flowers** actinomorphic, unisexual (plants dioecious), but the other sex often (rudimentarily) developed, sepals 3-6, connate, calyx persistent and often accrescent in fruit, petals 3-6, connate into a tubular corolla, stamens 2-numerous, epipetalous or borne on the receptacle, ovary superior, 2-16-locular, styles and stigmas 2-8; **fruits** dry or fleshy berries, subtended by the enlarged, persistent calyx, seeds 1-numerous. Distributed in the tropics and subtropics worldwide, with a few species reaching into temperate zones. Cosmopol. 2/485, CR 1/6, GD 1/3.

The family is closely related to the Sapotaceae, from which it can be easily distinguished by the lack of a milky latex.

The ripe fruits of most Ebenaceae are edible, although those from a few species are used as a fish poison (WHITE 1978). The best known species is the widely cultivated Asian *Diospyros khaki*. Other common species are the Central American *D. digyna* and *D. ebenaster*, both widely cultivated throughout the tropics, the North American *D. virginiana*, called "persimmon", with acid-sweet tasting fruits, and the Philippine *D. blancoi*, which is cultivated in some places in Panama (BRÜCHER 1989, WHITE 1978). The famous Asian species *D. ebenum*, the "ebony", is well known for its hard wood, used for making high quality furniture.

Diospyros (pantrop. ca. 475, CR 6, GD 3)
A large genus of trees and shrubs, characterized by the presence of glands on the lower leaf surface. This feature is not present in all the species or sometimes only on young leaves. *Diospyros* can be distinguished from the second genus of the family, the African *Euclea*, by the cymose or fasciculate inflorescences as well as solitary flowers and globose fruits with 2-numerous, elongate seeds.

D. digyna Jacq., Pl. 52c
Common Name (Latin America): sapote negro (WHITE 1978)



Diospyros digyna

Tree, up to 20 m tall; leaves elliptic, drying gray-green or blackish, lower surface glabrous, except a few minute strigillose hairs; fruits (4-)6-8 cm in diameter, black and glabrous when ripe. In Central America, from Mexico to Panama and in Colombia, but now widely distributed elsewhere in the tropics for its edible fruits with a very spicy taste.

D. hartmanniana S. Knapp
Tree, up to 20 m tall; leaves elliptic, drying shiny black, lower surface sparsely strigose with scattered, coarse black hairs, the young leaves densely black-strigose beneath; fruits 1,5-2 cm in diameter, yellow-orange when ripe, drying reddish -brown, glabrous. Usually in higher elevations (cloud forests), but also found in the Esquinas forest, endemic to Costa Rica.

KNAPP, S. 1997. Two new species of *Diospyros* (Ebenaceae) from Mesoamerica. - Novon 7 (3): 256-260.
SOTHERS, C. & P.E. BERRY. 1998. Pp.: 704-711. Ebenaceae. In: J.A. STEYERMARK, P.E. BERRY & B.K. HOLST (eds.): Flora of the Venezuelan Guayana. Vol. 4.
WHITE, F. 1978. Ebenaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 65: 145-154.

Elaeocarpaceae

A small family of mostly tropical but also subtropical and temperate trees and shrubs.
Leaves simple, alternate or sometimes opposite, entire or dentate margined, stipules present, at least in bud, petioles usually swollen at both ends and often of different length; **inflorescences** axillary or rarely terminal, cymose or paniculate, with 1 to numerous flowers; **flowers** with 4-5-11 sepals, petals usually 4-5, sometimes lacking (*Sloanea*), stamens numerous, usually free, ovary superior, with 2-numerous locules, style 1; **fruits** unarmed or armed, valvately dehiscent capsules, berries or drupes, seeds frequently arillate. Pantrop. + subtrop. 9/540, CR 2/28, GD 2/14.

This family is closely related to the Tiliaceae, sharing several characters such as 3-veined leaves, numerous stamens, dentate leaf margins, etc., which occur at least in some of the genera. It differs from Tiliaceae primarily in the lack of mucilaginous ducts. On the other hand, there exist only few characters which link the genera of the Elaeocarpaceae. Therefore it is not surprising that there is still confusion about the taxonomic placement of several genera within these families. For instance, *Muntingia* is, depending on author, included in Elaeocarpaceae, in Tiliaceae or placed in a separate family, Muntingiaceae.

Key to the genera (based on SMITH 1965)

1	Fruit capsular; petals absent	*Sloanea*
1*	Fruit baccate; petals present	*Muntingia*

Sloanea (pantrop. 120, CR 27, GD 13)
A genus consisting of trees and a few shrubs, usually of primary rainforests. The leaves are standing alternate or opposite, sometimes both arrangements present even in the same individual. Although somewhat variable vegetatively, this genus is well characterized by its greenish, inconspicuous flowers lacking petals and by the more or less globose, valvately dehiscent fruit, which is often armed with flexible or rigid spines.

S. laurifolia (Benth.) Benth.
Tree to 40 m tall, twigs frequently with conspicuous lenticels; leaves opposite to alternate, coriaceous, glabrous to puberulent, with subentire margin; inflorescences corymbo-racemose, several-flowered; flowers 4-6 mm in diameter, green to pale-cream; fruits 4-valved capsules, 1,35-3,5 cm long, subglobose to ellipsoid, seed 1, embedded in a three-lobed aril. In various habitats, from Central America to northern South America.
In this description *S. laurifolia* is treated in its widest sense, according to SMITH (1954), who includes herein, among others, the GD-endemic *S. brachytepala*, which he defines as an ecological variety of non-flooded habitats.

S. medusula K. Schum. & Pittier, Pl. 52d
Tree to 40 m tall; leaves alternate, coriaceous, glabrate to puberulent, margin undulate to irregular; inflorescences 4-18 cm long; flowers 10-20 mm in diameter, usually pinkish; fruits 4-valved capsules, to 4,5 cm long, subglobose, seed 1. In undisturbed forests, from Guatemala to Colombia.

SMITH, C.E. 1954. The New World Species of *Sloanea* (Elaeocarpaceae). - Contr. Gray Herb. 175: 1-114.
SMITH, C.E. 1965. Elaeocarpaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama, Part VI. - Ann. Missouri Bot.Gard. 52: 487-495.
SMITH, D.A. 1985. The Costa Rican species of *Sloanea* (Elaeocarpaceae). M.S.Thesis, Duke University, Durham.
STEYERMARK, J.A. 1988. Elaeocarpaceae. Flora of the Venezuelan Guayana VI. - Ann. Missouri Bot. Gard. 75 (4): 1570-1586.

Ericaceae

Usually terrestrial or epiphytic shrubs or herbs or fleshy achlorophyllous mycotrophs, rarely lianas or trees almost always with coriaceous, alternate leaves. The family can easily be recognized by their distinct cylindric, campanular or urceolate flowers, often with fleshy connate petals. **Leaves** alternate, rarely opposite, verticillate, sometimes reduced to scales, simple, coriaceous or membranaceous, entire or sometimes serrulate-crenate, stipules lacking; **inflorescences** axillary, rarely terminal, racemose, paniculate, fasciculate or flowers solitary; **flowers** actinomorphic or slightly zygomorphic, bisexual, rarely functionally unisexual, usually obdiplostemonous, sepals united, calyx 4-5(-7)-lobate, frequently persistent, petals 4-5(-7), usually connate, stamens opening by pores or slits, usually twice as many as the petals, in two whorls, borne on the edge of a nectariferous disk, anthers often distally with 2 distinct or connate tubules or terminal awns; ovary superior or inferior; **fruits** loculicidal or septicidal capsules, berries or drupes, calyx usually persistent, seeds small, usually numerous, sometimes winged or tailed. Widely distributed in the temperate regions worldwide, but also found in the tropics, where they are most abundant at higher altitudes. Cosmopol. 107/3400, CR 18/71, GD 4/7.

The species of Ericaceae prefer open and rather cool habitats and acidic soils. In the Neotropics they are usually found in montane forests between 1500 and 3000 m alt., where they can become dominant (e.g., in the ericaceous belt, which is a vegetation type of tropical montane regions). Several species are well-adapted constituents of the Paramos (LUTEYN 1989, 1999).

While the temperate Ericaceae are mostly pollinated by bees (CANE et al. 1985, LUTEYN 1995), the neotropical taxa are often adapted to hummingbird pollination (LUTEYN 1976, 1983, 1999). The following features can be seen as such adaptations: showy flowers lacking a fragrance, tubular corolla, nectariferous disk with producing copious nectar with high sugar concentrations, flowers pendent or arching and arranged in open, elongate or few-flowered clusters (LUTEYN 1999). In addition, bees and wasps also serve as pollinators of some *Cavendishia* spp. (LUTEYN 1983).

Genera with capsular fruits and winged seeds are apparently wind-dispersed, while those with baccate fruits are usually dispersed by birds and to a lesser extent by small mammals (SNOW 1981, LUTEYN 1983, 1995, 1999).

Many Ericaceae are used as ornamentals in horticulture, such as azaleas, rhododendrons, heaths or heathers. In montane regions of Central America and northwestern South America, the Asian species *Rhododendron simsii* is often cultivated terrestrially or in hanging baskets (LUTEYN 1999). The fleshy fruits of several Ericaceae species are edible. Many *Vaccinium* spp. are cultivated worldwide for their sweet-sour tasting fruits. In the Neotropics *V. floribundum,* whose fruits are used for making jams, drinks or pies, is the most common native species (LUTEYN 1999). The edible fruits of *Cavendishia* spp. are also used throughout tropical America (LUTEYN 1983).

Key to the genera (after LUTEYN 1991, 1999)

1	Stamens strongly unequal with filaments or anthers, or filaments and anthers alternately conspicuously unequal	2
2	Filaments equal and connate over entire length; anthers with tubules widening distally	*Satyria*
2*	Filaments unequal usually distinct, rarely slightly coherent at the extreme base at anthesis; anthers with sides parallel, not widening distally	*Cavendishia*
1*	Stamens equal with filaments and anthers of equal lengths (rarely anthers inconspicuously alternately unequal)	
3	Thecae conspicuously papillate; tubules rigid, elongate- to short - conical, sometimes laterally connate or fused into one tubule; stamens from about 1/3 to often nearly as long as corolla	*Psammisia*
3*	Thecae smooth to minutely papillate; tubules flexible, cylindric, elongate to short; stamens usually as long as corolla	*Sphyrospermum*

Cavendishia (neotrop. 100, CR 23, GD 2)
A large genus of epiphytic or terrestrial shrubs, easy to recognize in flower by the presence of brightly colored bracts and by having filaments of different length.

C. callista Donn.Sm., Pl. 52e
Common name (Costa Rica, Cartago): colmillo de perro (LUTEYN 1983, 1999)
Epiphytic or terrestrial shrub, up to 4 m tall, stems glabrate or white pilose; leaves chartaceous to coriaceous, petioles (4-)6-13(-22) mm long; inflorescences viscid, floral bracts pink to deep rose. Widely distributed in open habitats, from Guatemala to Panama and in northern South America to Ecuador and Brazil.

C. osaensis Luteyn & J.F. Morales, Pl. 52f
Epiphytic shrub, stems glabrous; leaves coriaceous, petioles 2-4 mm long; inflorescences subspherical, racemose, floral bracts pinkish-lilac. Endemic to southeastern Costa Rica (Osa Peninsula and adjacent areas).

Psammisia (neotrop. 55, CR 3, GD 1)
Epiphytic or terrestrial shrubs with leathery berry fruits, distinguishable from other genera by the spurred connectives.

P. ramiflora Klotzsch
Usually epiphytic shrubs, branchlets glabrous; glabrous, 5-plinerved; inflorescences axillary (ramiflorous), subfasciculate or short racemose; flowers 5-merous, filaments distally and alternately 2-spurred. Costa Rica and Panama.

Satyria (neotrop. 23, CR 5, GD 2), Pl. 52g
Epiphytic or terrestrial shrubs, often with plinerved leaves, filaments connate for more than half of their length and alternately unequal anthers.

Psammisia ramiflora
A. Habit. B. Inflorescences. C. Lateral view. D. Ventral view of the stamen

S. panurensis (Benth.) Benth. & Hook.
Epiphytic shrub, stems and twigs glabrous; leaves coriaceous to subcoriaceous, 3-5-plinerved; inflorescences axillary, racemose, 8-20-flowered; fruits berries, dark blue-black, 10-13 mm in diameter. In lowland and upland forests and open habitats (white sand savannas), from Costa Rica to Ecuador, Peru and Brazil.

Sphyrospermum (neotrop. 18, CR 4, GD 2)
Terrestrial and epiphytic shrubs with pendent branches with distinct small, coriaceous and obscurely nerved leaves and the flowers solitary or paired in the axils of the leaves.

S. ellipticum Sleumer
Epiphytic shrub; leaves subcoriaceous, suborbicular-elliptic, 2-4 cm long, entire; flowers solitary in the leaf axils, minute, 4-merous, less than 4 mm long, calyx densely grayish pilose; fruits berries, ca. 3,5 mm in diameter, pilose. In rain forests and cloud forests up to 900 m alt., ranging from Costa Rica to Colombia, Ecuador and Guyana.

CANE, J.H., G.C. EICKWORT & J. SPIELHOLZ. 1985. Pollination ecology of *Vaccinium stamineum* (Ericaceae: Vaccinioideae). - Amer. J. Bot. 72 (1): 135-142.
LUTEYN, J.L. 1975. The genus *Cavendishia* in Costa Rica. - Brenesia 6: 9-18.
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Erythroxylaceae

A family of small trees and shrubs, completely glabrous and with often conspicuous intrapetiolar stipules. **Leaves** alternate (opposite in *Aneulophus*), simple, entire, distichous, stipules persistent or caducous; **inflorescences** axillary, fasciculate, sessile or pedicellate, 1-many-flowered; **flowers** bisexual or unisexual, often heterostylous, 5-merous, petals free, usually with appendages adaxially, stamens 10, basally united, forming a short tube, ovary superior, 2-3-locular; **fruits** small, drupaceous, 1-seeded. Pantrop. 4/240, CR 1/8, GD 1/2.

The small flowers of *Erythroxylum* are usually visited by bees. BARROS (1998) studied the pollination of three sympatric cerrado species of *Erythroxylum* in central Brazil, and found in total 28 species of hymenopters (wasps and bees) as main pollinators.

Erythroxylum coca is native to the montane forests of the eastern slopes of the Andes. It is widely cultivated, especially in South America, as a masticatory, for folk medicines, and especially for the manufacture of cocaine. Another species, *E. novogratense,* has lower concentrations of cocaine, but a higher climatic tolerance, with the ability to grow in the lowlands, making it an important cultivar in lowland Peru, Venezuela and Colombia (BRÜCHER 1989, PLOWMAN 1984). Of both species several varieties exist which are distinguishable from each other by morphological as well as phytochemical differences. *E. novogranatense* var. *trujillense* (the "trujillo coca") is cultivated legally in Peru for the extraction of the flavor used in the production of the soft drink Coca-Cola and for pharmaceutical uses (PLOWMAN 1984).

Erythroxylum (pantrop. 230, CR 8, GD 2)
The only genus occurring in tropical America, easy to recognize by the presence of two venation lines parallel to the main vein of the leaf blade.
E. citrifolium A. St.-Hil.
Shrub or small tree, up to 10 m tall; leaves 8-14 cm long, 2-7 cm wide, coriaceous to subcoriaceous, stipules 3-setulose, caducous; inflorescences dense clusters of numerous flowers; flowers bisexual; fruits 7-10 mm long, 4-5 mm in diameter, red. In evergreen forests up to 1200 m alt., often in disturbed forests, ranging from Nicaragua to Bolivia, the Guianas and southeastern Brazil.

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Euphorbiaceae

One of the largest and most important families of the Neotropics, very difficult to recognize to the genus and even to the family because of the great variety of characters. Trees and shrubs, rarely lianas or herbs, sometimes with succulent stem, often with white or colored latex. **Leaves** usually alternate, sometimes opposite or whorled, simple, rarely trifoliolate or palmately compound, stipules present or absent, free or connate, usually early caducous; **inflorescences** axillary or terminal, very variable, cymes, thyrses, spikes or racemes, sometimes forming pseudanthia; **flowers** mostly actinomorphic, unisexual, usually small, sepals 3-6, sometimes lacking, usually connate, petals 3-6, often reduced or lacking, disk usually present, often bearing glands, stamens 1-numerous, filaments free or united, ovary superior, usually 3-locular; **fruits** capsules of 3 ventrally dehiscing, 2-valved cocci, each with one seed, rarely berries and drupes. Cosmopol. 313/8100, CR 51/213, GD 32/56.

Although wind-pollination occurs in some genera (e.g., *Croton*, DOMINGUEZ & BULLOCK 1989, DOMINGUEZ et al. 198; *Ricinus*, ALEX 1957), most Euphorbiaceae are pollinated by insects (WEBSTER 1994). The usually unspecialized flowers allow easy foraging for various visitors. Pollination studies were conducted primarily in temperate taxa and to a lesser extent in neotropical taxa. *Mabea occidentalis*, which occurs in the Golfo Dulce region, was studied by STEINER (1983). Its nocturnal flowers are visited by bats. Its flowers seem to be morphologically well-adapted to bat-pollination. Although there are some other nocturnal visitors (mammals), bats are probably the main pollinators. The second species investigated, *M. fistulifera*, is visited both by nocturnal pollinators (bats, mammals) and by diurnal ones (birds, bees) (VIEIRA et al. 1991, VIEIRA & CORALHO OKANO 1996). Pollination by midges (Heleidae) is the norm in *Hevea* (WARMKE 1951, 1952). Some species of *Cnidoscolus* are reported to be pollinated by sphingids and hawkmoths (WEBSTER 1994, PERKINS et al. 1975). Several wasps are apparently the legitimate pollinators of some species of *Croton* and *Euphorbia* (MOLDENKE 1976). With regard to pollination biology, *Dalechampia* is perhaps the most interesting member of Euphorbiaceae. Most of the species are pollinated by female euglossine bees (ARMBRUSTER 1993, ARMBRUSTER & HERZIG 1984, ARMBRUSTER & STEINER 1992, ARMBRUSTER & WEBSTER 1979, 1981, 1982, ARMBRUSTER & al. 1989, 1992, 1993). They collect the resins from the glands associated with the male flowers and use them for nest construction. This is also the case in *Dalechampia dioscoreifolia*, which occurs in the Golfo Dulce region. It is pollinated by species of *Eulaema* and *Euglossa* (ARMBRUSTER & HERZIG 1984). In contrast, a few *Dalechampia* species such as D. *spathulata* are pollinated by male euglossine bees which collect the fragrance produced on the stigmatic surface, or by stingless bees (ARMBRUSTER et al. 1989, 1992).

Seed dispersal is usually by simple dehiscence of the cocci (unspecified autochory). In the genera *Dalechampia* and *Hura* the seeds are dispersed by explosive dehiscence of the capsules (SWAINE & BEER 1977, ARMBRUSTER 1982). The seeds of some Euphorbiaceae (e.g., *Phyllanthus* spp.) possess an elaiosome and are apparently ant-dispersed. Several species produce fleshy and indehiscent fruits which are dispersed by birds. Dispersal by abiotic factors such as water or wind is rather rare in the family.
A few Euphorbs are of commercial value: *Hevea brasiliensis*, the rubber tree, native to the Amazon

region, was one of the most valuable plants at the beginning of the century. Its white milky latex, containing polymerized isoprenes, is best suitable for producing natural rubber. *Manihot esculenta*, called mandioka, cassava or yuca, is most of the main food crops of the neotropical region. The root tubers of the small treelet contain high amounts of starch. The seeds of *Ricinus communis*, an Old World species now also cultivated in the Neotropics, contain oil, which is used medicinally as a purgative, as a lubricant for airplane engines, as well as for several other purposes. Of local importance are some species of *Jatropha*, whose seeds are used as a purgative, whereas other species are used as ornamentals (BRÜCHER 1989, BURGER & HUFT 1995). The hard wood of *Hyeronima alchorneoides* is used locally for the construction of houses (FRANCO 1990).

Key to the genera (after BURGER & HUFT 1995, based on WEBSTER & HUFT 1988)

1	Ovules 2 in each locule of the ovary (seeds 1/locule in Drypetes); seeds 1-2 in each locule of the fruit, often 6/fruit (also 1-4/fruit), without caruncle; whitish latex absent; leaf blades never lobed, usually entire to obscurely serrate, usually lacking imbedded laminar glands, usually pinnately veined; trichomes simple or peltate (subfamily Phyllanthoideae)	2
2	Male inflorescences spikes or racemes; male flowers with prominent pistillode; plants dioecious (unisexual)	3
3	Trichomes simple; calyx deeply lobed (almost of separate sepals); male inflorescences spicate with sessile flower clusters; anther thecae not pendulous; ovary 2-3 locular; fruits dry capsules	*Richeria*
3*	Trichomes mostly peltate; calyx with short lobes; male inflorescences with alternate branches; anther thecae pendulous; ovary 2-locular; fruits fleshy and drupaceous	*Hyeronima*
2*	Male inflorescences of axillary flower clusters or on deciduous branchlets if racemose; male flowers lacking a prominent pistillode; plants monoecious (bisexual) or dioecious	4
4	Male flowers with a central intrastaminal disk; ovary with 1 or 2 locules, stigmas sessile and expanded; fruits drupaceous; ovules 1/locule; dioecious (unisexual) trees	*Drypetes*
4*	Male flowers without a central disk or the disk outside the stamens if present; ovary with 3-6 locules and styles, styles present and bifid, stigmas slender or expanded; fruits mostly capsules; ovules 2/locule; plants monoecious (bisexual) or dioecious	5
5	Ovary with 4 or 5 locules (rarely 3, 6), styles 4 or 5 (3, 6); fruits irregularly dehiscent; seeds with fleshy outer coat and hard bony inner coat; male flower with annual (ring-like) disk and 4 free stamens; distal branchlets persisting, not resembling pinnate leaves; dioecious trees	*Margaritaria*
5*	Ovary with 3 (rarely 2) locules, styles 3 (2); fruit usually breaking into valves; seeds without both a fleshy and bony layer; male flowers with 2 or 3 stamens or without a disk when 4 stamens are present; distal branchlets often deciduous and resembling pinnate leaves; monoecious or dioecious	*Phyllanthus*
1*	Ovules 1 in each locule of the ovary; seeds usually 3/fruit, seeds with or without an apical caruncle; whitish or colored latex present or absent; leaf blades often serrate or lobed (also entire), often with glands on blade or petiole, venation pinnate or palmate; trichomes various	6
6	Floral bracts without glands at the base; sepals imbricate to valvate, usually covering the anthers completely in bud, rarely petaloid; petals present or absent; disk often present; trichomes various; leaves simple to palmately lobed or compound	7
7	Petals absent, or if petals present the leaf blades with pinnate venation; petioles lacking stalked glands (but glands imbedded in leaf blades often present); seeds lacking caruncles (these only present in *Pera*); trichomes simple or attached at the center (peltate in *Pera*); flowers in axillary clusters, racemes, or spikes (these sometimes aggregated into panicles); latex usually absent, rarely white (subfamily Acalyphoideae)	8
8	Petals present in both male and female flowers (flowers in racemes; male flowers	

	with 10 stamens; seeds usually foveolate)	*Caperonia*
8*	Petals absent	9
9	Flowers sessile within a globose stipitate flower-like inflorescence, at first enclosed by the petal-like involucre; inflorescences resembling globose flower buds borne on leafless nodes below the leaves; seeds smooth and shiny black with caruncle (dioecious trees with peltate or stellate trichomes)	*Pera*
9*	Flowers not sessile nor enclosed in a stipitate involucre; inflorescences not resembling pedicellate flower buds in early stages; seeds neither black nor shiny	10
10	Flowers in a complex flower-like arrangement (pseudanthium) with 2 usually conspicuous palmately veined bracts often held in a vertical plane (ovary and fruit usually armed with stinging hairs; plants mostly vines or lianas with palmately veined or lobed leaves, or with palmately compound leaves)	*Dalechampia*
10*	Flowers not in a complex pseudanthium with 2 large palmately veined bracts held in a vertical plane	11
11	Male flowers with 4 sepals imbricate in 2 whorls, stamens 2, completely united and mushroom-shaped with connective enlarged and fleshy; latex reddish or purplish; fruits 8-12 cm in diameter, (globose; plants usually lianas)	*Omphalea*
11*	Male flowers with 3-5 valvate sepals, stamens 3-many (if 2 then the connective not enlarged); latex not reddish or purplish; fruits less than 7 cm in diameter	12
12	Stinging hairs present (styles undivided and connate basally; disk absent; seeds smooth, caruncle absent)	13
13	Anthers lacking a minute taft of apical hairs; bisexual vines; leaf blades usually cordate at base, usually with many stinging hairs	*Tragia*
13*	Anthers with a minute apical taft of stinging hairs (often difficult to see); unisexual shrubs and trees; leaf blades cuneate at base, glabrescent	*Acidoton*
12*	Stinging hairs absent	14
14	Styles basally connate into a long column; inflorescences bisexual and axillary; ovary 4-locular, strongly keeled; lianas (leaf blades with 2 circular glands at base)	*Plukenetia*
14*	Styles free or basally connate; inflorescences unisexual, various; ovary 2-3-locular, not strongly keeled; trees, shrubs or herbs	15
15	Styles usually divided into many slender laciniate branches; anthers minute (ca. 0,1 mm wide) with narrow pendulous-vermiform thecae (but difficult to see); female bracts much larger than the male ones, or if not the ovary verrucose (male inflorescences usually slender congested spikes)	*Acalypha*
15*	Styles various, but never divided into laciniate branches; anthers usually more than 0,2 mm wide and the thecae not narrow and pendulous-vermiform; female bracts not conspicuously larger or differently shaped than the male bracts	16
16	Ovary with 2 locules and 2 elongate free entire styles (stamens usually 8, pistillode absent; seeds tuberculate, lacking a caruncle, dry; trichomes often minutely stellate)	*Alchornea*
16*	Ovary with 3 locules and 3 bifid styles (or the seeds fleshy if styles are simple)	17
17	Stamens less than 10; plants unisexual (dioecious)	18
18	Larger leaf blades rounded at the base and cordate to subcordate, with paired laminar (stipel-like) glands near the base, flowers with 3-5 stamens	*Aparisthmium*
18*	Larger leaf blades cuneate to acute at the base, flat rounded glands sometimes present near the base, flowers with 4-8 stamens	*Alchorneopsis*
17*	Stamens more than 10; plants unisexual or bisexual (monoecious)	19
19	Stamens more than 50 in male flowers, anther connective enlarged; stipules thickened (disk absent in female flowers)	*Cleidion*
19*	Stamens less than 30 in each male flower, anther connective not enlarged; stipules thin	*Adelia*
7*	Petals present, at least in the male flowers, or else calyx petaloid; leaves often palmately veined or lobed; petioles or bases of the leaf blades often with stalked or prominent glands; seeds with caruncles or fleshy; trichomes simple, attached in the center, stellate or peltate; inflorescences various; latex clear, colored or whitish	

(subfamily Crotonoideae) 20

20 Flowers without petals, but the calyx petal-like (leaves palmately lobed; trichomes simple; sap white; plants monoecious/bisexual; inflorescences terminal and dichasial or paniculate; stamens 8-10) 21

21 Stinging hairs absent; calyx yellow to greenish or purple and often resembling a rotate corolla; male flowers with free filaments and central intrastaminal disk *Manihot*

21* Stinging hairs present (sometimes very few); calyx whitish and not resembling a rotate corolla; male flowers with connate filaments and extrastaminal disk *Cnidosculus*

20* Flowers with petals, or if the petals absent then the trichomes peltate; sap not whitish 22

22 Anthers inflexed in bud; some peltate or stellate trichomes usually present (male flowers with 8-many stamens, filaments free; inflorescences spicate or racemose (never branched); plants usually monoecious/bisexual in Central America; seeds with caruncles) *Croton*

22* Anthers usually erect in bud; trichomes not stellate or peltate 23

23 Leaves palmately veined or lobed; stamens mostly 8-12, filaments partly united; inflorescences terminal and dichasial, usually bisexual; trichomes simple or with gland-tipped segments *Jatropha*

23* Leaves pinnately veined; stamens 3-40, filaments free; inflorescences terminal or axillary, usually unisexual (unisexual or bisexual in *Sagotia*), spicate to racemose or paniculate; trichomes never with gland-tipped segments 24

24 Stamens 3-7; female flower with petals connate into a tube longer than the calyx; unisexual trees (inflorescences axillary and spiciform; trichomes simple and attached at the center but often difficult to see) *Pausandra*

24* Stamens 15-40; female flower lacking petals or the petals shorter than the calyx, bisexual shrubs and trees *Sagotia*

6* Floral bracts with 2 glands at the base, but sometimes difficult to see (absent in *Hura*); sepals imbricate or not well developed; anthers mostly exposed in bud; petals absent; and the sepals not petaloid, but glands of involucral cup may have petal-like lobes; disk absent or minute; trichomes simple or absent (dendritic in *Mabea*); leaves without lobes (subfamily Euphorbioideae) 25

25 Flowers not pseudanthial (as in 25*), without a well-developed involucral cup; flowers in spicate, racemose, or paniculate inflorescences; styles simple; stamens in whorls or united, not in radiating groups of 5 within a calyx cup or calyx tube; shrubs or trees, rarely herbs 26

26 Inflorescences thyrsoid or paniculate (resembling racemes); male flowers with anthers subsessile on an elevated receptacle *Mabea*

26* Inflorescences spicate or racemose; male flowers with anthers borne on well-developed filaments 27

27 Stylar column at least 25 mm long, terminated by a fleshy disk 2-3 cm wide and resembling a parasol; male flowers breaking their perianth irregularly in early anthesis, with anthers borne in whorls on cone-like columns from the axis of the inflorescence; ovary and fruit with more than 10 locules (capsule 5-9 cm in diameter) *Hura*

27* Stylar column < 25 mm long, styles diverging distally and not forming a flat disk; male flowers not rupturing the perianth and not borne on conical projections of the inflorescence axis; ovary and fruit with fewer than 10 locules 28

28 Ovary 6-9-locular; fruits drupaceous and not splitting open (seeds lacking a carencule; female flowers with 3-parted calyx; petiole with single gland; latex extremely caustic; seaside trees) *Hippomane*

28* Ovary 2-3-locular; capsules often splitting explosively 29

29 Seeds lacking a caruncle, seed coat fleshy; petioles usually with a pair of cylindrical glands; female sepals united at the base (male flowers with 2 stamens) *Sapium*

29* Seeds with a caruncle, seed coat dry; petioles without prominent glands; female flowers with separate sepals *Gymnanthes*

25* Flowers pseudanthial, actually flower-like inflorescences (called cyathia) in which

	the involucral bracts are united to form a calyx-like cup, usually with 1-5 glands along the edge of the involucral cup and these often with petal-like structures, central pistil actually a naked female flower on an articulated stipe (pedicel), styles bifid or simple; stamens usually in 5 lateral groups within the cupulate or shoe-shaped cyathium; cyathia often in cymose or dichotomous inflorescences; caruncle small or absent; herbs, shrubs, or small trees, sap usually whitish (often caustic)	30
30	Cyathia (flower-like pseudanthia) bilaterally symmetrical with involucre somewhat shoe-shaped, often with reddish coloring; involucral glands borne within the nectar spur and not visible from the exterior; styles connate into a long column; distal stems often green	*Pedilanthus*
30*	Cyathia radially symmetrical, involucre usually urceolate or campanulate and round in cross-section, usually greenish, yellow or white; involucral glands usually visible at the edge of the involucral cup; styles not forming a long column; distal stems green or woody and brown	31
31	Leaves alternate, opposite or whorled, if opposite then blades not asymmetric at the base; stipules absent or gland-like and small; veins of the leaf blade lacking a sheath of chlorenchyma; main axis of the plant not aborting soon after germination; trees, shrubs, or herbs	*Euphorbia*
31*	Leaves always opposite, blades usually small and strongly asymmetric at the base; stipules present and often lobed; veins of the leaf blade with a sheath of chlorenchyma (in dried leaves the veins often look translucent in transmitted light, in contrast to the darker areas between the veins); main axis of the young plant aborting just above the cotyledons; herbs and small shrubs	*Chamaesyce*

Acalypha (pantrop. + subtrop. ca. 430, CR 22 native, 2 introduced, GD 4)
Mostly herbs and shrubs but also a few trees, monoecious or dioecious with alternate, stipulate leaves with entire to strongly serrate margins. The genus is well characterized by the long, spicate inflorescences.

A. arvensis Poepp.
Monoecious herbs up to 70 cm tall; leaves 1,8-7 cm long, 1,2-4 cm wide, ovate to ovate-elliptic, base cuneate to rounded and truncate, margin dentate, pubescent on both sides with thin, straight hairs; male inflorescences 3-5 cm long, puberulent, female inflorescences 4-7 mm long, accrescent in fruit, becoming 24-80 mm long, sometimes basally with male flowers; fruits deeply 3-lobed, hidden within the expanded and persistent bracts of the cylindrical infructescence. On open or partly shaded sites in evergreen and deciduous forests, from Mexico to Bolivia and Brazil.

A. diversifolia Jacq.
Monoecious shrub or small tree up to 5(-15) m tall; leaves chartaceous, narrowly elliptic to ovate-elliptic or oblong-lanceolate, 6-20 cm long, 2-8 cm wide, base obtuse to cuneate, margin dentate, sparsely pubescent above, pubescent along the veins beneath; inflorescences axillary, spicate, 2-10 cm long, mostly bisexual, with a few female flowers at base; male flowers minute, calyx cupular, petals absent, stamens (4-)8(-16); female flowers minute, 2-3, subtended by a foliaceous, 3-4,5 mm long bract, petals absent, ovary (2-)3-locular; fruits small capsules with 3 bivalved cocci, ca. 2,5 mm in diameter. Common plants in evergreen and deciduous forests, from southern Mexico to Peru, Bolivia and Brazil.

A. villosa Jacq., Pl. 53a
Usually monoecious shrub or small treelet, up to 3(-8) m tall; leaves ovate to ovate-triangular, 8-17 (-25) cm long, 5-11(-13,5) cm wide, base truncate to cordate, margin crenate-serrate, sparsely strigose to glabrate above, more densely pubescent beneath; inflorescences usually axillary, always almost unisexual, unbranched, male inflorescences 4-12 mm long, spicate, female inflorescences 5-16 cm long, becoming racemose, with solitary flowers; fruits prominently 3-lobed, 1,5 mm long, 2 mm wide, muricate with narrow projections. In evergreen forests, from Mexico to Paraguay and Brazil.

Alchornea (pantrop. 70, CR 5, GD 3)
Usually dioecious trees and shrubs with alternate

and frequently serrate-margined leaves, usually bearing glands in the axils of the basal nerves beneath. They are very characteristic in fruit by having only 2 bivalved cocci.

A. costaricensis Pax & K. Hoffm.
Tree up to 10 m tall; leaves chartaceous to coriaceous, pinnately veined, margin serrate, stipules minute; male inflorescences axillary, 1-3 simple spikes per axil, 3-8 cm long, female inflorescences axillary, 1 simple or branched spikes per axil, 2-5(-10) cm long, male flowers white or yellowish, calyx 3-4-lobate, petals absent, stamens usually 8, female flowers calyx 4-lobate, petals absent; fruits pinkish-green to reddish brown, 5-7 mm long, 6-9 mm wide. In lowland rain forests, from Honduras to Panama.

Alchornea costaricensis
A. Habit. B. Female flower

Alchorneopsis (neotrop. 3, CR 1, GD 1)
A small genus of dioecious trees with alternate entire to subentire leaves. Rather similar to *Alchornea*, but without stellate indumentum and the spicate inflorescences never being branched.

A. floribunda (Benth.) Müll. Arg.
Large tree up to 40 m tall; leaves usually glabrous, margin slightly crenate with gland tipped lobes, stipules lacking; inflorescences axillary, unisexual, male inflorescences 5-14 cm long, female ones 4-6 cm long, male flowers minute, white to yellowish green, stamens usually 6, female flowers minute, ovary minutely pubescent; fruits ca. 4 mm long, 3-3,5 mm wide, of 3 bivalved cocci. In evergreen lowland forests, ranging from Costa Rica to Peru and Brazil.

Croton (pantrop. + subtrop. ca. 750, CR 41, GD 8)
Common names (Costa Rica): targua, colpachi (González, in prep.)
A very large and variable genus, always with stellate or lepidote indumentum and trilobate, entire (then often basally 3-veined) or slightly serrate-margined leaves.

C. schiedeanus Schlecht.
Monoecious shrub or tree, up to 15 m tall with an indument of lepidote hairs; leaves oblong-elliptic, stipules present, deciduous; inflorescences axillary, racemose to paniculate, 2-10(-12) cm long, bisexual or male only; male flowers, calyx 5-lobate, petals 1-3 mm long, white, stamens 9-11, female flowers calyx 5-lobate, petals 1,5-2 mm long, white, ovary covered with peltate hairs; fruits capsules of three cocci, 9-13 mm long. In lowland evergreen and partly deciduous forests, widespread in Central America, from Mexico to Peru.

Dalechampia (pantrop. + subtrop. 115, CR 9, GD 4)
Usually vines and lianas, but also a few erect species, lacking latex and with simple or palmately compound leaves, easy to recognize by its large, variously colored inflorescence bracts. Most abundant in the Neotropics.

D. dioscoreifolia Poepp. & Endl., Pl. 53b
Climbing vine, stem up to 4 cm in diameter; leaves alternate, simple, 6-15 cm long, cordate, basally 3-veined, margin entire or almost so, stipules glandular, 3-7 mm long; inflorescences axillary, flowers in cymules, inflorescence bracts 3,2-3,8 cm long, pinkish or white with pink or purple venation, margin toothed, male cymules with an involucel of 4 free, broadly imbricate bracteoles, female cymules only with abaxial bracteoles with ciliate margin; male flowers 8-9 per cymule, calyx lobes 4, petals absent, anthers 20-30, female flowers 3 per cymule, sepals 5-11, petals absent; fruits deeply trilobate capsules, calyx persistent. In lowland and submontane rain forests, from southeastern Nicaragua to Peru.

Euphorbia (cosmopol. ca. 2000, CR 18, GD 2)
A large genus of herbs shrubs and trees with milky latex, sometimes with succulent stems. Vegetatively very diverse, but well characterized by the typical aggregations of the flowers to a pseudoflower (" cyathium").

E. elata Brandegee, Pl. 53c
Shrub, up to 5 m tall; leaves alternate, entire; inflorescences terminal, solitary, 14-50 cm long, cymose; cyathia campanulate, with 5 perianth-like lobes and rounded, sessile -appressed glands; fruits 9-12 mm long, 11-14 mm wide, trilobate, smooth, short stipitate. In evergreen forests up to 1500 m alt., ranging from Mexico to the Amazon Basin.

Hura (neotrop. 2, CR 1, GD 1)
Monoecious trees with white latex, easy to recognize by the conical spines covering the stem. The fruits are rather large, explosively dehiscing capsules.

H. crepitans L., Pl. 53d-f
Small to large tree, up to 35 m tall, covered with 1-3 cm long spines; leaves ovate to broadly ovate or ovate-orbicular, 5-18(-25) cm long, 4-14(-17) cm wide, serrate or rounded-crenate with 9-20 gland-tipped teeth on each side, petiole with 2 glandular areas at the apex adaxially; male inflorescences spicate, 2-5 cm long, peduncles 2-16 cm long; male flowers 2-3 mm in diameter, female flowers solitary, 4-6 mm long, dark red; fruits rounded oblate, 3-5 cm long, 6-11 cm in diameter. In lowland rain forests, from Nicaragua and the West Indies to Peru and Brazil.

Hyeronima (neotrop. 36, CR 3, GD 2)
Dioecious trees and shrubs with alternate leaves, distinct in having unilocular, drupaceous fruits and an indument of lepidote hairs.

H. alchorneoides Allemao, Pl. 53g-h
Common names (Costa Rica): pilon, zapatero (González, in prep.)
Tree, up to 40 m tall, sometimes with large buttresses; leaves entire, pubescent with flat, peltate hairs, stipules present; inflorescences axillary, paniculate, with 3-9 racemose branches to 10 cm long; male flowers 1-1,3 mm long, calyx 4-lobate, petals lacking, stamens 4-6, female flowers 1,5-2 mm long, calyx 4-lobate, petals lacking, ovary glabrous; fruits fleshy drupes, ovoid to ellipsoid, red, becoming purple-black, calyx persisting. In lowland rain forests, from southern Mexico to Peru and Brazil.

Mabea (neotrop. 50, CR 4, GD 3)
Small tree and shrubs with white milky latex, easily recognized by the nearly always serrate margined leaves and the typical racemose, bottle-brush-like inflorescences.

M. klugii Steyerm., Pl. 54a,b
Tree, up to 18 m tall; leaves 8-20 cm long, 1,5-8 cm wide, reddish lepidote beneath, margin serrate; inflorescences ca. 14 cm long; fruits 20-25 mm long. In wet forests in Central America and northwestern South America, ranging from Nicaragua to Ecuador and Bolivia.

M. occidentalis Benth., Pl. 54c,d
Shrub or small tree, up to 6 m tall; leaves 5-23 cm long, 1,5-9 cm wide, glabrous to scurfy pubescent beneath, margin subentire to serrate; inflorescences 12-45 cm long; fruits 10-14(-18) mm long. In wet forests, from Mexico to Amazonian Brazil.

Pausandra (neotrop. 12, CR 1, GD 1)
A rather small genus of trees and shrubs with red or yellowish latex in the stem and always serrate leaves bearing glands at the base of the lamina.

P. trianae (Müll. Arg.) Baill., Pl. 54e-g
Tree, up to 30 m tall; leaves clustered near the branch tips, with 2-4 cylindrical glands near the petiole apex, leaf margin width rounded gland-tipped teeth; male inflorescences 7-15 cm long, spicate, with glomerules of 5-12 flowers; female inflorescences 2-17 cm long spicate, with solitary flowers; fruits ca. 13-14 mm long, woody. In evergreen lowland rainforests, from Honduras to Amazonian Peru and Brazil.

Phyllanthus (pantrop. + subtrop. ca. 600, CR 14, GD 4)
A large and variable genus, always without latex. Mostly weedy herbs with small alternate leaves, but also trees and shrubs.

P. amarus Schumach. & Thonn.
Monoecious herb or subshrub, up to 0,5 m tall; leaves small, up to 12 mm long; inflorescences axillary, usually bisexual; fruits 1-1,3 mm long, 1,3-2 mm wide, smooth, yellowish. A weed of open habitats, probably native to the Americas, but now distributed worldwide in the tropics.

Plukenetia (pantrop. 16, CR 2, GD 2)
Lianas, lacking latex and with entire or dentate leaves, usually with a pair of sessile glands at the petiole apex or at the base of the lamina. The fruits are usually 4-6-parted, smooth to carinate or winged capsules.

Key to the species of *Plukenetia* (after GONZÁLEZ, in prep.)

1 Leaves mostly ovate with palmate or subpalmate venation; inflorescences usually terminal or leaf-opposed; capsules 25-35 mm wide — *P. stipellata*
1* Leaves mostly oblong with pinnate venation; inflorescences axillary; capsules ca. 15 mm wide — *P. penninervia*

P. penninervia Müll. Arg., Pl. 54h
Monoecious vine, basally woody; leaves narrowly elliptic-oblong to oblong or oblong-lanceolate, minutely glandular denticulate, usually with 2 elliptic glands or glandular thickenings at the petiole apex, stipules small, caducous; inflorescences bisexual or male, 0,5-3 cm long; male flowers with 3 calyx lobes, stamens ca. 14-18; fruits oblate, ca 10 mm long, 15 mm wide, prominently 4-lobed. In evergreen lowland forests, from southern Mexico to Venezuela and Peru.

P. stipellata L.J. Gillespie
Monoecious vine or liana; leaves mostly ovate, minutely serrate with narrow glands near the base of the lamina and usually 2 minute glands at the petiole apex, stipules small, caducous; inflorescences usually bisexual, 2-10 cm long; male flowers with 5 calyx lobes, stamens 25-40, female flowers with 4 sepals, ovary 4-locular; fruits 13-26 mm long, 22-35 mm wide, smooth, with 4 prominent lobes. Usually in evergreen forests up to 800 m alt., ranging from southern and eastern Mexico to Panama.

Richeria (neotrop. 5-7, CR 2, GD 1)
Dioecious trees and shrubs without latex and with inflorescences in axillary spikes or racemes.
R. obovata (Müll. Arg.) Pax & K. Hoffm., Pl. 54i
Tree, up to 30 m tall; leaves often clustered at the twig ends, usually obovate, subglabrous, entire or slightly serrate, often with 2 glandular areas near the base of the lamina; inflorescences spicate, male inflorescences 1-4, female inflorescences solitary; male flowers with 3-5-lobate calyx, female flowers with 5-parted perianth, ovary 2-3-locular; fruits capsules, ellipsoid to narrowly oblong, 8-15 mm long, seeds with red to orange aril. In evergreen forests up to 1200 m alt., ranging from Costa Rica to southern Brazil.

Sapium (pantrop. + subtrop. 100, CR 11, GD 4)
Common name (Costa Rica): yos (GONZÁLEZ, in prep.)
Monoecious or dioecious trees and shrubs, nearly always glabrous and always with white and sometimes caustic milky latex. The petioles are bearing 2 prominent glands near the apex.

S. laurifolium (Rich.) Griseb., Pl. 54j,k
Tree, up to 25 m tall; leaves entire or with a few marginal glands, stipules 1-3 mm long, persistent; inflorescences terminal, 2-5, unisexual or bisexual, 2-12(-28) cm long; male flowers with bilobate calyx, yellowish to red, female flowers with trilobate calyx; fruits sessile. In evergreen rain forests up to 1200 m alt., ranging from Costa Rica to Brazil and the Greater Antilles.

S. allenii Huft
Tree, up to 25 m tall; leaves clustered near the twig apex, entire or slightly glandular-undulate, stipules 5-7 mm long; inflorescences lateral, borne on leafless nodes, 2,5-6 cm long in fruit; fruits stipitate, subglobose, 7-9 m long, 5-11 mm wide. In evergreen rainforests, endemic to southern Costa Rica.

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Fabaceae s.l. (Leguminosae)

Trees, shrubs, vines but also lianas or herbs, sometimes with transparent, red or colorless latex. **Leaves** usually alternate (opposite in *Platymiscium*), usually pinnately or bipinnately compound, trifoliolate, bi- or unifoliolate, rarely simple (*Lecointea*), or rarely simple bifid (*Bauhinia*), leaflets few to many, margin entire or lobed rarely serrate to serrulate (*Lecointea*, *Vatairea*) or denticulate (*Trifolium*), petioles and sometimes also the petiolules bearing a cylindrical pulvinus, stipules usually persistent and conspicuous, sometimes small and caducous, petioles and rhachis sometimes with glands; **inflorescences** axillary or terminal, sometimes rami- or cauliflorous, generally racemose, spicate, paniculate or capit-

ulate, rarely flowers solitary; **flowers** actinomorphic or zygomorphic, bisexual, generally 5-merous, stamens 5-10-to numerous, ovary superior, 1-locular; **fruits** usually pods, basically 2-valved, dehiscent or indehiscent, oblong or globose, sometimes modified into loments (constricted between seeds), samaras (long or orbicularly winged), fleshy or subwoody drupes (almond-shaped), or follicles (dehiscent only on one side), seeds 1-numerous, sometimes very large, frequently poisonous. Cosmopol. 643/18000, CR 108/600, GD 65/165.

Fabaceae is the most important tree family in the Neotropics. The growth forms range from forest giants to tiny herbs, and the family shows extremely diverse manners and strategies of survival, growth, competition, reproduction and defense.

The importance of the legume family in the forests results from the large species number, thus contributing enormously to biodiversity, from the great potential of providing food to a wide range of pollinators and herbi- or frugivorous animals, and from the enrichment of the soil with nitrogen (symbiosis with N-fixing bacteria).

The classification of the order Fabales into a single family with three subfamilies or three separate families is mainly due to the emphasis given to the relatively few genera that are intermediate between the three major groups. Here the Fabaceae is treated in its broad sense, that is as a single family with three subfamilies. The latter can be distinguished by their different flowers types:

Caesalpinioideae: flowers actinomorphic or slightly zygomorphic, with free petals and mostly 10 stamens.
Mimosoideae: flowers actinomorphic, campanulate or tubular, mostly polyandrous.
Faboideae (Papilionoideae): flowers distinctly zygomorphic, two petals connate to form a carina, stamen number usually 10.

The fruits of the Fabaceae are wind-dispersed, water-dispersed, or dispersed by birds, bats or other mammals (rodents). Explosive mechanisms are found in some neotropical weedy plants with 3-foliolate or bipinnate leaves (*Caesalpinia, Calopogonium*, *Canavalia*, *Zapoteca*), and less frequently in tree genera such as *Pentaclethra*.

Key to the subfamilies

1	Leaves bifoliolate or bifid	Caesalpinioideae
1*	Leaves trifoliolate, (rarely) simple, pinnate or bipinnate	2
2	Leaves trifoliolate	Faboideae
2*	Leaves simple	3
3	Flowers ± radial to slightly bilaterally symmetric, sepals free	Caesalpinioideae
3*	Flowers zygomorphic, with united sepals	Faboideae
2**	Leaves bipinnate	4
4	Leaves with cupular petiolar and/or rhachis glands	Mimosoideae
4*	Leaves without cupular petiolar and/or rhachis gland	5
5	Flowers tubular, actinomorphic	Mimosoideae
5*	Flowers more or less radial to slightly bilaterally symmetric	Caesalpinioideae
2***	Leaves paripinnate	6
6	Leaves with petiolar and/or rhachis glands	Mimosoideae (*Inga, Cojoba*) Caesalpinioideae (*Senna* spp.)
6*	Leaves without petiolar and/or rhachis glands	7
7	Flowers more or less radial to slightly bilaterally symmetric, sepals free	Caesalpinioideae
7*	Flowers zygomorphic, with united sepals	Faboideae
2****	Leaves imparipinnate or odd-pinnate	8
8	Flowers more or less radial to slightly bilaterally symmetric, sepals free	Caesalpinioideae
8*	Flowers zygomorphic, with united sepals	Faboideae

Fabaceae-Caesalpinioideae

Mostly trees, but also a few shrubs and spiny lianas (*Bauhinia* spp., *Caesalpinia* spp., *Senna* spp.) or herbs. **Leaves** simple or simple bifid, odd pinnate or bipinnate, leaflets alternate or opposite, stipules present, glands rarely present (*Senna* spp.); **inflorescences** paniculate, racemose or spicate; **flowers** actinomorphic or slightly zygomorphic, sepals 4-5, free or connate, petals 5, free, stamens usually 10, free or basally connate, sometimes staminodial, sometimes with prolonged or conspicuously broadened filaments, ovary superior, 1-locular; **fruits** pods, sometimes indehiscent, sometimes winged. Cosmopol. 153/2175, CR 24/111, GD 17/33.

Caesalpinioideae are supposed to be most primitive legume subfamily, due to their main life form as trees, their frequent lack of nodules with nitrogen-fixing bacteria and their symbiosis with ectotrophic mycorrhiza as well as their primitive floral morphology.

Key to the genera (after GENTRY 1993 and CROAT 1978)

1	Leaves bifid to bifoliolate	2
2	Lianas	*Bauhinia* p.p.
2*	Trees	3
3	Leaves palmately veined	*Bauhinia* p.p.
3*	Leaves not palmately veined	4
4	Leaflets conspicuously asymmetric, apex acute to mucronate	5
5	Leaflets punctate, petiolulate	*Hymenaea*
5	Leaflets not punctate, nearly sessile	*Cynometra*
4*	Leaflets nearly symmetric, apex long acuminate to caudate	*Peltogyne*
1*	Leaves paripinnate	6
6	Leaves always with 2 pairs of leaflets	7
7	Leaves with black, conical gland between basal pair of asymmetric leaflets, plant shrub or treelet	*Senna* (*S. caudata*)
7*	Leaves without glands	8
8	Leaflets oblong-elliptic to oblong-ovate, acute, symmetric, petiolulate, trunk with narrow buttresses	*Mora*
8*	Leaflets broad-elliptic, bluntly acute or acuminate, trunk cylindrical	*Prioria*
6*	Leaves usually with 3 pairs of leaflets, leaflets emarginate, nearly rhombic, subsessile, base of trunk shaped like elephant's foot	*Macrolobium* p.p.
6**	Leaves with 4-6 pairs of leaflets, stipules persistent, conspicuous	*Phyllocarpus*
6***	Leaves with numerous (more than 6) pairs of leaflets	9
9	Rhachis narrowly winged, constricted between each pair of leaflets	*Macrolobium* p.p.
9*	Rhachis not winged	10
10	Stipules foliar (leaf-like) semipersistent, petiole swollen, leaflets 9-15 cm long	*Tachigali*
10*	Stipules inconspicuous or caducous, petiole cylindrical	11
11	Leaves without glands	12
12	Leaflets 3–6 cm long, symmetric, short-petiolulate, caducous when dry	*Cassia*
12*	Leaflets small (less than 1.5 cm), asymmetric, sessile, persistent when dry	*Copaifera* p.p.
11*	Leaves with glands	13
13	Plant herb or subshrub, petiole with cup- or disk-shaped, often stipitate gland	*Chamaecrista*
13*	Plant liana with stipular spines (like in *Machaerium*), leaves with black, conical glands between each pair of leaflets	*Senna* (*S. spinescens*)
13**	Plant treelet or small tree, leaves with mounded or claviform glands, often located on stipules or stipels of young leaves	*Senna* p.p.
1**	Leaves odd-pinnate	14
14	Leaflets punctate, conspicuously asymmetric	*Copaifera* p.p.
14*	Leaflets not punctate	15
15	Leaflets small (less than 1,5 cm), asymmetric, sessile, oblong	*Copaifera* p.p.

15*	Leaflets more than 3 cm, symmetric, petiolulate, long acuminate	*Dialium*
1***	Leaves bipinnate	16
16	Trees	17
17	Stipules pinnate or bipinnate, conspicuous	*Delonix*
17*	Stipules lateral or lacking	18
18	Leaflets symmetric, petiole viscous, leaf-rhachis woody, trunk gray, with large buttresses	*Schizolobium*
18*	Leaflet-base asymmetric, petiole not viscous, leaf-rhachis herbaceous, often pubescent	*Peltophorum*
16*	Treelets or shrubs, older stems usually spiny, flowers yellow to orange-red	*Caesalpinia*

Bauhinia (pantrop. 300, CR 14, GD 3)
Lianas, sometimes treelets or small trees, sometimes armed with spines and with 2-foliolate or bifid leaves. The stems are usually conspicuously flattened ("monkey's ladder") and mostly bear lateral tendrils.

B. bahiachalensis Zamora ined., Pl. 55a
Liana; leaves bifid, nearly orbicular, split only to upper quarter of leaf-blade; flowers up to 5-6 cm long, white to whitish; fruits flat, dark brown, 7–14 cm long, 2,5–3,5 cm wide. Endemic to the Golfo Dulce Region.

B. guianensis Aubl., Pl. 55b-d
(syn. *B. manca* Standl.)
Leaves bifid, split only to upper quarter of leaf, lobes ovate to elliptic, with asymmetric bases, dark green; stipules caducous. From Honduras and Belize to Peru and Brazil.

Caesalpinia (pantrop. ca. 150, CR 7, GD 2)
Trees, treelets or shrubs, sometimes lianas, occasionally spiny and sometimes with very smooth bark. The leaves are bipinnate, oblong-elliptic with caducous stipules. The flowers are always yellow to orange-red.

Key to the species of *Caesalpinia*

1	Stipules conspicuous, leaf-like, persistent, rachis and rachillae spiny	*C. bonduc*
1*	Stipules caducous, rachis and rachillae not spiny	*C. pulcherrima*

C. bonduc (L.) R.Br., Pl. 55e
Lianas; twigs pale brown, spiny; leaves with 7 pairs of pinnae, leaflets opposite to subopposite, elliptic, 1,8–5 cm long, 1–3,5 cm wide, acute, stipules leaf-like, 4-lobed with 2 large, sub-orbicular lobes, up to 3.5 cm in diameter, 2 smaller lobes, up to 2 cm in diameter, leaf rhachis with spines between each pair of pinnae, rhachillae with spines beneath each pair of leaflets; inflorescences spicate, densely ferruginous pubescent, peduncle spiny; flowers yellow-orange, petals ciliate; fruits asymmetric, broadly elliptic, spiny, 6,5–7,5 cm long, 5–6 cm wide. In primary forests, from Nicaragua to Ecuador and Peru.

C. pulcherrima (L.) Sw.
Common names (Costa Rica): clavellina, hoja de sen, malinche
Treelet or shrub, older stems mostly spiny; leaves with 3–9 pairs of pinnae, leaflets 6–12 pairs per pinna, 1–3 cm long, apically rounded, pale green beneath, stipules caducous; inflorescences long racemose; flowers yellow to orange-red, stamens long, slender; fruits narrowly oblong, irregularly flattened, 9–12 cm long, 1,5–2 cm wide. In low to medium elevations with dry to very humid climate, widely distributed throughout the tropics worldwide, mostly cultivated or naturalized, probably native to Central America.

Chamaecrista (pantrop. 265, CR 7, GD 1)
Mostly weeds, sometimes subshrubs with small leaflets and the petioles with cup- or disk-shaped, often stipitate glands.

C. nictitans (L.) Moench, Pl. 55f
Weedy herb or subshrub; leaflets small, linear, petiole with cup-shaped, stipitate gland, stipules persistent; flowers yellow, bilaterally symmetric; fruits narrow, elastically dehiscent, opening longitudinally by coiling valves. Usually along roadsides, from Mexico to Ecuador and Bolivia.

Copaifera (pantrop. 30, CR 2, GD 2)
Large trees, cream-colored and reddish- to dark brown-spotted bark. The leaves are always odd-

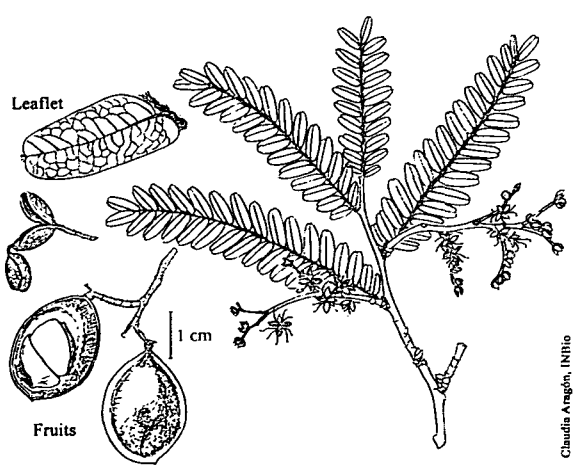
pinnate, with subcoriaceous, asymmetric, acuminate leaflets and caducous stipules. The apetalous flowers are white to pale brown in terminal or axillary paniculate inflorescences with unbranched spicate lateral branches. The unique fruits are 2-valved, subglobose and slightly compressed when mature, with single black seeds partially covered with an orange or dark red aril.

Key to the species of *Copaifera*

1 Leaflets 8–12, punctate, 2,5–9 cm long, 1,5–3,5 cm wide, apex falcate-acuminate — *C. aromatica*

1* Leaflets 30–46, not punctate, 4–12 cm long, 2–4 mm wide, apex rounded or minutely acuminate — *C. camibar*

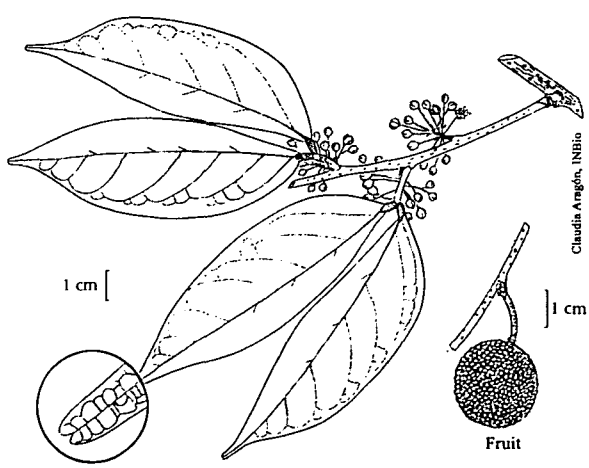
C. aromatica Dwyer
Common name (Costa Rica): camíbar
Large tree, trunk cylindrical, base slightly channeled, bark with aromatic smell; leaves odd-pinnate, leaflets 8–12, punctate, conspicuously asymmetric, narrowly or broadly ovate-oblong, 2,5–9 cm long, 1,5-3,5 cm wide, stipules caducous; inflorescences axillary, paniculate; flowers apetalous, pale brown; fruits small, subglobose, ca. 1,5 cm long, slightly compressed, seed 1, black with dark red aril. In low elevations with humid or very hemid climate, in Costa Rica and Panama.



Copaifera camibar

C. camibar N. Zamora & P. Sánchez, Pl. 55h
Common name (Costa Rica): camíbar
Large tree, trunk cylindrical; leaves odd-pinnate, leaflets 30–46, oblong, asymmetric, sessile, 4–12 cm long, 2–4 mm wide, stipules caducous; inflorescences terminal or axillary, paniculate; flowers apetalous, yellow, ferruginous pubescent; fruits subglobose, slightly compressed, 2–3 cm long, 1,5-2,3 cm wide, seed 1, black with orange aril. In low elevations with very humid climate, from Costa Rica to Venezuela.

Cynometra (pantrop. 70, CR 3, GD 3)
Large trees, with buttresses and 2-foliolate leaves with oblong-lanceolate, nearly sessile leaflets with caducous stipules. The axillary or rarely terminal inflorescences bearing brown flowers. Fruit woody.



Cynometra retusa

C. hemitomophylla (Donn. Sm.) Britton & Rose, Pl. 55g
Common names (Costa Rica): guapinol negro, cativo, caracolillo
Medium-sized to large tree; inflorescences axillary, racemose, solitary, glabrous; fruits 3-4 cm long, up to 3,5 cm wide. In low elevations, endemic to Costa Rica.

C. retusa Britton & Rose
Common name (Costa Rica): guapinolillo
Small to large tree; inflorescences axillary, racemose, solitary, puberulent; fruits up to 1,8 cm in diameter. In low elevations, from southern Mexico to Costa Rica.

Dialium (paleotrop. ca. 39 + 1 sp. neotrop., CR 1, GD 1)
Usually large trees with simple pinnate leaves with few leaflets.

D. guianense (Aubl.) Sandw., Pl. 55i
Common name (Costa Rica): tamarindo de montaña
Medium-sized to large tree, with slender buttresses; leaves odd-pinnate, leaflets alternate or subopposite, symmetrically ovate to lanceolate, 3–9 cm long; inflorescences terminal and axillary, paniculate, large; flowers small, pale yellow; fruits globose to ovate, 1,5–2,5 cm long, smooth, indehiscent, seed 1. In lowlands with humid or very humid climate, from Guatemala to Brazil.

Hymenaea (neotrop. & trop. Africa 16, CR 1, GD 1)
Usually large trees with spreading crown and distinct 2-foliolate, glandular punctate leaves. The fruit is a somewhat flattened ellipsoid, indehiscent pod.

H. courbaril L.
Common name (Costa Rica): guapinol
Large tree, without buttresses; leaves 2-foliolate, leaflets punctate, oblong-lanceolate, 7–12 cm long, glabrous, shiny, stipules caducous; inflorescences paniculate, flowers white; fruits 2-valved, dehiscent, oblong, woody 5–15 cm long, seeds 1-2, covered by a starchy, bad smelling, edible pulp. In Costa Rica and Panama.

Hymenaea courbaril

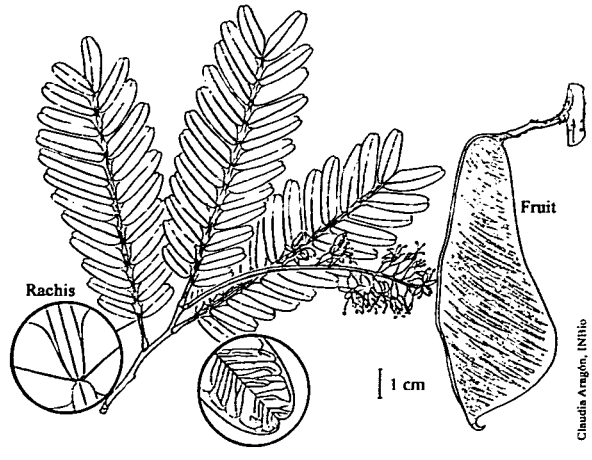
Macrolobium (neotrop. ca. 70, CR 3, GD 2)
Usually small trees, the leaves with few oblong to elliptic or rhombic leaflets or multifoliolate with narrowly oblong leaflets. Flowers with 1 petal, 3 fertile stamens and several brown staminodes in axillary, spicate inflorescences. Fruits usually flat pods.

Key to the species of *Macrolobium*

1	Leaflets usually up to 22 pairs, 1–3 cm long, linear to oblong, apex asymmetrically cleft	*M. hartshornii*
1*	Leaflets usually 3 pairs, 7–12 cm long, distally emarginate, nearly rhombic, acuminate	*M. costarricense*

M. costaricense W.C. Burger, Pl. 56a
Common name (Costa Rica): pata de elefante
Medium-sized tree; leaves usually with 3 pairs of leaflets, leaflets rhomboid-elliptic to nearly rhombic; flowers white; fruits oblong, woody, 10–15cm long, 2,5–3,5 cm wide, seeds 2-3. Endemic to Costa Rica.

M. hartshornii R.S. Cowan
Medium-sized to large tree; leaves usually with up to 22 pairs of leaflets, leaflets 1–3 cm long, linear to oblong, nearly cleft, rhachis narrowly winged, constricted between each pair of leaflets; flowers white; fruits flat, woody, smooth, globose to nearly quadrangular, seed 1. In Costa Rica and Panama



Macrolobium hartshornii

Mora (neotrop. 6, CR 1, GD 1)
Trees, usually found in swampy areas with simply pinnate leaves and small flowers in dense, spicate inflorescences.

M. oleifera (Triana) Ducke, Pl. 56b-d
Common name (Costa Rica): alconoque
Large tree, trunk irregular with slender but tall buttresses; leaves paripinnate, usually with 2 pairs of leaflets, leaflets narrowly ovate to elliptic, 6–18 cm long, 4–7 cm wide, stipules caducous; inflorescences spicate, up to 12 cm long; flowers minute, white; fruits woody, oblong, up to 25 cm long, 13 cm wide, brown, the seed is one of the largest of any dicot, ca. 15 cm long, kidney-shaped. From Costa Rica to Ecuador.

Peltogyne (neotrop. 23, CR 1, GD 1)
Trees with 2-foliolate, punctate leaves. The small whitish flowers are arranged in terminal or axillary, racemose inflorescences. Flat fruits with a single seed.

P. purpurea Pittier, Pl. 56e-g
Common names (Costa Rica): nazareno, purple heart
Large tree, with narrow buttresses; leaves 2-foliolate, oblong-lanceolate, 5–12 cm long, stipules caducous; inflorescences paniculate; flowers small, fragrant, white; fruits 2-valved, dehiscent, seeds 1-2. In well drained areas in Costa Rica and Panama.

Peltophorum (pantrop. 8, CR 2, GD 1)
Trees with bipinnate leaves and characteristic indehiscent and marginally winged fruits. The flowers are always yellow, and arranged in terminal inflorescences, compound of several racemes. The genus is introduced to Costa Rica.

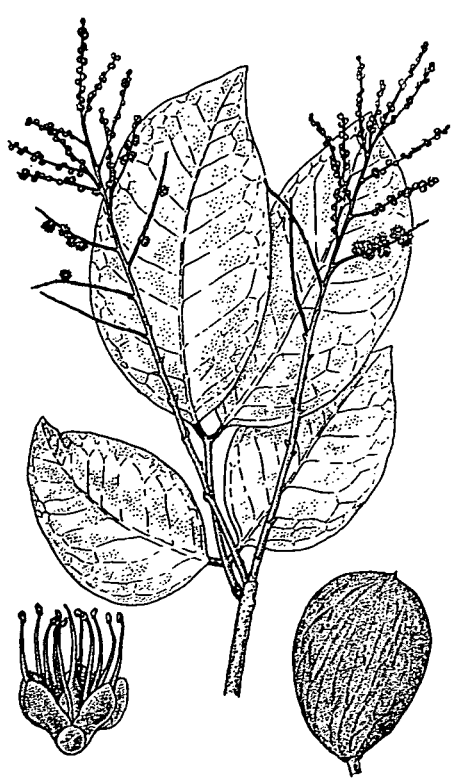
P. pterocarpum (DC.) Baker ex K. Heyne
(syn. *P. inerme* (Roxb.) Náves ex Fernald-Vill.)
Medium-sized to large tree, with wide-spead crown and the leaves with 7–14 pairs of pinnae and 10–20 pairs of leaflets per pinna. The conspicuous yellow flowers are arranged in large terminal panicles.

Phyllocarpus (neotrop. 2, CR 2, GD 1)
A small genus with simply pinnate leaves with a few pairs of leaflets. The flowers are distinct in having only 3 petals. The indehiscent fruit is conspicuously winged along the upper suture.

P. riedelii Tul.
(syn. *P. septentrionalis* Donn. Sm.)
Large tree; leaves with 4–6 pairs of leaflets, leaflets elliptic to elliptic-oblong, 6–7 cm long, stipules persistent, conspicuous, broad; inflorescences racemose, few-flowered; flowers showy, red; fruits flat, narrowly oblong pod, 20 cm long, 4-5 cm wide, with a 1 cm broad wing on one side, seeds 1(-2). In lowland wet forests, from Guatemala to Panama.

Prioria (neotrop. 1, CR 1, GD 1)
Monotypic genus.

P. copaifera Griseb.
Common name (Costa Rica): cativo
Large tree; leaves with 2 pairs of leaflets, leaflets pellucid-punctate, broad-elliptic, 4–16 cm long; inflorescences large, terminal; flowers apetalous, minute, sepals petaloid, white, stamens 10, free; fruits round, flat, up to 10 cm long, 7 cm wide, seed 1. In alluvial or swampy lowlands, close to freshwater, in the Osa Península usually in hilly terrain, from Nicaragua and Jamaica to Colombia.



Prioria copaifera

Schizolobium (neotrop. 1-2, CR 1, GD 1)
Large trees with bipinnate leaves and numerous leaflets. The yellow flowers are arranged in axillary or terminal, racemose or paniculate inflorescences. The flattened, single seeded pods are only slightly dehiscent.

S. parahyba (Vell.) S.F. Blake, Pl. 57a-d
Common names (Costa Rica): gavilán, gallinazo
Large tree, with very narrow, steeply ascending, buttresses; leaves very large, up to 2 m long on young individuals, pairs of pinnae with numerous, leaflets per pinna 15–20 pairs, leaflets oblong, 2–3,5 cm long; inflorescences terminal, paniculate, large; flowers conspicuous, yellow; fruits spatulate, flat, 8-12 cm long, 2-5 cm wide, apically rounded. In lowland forests, sometimes frequent in secondary forests, from Mexico to Brazil.

Senna (pantrop. ca. 350, CR 25, GD 8)
Shrubs or treelets and a few (sometimes spiny) climbers with frequently 4-foliolate leaves, bearing often large, conical and black glands. The fruit is usually compressed, dry and indehiscent, or opening longitudinally along the sutures.

Key to the species of *Senna* (based on BARNEBY et al. 1998)

1	Leaves with black, conical gland between basal pair of asymmetric leaflets, plant shrub or treelet	*S. caudata*
1*	Leaves without glands	2
2	Leaf rhachis with a mounded, clavate or blade-like nectary, between the first pair (and often successive pairs) of leaflets	*S. cobanensis*
2*	Leaf rhachis without nectaries	3
3	Stems armed at nodes with a pair of recurved infrastipular prickles; pods pendulous, elongately linear, 15-50 x 1,1-1,5 cm, when ripe lomentiform, breaking up into 1-seeded articles sealed at each end by a corky septum	*S. spinescens*
3*	Stems unarmed; ripe pods continuous	4
4	Seven fertile stamens subhomomorphic; pods of woody texture, the cavity traversed by interseminal septa	*S. spectabilis*
4*	Seven fertile stamens heteromorphic, 2 or 3 of the abaxial ones much longer than the 4 median ones	5
5	Petiole including pulvinus 3-13 cm long; leaflets thinly pubescent on ventral face; pods plano-compressed, not winged	*S. reticulata*
5*	Petiole 1-3,5 cm long, often reduced or almost so to the pulvinus; leaflets glabrous on ventral face; pods winged lengthwise along middle of valves, the wing 4-9 mm wide, crenulate	*S. alata*

S. alata (L.) Roxb., Pl. 57e,f
Shrub, usually 1-4 m tall; leaves with (6-)7-14 pairs of leaflets, the terminal pair usually broadest, leaflets broadly oblong or obovate, 7-19(-21) cm long, (3-)3,5-9,5(-13,5) cm wide, petiolar glands lacking; inflorescences racemose or paniculate, many-flowered; flowers bright yellow, conspicuously clawed; fruits broadly linear, sharply tetragonal, 11-18(-19) cm long, with papery, crenulate wings. Mostly along rivers and in wet areas, from southern Mexico and the Antilles to central Brazil, naturalized in the Paleotropics.

S. caudata (Standl.) H.S. Irwin & Barneby
(syn. *Cassia caudata* Standl.)
Shrub or treelet, 1-2 m tall; leaves 4-foliolate with large, conical and black glands, leaflets oblong or obovate-lanceolate, ca. 12–20 cm long, 5–6,5 cm wide; inflorescences pendent; flowers pale yellow; fruits usually compressed, dry and indehiscent or opening longitudinally along the sutures. In Costa Rica and Panama.

S. cobanensis (Britton & Roce) H.S. Irwin & Barneby
(syn. *Cassia cobanensis* Britton & Rose)
Common name (Costa Rica): candelillo
Shrub or herb, more than 2 m tall, with unpleasant smell in all parts; leaves with 3(-4) pairs of leaflets, leaflets rhomboid-ovate to oblanceolate, 1,5 cm long, 1–3,2 cm wide; flowers yellow; fruits very narrow, usually curved, up to 15 cm

long. In lowland forests, often in somewhat disturbed areas and in pastures, from southern Mexico to Panama and in Venezuela, Ecuador and Peru.

S. reticulata (Willd.) H.S. Irwin & Barneby, Pl. 57g,h
(syn. *Cassia reticulata* Willd.)
Common name (Costa Rica): saragundí
Small tree or shrub, up to 8(-9) m tall; leaves with (6-)7-13(-15) pairs of leaflets, accrescent distally, leaflets oblong to slightly obovate, (6,5-)7-18 (-19) cm long, (2-)3-7(-8,5) cm wide; inflorescences axillary, racemose; flowers yellow; fruits oblong to linear, flat, up to 15 cm long, brown, papery, opening longitudinally. In lowland forests, often along riversides, even on periodically flooded spots ("Bajagua"), from southern Mexico to Bolivia and Brazil.

S. spectabilis (DC.) H.S. Irwin & Barneby
(syn. *Cassia spectabilis* DC.)
Common name (Costa Rica): vainillo
Soft-wooded tree, up to 15(-20) m tall; leaves with 11-19(-20) pairs of leaflets, the largest pair beyond the middle of the leaf, leaflets (2,6-)3-9,5 cm long, 1-3 cm wide; inflorescences thyrsiform panicles of racemes, 12-60-flowered; flowers yellow; fruits pendulous, straight or nearly so, 16-30 cm long. Very widespread in the Neotropics, from southern Mexico and the Antilles to Argentina, Paraguay and southern Brazil.

S. spinescens (Vogel) H.S. Irwin & Barneby
(syn. *Cassia spinescens* Hoffmanns. ex Vogel)
Spiny liana; leaves with conical glands between each pair of leaflets, leaflets dark green, glabrous above, dark olive green beneath, stipules persistent, recurved, woody, spinescent; inflorescences pendent, racemose, up to 25 cm long; flowers bright yellow; fruits pendulous, linear, plano-compressed, straight or almost so, (10-)15-50 cm long. Mostly along rivers and in swamp forests, disjunctly distributed in Costa Rica as well as in Venezuela, Peru and Brazil.

Tachigali (neotrop. 24, CR 1, GD 1)
Usually large, often hapaxanthic trees with simple pinnate leaves and always yellow to yellowish flowers. The fruits are flat and wind-dispersed.
T. versicolor Standl. & L.O. Williams, Pl. 58a-c
Common names (Costa Rica): pellejo de toro, reseco
Tree with large buttresses; leaves paripinnate, with 6-9 pairs of leaflets, leaflets oblong-lanceolate, 9–14 cm long, stipules conspicuously large, leaf-like; inflorescences axillary, paniculate, sometimes 45 cm long; flowers yellow or white, sessile; fruits indehiscent, flat, pale orange, seed 1, ca. 2 cm long. In lowland rainforests, from Costa Rica to Colombia.

Fabaceae-Faboideae (Papilionoideae)

Trees, shrubs, lianas or herbs mostly with pinnately compound or trifoliolate leaves and unique zygomorphic flowers. The elaborate ant-attracting glands, characteristic of many Caesalpinioideae and Mimosoideae are lacking within this subfamily (though quite different, simple extra-floral nectaries are repeatedly evolved). **Leaves** alternate or rarely opposite (*Platymiscium*); **inflorescences** racemose or paniculate; **flowers** definitely zygomorphic, papilionoid (bean-like), sepals connate, petals heteromorphic, one adaxial, enlarged standard-petal, 2 wing-petals, and 2 fused or separate keel-petals enclosing the androeceum and gynoeceum, stamens 10, connate into a tube or 1 free and the others fused; **fruits** usually 2-valved pods, dehiscent or indehiscent, oblong or globose, frequently modified into loments, oblong or orbicular samaras, fleshy or subwoody drupes, or follicles, seeds 1-numerous, sometimes very large. Cosmopol. 426/12150, CR 82/363, GD 36/75.

There are two natural groups within the Faboideae (Papilionoideae), which are easily distinguishable:
1. Trees with imparipinnate, sometimes reduced to 1-foliolate or simple leaves and (apart from a few, rare tree-species of *Lonchocarpus*, *Pterocarpus* and *Machaerium*) the uniquely 3-foliolate, spiny, arborescent genus *Erythrina*.

2. Lianas, vines and herbs with odd-pinnate, trifoliolate or (rarely) simple leaves.
The tribe Swartzieae combines characteristics of both, Caesalpinoideae and Faboideae (Papilionoideae). The general lack of root nodules, the presence of stipels on odd-pinnate leaves and the - at least in bud - fused calyx-lobes suggest an association with Faboideae (Papilionoideae) rather than with Caesalpinioideae. The flowers, though, are radially symmetric as in the latter subfamily, but share the feature of 5 free petals and free stamens with the most primitive group of Faboideae (Papilionoideae), the Sophoreae (*Dussia*, *Myroxylon*, *Ormosia*, *Sophora*).

The usually highly nutritious seeds are frequently poisonous and may be wind-dispersed, water-dispersed, bat-dispersed or dispersed by birds or mammals, especially rodents.

Keys to the genera

Leaves unifoliolate	Key A
Leaves 3-foliolate	Key B
Leaves imparipinnate	Key C
Leaves odd-pinnate, lianas, vines, herbs or shrubs	Key D
Leaves odd-pinnate, trees	Key E

Key A: Leaves *unifoliolate*

1	Plant shrub	*Flemingia*
1*	Plant treelet	2
2	Petiole cylindrical	*Dalbergia*
2*	Petiole winged	*Swartzia*
1**	Plant tree, leaf-margin serrulate	*Lecointea*
1***	Plant herb, leaflets not serrulate	*Alysicarpus*

Key B: Leaves 3-foliolate

1	Plant tree	*Erythrina*
1*	Plant herb, erect or procumbent, stipules and stipels persistent	*Desmodium*
1**	Plant liana	2
2	Lateral leaflets conspicuously asymmetric at base, stipules caducous, secondary veins wide-spaced	*Mucuna*
2*	Lateral leaflets elliptic	4
4	Stipules persistent, with basal appendage, stipels persistent	5
5	Calyx 13-14 mm long, flowers purple to violet, fruits 4,5-5,5 cm wide	*Dioclea*
5*	Calyx 4-7 mm long, flowers rose to lilac, fruits 3-4,3 cm wide	*Oxyrhynchus*
4*	Stipules caducous, without basal appendage, stipels caducous	*Clitoria*
1***	Plant vine	6
6	Stipules caducous	7
7	Stipels persistent	8
8	Leaflets broad-ovate to rhomboid, obtuse at both ends	*Calopogonium*
8*	Leaflets broader than long, entire to slightly 3-lobate	*Pachyrhizus*
7*	Stipels caducous	9
9	Leaflets rhombic or 2-3-lobate	10
10	Leaflets with yellow glands beneath, rhombic	*Rhynchosia*
10*	Leaflets without glands, broadly rhombic or 2-3-lobate, all calyx lobes distinct	*Pueraria*
9*	Leaflets ovate-elliptic, roundish	*Canavalia*
6**	Stipules and stipels persistent	11
11	Stipules and stipels scale-like, ovoid	12
12	Lateral leaflets rhomboid, plant densely ferruginous or yellow pubescent	*Calopogonium*
12*	Lateral leaflets asymmetrically triangular, plant not conspicuously pubescent	*Phaseolus* (*P. lunatus*)

11*	Stipules lanceolate	13
13	Stipules with extended basal lobes or peltate, stipels nervate, mostly blunt	*Vigna*
13*	Stipules basifixed, stipels lanceolate to linear, acute	14
14	Leaflets with yellow glands beneath, rhombic, stipels reduced to auricles or scale-like structures	*Rhynchosia*
14*	Leaflets without yellow glands, stipels not reduced	15
15	Leaflets broad-elliptic to broad-ovate	16
16	Leaves and stems villous pubescent, calyx bilobate, plant frequent in coastal areas	*Canavalia*
16*	Leaves and stems with uncinate hairs	*Phaseolus*
15*	Leaflets oblong-elliptic to oblong-ovate	17
17	Laterals leaflets slightly asymmetric, secondary veins inconspicuous, wide-spaced	18
18	Stipules and bracts conspicuously striate or appendaged, fruits with the beak long and straight	*Centrosema*
18*	Stipules and bracts not striate or appendaged, flowers not resupinate, fruits with the beak short, turned upwards	*Teramnus*
17*	Lateral leaflets symmetric, secondary veins closely parallel, conspicuously prominent beneath, flowers not resupinate	*Dioclea*

Key C: Leaves imparipinnate

1	Leaves opposite	*Platymiscium*
1*	Leaves alternate	2
2	Rachis broadly winged	*Swartzia*
2*	Rachis not winged	3
3	Leaflets subtended by stipels	4
4	Flowers with 1 petal	*Swartzia*
4*	Flowers with more than 1 petal	5
5	Fruits globose	*Andira*
5*	Fruits flattened, linear	*Lennea*
3*	Stipels lacking	6
6	Leaflets opposite to subopposite	7
7	Herb or (sub-)shrub, leaflets 5-7	*Indigofera*
7*	Vine, leaflets 5	*Chaetocalyx*
7**	Plant tree	8
8	Bark with red sap, tertiary veins parallel, perpendicular to secondary	*Dussia*
8*	Bark without red sap	9
9	Leaflets sometimes punctate	*Lonchocarpus*
9*	Leaflets not punctate	10
10	Leaflets basally retuse, flowers pink	*Gliricidia*
10*	Leaflets basally not retuse	11
11	Leaflets with prominent, conspicuously parallel secondary and tertiary veins, flowers with 1 petal	*Swartzia*
11*	Leaflets with secondary veins pinnate and curved	*Lonchocarpus*
6*	Leaflets always strictly opposite	12
12	Leaves pellucid punctate, fruit fleshy, moniliform, compartmented between the 1-4 seeds	*Muellera*
12*	Leaves not punctate	13
13	Leaflets symmetric	14
14	Terminal leaflet short-petiolulate, secondary veins prominent beneath, straight, conspicuously parallel, leaflets subcoriaceous or coriaceous	*Ormosia*
14*	Terminal leaflet distinctly petiolulate, secondary veins not conspicuously parallel and curved	*Lonchocarpus*
13*	Leaflets apically asymmetric, acute (falcate), basally obtuse to subcordate, fruit samara with asymmetric wing	*Vatairea*

Key D: Leaves odd-pinnate, lianas, vines, herbs or shrubs

1	Plant climbing	2
2	Non-spiny, tendrilled liana	*Dalbergia*
2**	Mostly spiny liana, never tendrilled	*Machaerium*
2***	Vine without spines, leaflets usually 5, obovate	*Chaetocalyx*
1*	Plant not climbing, terrestrial	3
3	Leaflets 5-7, obovate to elliptic	*Indigofera*
3*	Leaflets numerous, narrow	4
4	Stipules inconspicuous or caducous, leaflets more than 60, spread horizontally, similar to *Phyllanthus* (Euphorbiaceae)	*Sesbania*
4*	Stipules persistent, conspicuous, leaflets up to 60, very close together, orientated towards leaf-apex	*Aeschonymene*

Key E: Leaves odd-pinnate, trees

1	Bark with red sap	2
2	Tertiary veins finely reticulate, peduncles and twigs frequently hollow, plant associated with ants	*Pterocarpus*
2*	Tertiary veins parallel, perpendicular to secondary, peduncles and twigs not hollow	*Dussia*
1*	Plant without red sap	3
3	Leaflets punctate with translucent rays and dots, symmetric, tertiary veins parallel to secondary	*Myroxylon*
3*	Leaflets not punctate	4
4	Tree growing in the forest	5
5	Leaves short petiolulate, ovate to lanceolate, fruit irregularly cylindrical, tamarind-like with edible aril but harder exocarp	*Uribea*
5*	Leaves distinctly petiolulate	6
6	Leaflets 5-9, asymmetric, acute	7
7	Leaflets drying dark, fruit woody, with persistent calyx	*Paramachaerium*
7*	Leaflets drying green, fruit woody, without persistent calyx	*Dalbergia*
6*	Leaflets 9-15	8
8	Leaflets emarginate to slightly serrate, apically asymmetrically acute, basally obtuse to subcordate flowers up to 25 cm, fruit with asymmetric wing	*Vatairea*
8*	Leaflets symmetric, rounded, ovate, fruit inflated	*Diphysa*
4*	Tree smallish, fence-tree or ornamental	9
9	Leaflets basally retuse, flowers pink	*Gliricidia*
9*	Leaflets symmetric, basally rounded, not retuse, flowers yellow	*Diphysa*

Aeschynomene (neotrop. + subtrop. 150, CR 17, GD 3)
Weedy herbs or small shrubs, the leaves with up to 30 pairs of small, linear and very close together leaflets, which are orientated towards the leaf-apex, sometimes with more than 1 costa. The flowers are yellow, usually with brown spurs

Key to the species of *Aeschynomene*

1	Leaflets with 2 to several costae	2
2	Stems nearly glabrous, leaflets with 2 to several costae, up to 15 x 2 mm	*A. americana*
2*	Stems hispid, leaflets with 3 costae, up to 6 x 1,5 mm	*A. villosa*
1*	Leaflets with 1 costa	*A. sensitiva*

A. americana L.
Erect, branched herb, 1–3 m tall; stems and inflorescences sparsely hirsute; leaflets linear, 12-30 pairs, 6–9 mm long, less than 2 mm broad, with 3 costae, obliquely acute, apically and basally oblique, very close together, orientated towards leaf-apex, stipules lanceolate, persistent, with lanceolate basal appendage; inflorescences axil-

lary, fasciculate, 1-few-flowered; petals dark yellow; fruits with entire upper and deeply constricted lower margin, breaking into 3–9 single-seeded articles. In moist and disturbed places, from Mexico to Panama.

A. sensitiva Swartz
Common names (Costa Rica): frijolillo, conene
Erect herb, about 1 m tall; glabrous or slightly strigose, trichomes less than 3 mm long; leaflets 15-20 pairs, oblong, with 1 costa, apically rounded and minutely acuminate, basally slightly asymmetric, rounded to subcordate, stipules semi-persistent, narrowly subulate; inflorescences axillary, fasciculate or racemose, 1-few-flowered; flowers yellow, often caducous; fruits brown, dryish, nearly subwoody, almost smooth, stipitate, breaking into 7-8, thick articles, seed 1. In swampy areas, from southern Mexico and the West Indies to Brazil as well as in Africa.

A. villosa Poir.
Herb, frequently creeping, up to 0,7 m tall, stems and twigs with hispid pubescence; leaves paripinnate, with 20-50 leaflets, leaflets linear, oblong, with 3 costae, up to 6 mm long, 1,5 mm wide, sickle-shaped, stipules with basal appendage, striate, up to 15 mm long, basally pubescent; inflorescences branched, few-flowered; flowers yellow, 3-5 mm long; fruits with 3–5 orbicular compartments, densely pubescent, seeds black. From the southwestern USA to northern south America.

Alysicarpus (paleotrop. 25, 1 introduced in the Neotrop., CR 1, GD 1)
Weedy herbs, with ascending to procumbent stems and 1(-3)-foliolate leaves. The inconspicuous, purple to orange flowers are arranged in axillary or terminal, racemose inflorescences.

A. vaginalis (L.) DC.
Herb, up to 50 cm tall; leaves unifoliolate, elliptic- to sub-orbicular, up to 2,5 cm long, 1,5 cm wide, stipules persistent, erect, conspicuouc, ciliate; inflorescences terminal, up to 10 cm long; flowers small, less than 7 mm long, pink, rather inconspicuous, stamens united, at least in part; fruits cylindrical, constricted or articulating between the seeds, slightly compressed. From the southern USA to Bolivia and Brazil.

Andira (neotrop. 30, CR 1, GD 1)
Trees with simply pinnate leaves, the leaflets with small persistent stipels. The flowers are always purple to violet. The fruit is a single-seeded, somewhat globose, indehiscent drupe.

A. inermis (W. Wright) Kunth, Pl. 58d,e
Common names (Costa Rica): almendro de montaña, carne asada
Medium-sized, unarmed trees; leaves paripinnate, caducous, leaflets 9–13 pairs, undulate, stipules caducous; inflorescences terminal, paniculate, rather large; flowers purple or violet, 1–1,5 cm long; fruits woody drupes, elliptic to subglobose, almond-shaped, 2–5 cm in diameter, surface smooth. In lowland forests, from Nicaragua to Brazil as well as in Africa.

Calopogonium (neotrop. 6-8, CR 3, GD 2)
Slender vines with twining stems, rhachises and villous fruits. The 3-foliolate leaves always lack glands. The small flowers are purple to violet or blue.

Key to the species of *Calopogonium*

1	Leaves softly pubescent beneath, brown tomentose; inflorescences more than 20 cm long	*C. caeruleum*
1*	Leaves and stems conspicuously long-pilose or hispid; inflorescences less than 15 cm long	*C. mucunoides*

C. caeruleum (Benth.) Sauv.
Large vines; leaflets broad, softly pubescent beneath; flowers 1-1,2 cm long, petals violet to blue; fruits dehiscent, more than 4 cm long, 5-8 mm wide, softly pubescent. Common in thickets, from Mexico to Brazil.

C. mucunoides Desv.
Vine, conspicuously long-pilose, hairs more than 1,5 mm long; flowers less than 1,5 cm long, blue; fruits narrowly oblong, less than 4 cm long. From southern Mexico to Bolivia and Brazil as well as in Africa.

Canavalia (pantrop. 51, CR 8, GD 2)
Slender vines with twining stems or lianas, with villous indumentum on the stems, rhachises and fruits. The 3-foliolate leaves bearing rhomboid leaflets. The flowers are white, pink or lavender.

Key to the species of *Canavalia*

1	Leaflets suborbicular or nearly heart-shaped, apically rounded	*C. rosea*
1*	Leaflets ovate to ovate-elliptic, apically acuminate	*C. oxyphylla*

C. oxyphylla Standl. & L.O. Williams, Pl. 58f
Twining vines, stems mostly glabrous; leaflets ovate, apically acuminate, scarcely pubescent; inflorescences axillary, 10–18 cm long; flowers whitish-pink to lavender, usually up to 4 cm long, calyx campanulate; fruits oblong, apically short-beaked, with a basal, cylindrical, woody stipe and with one marginal and one medial rib, seeds flat, ovoid, brown, ca. 14 mm in diameter. From southern Mexico to northern South America.

C. rosea (Sw.) DC.
(syn. *C. maritima* (Aubl.) Thouars.
Common name (Costa Rica): frijol de la playa
Prostrate vine or herb, stems glabrous, hollow; leaflets large, sub-orbicular to nearly heart-shaped, rounded at apex, asymmetric, retuse; inflorescences with 2–3 flowers per node; flowers pink to lilac, calyx 2-lipped, lower lip discrete, upper lip not folded at margin; fruits up to 10 cm long, 2,5 cm wide, beaked, with 1–3 extra ribs besides sutural ones. Frequently along beaches, from Mexico to Brazil.

Centrosema (neotrop. + subtrop. 35, CR 6, GD 2)
Slender vines with twining stems or lianas, leaves 3-foliolate with elliptic, laterals slightly asymmetric leaflets and persistent stipules. The large flowers are usually spurred on the back. The indehiscent fruits are linear and narrow.

Key to the species of *Centrosema*

1	Plant large vine, leaflets nearly glabrous, not acuminate	*C. plumieri*
1*	Plant small vine, leaflets pubescent, acuminate	*C. pubescens*

C. plumieri (Turpin) Benth., Pl. 58g
Common names (Costa Rica): gallina, gallinilla
Large vine, drying blackish; leaflets elliptic to ovate, large, nearly glabrous; flowers up to 4 cm long, yellowish white, with dark purple center; fruits very long, ca. 1 cm in diameter. Common in the tierra caliente, from Mexico to Brazil.

C. pubescens Benth.
Common name (Costa Rica): gallinilla
Small vine, stems slender, scarcely pubescent; leaflets ovate-elliptic, lateral leaflets basally slightly asymmetric, rounded, 4–10 cm long, scarcely pubescent; inflorescences few-flowered; flowers clustered at apex, usually only 1 open at a time, calyx green, standard sub-globose, with rounded spur at base, greenish white, densely pubescent outside, glabrous, dark-lilac with cream center and violet rays inside flower, wings and keel curved upwards, keel greenish-white outside, pale-lilac inside, turning blue when dry; fruits oblong, up to 13 cm long, 0,7 cm wide, long-beaked, margin winged, brown, scarcely pubescent. From southern Mexico to Peru and Ecuador.

Chaetocalyx (neotrop. 12, CR 1, GD 1)
Slender vines with 5-7-foliolate leaves. The inflorescences are of various shape and inserted axillary or terminal. The flowers are usually yellow, but sometimes also red to violet.

C. latisiliqua (Poir.) Benth. ex Hemsl.
Slender vine with twining stems or liana; leaves odd-pinnate, 5-foliolate, leaflets obovate, herbaceous; inflorescences axillary clusters of flowers; flowers yellow, stamens 10; fruits compartmented, with rather elongate segments and conspicuous, continuous nerves on both sides. From Costa Rica to Ecuador.

Clitoria (pantrop. 60, CR 9, GD 2)
Slender vines with twining stems or lianas with 3-foliolate leaves or with up to 9 leaflets. The inflo-

rescences are either axillary or cauliflorous and always racemose. They can be easily distinguished by their resupinate, pink to purple flowers with a large, erect standard. Rather similar to *Centrosema*, but having a funnelform rather than a campanulate calyx, and the standard always lacking a spur.

C. javitensis (Kunth) Benth., Pl. 59a
Common name (Costa Rica): boca culebra
Liana or woody vine, bark dark-brown, peeling off in longitudinal stripes; leaves 3-foliolate, leaflets ovate to oblong- elliptic, large, slightly pubescent or glabrous above, pilose to strigose beneath, stipules caducous; inflorescences axillary and cauliflorous, 0,5–4 cm long, the flowers pairwise on crowded nodes; flowers chasmogamous, up to 7 cm long, calyx campanulate purple, corolla pink to purple or violet; fruits pendent, stipitate, brown, densely strigose, up to 23 cm long, 2,5 cm wide, apically beaked. From Costa Rica to Brazil.

Dalbergia (pantrop. 100, CR 11 GD 2)
Trees, shrubs or lianas, with odd-pinnate, 1-few-foliolate leaves. The axillary or terminal racemose or paniculate inflorescences bearing small and usually white flowers. The fruits are small, flat, dry indehiscent pods, and are water- and/or wind-dispersed.

D. brownei (Jacq.) Urb.
Shrub with long, pendent twigs; leaves small, 1-foliolate, ovate to oblong-ovate, glabrous; inflorescences axillary, racemose; flowers small, usually white; fruits small, flat, oblong-ovate to suborbicular, seeds 1-3. Along coasts, often forming thickets near the sea, or in permanently inundated areas. Throughout tropical America, from Florida to South America.

Desmodium (pantrop. + subtrop. 450, CR 31, GD 9)
Common names (Costa Rica): mosote, pegapega
Shrubs or erect or prostrate herbs, sometimes scandent with 3-foliolate leaves. The very short racemose or fasciculate inflorescences bear small white, pink or purple flowers. The compressed pods break into articles between each seed. The articles are glabrous or stick to clothes, hairs and feathers by means of small, hooked hairs on the surface of the fruit (epizoochory). Especially common along trails and paths frequented by animals or humans.

D. adscendens (Sw.) DC.
Erect or procumbent herb, stems stiff ascending pubescent; rhachis ca. 0,8 cm long, leaflets rhomboid-elliptic, 1–2,5 cm long, apically rounded, strigose, stipules persistent; flowers 5 mm long, purple, calyx 2-lipped; fruits stipidate 3–4,5 cm long, ca. 3 mm wide, pubescent, with usually 4 or 5 articles. In disturbed grassy areas and thickets in tropical Asia, Melanesia, Africa and America.

D. axillare (Sw.) DC., Pl. 59b-d
Procumbent herb, with nodes at the roots; rhachis very short or lacking, leaflets rhomboid (var. axillare), ovate to elliptic, obtuse or acute, softly pilose, stipules connate, persistent; flowers pink or purple; fruits shaped like a pair of glasses, beaked, stipitate, with 2 broad articles. Close to the coast and other open disturbed areas, widely distributed from Mexico, Central America and the West Indies to central South America.

D. barbatum (L.) Benth.
Erect or sometimes scandent, woody herb; stems with long, white pilose pubescence; leaflets oblong-elliptic to obovate or sub-globose, basally rounded, apically folded, glabrous above, with long, white, strigose pubescence beneath, stipules persistent; inflorescences short, congested, dense racemes with the flowers in pairs; flowers 2,8-4 mm long, purple, turning dark-violet or blue, calyx with white, pilose pubescence; fruits with 2 articles and the upper margin straight, the lower transversally constricted. In disturbed grassy areas and thickets. Widely distributed from southern Mexico to Peru, Bolivia and Brazil.

D. incanum DC.
Erect, woody herb or subshrub, up to 3 m tall, twigs scarcely pubescent; leaflets mostly elliptic, apically acute, basally rounded, glabrous and shiny above, densely pilose beneath, stipules persistent; inflorescences elongate racemes, densely pilose; flowers pink or lilac, calyx bilobed, puberulent; fruits up to 4,5 cm long, 3 mm wide, constricted on 1 side, with 8 nearly quadrangular articles. Widely distributed throughout the Neotropics.

Dioclea (pantrop. ca. 30, CR 7, GD 4)
Lianas or woody vines with trifoliolate leaves, usually with large leaflets. The inflorescences are dense, nodose spikes or spicate racemes with showy purple flowers.

D. malacocarpa Ducke
Liana, sometimes rather large; calyx with dark lilac to brown pubescence, corolla pinkish-lavender to dark lilac, standard with a central green and yellow spot, pistil basally lilac with brown pubescence, filaments white, basally lilac; fruits oblong, cylindrical, somewhat fleshy, reddish brown to maroon, densely whitish to ferruginous pubescent, hairs caducous, seeds 3–4, white to brown with white aril. Frequently along roadsides and open areas, from Costa Rica to Ecuador and Peru.

D. virgata (Rich.) Amshoff
Liana, stems dark brown with scarce, white, appressed pubescence; leaflets oblong-elliptic to obovate, apically acuminate and mucronate, stipules semi-persistent; inflorescences 40–50 cm long; flowers 2,2-2,5 cm long, calyx deep to dark purple or violet, mostly pubescent outside, densely white pubescent inside, standard with yellow central markings, keel-petals with 2 mm long, lanceolate "teeth" (fimbriate), filaments apically purple, anthers yellow, persistent on fruit; fruits woody, oblong, beaked, seeds 7–8. In open areas and forest edges, widespread, from Mexico to South America.

Diphysa (neotrop. 15, CR 3, GD 1)
Trees or shrubs, sometimes spinescent, with imparipinnate leaves with small, caducous stipules. The always yellow flowers are arranged in short, axillary, racemose or fasciculate inflorescences. The fruit is very distinct in being bladder-like, due to the inflated pericarp.

D. americana (Mill.) M. Sousa
(syn. *D. robinioides* Benth.)
Common name (Costa Rica): guapichelín
Small tree or treelet, leaflets 9–15, ovate, 1,5–3,5 cm long, basally rounded, glabrous; inflorescences axillary, racemose; flowers yellow, 2 cm long; fruits stipitate, indehiscent, oblong, conspicuously inflated, 6–11 cm long, glabrous. From Mexico to Panama.

Dussia (neotrop. 10, CR 4, GD 4)
Large trees, well characterized by the presence of red sap and pink or purple flowers. The fruits are laterally dehiscent, flattened pods with ferruginous pubescence and with 1–3 seeds, enveloped by a red or orange aril.

D. discolor (Benth.) Amsh., Pl. 59e
(syn. *D. tessmanii* Harms)
Large tree, usually with buttresses; leaflets (7-)11-15, opposite or subopposite, oblong or oblong-elliptic, sometimes slightly ovate or obovate, 5–26(-35) cm long, 3–7 cm wide; inflorescences 14–25(-50) cm long; fruits subcylindrical or elliptic, 5–11,5 cm long, 2,5-5,5 cm wide. From Mexico to Brazil and the Antilles.

D. macroprophyllata (Donn.Sm.) Harms, Pl. 59f
Large tree, usually with buttresses; leaflets 5–9, subopposite or alternate, ovate, elliptic, oblong-elliptic, to obovate 6–25 cm long 4–11(-14,5) cm wide, ferruginous pubescent beneath; inflorescences 14–27 cm long; fruits ovate-elliptic, 5–13,5 cm long, 5,6–6,7 cm wide, maroon. From Costa Rica to Ecuador.

Erythrina (cosmopol. 112, CR 14, GD 6)
Trees or treelets, usually armed with prickles and with large, showy, orange or red flowers and 3-foliolate leaves with glands beneath the petiole or the leaflet-base. The fruit is a linear, dehiscent pod, constricted between the red seeds.

E. berteroana Urb., Pl. 59g
Common name (Costa Rica): poró
Small tree or treelet, trunk and branches armed with strong prickles; leaflets broadly rhomboid-ovate, 5–17 cm long; flowers red, the standard sable-shaped, other petals reduced; fruits 10–20 cm long, constricted between the red seeds, with a black line spreading from the hilum. In lowlands to medium elevations, from southern Mexico and the Antilles to South America.

E. costaricensis Micheli, Pl. 59h
Common names (Costa Rica): poró, poró cimarrón
Small to medium-sized tree, armed with few prickles; lateral leaflets ovate to rhomboid-ovate, with asymmetric bases and pulvinuli subtended by lateral, round glands, terminal leaflet rhombic, 7–23 cm long, 4,5–25 cm wide; flowers deep red, the standard sabre-shaped, the other petals reduced; fruits gray, 15–23 cm long, seeds orange-red. In natural forests in lowlands to medium elevations, from Costa Rica to Colombia.

E. fusca Lour, Pl. 59i,j
(syn. *E. glauca* Willd.)
Common name (Costa Rica): poró
Large tree, frequently with large buttresses, armed with prickles; leaflets ovate or elliptic, symmetric, 8-15 cm long; flowers cream-colored to pale orange, the standard very broad; fruits 15–33 cm long, slightly constricted between the seeds. From Central America and the Antilles to Amazonian Brazil.

E. lanceolata Standl., Pl. 59k
Common name (Costa Rica): poró
Treelet or shrub, with armed trunk, branches and leaves; leaflets ovate-elliptic to rhomboid-ovate or broad-lanceolate, 6–18 cm long, 4–8 cm wide, glabrous, lateral leaflets rhomboid, basally asymmetric, smaller than the symmetrically terminal one, glands beneath leaflets 3-angular; flowers bright red, the standard shaped like a sabre or machete, the other petals reduced, calyx reddish, tubular; fruits 15-30 cm long, seeds numerous, red. From Honduras to Panama.

Flemingia (paleotrop. 30, introduced into the Neotropics, CR 2, GD 1)
Shrubs with unifoliolate leaves and ovate to obovate leaflets. The inflorescences are axillary racemes. The oblong fruits bearing 1-3 seeds.

F. strobilifera (L.) W.T. Aiton
Shrubs, stems and twigs with dense, appressed pubescence and conspicuous scars of fallen leaves; leaves 1-foliolate, lanceolate-elliptic, minutely yellow-punctate, petiole minutely winged; inflorescences pendent, as long as the leaves or surpassing them; flowers greenish-yellow to yellow, stamens completely free; fruits 7-10 mm long, 5-6 mm wide, seeds 1-2. From Costa Rica to Panama.

Gliricidia (neotrop. 4, CR 1, GD 1)
Shrubs and trees with odd pinnate leaves and without spines. The inflorescences are axillary or cauline racemes, usually bearing rose or rose-tinged flowers. The fruit is a dehiscent pod, with the hard valves usually coiling when dehiscing.

G. sepium (Jacq.) Kunth ex Walp., Pl. 60a,b
Common name (Costa Rica): madero negro
Medium-sized tree, with wide spreading crown; leaves paripinnate to odd-pinnate, caducous at the end of the dry season, leaflets 7–17, ovate-elliptic to oblong-lanceolate, 3–7 cm long, pale gray with purple spots beneath; inflorescences axillary, densely racemose, 5–10 cm long; flowers pink, purplish or white, 2 cm long; fruits dehiscent, flat, 15-20 cm long, 1–1,5 cm wide. From Mexico and the Antilles to northern South America.

Indigofera (pantrop. + subtrop. ca. 700, CR 9, GD 2)
Herbs or shrubs, pubescent, with 2-branched hairs. Leaflets usually 5–7, obovate to elliptic and more than 5 mm wide. The flowers are small, orange, reddish or pinkish with caducous petals.

Key to the species of *Indigofera*

1	Stems and inflorescences densely pubescent	*I. hirsuta*
1*	Stems and inflorescences nearly glabrous	*I. trita*

I. hirsuta L.
Small herb, sometimes scandent, young stems densely pubescent, glabrescent; inflorescences reddish brown, pubescent; flowers deep salmon-pink; fruits grayish green, turning brown at maturity, densely pubescent. Frequently along roadsides and in open areas, from Honduras to Peru and Brazil.

I. trita L.
Creeping herb; stems nearly glabrous; inflorescences racemose, 6–12 cm long, sometimes pendent; flowers orange-red, 5–6 mm long; fruits linear, straight to slightly curved, up to 3,5 cm long, angled. From southern Mexico and the West Indies to Colombia and Venezuela.

Lecointea (neotrop. 5, CR 1, GD 1)
A rather distinct genus within the Faboideae (Papilionoideae) with simple leaves and serrate to serrulate leaf margins and free filaments. It can be recognized to the family by the typical cylindric pulvinus.

L. amazonica Ducke
Tree, twigs glabrous; leaves 1-foliolate, leaflets elliptic to ovate, slightly asymmetric, margin serrulate; petals 5, stamens free; fruits edible, sub-

globose, dryish-fleshy, white, with a sweet, tasty, edible pulp.

Lonchocarpus (neotrop. 130, CR 31, GD 5)
Trees or shrubs with strong green bean odor and strictly opposite to subopposite leaflets. The flowers are purple, pink or whitish, with 5 petals. The indehiscent, oblong or suborbicular, flat fruit is bears 1–4 winged seeds.

L. ferrugineus M. Sousa
Common name (Costa Rica): comenegro
Medium-sized tree with pubescent twigs; leaflets 7–11, opposite to subopposite, ovate, oblong or obovate-elliptic, 11–23 cm long, 5–8 cm wide; inflorescences axillary racemes; flowers dark violet; fruits narrow, elliptic to lanceolate, 11–23 cm long, 5–8 cm wide, ferruginous pubescent. From Nicaragua to Panama.

L. heptaphyllus (Poir.) DC.
(syn. *L. pentaphyllus* (Poir.) Kunth ex DC.)
Medium-sized tree; leaves imparipinnate with 5-9 leaflets, leaflets subopposite, rather large, obovate or oblong-elliptic, 5–18 cm long, 3–7,5 cm wide; inflorescences axillary, dense racemose, 6–14 cm long; flowers reddish or greenish purple; fruits elliptic, strongly compressed, 4,5–6,5 cm long, 1,5-2 cm wide, seeds 1-3. Frequently along riversides, from Mexico to northern South America.

L. macrophyllus Kunth, Pl. 60c
Medium-sized tree; leaflets oblong-elliptic; inflorescences racemose, erect; calyx reddish brown to purple, corolla lilac and white; fruits whitish green, turning pale brown or coffee-colored. From Nicaragua to Costa Rica.

Machaerium (neotrop. 120, CR 17, GD 9)
Lianas, shrubs or sometimes with spinescent stipules and sometimes red or orange sap. The leaves are always imparipinnate with few or many, usually glabrous leaflets. Characteristic in fruit with indehiscent and stipitate, flat, one-seeded samaras.

M. cirrhiferum Pittier
Liana or shrub; leaves up to 10 cm long, rhachis densely ferruginous and villous pubescent, leaflets 27-51, elliptic, up to 8 mm long, 3–4 mm wide, stipules spinescent; flowers lavender, up to 8,5 mm long, calyx fleshy, pubescent; fruits winged, sub-sessile, up to 4,5 cm long, 1,7 cm wide, wing 3 cm long, scarcely pilose. In Costa Rica and Panama.

M. floribundum Benth.
Liana; leaflets 9-11, ovate, oblong or obovate, 3-10 cm long, 1,5-4,5 cm wide, stipules spinescent; inflorescences axillary, paniculate, 4-7 cm long; flowers ca. 1,3 mm long, white with a purple throat. From southern Mexico to Venezuela and Peru.

M. kegelii Meisn., Pl. 60d
Liana or sometimes trees up to ca. 15 m tall; leaves clustered near stem apex, leaflets 11-15, pairs, slightly asymmetric, oblong-elliptic to oblong-obovate, up to 17 cm long, 2,7–6 cm wide, stipules persistent, spinescent; inflorescences axillary or terminal, paniculate; flowers ca. 1,5 cm long, white to violet; fruits winged. From southern Mexico to Bolivia and Brazil.

M. lunatum (L.f.) Ducke, Pl. 60e
Shrub, tree or woody vine, stems and branchlets with conspicuous, strong spines; leaflets usually 7-11, oblong, 1,5-3,5 cm long, 0,8-2 cm wide, glabrous, stipules persistent, spinescent, up to 1 cm long; inflorescences terminal, paniculate, up to 15 cm long, rhachis spiny; flowers lilac to purple; fruits strongly spiralled upward, ca. 3 cm long, 3 cm wide, glabrous, rather hard. Widely distributed throughout tropical America and the West Indies, as well as in tropical Africa.

M. seemannii Benth.
Liana, stems with conspicuous, broad, strong spines; leaflets 6–13, asymmetrically lanceolate or elliptic, 3–7 cm long, 2,5–5,5 cm wide, stipules persistent and spinescent only on young sideshots; flowers ca. 1 cm long, blue to black, standard pubescent; fruits stipitate, up to 6 cm long, 2,5 cm wide, with conspicuous marginate wing. In forests and forest-edges, from Honduras and Guatemala to Colombia.

Mucuna (pantrop. 100, CR 7, GD 2)
Lianas with rather large, 3-foliolate leaves, and distinct flat capsules with urticating indumentum. Other characteristic features are the inflorescences and fruits pendent and long pedunculate and the usually black drying leaves.

Key to the species of *Mucuna*

1	Leaflets densely strigose, rather large and rough	*M. holtonii*
1*	Leaflets pendent, glabrous or sparsely strigose, shiny, soft and smooth	*M. mutisiana*

M. holtonii (Kuntze) Moldenke, Pl. 60f,g
Liana; leaves densely strigose, lateral leaflets basally asymmetric; inflorescences umbellate, peduncles up to 2,5 m long; flowers up to 6 cm long, cream-colored or greenish-white; fruits thick, woody, irregular pods, warty, smooth or lacking transverse ridges. From Nicaragua to Panama.

M. mutisiana (Kunth) DC., Pl. 61a-c
Liana; leaves glabrous or sparsely strigose, turning black when dry; inflorescences umbellate, peduncles up to 2 m long; flowers, up to 5 cm long, greenish-white; fruits thick, woody, irregular pods, warty, with stiff orange hairs and numerous transverse ridges or crests. From Costa Rica to northern Colombia.

Muellera (neotrop. 2, CR 1, GD 1)
A small genus, sometimes included in *Lonchocarpus*, with 5-7 opposite leaflets and purple flowers. Very distinct fruits with moniliform, indehiscent pods.

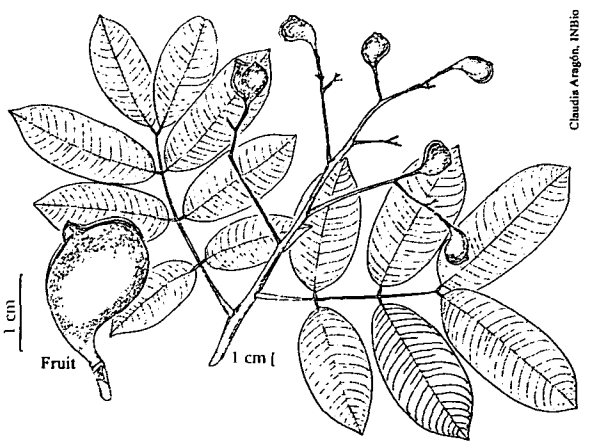
M. frutescens (Aubl.) Standl, Pl. 61d
Small to medium-sized tree; leaflets ovate to elliptic or oblong, 5–12 cm long, pellucid punctate; inflorescences axillary racemes or panicles; flowers 2 cm long, violet, stamens united, at least in part; fruits constricted between the 1–4 seeds. In lowlands, sometimes in mangroves, in regions with dry to very humid climate from Mexico to South America.

Ormosia (pantrop. 100, CR 8, GD 4)
Medium-sized to large trees, with strictly opposite usually oblong, ovate, obovate or elliptic leaflets The fruit is a coriaceous to subwoody pod with very characteristic red or red and black, shiny seeds, which are often used for necklaces.

O. coccinea (Aubl.) Jacks., Pl. 61e,f
Leaflets 5-7, oblong or oblong-ovate, 7–25 cm long; flowers purplish pink to lilac; fruits subglobose to oblong-elliptic, 3–7 cm long, 2–3 cm wide, seeds 1–2, red and black. From Costa Rica to South America.

O. panamensis Benth.
Leaflets 7–13, obovate, oblong-obovate or oblong-elliptic, 5–15 cm long, 2–6 cm wide; flowers white or lilac; fruits subglobose, 3–7 cm in diameter, narrowly rimmed to slightly winged, seeds 2–4, red. From Costa Rica to Panama.

O. paraensis Ducke
Medium-sized to large tree, up to 40 m tall; leaflets 5-11, elliptic-oblong, 4-15(-16) cm long, 1,5-5(-6) cm wide; flowers purple; fruits 3-6,5 cm long, 2-3,5 cm wide, seeds 1-3, red and black. From Costa Rica to Ecuador and Brazil.



Ormosia paraensis

Paramachaerium (neotrop. 5, CR 1, GD 1)
A small genus with red sap in the inner bark, rather similar to *Machaerium*, but the purple or reddish flowers with the wing petals much broader than the keel.

P. gruberi Brizicky
Shrubs or trees, up to 30 m tall, usually with red or orange sap; leaves imparipinnate, leaflets usually 9-13, subglabrous, drying dark, leaf-rhachis ca. 15 cm long, stipules caducous; inflorescences axillary or terminal, usually dense racemes with small bracts and persistent bracteoles; flowers small, petals dark purple, standard usually broad, emarginate, wings broader than keel, ovary stipi-

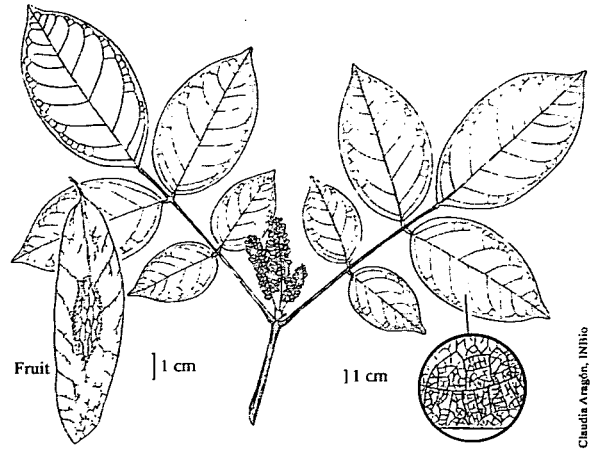
tate, surrounded by a glandular collar; fruits flat samaras, indehiscent, stipitate, 10-12 cm long, 3 times as long as wide, glabrous. In lowland rainforests, endemic to southeastern Costa Rica and adjacent Panama.

Paramachaerium gruberi

Platymiscium (Neotrop. 20, CR 4, GD 1)
Large trees with strong green bean odor and opposite, imparipinnate leaves with conspicuous pulvini and pulvinuli; the yellow to orange flowers are rather small and arranged in axillary racemes, frequently clustered in the axils of young or fallen leaves.

P. curuense N. Zamora & Klitgaard
Large tree, up to 30 m tall, bark smooth; leaves clustered on short shoots, leaflets 5–7, opposite to subopposite, elliptic to ovate, (5-)6,2-17 cm long, (2,2-)3,5-6,8 cm wide, glabrous; inflorescences axillary, up to 10 per axil, short, erect racemes, inflorescence axis 1,7-8,5 cm long, tomentose; flowers 7-9 mm long, yellow, falling easily; fruits indehiscent samaras, flat, elliptic to oblong, 9,7-13,5 cm long, 3,3-3,8 cm wide, glabrous, seed 1. Endemic to the Osa Peninsula, Costa Rica.

Pterocarpus (pantrop. 21, CR 3, GD 3)
Trees, usually with red latex and frequently with hollow twigs, inhabited by ants. The yellow flowers are arranged in axillary or terminal, racemose or paniculate inflorescences. The fruits are orbicular to broad-elliptic, with very distinct seeds, surrounded by a broad wing.



Platymiscium curuense

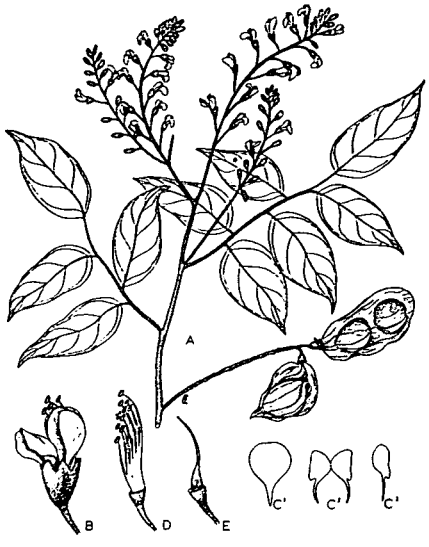
Key to the species of *Pterocarpus*

1	Tree developing buttresses, bark wrinkled, branching conspicuously horizontal	*P. officinalis*
1*	Tree without buttresses, bark smooth	2
2	Stipules persistent, curved, claw-shaped, dryish, leaflets oblong-elliptic, acumen apically curved (falcate), mucrunolate	*P. rohrii*
2*	Stipules caducous, leaflets symmetric, broad-ovate or broad-obovate acumen straight, blunt	*P. hayesii*

P. hayesii Hemsl.
Common names (Costa Rica): sangrillo, cuajada amarillo
Medium-sized to large tree with red latex; leaflets 9–13, alternate, oblong, rather large and narrow, stipules caducous; flowers orange-yellow, calyx densely brown-pubescent; fruits orbicular, more than 5 cm in diameter. From Guatemala to Panama.

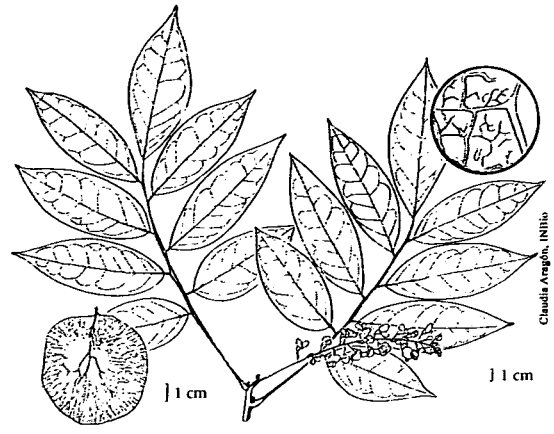
P. officinalis Jacq., Pl. 61g
Common name (Costa Rica): sangregao
Medium-sized to large tree, latex turning red in fresh air; leaflets 6–12, alternate, ovate-oblong, 7,5–15 cm long, 3,5–7 cm wide, stipules caducous; flowers pale or bright yellow with purple stripes, calyx glabrous; fruits estipitate, indehiscent, suborbicular to broadly oblong, ca. 5 cm in diameter. In periodically flooded areas or along

river-sides, from Mexico and the Antilles to northern South America.



Pterocarpus officinalis
A. Flowering and fruiting branch. B. Flower. C. Petals. D. Androecium and receptacle. E. Pistil

P. rohrii Vahl, Pl. 61h
(syn. *P. violaceus* Vogel)
Medium-sized to large tree, sometimes with red latex; leaflets 7–13, alternate, elliptic, 5–8 cm long, 3,5–5 cm wide, stipules (semi-)persistent; flowers orange-yellow; fruit orbicular, more than 5 cm in diameter. From Belize to Ecuador and Peru.



Pterocarpus rohrii

Rhynchosia (pantrop. ca. 300, CR 9, GD 2), Pl. 62 a
Slender vines with twining, sometimes subangular stems and caducous stipules and stipels. The rhombic leaflets bearing minute yellow glands, the small or medium sized, yellow or reddish flowers are arranged in elongate racemes. The fruits are small, oblong, compressed, lunate, sickle- or dumb-bell-shaped pods.

Key to the species of *Rhynchosia*

1	Leaflets ca. 5–7 cm long, 3,5–6 cm wide, acute, glabrous	*R. eythrinoides*
1*	Leaflets usually less than 5 cm long and 3,5 cm wide, pubescent or almost glabrous	*R. minima*

R. erythrinoides Schltdl. & Cham.
Large vine with twining stems; leaflets rhombic, rather small, ca. 5–7 cm long, 3,5–6 cm wide; flowers yellow; fruits 1-2-seeded. From southern Mexico to Panama.

R. minima (L.) DC.
Large vine with twining stems; leaflets rhombic, small, usually less than 5 cm long and less than 3,5 cm wide; flowers greenish, 4–5 mm long; fruits 1-2-seeded. Widely distributed in the Neotropics, from Mexico to Paraguay and Brazil.

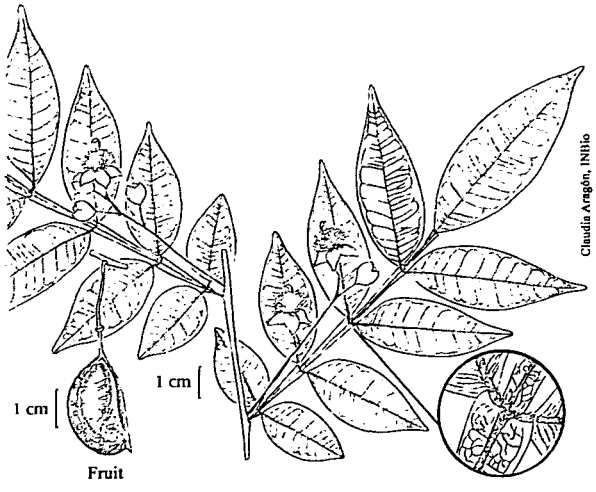
Swartzia (neotrop. 140, CR 9, GD 3)
Small to medium-sized trees, sometimes with red latex and with unifoliolate or imparipinnate leaves. Distinct in flower by having only 1, sometimes enlarged, suborbicular, clawed, usually white or yellow petal and numerous, dimorphic, stamens. The inflorescence is a few- or many-flowered raceme, often emerging from twigs or trunk (cauli- or ramiflorous).

Key to the species of *Swartzia* (after TÉLLEZ et al. 2001)

1	Leaflets 3	*S. simplex*
1*	Leaflets usually 5-11(-19), although rarely 3	2
2	Leaves with the rhachis conspicuously winged	*S. myrtifolia*
2*	Leaf rhachis not winged or only along the basal zones around the insertion of the leaflets	*S. panamensis*

S. myrtifolia Sm., Pl. 62d
Small tree or shrub, 3–3,5 m tall, branchlets densely pilose; leaves imparipinnate, leaflets small, opposite, oblong-ovate to elliptic-lanceolate, up to 7,5 cm long the terminal leaflet up to 11,5 cm long, up to 3,5 cm wide, the terminal leaflet up to 5,5 cm wide, rhachis and petiole broadly winged; inflorescences axillary, 3-9 cm long; flowers yellowish; fruits oblong elliptic or oval, 3-5,5 cm long, 1,5-2,5 cm in diameter. From Honduras to Bolivia and Brazil.

S. panamensis Benth., Pl. 62b
Tree, up to 30 m tall, branchlets minutely strigulose; leaves imparipinnate, leaflets opposite, ovate to oblong-elliptic, (7,5-)9,5-17(-22) cm long, (3,5-)4-7(-8,5) cm wide, rhachis and petiole terete; inflorescences racemose, pendent, 38-59 cm long; flowers yellow; fruits flat, dehiscent, oblong, 19-25 cm long, 8-10 cm wide. In forests as well as in open areas, from Honduras to Panama.



Swartzia myrtifolia

S. simplex (Sw.) Spreng
Common name (Costa Rica): naranjito
Small tree, up to 35 m tall, branchlets glabrous or minutely strigulose, usually glabrescent; leaves unifoliolate or trifoliolate, leaflets coriaceous, oblong or elliptic, (3-)6–15(-24) cm long, (1,5-)3-7,5(-9) cm wide, glabrous on both sides, rhachis and petiole usually winged; inflorescences flowers yellow. From Mexico to South America.

Uribea (neotrop. 1, CR 1, GD 1)
Monotypic genus

U. tamarindoides Dugand & Romero, Pl. 62e
Common names (Costa Rica): almendro, tamarindo
Medium-sized trees; leaves odd-pinnate, leaflets 5-13, alternate, conspicuously short petiolulate, ovate to lanceolate, acute; flowers pale violet, pedicels 1–2 cm long, subtended by minute bracts, calyx slightly puberulent; fruits irregularly cylindrical, with edible, pasty, sour to penetrantly sweetish aril. In hot and rainy lowlands, from Costa Rica to northwestern Colombia.

Vigna (pantrop. 150, CR 17, GD 3)
Vines, stems and leaves often villous or erect pubescent, but not with uncinate hairs. The flowers are yellow or pink to lavender and usually more than 1,2 cm long. The fruit is a linear to oblong pod, sometimes compressed, straight or somewhat curved and not compartmented inside, with 6–18, sometimes arillate seeds.

V. lasiocarpa (Benth.) Verdc.
Large, herbaceous vine, stems with yellowish pubescence; leaflets ovate, frequently shallowly 3-lobed; inflorescences few-flowered, constricted apically; flowers yellow, up to 3 cm long, standard emarginate, keel spiraled, style not coiled; fruits linear, up to 8 cm long, black. From Belize and Honduras to Paraguay and Brazil.

Fabaceae-Mimosoideae

Mostly tree or treelets, shrubs, but also lianas, distinguishable from the other two subfamilies of Fabaceae by the actinomorphic, multistaminate flowers. **Leaves** usually bipinnate compound, but sometimes also paripinnate, with or without petiolar and/or rhachis glands; **inflorescences** spicate, racemose or paniculate; **flowers** actinomorphic, tubular, sepals (3-)5, basally connate, petals (3-)5(-7), partly connate, stamens (5-)10-numerous, ovary superior, 1-locular; **fruits** elongate, cylindrical or flat, sometimes moniliform, spiraled or coiled, woody or fleshy, transversally or longitudinally dehiscent or indehiscent, seeds 1-numerous, sometimes arillate. In the tropics and subtropics worldwide 64/2950, CR 29/203, GD 15/70.

Key to the genera (after N. ZAMORA 1991)

1	Leaves paripinnate with glands between each pair of pinnae	2
2	Fruit flat, quadrangular or (sub-)cylindrical, straight, curved or longitudinally spiraled, coriaceous or subwoody	*Inga*
2*	Fruit moniliform, seeds not arillate	*Cojoba*
1*	Leaves bipinnate	3
3	Leaves without glands	4
4	Leaves with up to 15 pairs of pinnae	5
5	Treelet, flowers deep red or white with red stamens	*Calliandra*
5*	Shrub	6
6	Plant, especially leaf-rhachis, usually spiny	*Mimosa* p.p.
6*	Plant not spiny	*Zapoteca*
5**	Liana, leaflets 3–8 pairs per pinna	*Entada*
5***	Herb, usually spiny	*Mimosa* p.p.
4*	Leaves with 15-30 pairs of pinnae	*Mimosa* p.p.
3*	Leaves with glands	7
7	Petiole and rhachis with glands	8
8	Leaves with 1 pair of pinnae, gland between pinnae	*Zygia*
8*	Leaves with 1-3 pairs of pinnae, 1 small gland at base of petiole	*Albizia* (*A. adinocephala*)
8**	Leaves with 3-5 pairs of pinnae, 1 usually conspicuous, cupular gland at apex of petiole and small glands between pinnae	*Abarema*
8***	Leaves with 5–15 pairs of pinnae	9
9	Trunk cylindrical	10
10	Bark with conspicuous, red lenticels, fruit spiraled, ear-shaped	*Enterolobium*
10*	Bark peeling (squamose)	11
11	Rachillae with gland between terminal pair of leaflets	*Albizia* (*A. carbonaria*)
11*	Rachillae without, petiole and rhachis with glands	*Cojoba* p.p.
9*	Trunk with conspicuous buttresses, fruit linear, constricted between seeds	*Balizia*
7*	Petiole glandular, rhachis without glands	12
12	Stipules small, caducous	13
13	Leaves with 6–18 pairs of pinnae, gland at base of petiole, seeds winged, corolla pubescent outside	*Newtonia*
13*	Leaves with 15–27 pairs of pinnae, gland at apex of petiole, seeds not winged	*Parkia*
12*	Stipules persistent, spinescent, bullhorn-shaped, ant-inhabited, leaves with 10–25 pairs of pinnae	*Acacia*
7**	Petiole eglandular or glands borne only at the apex of the petiole at or just below insertion of the petiole	*Pithecellobium* (incl. *Samanea*)

Abarema (neotrop. 44, CR 4, GD 4)
Large trees with unarmed stems and bipinnate leaves with 3-5 pairs of pinnae usually with 1 gland at the apex of the petiole and small glands between the pinnae. It is further characterized by fruits rather coiled or curved and seeds covered with variously colored seed coats.

A. adenophora (Ducke) Barneby & Grimes, Pl. 62f-i
(syn. *Pithecellobium adenophorum* Ducke)
Tree, up to 30 m tall; leaves deciduous during the flowering period, leaves bipinnate with 2-4(-5) pairs of leaflets per pinna, gland at base of petiole bowl-shaped, stipules caducous; inflorescences terminal, panicle of short racemes; flowers strongly dimorphic, greenish-white; fruits coiled into a ring, seeds 6-9. From Nicaragua to Costa Rica and in Amazonian Ecuador and Brazil.

A. macradenia (Pittier) Barneby & J.W. Grimes
(syn. *Pithecellobium macradenium* Pittier)
Common names (Costa Rica): guavo, guavo de montana (BARNEBY & GRIMES 1996)
Tree, up to 36 m tall; leaves bipinnate, with 7–12 pairs of leaflets per pinna, not completely deciduous during floweringperiod; petiole with 1 conspicuous, up to 1–1,5 cm large, flat to cupular gland at apex (sometimes lacking), rhachis with small glands between pinnae, stipules caducous;

inflorescences flat umbels of capituliform racemes; flowers slightly dimorphic, pale green, with intense fruit-juice odor; fruits flat, recurved, brown, woody outside, seeds 10-15. In humid forests, from Nicaragua to Panama and Ecuador.

Acacia (cosmopol. 1200, CR 18, GD 2)
Trees or shrubs, usually with armed trunks and twigs, the stipules mostly transformed into cylindrical, inflated, bullhorn-shaped spines. The bipinnate leaves bearing mostly 2–26 pairs of pinnae, each pinna with numerous linear or narrowly oblong leaflets. The inflorescence is a capitulum or short spike. Fruit flattened, longitudinally dehiscent or indehiscent.

A. allenii D.H. Janzen, Pl. 63a,b
Common name (Costa Rica): cornizuelo
Tree, 8–25 m tall, spines bullhorn-shaped, 3–6 cm long, inflated over their whole length, inhabited by ants; leaves with 10–20 pairs of pinnae, 20–30 pairs of leaflets per pinna, leaflets oblong to linear, 5–11 mm long, 2–3,5 mm wide, petiole with 1–10 glands; inflorescences capitulae, frequently fasciculate; flowers yellow, numerous, up to 2 mm long; fruits flattened, up to 10 cm long, 1,5 cm wide. Endemic to the Golfo Dulce region.

Albizia (pantrop. + subtrop. 118, CR 4, GD 2)
Trees, usually with peeling bark and bipinnate leaves with 2–15 pairs of pinnae, each pinna with 2–30 pairs of leaflets. The flowers are arranged in umbellate or capitate inflorescences. The fruit is a very flat, oblong, papery to subwoody pod.

Key to the species of *Albizia*

1	Leaves with 1–3 pairs of pinnae	*A. adinocephala*
1*	Leaves with 7–18 pairs of pinnae	*A. carbonaria*

A. adinocephala (Donn. Sm) Britton & Rose, Pl. 63c
Tree, 6–18 m tall, twigs glabrous; leaves bipinnate with 1–3 pairs of pinnae, leaflets coriaceous, 2–5 pairs per pinna, ovate-lanceolate to ovate-elliptic, petiole with 1 basal gland; inflorescences paniculate racemes, flowers in capitulae; flowers white; fruits very flat, oblong, linear, 9–20 cm long 1,5–2,6 cm wide. In areas with long dry season, from Belize to Panama.

A. carbonaria Britton ex Britton & Rose
Tree, 8–35 m tall, with short trunk, twigs minutely ferruginous pubescent; leaves bipinnate with 7–18 pairs of pinnae, bearing a gland between the terminal pair of leaflets, leaflets 2–30 pairs per pinna, oblong or linear; inflorescences capitate or umbellate; flowers pale yellow, corolla campanulate; fruits very flat, linear, 8–13 cm long, 1,5–2 cm wide, ferruginous pubescent. Mostly in riparian and in open, disturbed areas, from El Salvador to South America.

Balizia (neotrop. 3, CR 1, GD 1)
A small genus of unarmed trees with bipinnate leaves and umbelliform or capitulate inflorescences, closely related to *Albizia* from which it can be distinguished by the pinnate leaf venation and the truncate ovary.

B. elegans (Ducke) Barneby & Grimes, Pl. 63d
Common name (Costa Rica): ajillo
Large tree, up to 50 m tall with conspicuous buttresses; leaves bipinnate with 9–15 pairs of pinnae, leaflets 20–30 pairs per pinna, oblong, 6–9,5 mm long, 1,7-3 mm wide, ferruginous pubescent beneath, petiolar and rhachis-glands present; inflorescences umbellate; flowers white, up to 1cm long; fruits linear, flattened, 9–20 cm long, 2,4-3,5 cm wide, constricted between seeds. In primary forests, disjunctly distributed, from Nicaragua to Costa Rica and in Bolivia and Amazonian Brazil.

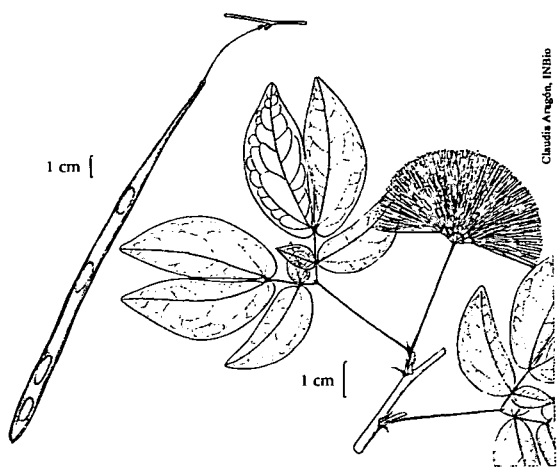
Calliandra (neotrop. + Madag. + India 200, CR 14, GD 4)
Trees or shrubs with bipinnate leaves with 1–15 pairs of pinnae, each with 1–numerous pairs of leaflets and always without glands. The inflorescences are capitulae, bearing pink or red flowers. The fruit is an oblong, woody pod with raised margins.

C. grandifolia P.H. Allen, Pl. 63e
Tree or shrub; Leaves with 1 pair of pinnae with 1–numerous pairs of leaflets per pinna, leaflets 18-24 cm long, 6-12 cm wide, subsessile, stipules persistent, lanceolate; inflorescences capitulae, 5

cm in diameter; flowers bright red, stamens long, exerted; fruits oblong, flat legume, 14 cm long, 1,5 cm wide. Endemic to the Golfo Dulce region.

C. surinamensis Benth.
Tree or shrub, up to 6 m tall; leaves with 1 pair of pinnae with 7-10 pairs of leaflets per pinna, leaflets oblong-lanceolate, 10–15 mm long, 3–4 mm wide, stipules persistent; inflorescences capitulae; flowers white and pink; fruits oblong, flat, 6–10 cm long, 0,8–1,2 cm wide, glabrous. Distributed throughout tropical America.

C. tergemina (L.) Benth.
Shrub or treelet, up to 6(-10) m tall; leaves with 1 pair of pinnae with only 1 pair of leaflets, leaflets elliptic to obovate, ca. 1,6-7,5 cm long, 0,6-3 cm wide; inflorescences capitulae, 12-21-flowered; flowering buds white, turning red during maturation, flowers yellowish to creamy white, opening in the evening, stamens white with pink; fruits brown at maturity, 5,5-15 cm long, 0,6-1,4 cm wide. Frequently growing together with *Peltogyne*, often in secondary growth or on rocky riversides, from Mexico to Colombia and northern Venezuela.

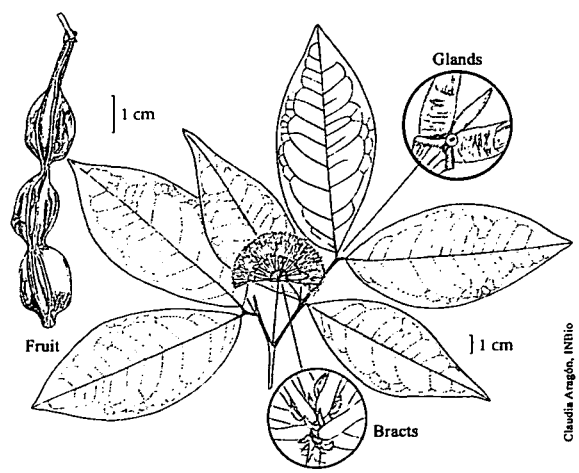


Calliandra tergemina

Cojoba (neotrop. 20, CR 8, GD 4)
Small to medium-sized tree, frequently with conspicuously ferruginous pubescent and/or lenticellous trunk and twigs and simple pinnate or bipinnate leaves with glands. The red moniliform fruit is somewhat fleshy, and spirally dehiscent.

C. arborea (L.) Britton & Rose, Pl. 63f,g
Common names (Costa Rica): lorito, ardillo
Medium-sized to large tree, twigs densely ferruginous pubescent, lenticellous; stipules caducous, small, densely ferruginous pubescent; leaves bipinnate with 7-15 pairs of pinnae, with 20-40 pairs of leaflets, leaflets obliquely oblong-lanceolate, 8-12 mm long, 2 mm wide, rhachis with glands between each pair of pinnae, petiole with a gland; inflorescences capitate, peduncle 5–10 cm long, pilose; flowers white, corolla 6-8 mm long; fruits red. Widespread, from Central America and the Antilles to Ecuador, Peru and Bolivia.

C. rufescens (Benth.) Britton & Rose
Small tree, 7–10 m tall, twigs conspicuously ferruginous pubescent, densely lenticellous; leaves paripinnate, with 3(–6), pairs of leaflets; rhachis cylindrical with glands between each pair of leaflets, leaflets subcoriaceous to coriaceous, oblong-elliptic to lanceolate, 4–16 cm long, 2–7,5 cm wide, with undulate margins; inflorescences capitate, peduncle 1–5 cm long; flowers white, corolla 6-8 mm long; fruits bright red. From Costa Rica to northern Colombia.



Cojoba rufescens

C. sophorocarpa (Benth.) Britton & Rose, Pl. 63h
Small to medium-sized trees, twigs reddish brown, lenticellous; leaves bipinnate with (2-)3-6 pairs of pinnae, leaflets asymmetrically elliptic to rhomboid, acute to acuminate, 2-3,5 cm long, 1-1,5 cm wide; flowers white, corolla 8-15 mm long; fruits dark red to purple. From southern Mexico to Panama.

Entada (neotrop. + Africa to Austral. ca. 30, CR 3, GD 2)
Tree, shrub or climber, with or without spines and bipinnate leaves, usually with 2–4 pairs of pinnae

and 3–8 pairs of leaflets per pinna, glandc always lacking, the rhachis sometimes elongate into a tendril. The inflorescences are usually elongate spikes, sometimes clustered in terminal racemes, with small, white or yellow flowers with 10 stamens.

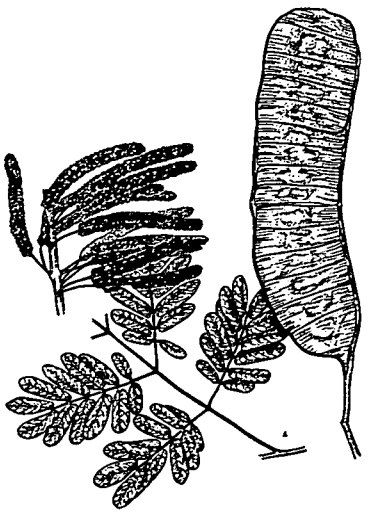
Key to the species of *Entada*

1 Leaves usually with 2 pairs of pinnae, terminal pair of pinnae transformed into a tendril, leaflets asymmetric, 3–6 pairs per pinna — *E. gigas*

1* Leaves usually with 3-4 pairs of pinnae and 5–8 pairs of symmetric leaflets per pinna — *E. polystachya*

E. gigas (L.) Fawc. & Rendle, Pl. 64a-c
Common name (Costa Rica): habilla
Large, woody liana, up to 50 m tall; leaves bipinnate, usually with 2 pairs of pinnae, a third pair of pinnae transformed into a tendril, leaflets 3–6 pairs per pinna, asymmetrically oblong, 2–6,5 cm long, 1,5–3 cm wide; inflorescences large spikes, inserted above the leaf-axils; flowers small, white or yellow; fruits woody, up to 2 m long and 10 cm broad. From Mexico to South America and in Africa.

E. polystachya (L.) DC., Pl. 64d
Common name (Costa Rica): parra rosa
Large, woody liana; twigs hollow, inhabited by ants; leaves bipinnate with (2-)3–4(-5) pairs of pinnae, leaflets 5-8 pairs per pinna, oblong, 1,5–4 cm long, 0,5–2 cm wide; inflorescences terminal racemes of spikes; flowers small, white or yellow; fruits oblong, up to 40 cm long, 7,5 cm wide. In coastal areas, from Mexico to South America.

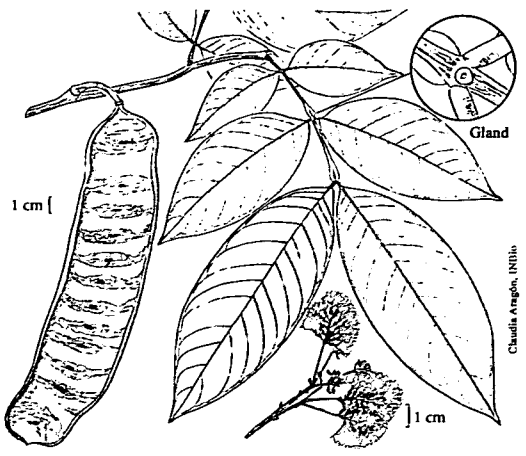


Entada polystachya

Enterolobium (neotrop. 5, CR 2, GD 1)
Usually large trees with bipinnate leaves and mostly numerous small leaflets. The petioles are always bearing a gland near the middle. The indehiscent, flattened fruit is very characteristically coiled in a circle or almost so.

E. cyclocarpum (Jacq.) Griseb., Pl. 64e,f
Common name (Costa Rica): guanacaste
Tree, up to 30 m tall, with larg extended crown; leaves bipinnate, nearly distichous, with 5–20 pairs of pinnae and 16–60 pairs of leaflets per pinna, leaflets oblong to linear, rachillae with 1-2 apical glands, pulvines with plate-shaped, slightly elevated, caducous gland, stipules caducous; inflorescences capitate; stamens numerous, fused into a tube; fruits indehiscent, strongly spiraled, rather broad, flattened. In regions with dry to humid climate, from Mexico and the Antilles to South America.

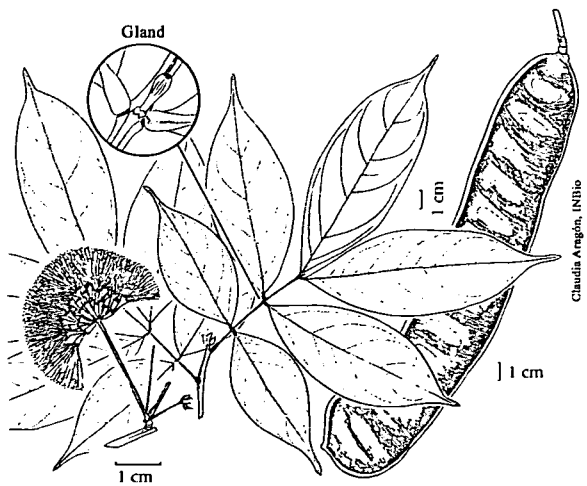
Inga (neotrop. + subtrop. ca. 350, CR 66, GD 34)
Small to large trees with paripinnate leaves with usually 2 to numerous pairs of leaflets, and with conspicuous glands on the rhachis, between each pair of leaflets. The stipules are either small and caducous or rather large, conspicuous or persistent. The flowers have numerous, rather long stamens. The fruit is a flat to nearly quadrangular or cylindrical pod with the seeds covered by a white aril.



Inga acrocephala

I. acrocephala Steud.
Tree, up to 20 m tall; bark gray brown, lenticellous, twigs glabrous; leaflets 3(-4) pairs, glabrous, leaf-rhachis 8,2-16 cm long, not winged or sometimes only narrowly winged beneath junction of terminal pairs of leaflets, glands stipitate, jar-shaped, stipules caducous; inflorescences 1-3 per axil, congested spikes or racemes, peduncle 2–5,5 cm long, rhachis 1–2,5 cm long; flowers white or pink; fruits flat, 18-32 cm long, 3,5-4,2 cm wide. From Mexico to Amazonian Peru and Brazil.

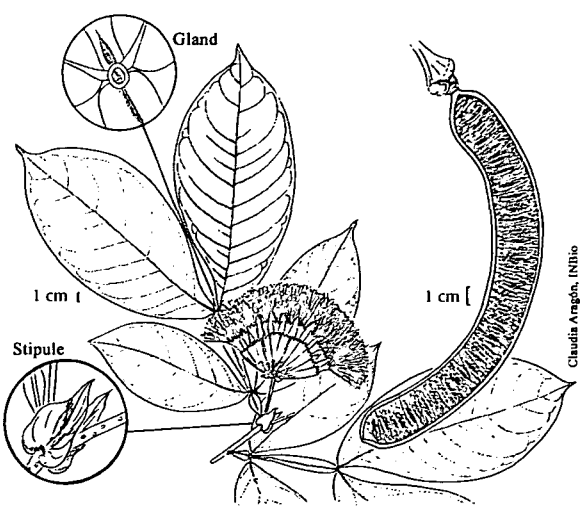
I. alba (Sw.) Willd., Pl. 65a
Common name (Costa Rica): guaba colorada
Large tree, up to 40 m tall, bark conspicuously red; leaflets (3-)4-5(-6) pairs, distal pair 6.1-10 (-15,5) cm long, 2,5-7,7 cm wide, subglabrous, leaf-rhachis 5-13,5 cm long, not winged, glands conical, stipules caducous; inflorescences axillary, short spike, peduncle 4-20 mm long, floral-rhachis 5-8 mm long; perianth pale green, stamens white; fruits flat, up to 14 cm long, 2 cm wide. Very widespread, from Mexico to Peru and Central Brazil.



Inga allenii

I. allenii J. León
Small or medium tree, twigs glabrous, lenticellous; leaflets 3 pairs, elliptic to ovate, coriaceous, distal pair 8–16 cm long, 3–4 cm wide, basal pair of leaflets 5–7 cm long 2,5–3 cm wide, glabrous, leaf-rhachis 1,8-5 cm long, channelled, with long-stipitate glands between each pair of leaflets, stipules mostly persistent, 2–3 mm long, petiole channelled; inflorescences in the axils of undeveloped leaves, capitate, peduncle 1,8-2 cm long, floral-rhachis ca. 2 mm long; corolla 6–7 mm long; fruits flat, straight, glabrous, 15–20 cm long, 2,5–3,2 cm wide. In Costa Rica and Panama.

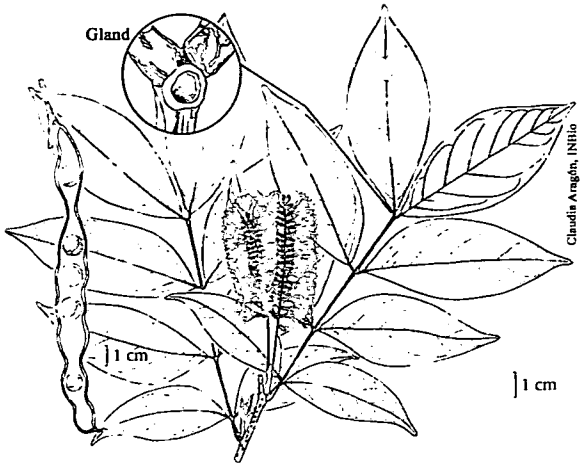
I. bella M. Sousa
Tree, bark and twigs grayish, glabrous, lenticellous; leaflets 2 pairs, oblanceolate to obovate, glabrous, leaf-rhachis 4,5-7 cm long, winged only along the upper 2/3, wings up to 1 cm wide on either side, stipules persistent, conspicuous, up to 2 cm long; inflorescences axillary and in the axils of undeveloped leaves, solitary, umbellate, peduncle 0,2-2 cm long, floral-rhachis ca. 3 mm long; flowers greenish-white; fruits oblong, flat with elevated rims, slightly curved, apically beaked, glabrous, greenish-white before, dark-brown, shiny after maturity. Endemic to the Golfo Dulce region and adjacent Panama.



Inga bella

I. cylindrica (Vell.) Mart.
Treelet with short, branched stems, twigs glabrous; leaves paripinnate, leaflets 3–4 pairs, distal pair 6-10,5(-12,5) cm long, (1,7-)2-3,7(-4,5) cm wide, leaf-rhachis 5-7,5 cm long, rhachis and petiole cylindrical, glands conspicuous, stipules 3-9 mm long, caducous; inflorescences axillary and in the axils of fallen leaves, solitary or clustered, spicate, peduncle 1,5-3,5 cm long, floral-rhachis 4,5-15 cm long; flowers fragrant, white; fruits hunched or inflated above the seeds, deeply constricted between them, ca. 1,5 cm wide, very

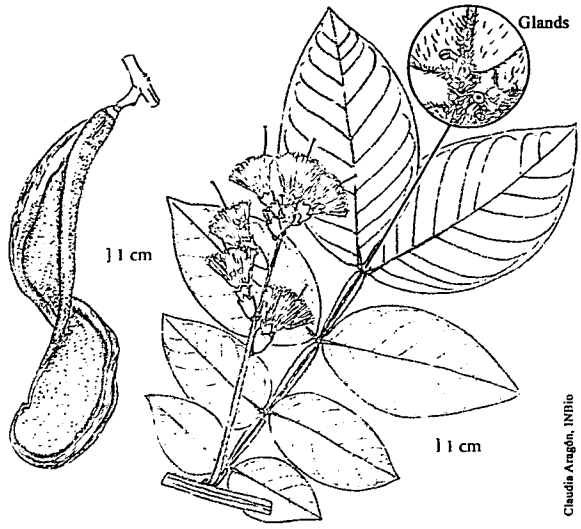
bright green, shiny. From Costa Rica to Bolivia and Central Brazil.



Inga cylindrica

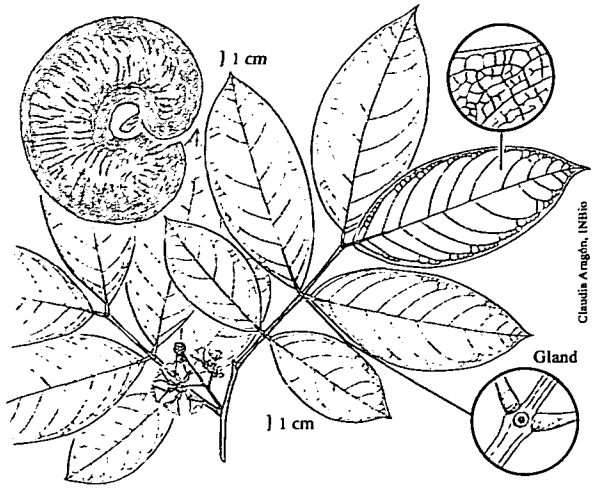
I. densiflora Benth., Pl. 65b,c
Common names (Costa Rica): guaba salada (PENNINGTON 1997), caite, guabo salado
Tree, up to 20 m tall, bark gray; leaflets 4-5(-6) pairs, margins ferruginous pubescent; main veins prominent on both surfaces, conspicuously ferruginous pubescent, rhachis 5,5-12,2 cm long, yellow to ferruginous pubescent, usually winged, wings distally auriculate, glands cup-shaped; inflorescences axillary,and in the axils of undeveloped leaves, clustered, 1-3 congested spikes, peduncle 1,7-8 cm long, floral-rhachis 1,5-3,5 cm long, yellow to orange pubescent; perianth greenish cream, stamens white; fruits 22-50 cm long, 4,8-10 cm wide, green to brown. From Mexico to Peru and Venezuela.

I. goldmanii Pittier
Common name (Costa Rica): guabo pachon (PENNINGTON 1997), guabo amarillo
Medium-sized tree, trunk red and gray patterned, young twigs sparsely lenticellous, densely hirsute ferruginous pubescent; leaflets (3-)4(-5) pairs, rigidly coriaceous, elliptic to ovate, distal pair 18-25 cm long, 7-14 cm wide, basal pair 5-9 cm long, 3-6 cm wide, pilose beneath, 1-2 glands present on the midvein, leaf-rhachis 11-15 cm long, broadly winged, with glands between each pair of leaflets, petiole broadly winged, stipules up to 2 cm long, cordate, persistent; inflorescences axillary, solitary or paired, spicate or racemose, peduncle 7,5-9(-13) cm long, ferruginous-hirsute, floral-rhachis 3-12,5 cm long; fruits flat to quadrangular, 18-30 cm long, 3-6 cm wide, densely ferruginous hirsute, straight or curved. In disturbed lowland rainforests, pastures and along roadsides, from Nicaragua to Venezuela.



Inga goldmanii

I. golfodulcensis N. Zamora
Small tree, twigs scarcely lenticellous, glabrous; leaflets 3 pairs, elliptic, distal pair 11-19 cm long, 3,5–6,8 cm wide, basal pair 8,5–14,5 cm long, 2,7–5,2 cm wide, glabrous, leaf-rhachis 5-10 cm long, cylindrical, with glands between each pair

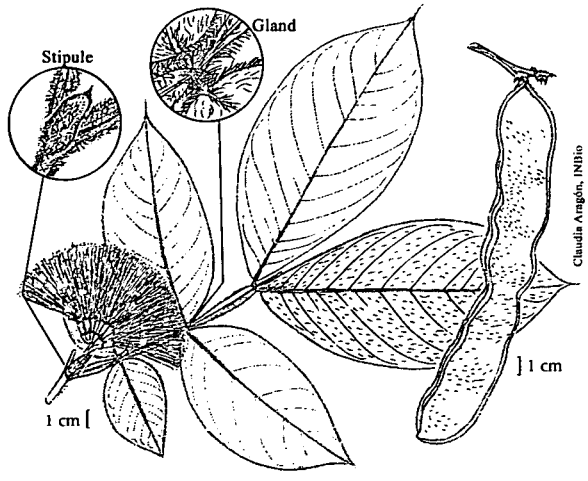


Inga golfodulcensis

of leaflets, stipules ca. 1 mm long, caducous, petiole cylindrical; inflorescences on leafless axillary shoots, clustered, congested spikes, peduncle 1,2-1,5 cm long, pubescent, floral-rhachis 4-5 mm long; fruits flat, spirally coiled, ca. 7 cm in diameter, covered with white, scaly hairs. Endemic to the Osa Peninsula.

I. jimenezii N. Zamora

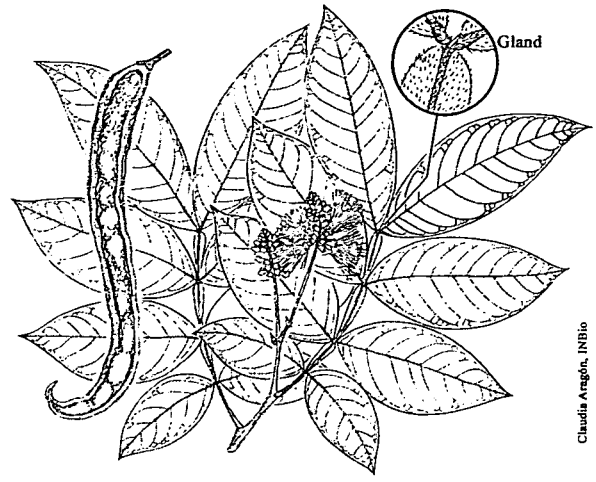
Small tree; twigs, scarcely lenticellous, densely ferruginous pubescent; leaflets usually 2 pairs, elliptic to slightly ovate, distal pair 19–22 cm long, 7–10,5 cm wide, basal pair 4,5–9 cm long, 2,1-5 cm wide, sparsely hispid above, pilose beneath, leaf-rhachis 4,4-5,5 cm long, winged, with very slender, stipitate glands between each pair of leaflets, petiole winged, stipules lanceolate, 1,5-2 cm long, persistent; inflorescences axillary, solitary, congested spike, peduncle 2,5–4,2 cm long, hispid, floral-rhachis 2,5–4 cm long; flowers sessile, up to 2 cm long; fruits flat, 13-16 cm long, 2,5-3,5 cm wide, densely ferruginous pilose. In seasonal, semideciduous rainforests, endemic to Costa Rica.



Inga jimenezii

I. litoralis N. Zamora

Small tree, twigs sparsely lenticellous, densely ferruginous pubescent; leaflets 3 pairs, elliptic, distal pair 14,6–23 cm long, 5–10 cm wide, basal pair 3-9 cm long, 1,3-5 cm wide, densely ferruginous pilose beneath, leaf-rhachis 5-10 cm long, winged, with very slender, short-stipitate glands between each pair of leaflets, petiole cylindrical or slightly winged, stipules up to 4 mm long caducous; inflorescences axillary, solitary or clustered, congested to lax spike, peduncle 3,3–7 cm long, floral-rhachis 2,5-6 cm long; flowers sessile; fruits flat, straight, 14-25 cm long, 1,3-2 cm wide, densely hispid. In semideciduous forests, endemic to Costa Rica.



Inga litoralis

I. marginata Willd., Pl. 65d

Common name (Costa Rica): cuajiniquil negro

Tree, up to 30 m tall, crown dense, bark gray, smooth, twigs lenticellate, puberulous to glabrous; leaflets 2-3 pairs, usually elliptic, distal pair 7,8-20 cm long, 2,1-7 cm wide, basal pair

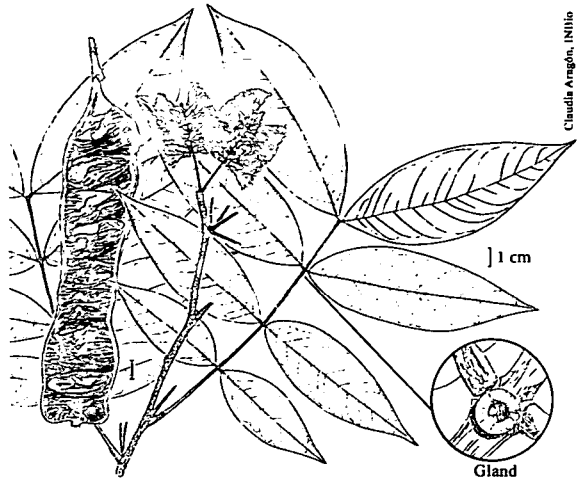
Inga marginata

3,6-12 cm long, 1,1-5 cm wide, glabrous, leaf-rhachis 1,5-5,5 cm long, winged, wings broad apically, acute basally, stipules 0,2-1,5 cm long, usually caducous; inflorescences axillary, solitary or clustered, spicate, peduncle 0,6-3(-4) puberulous, floral-rhachis 3,5-11,5 cm long; flowers sessile, perianth greenish-yellow, stamens white; fruits 7-12,5 cm long, 0,6-0,9 cm wide, glabrous. Often growing close to riversides, from Mexico to Argentina and Paraguay.

I. multijuga Benth., Pl. 65e-g
Common name (Costa Rica): guaba de montaña (PENNINGTON 1997), guaba de estero
Tree up to 20 m tall, bark gray-brown, twigs ferruginous pubescent; leaflets 7-10 pairs, elliptic, oblong-elliptic or oblanceolate, distal pair (7-) 9,6-15,2 cm long, (2,5-)3-5,2(-6) cm wide, basal pair 3,6-7 cm long, 2,1-3,3 cm wide, shortly hirsute, leaf-rhachis cylindrical, 7-16,5 cm long, glands large, plate-shaped, stipules 1,5-2 mm long, caducous; inflorescences axillary, solitary or clustered, congested spikes, peduncle 1,5–5,5 cm long, floral-rhachis 1,5–2 cm long, pubescent; flowers sessile, perianth greenish, stamens white; fruits straight or curved, 15–26 cm long, 1,5–3,5 cm wide, shiny. From Mexico to Venezuela and Ecuador.

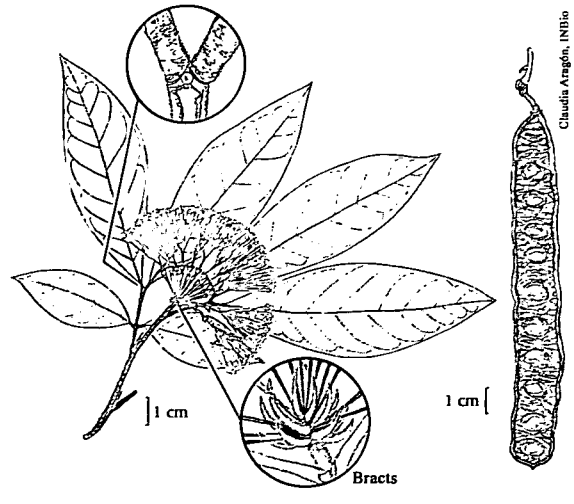
I. oerstediana Benth. ex Seem., Pl. 65h
Common name (Costa Rica): cuajiniquil peludo
Tree, up to 30 m tall, bark gray, twigs pale-lenticellate, pubescent; leaflets 3-5 pairs, broadly elliptic to obovate, distal pair 11-20 cm long, 5-11 cm wide, basal pair 3,5-11 cm long, 2-6 cm wide, ferruginous pubescent beneath, leaf-rhachis 6-21 cm long, naked or winged, glands with broad, transversally compressed rims, stipules 2-3 mm long, caducous; inflorescences axillary or in the axils of undeveloped leaves, often clustered, 1-3 congested spikes, peduncle 1–9 cm long, ferruginous pubescent, floral-rhachis 1–4 cm long; perianth brownish-green to greenish-yellow, stamens white; fruits cylindrical, 20-30 cm long, 1–2,5 cm wide, ferruginous pubescent. In lowland and montane rain forests, from Mexico and the Antilles through western South America to Bolivia.

I. pezizifera Benth., Pl. 65i
Tree up to 35 m tall, bark pale brown, twigs pale-lenticellate, puberulous; leaflets (3-)4-5 pairs, ovate, lanceolate or elliptic, distal pair 11,6-19 cm long, 4,3-8,4(-10) cm wide, basal pair 5-9,3 cm long, 2,3-5 cm wide, glabrous or ferruginous pubescent along the venation above, short,



Inga pezizifera

strigose beneath, leaf-rhachis cylindrical, 8,5-14,2 cm long, glabrous to puberulous, glands plate-shaped, stipules 3-12 mm long, caducous; inflorescences axillary and in the axils of undeveloped leaves, clustered, 1-6 congested racemes, peduncle 2,5-6 cm long, floral rhachis 1,5–3,5 cm long; perianth green, stamens white; fruits flat, 15-21 cm long, 2-4 cm wide, glabrous. From Costa Rica to Amazonian Ecuador and Brazil.

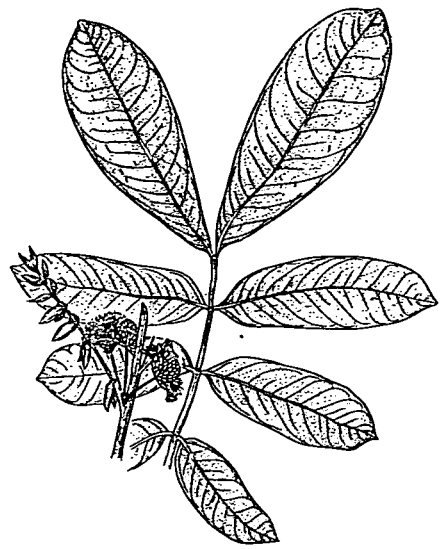


Inga polita

I. polita Killip
Tree up to 18m tall, bark gray, twigs dark brown, lenticellous; leaflets 1(-2) pairs, ovate, 5,5-20,6 cm long, 2,1-7,2(-10) cm wide, glabrous, leaf-rhachis apically slightly winged, with small glands between each pair of leaflets, petiole cylindrical, sometimes winged, stipules 5-10 mm long, caducous; inflorescences axillary, 1-2, umbellate, peduncle 5-10 mm long, puberulous, floral-rhachis 2-3 mm long; flowers white, filaments white, anthers greenish yellow; fruits flat, 9-10 cm long, 1,9-2 cm wide, glabrous. In lowland and lower montane forests, from southeastern Costa Rica to Pacific Colombia.

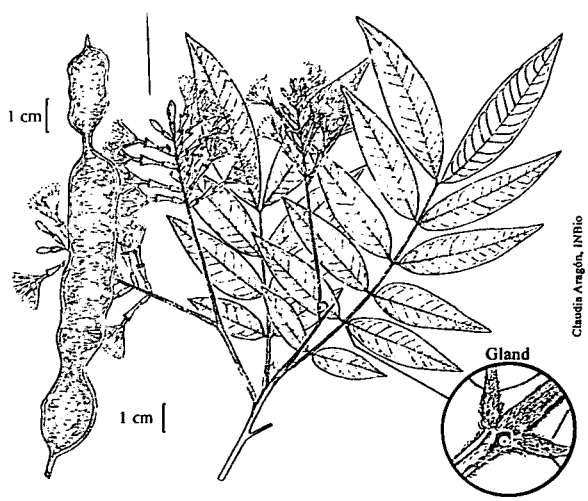
I. punctata Willd., Pl. 66a
Common names (Costa Rica): cuajiniquil, juaniquil
Tree up to 20 m tall, bark gray brown, twigs brown, ferruginous pubescent; leaflets 2(-3) pairs, elliptic to obovate, distal pair 8-19(-23) cm long, 2,6-9,3 cm wide, basal pair 4-13 cm long, 1,9-5,8 cm wide, glabrous or pubescent, leaf-rhachis cylindrical, 1,2-6,2 cm long, glands inconspicuous, stipules 2-8 mm long, caducous; inflorescences in the axils of undeveloped leaves, clustered, 1-6 congested spikes, peduncle 1,5-5,5 cm long, densely ferruginous pubescent, floral-rhachis (0,5-)1(-3) cm long; flowers sessile, perianth pale green, stamens white or cream; fruits flat, 4–20 cm long, 1–2(-4) cm wide, glabrous or strigose. From Mexico and the Antilles to Bolivia and Amazonian Brazil.

I. ruiziana G. Don, Pl. 66b,c
Tree, up to 30 m tall, bark reddish brown, twigs densely ferruginous pubescent, conspicuously lenticellous; leaflets 4–5 pairs, broadly oblanceolate to oblong or elliptic, distal pair 15-25 cm long, 5,5-9 cm wide, basal pair 4,5-18 cm long, 2,2-6,5 cm wide, glabrous above, pubescent beneath, leaf-rhachis cylindrical, 13-20 cm long, ferruginous pubescent, glands bowl-shaped, petiole cylindrical, ferruginous pubescent, stipules 4-8 mm long, puberulous, caducous; inflorescences in the axils of undeveloped leaves, clustered, 1-4 congested spikes, peduncle 0,4-5 cm long, floral-rhachis 0,5-1,5 cm long; perianth cream- to greenish-white, stamens white; fruits 7-22 cm long, 2,3-3,5 cm wide, glabrous. From Nicaragua to Ecuador, Peru and Bolivia.



Inga ruiziana

I. skutchii Standl.
Tree, up to 9 m tall, twigs densely ferruginous pubescent; leaflets 6-8 pairs, elliptic to ovate, 4-7 cm long, 1-2 cm wide, leaf-rhachis cylindrical, stipules up to 2 mm long, deciduous; inflorescences spicate, peduncle 3-4 cm long, floral-rhachis 5-7 cm long; flowers 15-18 mm long, white; fruits flat, 13 cm long, 2,3 cm wide. Endemic to the Osa Peninsula.



Inga skutchii

I. sapindoides Willd., Pl. 66d
Common name (Costa Rica): guaba cuadrada (ZAMORA & PENNINGTON 2001)
Medium-sized or small tree, up to 16 m tall, twigs

ferruginous pubescent, lenticellous; leaflets 3-4 pairs, elliptic to lanceolate, distal pair 9–28 cm long, 5–13 cm wide, basal pair 5–12 cm long, 3–6 cm wide, glabrous above, yellowish pubescent beneath, rhachis winged, with glands between each pair of leaflets, petiole winged, pulvinate, sometimes cylindrical, stipules persistent, ovate, 0,8–1,8 cm long 0,4–1 cm wide; inflorescences spicate, peduncle up to 1 cm long; flowers sessile; fruits quadrangular, 11–30 cm long, 2–3 cm wide, glabrous, green or yellowish. Mainly in lowland forests, from Mexico and the Antilles to Venezuela and Peru.

I. spectabilis (Vahl) Willd., Pl. 66f
Common name (Costa Rica): guaba machete
Small to medium-sized tree, up to 15 m tall, twigs conspicuously angulate or quadrangular; leaflets 2 pairs, elliptic to obovate, distal pair 19-30 cm long, 8-18 cm wide, basal pair 10-16 cm long, 5-9 cm wide, glabrous on both sides, leaf rhachis with glands between each pair of leaflets, petiole and rachis cylindrical or winged, stipules 6-9 mm long, sub-persistent; inflorescences spicate, peduncle 3–8 cm long, rhachis 1–5 cm long; flowers sessile; fruits woody, flat, glabrous, up to 70 cm long, up to 8 cm wide, glabrous. From Mexico to South America, frequently cultivated for its edible fruits.

I. thibaudiana DC., Pl. 66g
Tree, up to 25 m tall, bark green-, gray- and reddish brown-spotted, twigs ferruginous pubescent, dark brown; leaflets usually 5–6 pairs, elliptic or oblanceolate, distal pair (6,5-)7,4-17,5 cm long, (1,8-)2,8-7,6(-8,5) cm wide, basal pair 3-10,2 cm long, 1,5-4,9 cm wide, glabrous above, densely and minutely pubescent beneath, leaf-rhachis 7-20 cm long, terete or winged, glands cup-shaped, green to orange or black, petioles cylindrical, stipules 1-3 mm long, puberulous to tomentose, caducous; inflorescences axillary, 2-5 congested spikes, peduncle 1-4 cm long, ferruginous pubescent, floral-rhachis 1-3,5 cm long; perianth yellowish green, stamens white; fruits flat, straight or slightly curved, 8-30 cm long, 1,8-2,5 cm wide. From Mexico to Bolivia and central Brazil.

I. umbellifera (Vahl) Steud.
Tree up to 20 m tall, bark gray and brown spotted, glabrescent; leaflets (1-)2-3 pairs, elliptic to lanceolate, distal pair 6-20 cm long, 2,8-7,5 cm wide, basal pair 3,3-7,6 cm long, 1,8-3,3 cm wide, glabrous, leaf-rhachis 1,3-3,5 cm long, very narrowly winged (cylindrical only when just 1 pair of leaflets present), glabrous, glands very large, flat or patelliform, petiole usually winged, glabrous, stipules 2-6 mm long, persistent or caducous; inflorescences axillary or in the axils of undeveloped leaves, umbellate, peduncle 1-5 cm long, rhachis 1,5-4 mm long; perianth pale green, stamens white; fruits flat, curved, 6–12 cm long, 1,5–2,5 cm wide, glabrous. From Costa Rica to Bolivia and Amazonian Brazil.

I. venusta Standl.
Common names (Costa Rica): guabo, guabo amarillo (PENNINGTON 1997)
Tree, up to 40 m tall, bark gray brown; leaflets 3-4 pairs, elliptic to oblong, distal pair (9-)15-29 cm long, (3-)5,9-13,5 cm wide, basal pair 6,5-18,5 cm long, 3-11 cm wide, glabrous or pubescent, leaf-rhachis 5-28 cm long, winged, glabrous or pubescent, glands cup-shaped, petioles winged, stipules 5-10 mm long, caducous; inflorescences axillary, sometimes clustered, 1-5 congested spikes, peduncle 2-5 cm long, floral-rhachis 0,8-3 cm long; perianth yellow to greenish-yellow, stamens bright yellow; fruits spiralled or obliquely stretched, 15-35 cm long, 3,5–4,5 cm wide, glabrous, brown. From Costa Rica to Colombia and Ecuador.

Mimosa (pantrop. + subtrop. 480, CR 24, GD 4)
Erect, procumbent or scandent herbs, (sub-)shrubs or lianas, usually spiny with bipinnate leaves with up to 15 pairs of pinnae and 2–20 pairs of leaflets per pinna. The white, pink or pale lavender flowers are arranged in capitate or short spicate inflorescences The stamens are one or two times as many as the petals. The herbs and shrubs prefer open, disturbed areas, such as road- or riversides or pastures.

M. pigra L., Pl. 66i,j
Common names (Costa Rica): dormilona, dormilona grande
Shrub, 1–3 m tall; twigs cylindrical, setose to hispid, spines up to 1 cm long; leaves with 7–15 pairs of pinnae, leaflets 25–45 pairs per pinna, linear, glabrous or pubescent, petiole and rachis with up to 1 cm long spines, stipules persistent, up

to 8 mm long; inflorescences capitulae, peduncle 1,5-4,5 cm long; flowers pink; fruits 3–10 cm long, 1–1,5 cm wide, densely setose. From Mexico and the Antilles to Paraguay and central Brazil as well as in the Old World Tropics.

M. pudica L., Pl. 67a,b
Common names (Costa Rica): dormilona, naupete, puta vieja
Herb or subshrub, twigs glabrous or hirsute, with recurved spines; leaves sensitive, closing after touch, during rain and at night, pinnae 1–2 pairs, clustered at apex of petiole, leaflets 15–35 pairs per pinna, linear-oblong, up to 10 mm long, 1-2 mm wide, glabrous, petiole 1,5–4 cm long, petiole and rachis sometimes spiny, stipules persistent, up to 1 cm long, setose; inflorescences capitulae of several flowers; flowers pink, minute, corolla, the peduncle 1–2 cm long; fruits 10–25 mm long, 5–6 mm wide, setose. Widely distributed fom Mexico and the Antilles to S-America as well as in the Paleotropics.

Parkia (pantrop. 30, CR 1, GD 1)
Large trees with bipinnate leaves and characteristic petiolar glands. The inflorescences are very characteristic, usually large capitulae. The fruits are flat, oblong or broad-linear, straight or curved, woody or fleshy. The genus is said to be partly hapaxanthic, since it produces special shoots on which the flowers are located and which die as a whole after the maturity of fruits.

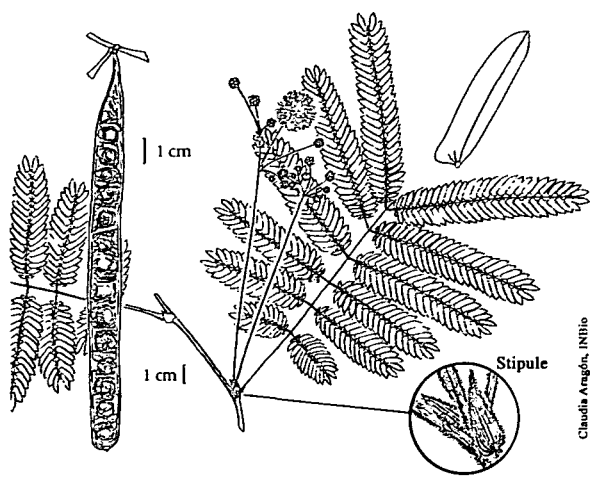
P. pendula (Willd.) Benth ex Walp. Pl. 67c-e
Common name (Costa Rica): tamarindo gigante
Large tree with widely extended crown; leaves bipinnate, with 15-27 pairs of subopposite to alternate pinnae, leaflets linear, 3-6 mm long, 0,5-0,7 mm wide, numerous pairs per pinna, petiole cylindrical, stipules caducous; flowers small, upper flowers of the capitulum yellow or red, fertile, the lower ones white or red, sterile, stamens 10; inflorescences pendent; fruits flat, oblong or broad-linear, straight or curved, woody or fleshy. From Honduras to Peru, Bolivia and Brazil.

Pithecellobium (neotrop. 37, CR 16, GD 4)
A very large and variable genus with bipinnate leaves and usually with a gland on the petiole. The flowers are usually arranged in umbels or sometimes in spikes.

P. saman (Jacq.) Benth., Pl. 67f-h
[syn.: *Samanea saman* (Jacq.) Merr.]
Tree, up to 30 m tall, branchlets pubescent; leaves up to 30 cm long, with 3-5 pairs of pinnae, each pinna with 3-6 pairs of leaflets, leaflets oblong to obovate, 15-35(-45) mm long, 9-20 mm wide, glabrous above, scarcely pubescent beneath, rhachis 5,5-14,5 cm long, with a gland between the first and the last pair of pinnae; inflorescences umbellate, up to 15 cm long, with flowers in capitulae; fruits 15-20 cm long, 1,5-2,3 cm wide, brown. Usually along rivers, in rather dry, deciduous forests, from Mexico to South America.

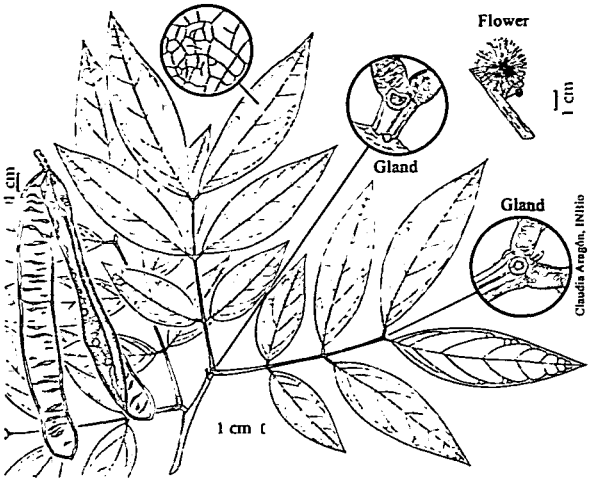
Zapoteca (neotrop. 17, CR 5, GD 2)
Shrubs with cylindrical or quadrangular branches and bipinnate leaves with 1–7 pairs of pinnae and 1 to numerous pairs of leaflets per pinna, lacking glands. The flowers are always white, the linear to oblong fruit is slightly woody and elastically or explosively dehiscent from apex to base.

Z. portoricensis (Jacq.) H.M. Hern.
Shrub, 1–3 m tall, twigs glabrous or densely pubescent or villous; leaves bipinnate with (1-) 3–7(-8) pairs of pinnae, leaflets oblong to oblong-lanceolate, glabrous or minutely pubescent, 16-numerous per pinna, without glands, stipules persistent; inflorescences capitulae, peduncle 3,5–10 cm long; flowers sessile; fruits linear to oblong, 4–12 cm long, 1–1,2 cm wide, slightly woody, with raised margins. From Mexico to Panama.



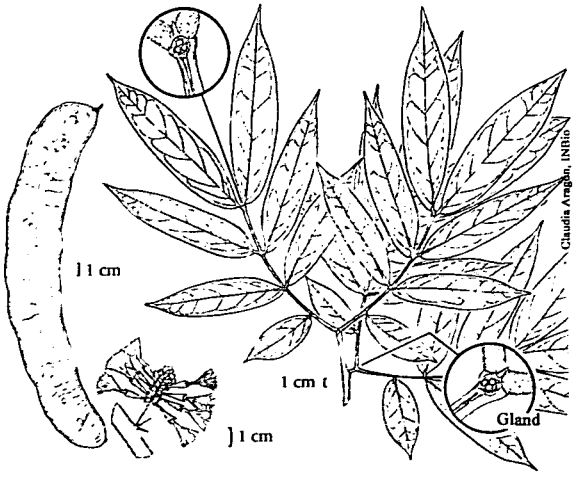
Zapoteca portoricensis

Zygia (neotrop.20, CR 12, GD 5)
Trees or shrubs, sometimes scandent with bipin-



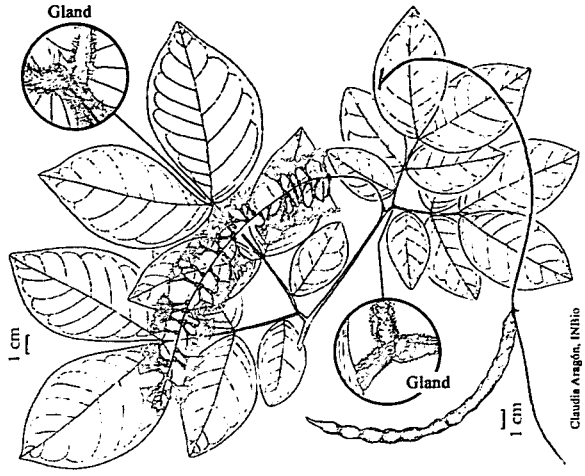
Zygia cognata

Z. cognata (Standl.) Record
Tree, 3-8 m tall, twigs brownish-puberulent; leaves with 1 pair of pinnae, with a gland between the base of the pinnae, pinna with 3(–4) pairs of leaflets, leaflets elliptic or ovate-elliptic, distal leaflets larger than the basal ones, (8-)11-22 (-27) cm long, (3-)4-8 cm wide, rhachis of longer pinnae 7-17(-20) cm long; inflorescences cauli- or ramiflorous, spicate; fruits broad-linear, almost straight, 13-25 cm long, 1,9-2,4 cm wide, densely minutely strigulose-tomentulose. In wet forests, along riverbanks and wooded shores, from Mexico to Costa Rica.



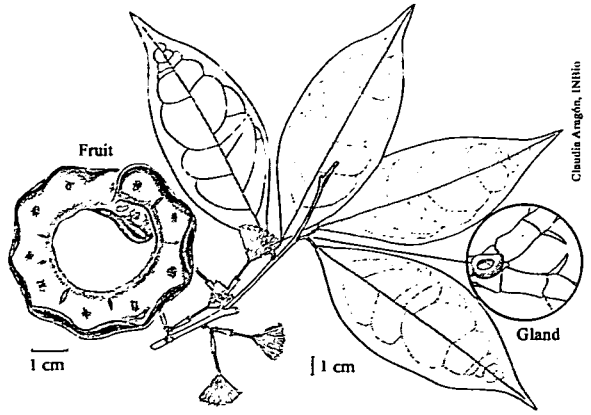
Zygia englesingii

Z. englesingii (Standl.) Record
[syn. *Z. gigantifolia* (Schery) L.Rico]
Small tree, 4–8 m tall, twigs glabrous, lenticellous; leaves with 1 pair of pinnae, with a gland between the base of the pinnae, pinna with 3–5 pairs of leaflets, distal leaflets larger than the basal ones, 17-38 cm long, 6-12(-14) cm wide, rhachis of pinnae 15-50 cm long; inflorescences cauli- or ramiflorous, spicate; flowers white to pinkish red; fruits narrowly oblong, flat, 8,5–20 cm long, 1,6–2 cm wide. From Mexico to Panama.



Zygia rubiginosa

Z. rubiginosa L. Rico & Q. Jiménez, Pl. 67i
Tree, up to 10 m tall, trunk smooth, young twigs ferruginous pubescent, glabrescent; leaves with 1 pair of pinnae, with a gland between the base of the pinnae, pinna with 2-3 pairs of leaflets, leaflets broadly elliptic-acuminate 2,5-7 cm long, 1,3-3,3 cm wide, glabrous, rhachis of pinnae 3-7 cm long, with a gland at the apex; inflorescences cauliflorous, spicate, to 11 cm long, corolla white; fruits



Zygia unifoliolata

slightly curved, laterally compressed, 9-13 cm long, 6-8 mm wide. Endemic to the Golfo Dulce region.

Z. unifoliolata (Benth.) Pittier

Shrub or treelet, 2-8 m tall; leaves with 1 pair of pinnae, with a gland between the base of the pinnae, each pinna with 1 leaflet, leaflets narrowly or broadly elliptic, ovate elliptic or linear elliptic, the larger ones 6-16(19,5) cm long, 2,5-7(-8) cm wide; inflorescences fasciculate or pseudoracemose, few-flowered, corolla whitish or pinkish; fruits 9-19, 5 cm long, 1,4-2,8 cm wide, glabrous. Usually on riverbanks, from southern Mexico to Amazonian Peru and Brazil.

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Fagaceae

Trees or shrubs with nondescript, alternate, simple leaves and inflorescences of small clustered flowers. **Leaves** deciduous or evergreen, entire, toothed to deeply lobed, stipules caducous; male **inflorescences** usually pendulous catkin-like, with dichasial clusters or solitary flowers, female inflorescences usually erect dichasial clusters of 1-few flowers; **flowers** unisexual, plants monoecious, male flowers: tepals 4-8, reduced and bract-like, basally united, stamens (4-)6-12(-90), female flowers surrounded by a cupule, tepals usually 6, basally united, staminodes 6-12 or absent, ovary inferior, 2-6-locular, **fruits** nuts, enclosed by the cup-shaped, woody cupule. Mostly in temperate areas of the northern hemisphere. Cosmopol. 8/700, CR 2/16, GD 1/2.

The flowers of most Fagaceae (incl. *Quercus*) are obviously wind-pollinated, while a few genera (e.g., *Castanea*) are pollinated by insects, mainly beetles (PORSCH 1950).
Castanea sativa, the castaño, is cultivated worldwide (also in some parts of Costa Rica) for its edible fruits.

Key to the species of *Quercus* (based on BURGER 1977)

1	Laminae usually bluntly serrate and obovate in general form, commonly 10-25 cm long; stipules usually persisting; fruits becoming more than 3 cm thick at maturity; white oaks with the year-old stems usually pale gray (white oak: subgen. *Quercus*)	*Q. insignis*
1*	Laminae entire or undulate and not usually obovate; fruits less than 3 cm wide, with the year-old stems smooth and dark (black oak: subgen. *Erythrobalanus*)	*Q. rapurahuensis*

Quercus (temp. ca. 400, CR, GD 2)
Trees and shrubs with entire to deeply lobed leaves. They can be recognized by the distinct inflorescence types: male inflorescences of axillary, long-pendulous spikes and the female inflorescences axillary, of erect spikes or flowers solitary.

Q. insignis M. Martens & Galeotti
Tree, up to 30(-40) m tall, leafy internodes densely covered with orange to yellowish stellate hairs becoming glabrescent after 1-2 years and grayish or brown; leaves 10-24 cm long, 3,5-9 cm wide, usually oblong to obovate, margin entire to undulate or bluntly short serrate, puberulent on the midvein above, densely to sparsely puberulent beneath with orange to yellowish stellate hairs, stipules often persisting; male inflorescences 3-8 cm long, female inflorescences 1-3 cm long, with 1-3 flowers; fruits ovoid to globose, 3-5 cm long, 3-7 cm wide. Usually in lower montane wet forests (in Costa Rica between 1000 and 1800 m alt.), ranging from Mexico to Panama.

Q. rapurahuensis Pittier ex Trel.
Tree, up to 30 m tall, leafy internodes stellate tomentulose, but quickly becoming glabrous, dark brown or reddish-brown; leaves 9-18 cm long, 3-7 cm wide, narrowly ovate or lanceolate to elliptic or oblong, margin entire or undulate, glabrous above, tomentulose in the axils of the veins beneath, with pale or yellowish-brown stellate hairs, stipules soon caducous; male inflorescences ca. 4-5 cm long, female inflorescences with 1-4 flowers on short peduncle; fruits ovoid to ellipsoid, 15-20 mm long, 14-20 mm wide. Usually in lower and premontane wet forests (in Costa Rica between 1000 and 2500 m alt.), ranging from Costa Rica to Panama.

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Flacourtiaceae

This family represents the basal group of the order Violales, with the status of a very heterogeneous family, due to a high variability, especially within the flower parts. The family consists of trees, shrubs and a few climbers, sometimes with spines on the branches, trunks or in the leaf axils, and with simple or rarely stellate indumentum. **Leaves** alternate, rarely opposite, often distichous, simple, entire or frequently serrate or crenate, often with glands on the margin-teeth or sometimes a pair of glands on the petiole apex or at the leaf base, stipules usually present, but mostly caducous and leaving characteristic stipule scars; **inflorescences** axillary or terminal, of various types; **flowers** actinomorphic, bisexual or unisexual, then mostly dioecious, sepals (2-) 3-6, rarely more, free or connate at the base, petals 3-8 rarely more or absent, always free, sometimes persistent and accrescent, receptacle often with appendages, i.e. various structures like discs, glands or staminode-like scales; stamens 1- usually numerous, free, or rarely the filaments united into a tube, ovary superior, rarely semi-inferior, unilocular with 2-9 parietal placentas, rarely incompletely 2-9-celled; styles 1-numerous; **fruits** fleshy or dry indehiscent berries or valvately dehiscent capsules, rarely a drupe, sometimes winged or prickly; seeds 1-numerous. Predominantly in the tropics, but also in the subtropics and with a few species reaching into temperate zones, worldwide, usually in primary and secondary evergreen lowland and montane forests, the genera more or less equally represented in Africa, Asia and the Americas. Pantrop. + few spp. subtemp. 86/875, CR 21/47, GD 13/22.

The genera with catkin-like inflorescences are most probably wind-pollinated, whereas most of the other genera are assumed to be pollinated by insects, despite the lack of evidence of nectar production. But there is generally little knowledge about the pollination of the Flacourtiaceae (SLEUMER 1980).
Common in the family are species with fleshy fruits and arils, which are probably dispersed by mammals and birds (SLEUMER 1980).
Chaulmoogra-oil is extracted from the seeds of *Carpotroche brasiliensis* as well as from some *Hydnocarpus* spp. and was once used for the treatment of leprosy. Other Flacourtiaceae have become only of local commercial importance for their wood or as ornamental plants (e.g., *Lindackeria spinosa*).

Key to the genera (based on SLEUMER 1980)

1	Segments of the perianth asymmetrically arranged, the sepals distinct from the petals, the latter varying in number and more numerous than the sepals	2
2	Style 1	*Lindackeria*
2*	Styles (2-)3-7	3
3	Styles (2-) 3 or 4 (rarely 5); fruit baccate, with a generally thin pericarp, indehiscent	

	or dehiscent distally only, never winged, set all over with slender bristles	*Mayna*
3*	Styles (4-) 6 or 7 (-8); fruit capsular, with thick pericarp, may be tardily dehiscent to 3-5 (-7) valves, provided with up to 16 vertical (very rarely much reduced) wings, the latter entire, crenate or lacerate	*Carpotroche*
1*	Segments of the perianth symmetrically arranged, the sepals distinct from the petals, the latter, if any, of the same number as are the sepals	4
4	Stamens hypogynous; leaves never pellucid-punctate or –lineate	5
5	Stamen 1	6
6	Flowers densely arranged to relatively short cylindrical catkin-like thickish spikes	*Lacistema*
6*	Flowers laxly arranged to elongate slender spiciform racemes or panicles	*Lozania*
5	Stamens 4 to numerous	7
7	Petals normally present, usually 4-6 (very rarely 3); disk glands absent, or, when present, inserted between the base of the filaments of fertile stamens	8
8	Ovary 2 (rarely 3)-celled; fruit indehiscent (berries)	*Hasseltia*
8*	Ovary unilocular; fruit irregularly dehiscent (capsules)	*Pleuranthodendron*
7*	Petals normally absent; disk glands generally present and extra-, very rarely intra-staminal, or inserted between the outer sterile (filament-like) and the inner fertile (anther-bearing) stamens	*Xylosma*
4*	Stamens perigynous to various degree; leaves generally pellucid-punctate and lineate	9
9	Calyx usually rather shortly valvately 2-5-lobate	*Lunania*
9*	Calyx deeply 4-5(-6)-lobate, the lobes more or less imbricate	10
10	Stamens 4, i.e. as many as the sepals (or calyx lobes)	*Tetrathylacium*
10*	Stamens twice as many as the sepals (or calyx lobes) or more	11
11	Receptacle without disk-like lobes or appendices	*Laetia*
11*	Receptacle with a disk, the latter partly or completely lobed	12
12	Disk urceolate, entire, with distal barbate lobes	*Ryania*
12*	Disk lobes free, or rarely adnate to the filaments	*Casearia*

Carpotroche (neotrop. 11, CR 1, GD 1)
Shrubs and small trees, usually with large, serrate-margined leaves, unisexual flowers and characteristic valvately dehiscent fruits with vertical papery wings with entire, crenate or lacerate margin.

C. platyptera Pittier, Pl. 68a-c
Shrub or small tree, up to 6 m tall; leaves rather coriaceous, serrate to serrulate, to 50(-65) cm long, glabrous or nearly so; female flowers solitary and axillary, the male ones fasciculate in the leaf axils, ramiflorous or even cauliflorous; fruits subglobose, reddish to purplish, with 8-10 entire, undulate-margined wings. In coastal and lower montane wet forests in Central America, from Guatemala to Panama.

Casearia (pantrop. 160, CR 13, GD 6)
Shrubs and trees with alternate, entire to serrate, distichous leaves, which usually have conspicuous pellucid punctations or lines all over the surface. The inflorescences are axillary fascicles of small hermaphrodite, apetalous flowers, which have a variable number of sepals and stamens. The fruits are always dry to succulent, dehiscing capsules with 3(-4) valves and with usually numerous arillate seeds.

C. arborea (L. Rich.) Urban, Pl. 68d,e
Shrub or tree, to 5(-20) m tall; leaves densely pellucid punctate and -striate, with serrulate to serrate margin; flowers white to yellow or greenish, calyx 5-lobate, stamens 8-10; capsule ellipsoid to subglobose, 3-valved, 0,4-1,5 cm long. In Central America, from Guatemala, the Antilles to tropical South America.

Hasseltia (neotrop. 3, CR 4, GD 3)
A genus consisting of trees and shrubs with basally three-veined leaves and two conspicuous basal glands on the upper leaf surface, just above the petiole and with a characteristic fruit, which is a red to blackish berry, subtended by the persistent remnants of the perianth.

H. floribunda H.B.K., Pl. 68f
Shrub or small tree, 3-10 m tall; leaves coarsely and irregulate crenate-serrate; inflorescences (sub)terminal, many flowered; flowers greenish,

whitish or cream, sepals and petals (3-)4, similar in color and shape, stamens 30-40; fruit subglobose, 4-6 mm long, puberulous, glabrescent. Generally in premontane and lowland forest, but also in semiarid woodland in Central America and northern South America, from Honduras to Amazonian Peru, Bolivia and Brazil.

Hasseltia floribunda

Lacistema (neotrop. 11, CR 1, GD 1)
Shrubs and small trees, characterized by their catkin-like inflorescences with numerous sessile flowers, usually lacking petals and with only 1 stamen. The fruit is a red, almost fleshy, three-valved capsule that dehisces incompletely.

L. aggregatum (Bergius) Rusby, Pl. 68g,h
Shrub or tree to 5(-12) m tall; leaves usually subentire, stipules subpersistent, 8-9 mm long, leaving an annular scar when falling; inflorescences axillary, in clusters of (3-)8-12; flowers white to cream, sepals usually 4, disk reddish, fleshy, cup-shaped; fruits obovoid-ellipsoid, 6-8 (-10) mm long, red to brown, seed 1 with white aril. In various habitats of a wide ecological range, from the lowland to 1450(-1800) m alt., widespread, from southern Mexico and the West Indies to Paraguay and Argentina.

Pleuranthodendron (neotrop. 1, CR 1, GD 1)
Monotypic genus.

P. lindenii (Turcz.) Sleumer
Shrub or tree to 5(-7) m tall, leaves basally 3(-5) nerved, entire or remotely subserrate to subcrenulate, with two large glands at the base of the upper leaf surface; inflorescences terminal thyrsoid panicles; flowers white to cream, sepals and petals 4-6, almost similar, caducous; fruits red to blackish capsules, subglobose, 5-7 mm long, tomentellous and somewhat rugose on the surface. In moist or wet lowland forests, from southern Mexico to Colombia, in Ecuador and Amazonian Brazil and Peru.

Tetrathylacium (neotrop. 6, CR 2, GD 1)
Trees and sometimes shrubs, with alternate, rather large, entire to serrate-margined leaves and with paniculate inflorescences, which are composed of spikes, with small sessile apetalous 4-merous flowers. The fruits are coriaceous berries, sometimes with tardily dehiscent valves.

T. macrophyllum Poepp., Pl. 69a
Tree to 8(-15) m tall; leaves oblong, entire to serrate with caducous stipules; inflorescences usually axillary, pendent with numerous spike-like secondary axes; flowers reddish-purple or maroon, spaced along the spikes; fruits subglobose, red-purple, up to 1,5 cm in diameter. Mostly in primary and secondary lowland rain forest, from Costa Rica to Amazonian Peru and Brazil.

Xylosma (pantrop. 85, CR 9, GD 2)
Trees and shrubs, usually with spines on trunk and branches and the leaves lacking glandular punctations. Also characteristed by the almost always unisexual flowers lacking petals and the baccate fruits.

X. intermedia (Seem.) Triana & Planch., Pl. 69b
Large shrub or tree, up to 6(-20) m tall, with simple spines or compound thorns on trunk and older branches, sometimes unarmed; leaves ovate-oblong to oblong-elliptic, (5,5-)8-16 cm long, 3,5-5(-7) cm wide, obtusely subserrate-crenate; inflorescences axillary, of 1-2 racemes, rhachis ca. 1-2 cm long, yellowish to grayish puberulent or -tomentellous, few- to several-flowered; flowers bisexual (but anthers often reduced in size); fruits subglobose, reddish-blackish at maturity. From Mexico to Amazonian Peru and Brazil.

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Gentianaceae

The Gentianaceae are primarily a temperate family of annual or perennial, erect, rarely climbing or epiphytic herbs or rarely shrubs, sometimes saprophytic and then without chlorophyll. **Leaves** opposite, often connate at the base, simple, entire, sometimes reduced to scales, stipules lacking; **inflorescences** terminal and/or axillary, generally cymose, often dichasial, sometimes reduced to a single flower; **flowers** usually actinomorphic, bisexual, rarely polygamous, usually 4- to 5-merous, often showy, sepals persistent, the segments more or less united, petals united, generally tubular the tube usually campanulate, salverform to infundibular, occasionally calcerate, stamens 5, alternate with the lobes, inserted in the throat or tube, ovary 1-2-locular; **fruits** septicidal 2-valved capsules, membranaceous to coriaceous, rarely berry-like, seeds usually numerous, small, globose, sometimes more or less compressed, sometimes winged. Cosmopol. 75/1225, CR 13/31, GD 3/7.

Key to the genera (after Gentry 1993 and Elias & Robyns 1975)

1*	Plants leafless achlorophyllous saprophytes	*Voyria*
1*	Leaves present; plants with chlorophyll	2
2	Flowers 5-merous, white to greenish or bluish; corolla openly campanulate	*Irlbachia*
2*	Flowers 4-merous, white to pale yellow or pinkish; corolla narrowly tubular	*Schultesia*

Irlbachia (neotrop. 17, CR 1, GD 1)
Often more or less weedy lowland herbs with white to greenish or bluish flowers.

I. alata (Aubl.) Maas
(syn. *Chelonanthus alatus* (Aubl.) Pulle)
Herb 1-5 m tall, stem erect, green; leaves ovate to ovate-elliptic, 4-18 cm long, 2,7-10,3 cm wide; inflorescences axillary or terminal, large, simple or compound dichasia; petals greenish-yellow, the lobes 5-7 mm long and 6-8 mm wide at the base. From Mexico and Central America southward to Brazil.

Schultesia (neotrop. 20, CR 3, GD 1)
Annual herbs with narrow or broad leaves and few or numerous, cymose, narrowly tubular flowers. The style is deciduous and the anthers are not twisted.

S. lisianthoides (Griseb.) Benth. & Hook.
Herb, 7-90 cm tall, stems terete, erect, unbranched or sparsely branched; leaves ovate, ovate-elliptic or oblong to obovate, 1,5-10 cm long, 0,5-4,5 cm broad; inflorescences axillary and terminal, simple or compound dichasia, few-to many flowered; flowers pink to lavender, calyx 6-7 mm long, cupular, the lobes fused only at the base, corolla 1-1.7 cm long, the lobes triangular, stamens 4-5 mm long; capsules fusiform, 6-9 mm long, 2-3 mm in diameter. From southern Mexico to northern South America.

Voyria (neotrop. 20 + 1 sp. W-Africa, CR 8, GD 5)
A genus of small, saprophytic herbs, occurring mainly in Central and South America and the West Indies, which grow on decayed leaves on the forest floor.

V. tenella Hook., Pl. 69c
Herb to 20 cm tall, erect; leaves reduced to scales, white to yellow, connate in their lower half, triangular to narrowly triangular, 2-5 mm long; flowers solitary, 5-merous, calyx tubular-campanulate, 2,5-4 mm long, tube about as long as the lobes, 1-2 mm long, orange to yellow, rarely white, corolla white to orange, 9-22 mm long, tube 7-15 mm long, lobes blue, rarely white, obovate, 2-7 mm long, stamens inserted 2-3 mm below the throat;

capsules ellipsoid to globose, 4-7 mm long, 2-4 mm wide, up, seeds filiform. Very widespread, distributed throughout the Neotropics.

V. truncata (Standl.) Standl. & Steyerm.
Herb to 18 cm tall, erect; leaves reduced to scales, dull red, thin-cartilaginous, connate at the base, broadly to very broadly ovate, obtuse to rounded apically, 3-5 mm long, minutely ciliolate along the margin; flowers solitary, 5-merous, calyx campanulate, 4,5-6 mm long, the lobes broadly ovate, obtuse apically, 1-3 mm long, corolla pale yellow, cream-colored, bright pink, or purplish-lavender, 40-55 mm long, the tube cylindric, scarcely dilated at the throat, 3-4 cm long, inconspicuously puberulous without towards the apex, the lobes spreading, 7-15 mm long, stamens inserted in the upper half of the corolla tube; capsules up to 1,5 cm long and 5 mm in diameter, seeds urceolate. From Guatemala to Panama.

Voyria truncata

ELIAS, T.S. & A. ROBYNS. 1975. Gentianaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 62 (1): 61-101.
MAAS, P.J.M. & P. RUYTERS. 1986. *Voyria* and *Voyriella* (saprophytic Gentianaceae). - Fl. Neotrop. Monogr. 41: 1-93.
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Gesneriaceae

An important family of perennial or rarely annual herbs, (sub)shrubs, or small trees, well known for ornamental plants, such as the African Violets (*Saintpaulia* spp.) and Gloxinias (*Sinningia speciosa* and derivatives). While the Old World Gesneriads are mainly terrestrial, the Neotropical ones include a large proportion of epiphytes (e.g., *Columnea* spp.). The perennial herbs are provided with underground stems, rootstock, rhizomes, scaly rhizomes, tubers or fibrous roots; **leaves** opposite, often the leaves of a pair strongly unequal (anisophylly) or in whorls of 3-4, rarely alternate, simple, usually undivided, stipules absent; **inflorescences** usually axillary cymes with the flowers placed in pairs; **flowers** usually showy, zygomorphic, rarely (secondarily) actinomorphic, usually 5-merous, sepals free or connate to a variable extent, corolla sympetalous, variously colored, stamens mostly 2 or 4, rarely five, filaments always adnate to the corolla, ovary superior, semi-inferior or inferior, mostly unilocular; **fruits** capsules opening by 2 or 4 valves or by a dorsal slit or fleshy berries, sometimes vividly colored, in some cases exposing the seeds ("display fruits"). Distributed in the tropics and subtropics of the Old and New World, with transgressions to the (warm) temperate areas in E-Asia and Europe. Pantrop. ca. 150/3000, CR 29/136, GD 14/36.

The flowers of Gesneriaceae are pollinated by insects (in the Neotropics especially by euglossine bees, rarely by butterflies and moths), hummingbirds and bats (WIEHLER 1983). Corresponding to the pollination mode, various flower types are present within the family, with a range from long-tubular to flat-rotate corollas. The nectar composition seems to play only a minor role in pollinator specialization (PERRET et al. 2001). The flowers of *Columnea* are well adapted to attract hummingbirds, either through the bright red or yellow corolla or through red (sometimes translucent) blotches or windows on the leaf underside (JONES & RICH 1972, KASTINGER & WEBER 1999). The anthers of *Drymonia* are of an urn-

like shape, which is is a special construction to optimize the pollination by euglossine bees and other visitors (ERTELT 1986). The red corolla of most *Kohleria* species suggests pollination by hummingbirds, but KVIST & SKOG (1992) report a wider range of flowers visitors. SKOG (1978: 937) noted that *Kohleria allenii*, one of the most remarkable Gesneriads in GD, "in floral characters is reminiscent of *Capanea grandiflora* with its large campanulate spotted corolla" and is apparently bat-pollinated. The most common species of Gesneriaceae in GD, *Episcia lilacina* and *Gasteranthus delphinioides,* may serve as examples of euglossine-pollinated plants.

Dispersal of the seeds is by wind, water (rain) or in the (usually epiphytic) taxa with berry- or display-fruits by birds. Ant-dispersal of a few species is a possibility.

Many Gesneriads are used in horticulture for their showy flowers.

Key to the genera

1	Plants epiphytic	2
2	Leaves glabrous, smooth, shining, succulent-leathery; plant creeping on tree trunks and branches; often associated with ants and found in ant nests; corolla waxy white	*Codonanthe*
2*	Leaves usually hairy or pubescent and of different texture; plant not associated with ants; corolla variously colored	3
3	Leaves to 1,5 cm long; flowers solitary, bracts (prophylls) lacking; corolla broadly funnelform; nectary a single (bilobate) dorsal gland; fruit an ovoid, laterally compressed berry, seeds basally surrounded by an aril	*Neomortonia*
3*	Leaves larger; inflorescences of 1 to several flowered, bracts present (but sometimes caducous); corolla variously shaped; nectary of 1 to 5 glands; fruit, if a berry, not compressed and seeds without aril	4
4	Fruit a berry	*Columnea* s.l.
4*	Fruit a fleshy capsule, dehiscing by two lateral valves	5
5	Anthers opening by an apical pore	*Drymonia*
5*	Anthers opening by longitudinal slits	*Paradrymonia*
1*	Plants terrestrial	6
6	Inflorescence a terminal raceme (flowers emerging from the axils of bracts, rarely additionally from the upper foliage leaves); fruit a dry capsule	7
7	Corolla orange to red or yellowish and speckled with red; leaves opposite or whorled	*Kohleria*
7*	Corolla white to cream; leaves opposite	8
8	Plants small, rarely more than 25 cm tall; leaves of a pair equal; corolla funnelform; nectary glands 2-5, prominent	*Diastema*
8*	Plants usually larger, coarse; leaves of a pair strongly unequal; corolla campanulate; nectary glands lacking or very small	*Monopyle*
6*	Flowers emerging singly or in cymes from the axils of the foliage leaves; fruit a berry or a dry or fleshy capsule	9
9	Fruit a globose or ovoid berry; shrubs or small trees	*Besleria*
9*	Fruit a dry or fleshy capsule; herbs or (sub-)shrubs	10
10	Low herbs with stolons, often forming dense patches in moist places; flowers solitary from leaf axils	*Episcia*
10*	Plants without stolons; flowers in 1- to several-flowered inflorescences	11
11	Herbs arising from tubers; stems fleshy-succulent; sepals connate nearly to top, calyx thus cup-shaped	*Chrysothemis*
11*	Plants without tubers, eventually with underground stem; stems herbaceous to woody; sepals free or connate in the lower half	12
12	Flowers solitary or in ependuculate axillary fascicles, with two or more leafy bracts	*Alloplectus*
12*	Inflorescences pedunculate	13
13	Bracts present; corolla subactinomorphic, white	*Napeanthus*

13* Bracts absent; corolla zygomorphic, sub-campanulate and with a prominent spur, cream-colored, yellowish or yellow — *Gasteranthus*

Alloplectus (neotrop. 65, CR 7, GD 1)
Terrestrial or epiphytic shrubs or herbs, usually with densely pubescent red or orange corolla tube. The flowers are arranged in axillary fascicles or sometimes in the axils of fallen leaves.

A. ambonensis L.E. Skog
Terrestrial subshrubs, to 1,7 m tall; leaves broadly elliptic, sometimes falcate, 12-20 cm long, 6-12 cm wide, crenulate or denticulate, glabrous above, strigillose beneath, petioles red spotted; inflorescences axillary, cymose; corolla tube yellow or cream colored, puberulent outside, glabrous inside; fruits 2-valvate, broadly globose, 5-6 mm in diameter, white, glabrous. In Costa Rica and adjacent Panama.

Besleria (neotrop. > 200, CR 15, GD 4)
An important and species-rich genus of terrestrial Gesneriads. Shrubs or perennial herbs with axillary cymes without bracts. The flowers are short-tubed, cylindric or gibbous at base, with a yellow, orange, red or white corolla.

B. hirsuta (Oerst.) Hanst.
Erect shrub, 1-3 m tall, stem, branches and leaves pilose or hirsute; inflorescences axillary cymes, few-flowered, peduncle short or lacking; sepals briefly connate at base, corolla orange-red, slightly saccate at base, ventricose below the slightly expanded limb. In moist forests, with disjunct distribution in Mexico, Costa Rica and Panama.

B. laxiflora Benth.
Low shrub to small tree, 0,5-4 m tall, stem and leaves glabrescent to glabrous; inflorescences umbellate axillary cymes, peduncle 1-4,5 cm long; sepals free to base, corolla yellow, orange, pink, salmon or golden red, not saccate at base, slightly ventricose above. At low to middle elevations in damp, shaded woods, near streams and on rock banks, ranging from Mexico through Central America to Colombia, Venezuela, the Guianas and Brazil.

Codonanthe (neotrop. 17, CR 3, GD 2)
Epiphytes with thin stems and branches climbing on tree trunks and branches. Leaves leathery-fleshy, in pairs. The corolla is waxy white, funnelform-arcuate and gibbous at the base. The seeds exposed by the fleshy capsule are colored and bear a thin aril. The genus is remarkable for its association with ants, who possibly also disperse the seeds. Two closely related species have been collected in the GD, which are vegetatively indistinguishable.

Key to the species of *Codonanthe*

1 Corolla with a red blotch inside — *C. macradenia*
1* Corolla pure white or yellowish inside — *C. crassifolia*

C. crassifolia (Focke) Morton, Pl. 69d
Epiphytic subshrub, stem ca. 30 cm long; leaves ovate, elliptic to oblong, 1,5-5,5 cm long, 0,8-2,2 cm wide, succulent; fruits subglobose. Widely distributed throughout Central America to Peru and Brazil.

C. macradenia J.D. Sm., Pl. 69e,f
Vinelike herbs or subshrubs, stems to 50 cm long or sometimes longer; leaves ovate, elliptic or lanceolate, 1,4-5 cm long, 1-2 cm wide, succulent; fruits ovoid, apiculate. From Guatemala to Panama.

Chrysothemis [neotrop. 7 (Central and N-South America, West Indies), CR 2, GD 1]
A genus of terrestrial or epiphytic herbs with succulent stems. The somewhat zygomorphic flowers have a cupular calyx and a corolla of 5 connate, yellow to orange petals.

C. friedrichsthaliana (Hanst.) H.E. Moore
Terrestrial or rarely epiphytic herb, up to 60 cm tall, leaves 7,5-37,5 cm long, 2,5-13,5 cm wide, crenate to dentate, the blade long decurrent into the petiole; inflorescences axillary, compound cymes or umbels with 1-9 flowers; flowers bright orange; fruits fleshy capsules surrounded by the persistent calyx. From Nicaragua throughout Central America to Ecuador.

Columnea (neotrop. ca. 300, CR 37, GD 9)
An important and very large genus of subwoody epiphytes, often with the leaves of a pair slightly or strongly unequal. The genus is split into 5 genera by WIEHLER (1983) (*Columnea* s.str., *Dalbergaria, Trichantha, Pentadenia*, and *Bucinellina*). This has not been generally accepted, but the respective synonyms are given below. As Columneas are frequent and most conspicuous epiphytes, all species recorded so far from GD are keyed out:

Key to the species of *Columnea*

1	Leaves of a pair (sub)equal	*C. angustata*
1*	Leaves of a pair distinctly to strongly unequal	2
2	Blades of large leaves up to 3,5 cm long	*C. flaccida*
2*	Blades of large leaves longer than 3,5 cm, usually over 10 cm	3
3	Leaf underside with deep red blotches	4
4	Large leaves 25-36 cm long, 3,5-11 cm wide; underside with two well-defined red blotches below the tip of the leaf, each consisting of a translucent center and a blackish border	*C. florida*
4*	Large leaves 8-14 cm long, 2,5-4,4 cm wide, underside with large and often confluent red blotches above the middle of leaf	5
5	Corolla red, ventricose, distinctly constricted below throat, 4-4,5 cm long	*C. sanguinolenta*
5*	Corolla yellow, with reddish lobes, tubular-funnelform, ca. 2 cm long	*C. segregata*
3*	Leaf underside green or flushed red, without red blotches	6
6	Corolla yellow (eventually reddish pilose), tubular; leaves pilose to hirsute	7
7	Sepals red, laciniate-pectinate; corolla 2 x as long as calyx, somewhat constricted below mouth; leaves with gold-colored, silky hairs	*C. aureonitens*
7*	Sepals green, not pectinate; corolla 3 x as long as calyx, not constricted; leaves with reddish, silky hairs	*C. polyantha*
6*	Corolla deep red, galeate; leaves sparsely strigose to almost glabrous, the hairs transparent	8
8	Sepals green throughout, corolla sericeous outside, lateral and inferior lobe reflexed	*C. nicaraguensis*
8*	Sepals mostly reddish towards the tips, corolla pilose outside, lateral and inferior lobes spreading	*C. raymondii*

C. angustata (Wiehler) L.E. Skog
(syn. *Pentadenia angustata* Wiehler)
Epiphytic herb or subshrub, stem up to 50 cm long; leaves nearly equal, elliptic, entire, 4,5-8,5 cm long, 1,2-3 cm wide; inflorescences axillary, cymose, few-flowered; corolla slender, ca. 2 cm long, yellow to yellow orange; berries white, pilose. From Costa Rica to Colombia.

C. flaccida Seem., Pl. 69g
Epiphytic herb; leaves subequal, narrowly oblong to lanceolate, entire, 2,3-3,5 cm long, 7-9 mm wide; flowers solitary, corolla, strongly zygomorphic, 6,1-6,8 cm long, scarled or rose; berries green, reddish pubescent. In Costa Rica and Panama.

C. florida Morton, Pl. 69h
[syn. *Dalbergaria florida* (Morton) Wiehler]
Epiphytic herbs or shrubs, sometimes terrestrial, stems erect, up to 1 m tall; leaves strongly

Columnea florida

unequal, larger leaves oblanceolate, entire to denticulate, 26-36 cm long, 3,6-11,2 cm wide, smaller leaves lanceolate, entire, 7-8 mm long; inflorescences axillary, fasciculate, several-flowered; corolla tubular, ca. 3,4 cm long, yellow to orange; berries globose, 13 mm long, 9 mm in diameter, yellow. In Costa Rica and Panama.

C. polyantha (Wiehler) L.E. Skog, Pl. 70a-d
(syn. *Dalbergaria polyantha* Wiehler)
Woody herb or shrub, stem up to 1,5 m tall; leaves unequal, larger leaves oblanceolate, serrate, 10,3-22,5 cm long, 2,3-4,5 cm wide, hirsute tomentose with reddish hairs, smaller leaves up to 2,5 cm long; inflorescences axillary, cymose, with 3-6 flowers; corolla funnel-shaped, 3,7-4,3 cm long, yellow with red marks. In Costa Rica and Panama.

C. raymondii Morton, Pl. 70e
Epiphyte, up to 40 cm tall; leaves strongly unequal, oblanceolate, larger leaves to 9 cm long, to 3 cm wide, smaller leaves to 1,5 cm long, minutely reddish pilose along the veins and margins; flowers solitary in the axils, corolla tubular, 8 cm long, red, with yellow stripes on the limb; fruits whitish. Endemic to the Golfo Dulce region. This species, originally described as *C. costaricensis* by MORTON (1971) is closely related to (or perhaps only infraspecifically distinct from) the widespread *C. nicaraguensis*, differing by the sepals being reddish towards the tips, the pilose-hairy corolla, the quadrate (vs. elliptic) upper lip and the non-reflexed lateral and inferior corolla lobes.

C. segregata Morley, Pl. 70f
[syn. *Trichantha segregata* (Morley) Wiehler]
Suffrutescent herbs; leaves unequal, larger leaves lanceolate, 11,3-13,6 cm long, ca. 3,5 cm wide, serrulate-crenulate, green with red spots, smaller leaves lanceolate, 1,2-1,8 cm long, ca. 5 mm wide, serrate, green; flowers solitary, corolla funnelform, ca. 2 cm long, yellow with reddish lobes; berries ca. 7 mm in diameter, green with reddish hairs. In Costa Rica and Panama.

Diastema (neotrop. 20, CR 3, GD 1)
Perennial herbs with short stems and slightly unequal, serrate to dentate leaves. The axillary or terminal racemose inflorescences bearing flowers with white and sometimes purple-dotted petals. The fruits are always capsules.

D. racemiferum Benth.
Small herb, stem erect, up to 25 cm tall; leaves lanceolate to ovate, elliptic or oblong, 1,5-13,5 cm long, 0,9-6,4 cm wide; inflorescences numerous, axillary or terminal, erect, 3-15 cm long, with several flowers; corolla 1-1,8 cm long, white or yellow, sometimes with a few purple spots; capsules 2-valved, obovoid. From Mexico to Venezuela and Ecuador.

Drymonia (neotrop. > 140, CR 20, GD 7)
Usually epiphytic shrubs or lianas with nearly equal, entire leaves. The flowers are often showy and brightly colored. Unusual for the family are the anthers opening by 2-4 pores.

D. alloplectoides Hanst., Pl. 71a
Epiphytic herbs, shrubs or lianas, pendent to repent, stem up to 5 m long; leaves subequal, ovate, oblong or obovate, 3,6-12,9 cm long, 2,5-4,9 cm wide, subentire to serrate; flowers solitary, calyx green or red, corolla 4,5-6,5 cm long, white, cream, pink or purple, with reddish lines, rarely greenish; fruits fleshy, 2-valved capsules, surrounded by the accrescent calyx. Common in lowland wet forests in Costa Rica and Panama.

D. macrantha (J.D. Smith) D. Gibson, Pl. 71b
Epiphytic or terrestrial shrub, up to 2 m tall; leaves broadly ovate to broadly elliptic, 20-30 cm long, 10-20 cm wide, dentate or serrate; calyx lobes green, becoming reddish or orange, corolla greatly

Drymonia alloplectoides

exceeding calyx, tube 3-7 cm long, white or cream, often yellow within the tube, and red or purple on the throat, lobes unequal, orange; fruits ovoid, 2-valved capsules, up to 1,7 cm long, surrounded by the accrescent calyx. From Mexico to Panama.

D. serrulata (Jacq.) Mart., Pl. 71c
Succulent terrestrial herb or shrub, up to 2 m tall, or epiphytic or scandent shrub or liana, up to 10 m long, young stems succulent; leaves elliptic or oblong to obovate, 4-19 cm long, 2-8 cm wide, serrulate to sinuate dentate, often somewhat purplish beneath, flowers showy, calyx of 5 or more free, leaf-like lobes, corolla scarcely exceeding calyx, 3-7 cm long, white, cream, yellow red or purple; fruits globose to broadly ovoid, 1-2 cm in diameter, yellowish to purplish, surrounded by the accrescent calyx. In disturbed and undisturbed forests, as well as in clearings, very widespread, from Mexico and the Lesser Antilles to central Brazil.

Episcia (neotrop. 9, CR 1, GD 1)
Terrestrial or epiphytic herbs with creeping stem, 1 m long or more. The leaves are often crowded. The flowers are usually conspicuous.

E. lilacina Hanst., Pl. 71d
Terrestrial herb, prostrate or decumbent, up to 20 cm tall; leaves oblong ovate to elliptic oblong, 3-14 cm long, 1,5-9 cm wide, crenate or dentate, hirsute, usually red purple beneath; inflorescences axillary, cymose with 1-6 flowers; corolla showy, tube short, white to pale lavender outside, white to yellow inside, lobes denticulade; fleshy capsules, globose, ca. 8 mm in diameter, pilose. From Nicaragua to Colombia.

Gasteranthus (neotrop. 35, CR 5, GD 3)
A genus, closely related to *Besleria* and comprising mainly terrestrial forest herbs or shrubs. Distinctive features are the fleshy capsules, opening by two valves, stomata arranged in distinct groups, the always distinctly spurred corolla and the non-annular disc.

G. delphinioides (Seem.) Wiehler, Pl. 71e,f
Terrestrial herb or small shrub, up to 1 m tall; leaves nearly isomorphic, 7-27 cm long, 3-12 cm wide, subentire to serrulate; flowers large, 3,5-7,5 cm long, broad-tubed-campanulate, yellowish; fruits 4-valved capsules, flattened, ca. 5 mm long, ca. 8 mm wide. Common on slopes and riverbanks in shaded forests, from Costa Rica to Colombia.

Gasteranthus delphinioides

Kohleria (neotrop. 17, CR 3, GD 2)
Terrestrial herbs and shrubs usually with equal or subequal leaves. The tubular, almost always reddish to orange and often ventrally yellow flowers are arranged in terminal inflorescences.

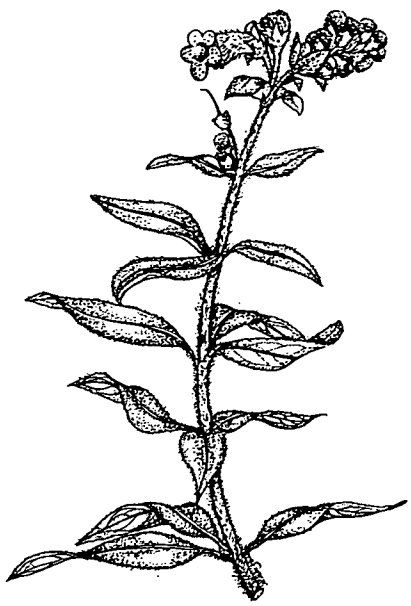
Key to the species of *Kohleria*

1	Corolla tubular, orange to deep red; upper and lateral lobes spreading, basal lobe reflexed	*K. spicata*
1*	Corolla campanulate, yellow speckled red-brown; all lobes spreading	*K. allenii*

K. allenii Standl. & L.O. Williams, Pl. 71g
Erect herb or subshrub, stem purplish, up to 1,5 m tall; inflorescences spicate; corolla 25-32 mm long, campanulate, sericeous and glandular hairy outside, yellow, lobes yellow, red punctate; fruits 2-valved capsules, ovoid, 10-12 mm long, 6-7 mm in diameter. Endemic to Costa Rica (Puntarenas) and adjacent Panama.

K. spicata (Kunth) Oerst., Pl. 71h
Erect herb or subshrub, stem up to 1(-2) m tall; inflorescences spicate; corolla 12-20 mm long, tubular, sericeous outside, red, lobes yellow red,

dark punctate; fruits 2-valved capsules, ovoid, 7-10 mm long, 4-6 mm in diameter, pubescent and usually glandular-hairy. From southern Mexico to Peru and Venezuela.



Kohleria spicata

Paradrymonia (neotrop. ca. 40, CR 8, GD 3)
Usually succulent epiphytes with the flowers in dense axillary clusters. Leaves opposite, equal to strongly unequal and usually lanceolate.

P. decurrens (C.V. Morton) Wiehler
Epiphytic herb or subshrub, stem creeping or scandent, succulent, up to 50 cm tall; leaves of a pair strongly unequal, larger leaf 12-24 cm long, 2-10 cm wide, smaller leaf linear, up to 5 cm long; inflorescences umbellate, with numerous flowers; flowers white to yellow; capsules globose, ca. 5 mm in diameter, green to cream colored with red villous hairs. Costa Rica and Panama.

Paradrymonia decurrens

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Hernandiaceae

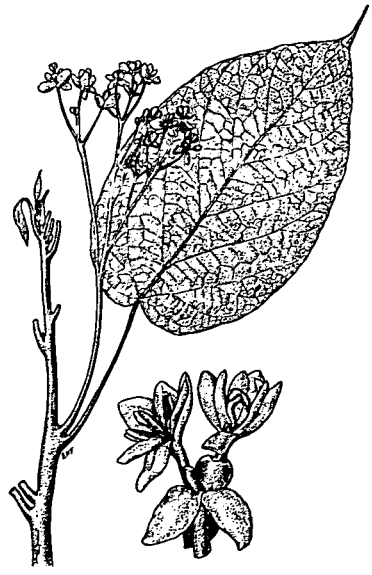
A small family of trees or rarely shrubs and lianas, closely related to the Lauraceae, with whom they share the peculiar character of the anthers opening by flaps, these often persistent at the apex of the anthers. Additionally the odor of the fresh leaves and wood is quite similar to that of the Lauraceae.

Leaves alternate, palmately compound with 3-5 leaflets, or simple, then often palmately veined or 3-5-lobate, stipules lacking; **inflorescences** axillary, subterminal or rarely terminal, cymose; **flowers** bisexual or unisexual (then plants monoecious, rarely dioecious), small and inconspicuous, tepals 3-4(-10), in 1 or 2 whorls, free or basally connate, stamens 3-5(-7), in 1 whorl, free, basally often with 2, usually cordate, nectar-secreting glands, anthers opening by large valves, ovary inferior, unilocular; **fruits** drupes or nuts, sometimes winged, or basally subtended by a cupule, seed 1. Pantrop. 5/57, CR 3/5, GD 1/2.

The Hernandiaceae are principally members of the moist forests of the tropical lowland, with several species having migrated into subtropical and semiarid regions. Two species with buoyant, sea-dispersed fruits are widespread along tropical shores (KUBITZKI 1993).
Until now, no studies about the pollination and the seed dispersal of this family exists.
Due to the red cupule, the fruits of most of the species of *Hernandia* are likely dispersed by birds. Two species are known to be water dispersed (*H. guianensis* by rivers and *H. nymphaeifolia* by sea currents). Genera with winged fruits are usually wind dispersed. Exceptions occur, though for example the winged fruits of *Gyrocarpus americanus* are dispersed by the sea (KUBITZKI 1993).

Hernandia (pantrop. 22, CR 2, GD 2)
Common name (Costa Rica): zopilote (J. GONZALEZ pers. comm.)
Trees or rarely shrubs, usually of lowland evergreen forests, characterized by distinct pseudanthia, made up of 4 sepaloid bracts, subtending each group of usually 2-5 flowers and unwinged, cupulate fruits.

H. stenura Standl.
Large tree, up to 40 m tall; leaves simple, entire, broadly ovate, 9-27(-40) cm long, glabrous or nearly so, venation pinnate or subpalmate; inflorescences 8-30 cm long, the 4 sepaloid bracts subtending 1 female and 1-4 male flowers; fruits drupes, ca. 2 cm wide, basally subtended by a subglobose cupule. In wet evergreen forests, from Guatemala to the province of Coclé in Panama.



Hernandia stenura

BURGER, W.C. 1990. Hernandiaceae. - Flora Costaricensis. Fieldiana Bot. 23, n.s.
GONZÁLEZ, J. In prep. Hernandiaceae. Manuál de las plantas de Costa Rica. Missouri Botanical Garden. Instituto Nacional de Biodiversidad. Museo Nacional de Costa Rica.
KUBITZKI, K. 1969. Monographie der Hernandiaceen. Teil II. - Bot. Jahrb. Syst. 69 (2): 78-209.
KUBITZKI, K. !993. Hernandiaceae. In: K. KUBITZKI (ed.): The families and genera of vascular plants. Vol II. Magnoliid, Hamamelid and Caryophyllid families. - Berlin: Springer Verlag.

Hippocastanaceae

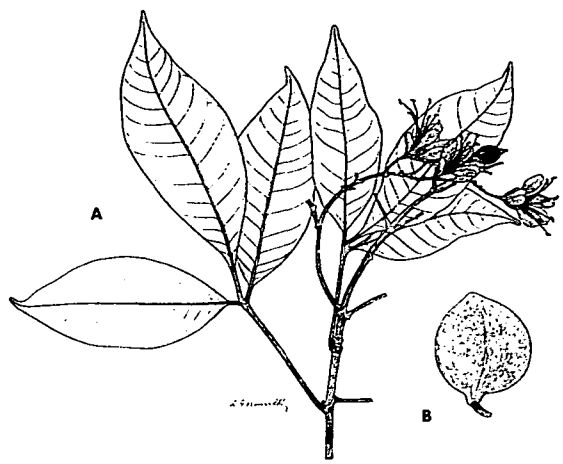
Trees and shrubs, easy to recognize vegetatively by the always opposite and digitately compound leaves. **Leaves** with 3-11 leaflets, entire to variously toothed or sinuate, glabrous or tomentose, stipules lacking; **inflorescences** terminal, paniculate, with racemose or cymose branches; **flowers** andromonoecious, sepals 5, free or partly united, petals 5, free, often clawed, white, red or yellow, extrastaminal disk present, stamens 5-8, in 2 whorls, ovary superior, (2-)3(-4)-locular; **fruits** capsules, usually dehiscing by 3 valves, pericarp leathery, sometimes spiny. In the temperate zones of the northern hemisphere

worldwide (*Aesculus*), ac well as in the tropics and subtropics in the New World (*Billia*). Cosmopol. 2/15, CR 1/2, GD 1/1.

Some species of *Aesculus* are cultivated as ornamentals. *A. hippocastanum*, the horse chestnut, is widely cultivated as an ornamental and also used for treating chronic venous insufficiency.

Billia (neotrop. 2, CR 2, GD 1)
A genus of small to medium sized trees with showy flowers and trifoliolate, entire leaves.

B. colombiana Planch. & Lindl., Pl. 72a
Tree up to 10 m tall; leaves coriaceous, usually glabrous; inflorescences corymbiform panicles, up to 30 cm long, densely golden-brown puberulent, subtended by a series of leaf-like bracts; flowers fragrant, sepals maroon, petals 4(-5), white with yellow base, often pinkish outside; fruits leathery, thick-walled capsules. In mixed forests along rivers or mountain slopes, from Costa Rica to Ecuador.



Billia colombiana
A. Flowering branch. B. Fruit

D'ARCY, W.G. 1975. Hippocastanaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 62: 57-60.
HARDIN, J. W. 1957. A revision of the American Hippocastanaceae. - Brittonia 9: 145-171.

Hippocrateaceae

A family, generally easy to recognize by the unique combination of climbing plants with opposite and serrate to serrulate leaves, but these characters are not always present together. Usually lianas, but also shrubs and trees, mostly glabrous, always without latex; **leaves** opposite, rarely subopposite or alternate, simple, petiolate, serrate to serrulate or entire, stipules usually present, small and inconspicuous, interpetiolar, caducous, sometimes lacking; **inflorescences** terminal or axillary, cymose, paniculate, fasciculate or flowers solitary; **flowers** bisexual, usually small, often yellowish-green, sepals (2-4-)5, basally connate, petals (3-4-)5, free, disk present, stamens usually 3, inserted between the disk and the ovary, ovary superior, usually 3-locular, style 1; **fruits** capsules with 3 dehiscent mericarps or drupaceous berries, with seeds embedded in a mucilaginous pulp, seeds few-numerous, sometimes winged. Pantrop. + subtrop. ca. 23/ ca. 300, CR 12/15, GD 10/11.

The family is closely related to the Celastraceae and is sometimes treated as a subfamily of the latter. Differentiating characters are mainly the position and dehiscence of the stamens, but also fruiting characters as well as the presence of mucilaginous fibers (SMITH 1940).
The economic importance of the Hippocrateaceae is quite small. There are a few species providing fruits with edible pulp (*Peritassa* spp., *Tontelea* spp., *Salacia* spp.) or edible seeds (*Hippocratea volubilis*). *Pristimera celastroides* is widely used as an insecticide in Central America (SMITH 1940).

Key to the genera (after HEDIN, in prep.)

1 Leaves scabrous or with minute hairs on underside of leaf; twigs and disk pubescent ..... *Semialarium*

1*	Leaves smooth and glabrous; twigs and disk glabrous	2
2	Leaves papyrous or chartaceous; fruit a flattened capsule; stem rays radiate	3
3	Petioles and leaves usually with "elastic threads" visible when broken; young inflorescence branches brown puberulent, terete; petals with transverse row of hairs (yellow when fresh, brown when dried) on abaxial side 1-2 mm below apex	*Hippocratea*
3*	Petioles without "elastic threads"; inflorescence branches and petals glabrous	4
4	Leaves drying green with yellow venation; flowers without fragrance	*Hylenaea*
4*	Leaves drying brown or grayish green without prominent yellow venation; flowers fragrant	5
5	Inflorescence branches quadrate-ribbed; flowers minute, 1-2 mm in diameter	*Elachyptera*
5*	Inflorescence branches smooth; flowers small, 5-15 mm in diameter	6
6	Leaves drying brown; flowers green, 5-11 mm in diameter; petal margins regularly denticulate, apex acute; stigma lobes forming triangular surface; fruits mericarps, connate at base for 2-4 cm, surrounded by a trilobate subcoriaceous, broad rim	*Anthodon*
6*	Leaves grayish green without prominent yellow venation; flowers white, 9-15 mm in diameter; petal margins entire, apex rounded; stigma lobes prominent, reniform; fruits mericarps, free, orbicular	*Cuervea*
2*	Leaves coriaceous or subcoriaceous; fruit drupaceous; in stem cross section, included phloem of concentric rings	7
7	Disk discontinuous, forming pockets at base of each stamen; stigma lobes adnate to top ofovary; leaves drying green above and below	*Cheiloclinium*
7*	Disk continuous; stigma lobes free from top of ovary; leaf drying in variable color	8
8	Disk either truncate, conical or flat, or with a flattened base and narrow upper part, sheathing the stamens, ending with 3 points between the filaments	*Salacia*
8*	Disk a subcoriaceous cupule	9
9	Leaves drying dark brown above, reddish brown below, venation lighter; petals erect; stamens with connective extending past anthers, forming an apicule which dries blackish brown; anther thecae parallel, dehiscing longitudinally; stigma punctiform	*Peritassa*
9*	Leaves drying olive green, venation obscure; petals spreading; stamens without apicule; anther thecae transversely reniform, dehiscing transversely, giving a "butterfly-like" appearance; stigma lobes prominent, slightly emarginate at apex, alternate with stamens	*Tontelea*

Anthodon (neotrop. 2, CR 1, GD 1)
Mostly canopy lianas with crenulate-serrulate leaves. The species are very distinct in flower, because of the serrate margined petals. The flattened, capsular mericarps are connate for up to 4 cm of their lenght.

A. panamense A.C. Sm.
Glabrous liana; leaves elliptic, membranaceous, 5-10 cm long, 3-5 cm wide, undulate or crenulate; inflorescences 2,5-7 cm long; flowers fragrant, petals carnose, conspicuously serrate at the margin, green; fruits up to 15 cm in diameter, mericarps connate for 2-4 cm, surrounded by a broad rim. In wet forests, from southeastern Costa Rica to Panama.

Cuervea (neotrop. + Africa 5, CR 1, GD 1)
A small genus of tropical Africa and America, characterized by few flowered, paniculate-corymbose inflorescences with white flowers and capsular fruits with winged seeds.

C. kappleriana (Miq.) A.C. Sm., Pl. 72b,c
Liana; leaves elliptic to ovate, margin entire, stipules present; inflorescences 5-12 cm long; flowers 9-11 mm in diameter; fruiting mericarps depressed-obovate to suborbicular, 5-9 cm long, 5,5-10 cm wide. In wet forests bordering seacoasts, ranging from Mexico to Brazil and Paraguay.

Salacia (pantrop. ca. 200, CR 3, GD 2)
A large and heterogeneous genus of lianas, a few shrubs and trees, usually with coriaceous leaves

drying dull olive green. It is further characterized by the presence of a conspicuous disk and drupaceous fruits with the unwinged seeds embedded in a mucilaginous pulp.

S. multiflora (Lam.) DC.

Liana, glabrous or sparsely tomentellous; leaves opposite to oblong; inflorescences axillary or ramiflorous, paniculate, few-flowered, fruiting inflorescence greatly swollen; flowers 8-11 mm in diameter, greenish; fruits usually solitary, ellipsoid to obovoid, up to 7 cm long and 4 cm wide, yellowish green to grayish. In primary forests, from Costa Rica to Peru and Brazil.

DODSON, C.H. & A. ROBYNS. 1965. Hippocrateaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 52: 81-98.

HEDIN, J.P. In prep. Hippocrateaceae. Manuál de las plantas de Costa Rica. Missouri Botanical Garden. Instituto Nacional de Biodiversidad. Museo Nacional de Costa Rica.

MENNEGA, A.M.W. 1992. New combinations and nomenclatural notes on the genera *Salacia* and *Tontelea* (Celastraceae, s.l.) in the Neotropics. - Novon 2 (3): 232-234

SMITH, A.C. 1940. The American species of Hippocrateaceae. - Brittonia 3: 341-555.

Humiriaceae

A family of usually large trees, but also small trees and shrubs with rather hard and red-colored wood. **Leaves** alternate, simple, entire or frequently with serrate to crenate or undulate margin; **inflorescences** axillary, rarely terminal, paniculate; **flowers** bisexual, 5-merous, sepals connate, forming a cup-shaped or shortly tubular calyx, petals free, white, yellow or red, stamens 10-30 or many, in two rows, basally united into a short staminal tube, ovary superior, 5-locular, style 1; **fruits** drupes with 1-2(-5) seeds. In lowland rain forests, deciduous forests and savannas. Neotrop. 8/50 + 1 sp. in W-Africa, CR 3/4, GD 2/2.

Because of its hard wood, *Humiriastrum diguense* is an important timber tree (BURGER & ZAMORA 1991).

Key to the genera (after BURGER & ZAMORA 1991)

1 Flowers with 50-180 stamens, anthers with 2 bilocular thecae; locules 2-ovulate; endocarp with 5 separate ligulate valves; leaves bluntly obtuse to rounded at the apex, margins usually entire ..... *Vantanea*

1* Flowers with 20 stamens, anthers with 2 unilocular thecae; locules 1-ovulate; endocarp with 5 foramina at the apex, with 5 short operculate valves; leaves acuminate or abruptly short-acuminate at the apex, margins mostly bluntly serrulate to crenulate ..... *Humiriastrum*

Humiriastrum (neotrop. 12, CR 1, GD 1)

Large to medium sized trees, with the stamens of two alternate lengths and the drupes ellipsoid to subglobose and 1-5 cm in size.

H. diguense Cuatrec., Pl. 72d

Common name (Costa Rica): chiricano, lorito, laurelito, nìspero (BURGER & ZAMORA 1991)

Tree, up to 40 m tall, with reddish-brown wood; leaves subsessile, margin bluntly crenate to serrulate, drying dark-brown, glabrous, except the undersurface sparsely covered with thin and inconspicuous hairs; inflorescences (pseudo)terminal, with small, greenish-white flowers; fruits 2-2,6 cm in diameter, black. In lowland rain forests in Costa Rica, Panama and western Colombia.

Vantanea (neotrop. 16, CR 1, GD 1)

Large to medium size trees, flowers small with many stamens of uniform length. Fruits drupes, with woody stone.

V. barbouri Standl.

Common name (Costa Rica): chiricano alegre, campano (N. ZAMORA pers. comm.)

Tree up to 45 m tall, with reddish-brown wood, young twigs conspicuously angulate and green; leaves glabrous, drying brown and shiny, margin mainly entire, petioles short; inflorescences terminal; flowers green; fruits 2,8-3 cm long, 1,8-2 cm wide, ellipsoid. In lowland forests on hilly, well drained terrain, from Nicaragua to Costa Rica.

BURGER, W. & N. ZAMORA 1991. Humiriaceae. Flora Costaricensis. - Fieldiana Bot. n.s.28: 25:30
CUATRECASAS, J. 1961. A taxonomical revision of the Humiriaceae. - Contr. U.S. Natl. Herb. 35: 25-214.
GENTRY, A. 1975. Humiriaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama.-Ann. Missouri Bot. Gard. 62: 35-44.
ZAMORA, N. In prep. Humiriaceae. Manuál de las plantas de Costa Rica. Missouri Botanical Garden. Instituto Nacional de Biodiversidad. Museo Nacional de Costa Rica.

Hydrangeaceae

Small trees, shrubs, lianas and some herbs with terminal, usually flat-topped, cymose, or corymbose inflorescences and simple or stellate indumentum. **Leaves** alternate, or opposite, simple, entire to serrate or dentate; **flowers** small, bisexual, sometimes sterile and larger peripheral flowers present, sepals 4-10, free, petals 4-10, free or connate, stamens twice as many as the sepals or more, ovary inferior, 1-10-locular; **fruits** loculicidal capsules or sometimes fleshy berries, seeds numerous, sometimes winged. In temperate areas and in the tropics and subtropics worldwide. Cosmopol. 17/190, CR 1/5, GD 1/2.

The family is a segregate of the Saxifragaceae and is sometimes still included in it.
Several species of *Hydrangea* are used in horticulture (MCCLINTOCK 1958).

Hydrangea (pantrop. + subtrop. 23, CR 5, GD 2)
A genus with opposite and usually serrate or rarely entire leaves and white, pinkish or maroon flowers. Some species bear domatia in the form of hair-chambers in the axils of the secondary veins beneath.

Key to the species of *Hydrangea* (after MORALES, in prep.)

1	Sterile flowers present, rose	*H. peruviana*
1*	Sterile flowers absent	*H. preslii*

H. peruviana Moric.
Scandent epiphytic shrub, rarely terrestrial, branchlets and youngest leaves covered with stellate hairs; leaves oblong to elliptic, 4,5-13(-15) cm long, 2,5-5(-6) cm wide, entire or weekly dentate, glabrous or pubescent along the midvein; flowers 4-merous, petals pinkish, peripheral sterile flowers present. In primary and secondary forests, usually in montane areas, from Costa Rica to Ecuador and Peru.

H. preslii Briq.
Scandent epiphytic or terrestrial shrub, branchlets glabrous; leaves elliptic to oblanceolate, 6,5-17 cm long, 3-8,5 cm wide, entire, glabrous to glabrate on both sides; sterile flowers lacking, petals rose. From Costa Rica to Ecuador and Peru.

MCCLINTOCK, E. 1950. Saxifragaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 37: 137-145.
MCCLINTOCK, E. 1957. A monograph of the genus *Hydrangea*. - Proc. Calif. Acad. Sci., Ser. 4, 29 (5): 147-256.
MORALES, J.F. In prep. Hydrangeaceae. Manuál de las plantas de Costa Rica. Missouri Botanical Garden. Instituto Nacional de Biodiversidad. Museo Nacional de Costa Rica.

Icacinaceae

A family of trees, shrubs and lianas, usually difficult to recognize to family, because of the lack of distinct vegetative characters. **Leaves** simple, alternate, mostly coriaceous to subcoriaceous, margins entire or sometimes the juvenile leaves spinose tipped or -margined, stipules lacking, petioles canaliculate; **inflorescences** axillary, extra-axillary, terminal or cauliflorous, cymose or racemose; **flowers** actinomorphic, rarely zygomorphic, bisexual or unisexual, mostly small, sepals united, 4-5-lobate or -toothed, petals 4-5, free or rarely united, white, pink or yellow, stamens 4-5, alternate with the petals,

ovary superior, unilocular; **fruits** drupes, globose, ovoid or oblong, rarely flattened, seed 1. Throughout the tropics worldwide. Pantrop. + few temp. 52/300, CR 9/9, GD 4/4.

No species of Icacinaceae of important commercial use. HOWARD & STEFANO (1999) refer to the local use of two Guayana species: *Leretia cordata*, with tubers that contain starch, and *Poraqueiba sericea*, with fruits that contain an oily mesocarp and seeds with starchy endosperm. HOWARD (1976) mentions *Poraqueiba* spp. to have edible fruits and *Calatola*, whose seeds are reported to be edible when roasted, but after other reports might be toxic.

Key to the species (after HAMMEL, in prep.)

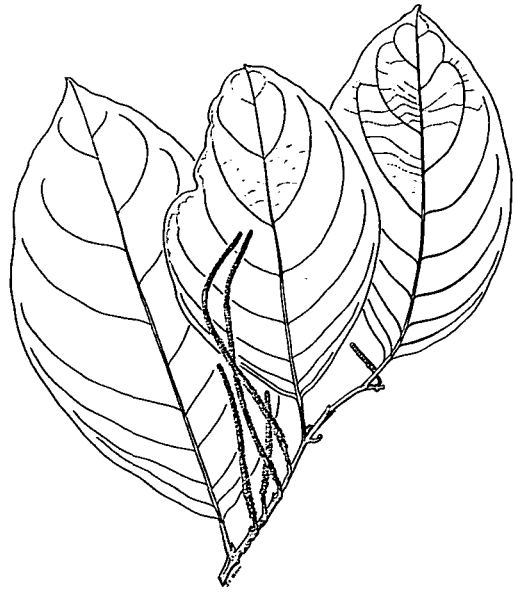
1	Indumentum of stellate hairs; leaves drying black	*Dendrobangia boliviana*
1*	Indumentum of simple hairs	2
2	Mature fruits less than 1 cm long, oblong-flattened, black on one side and white on the other; pubescence tawny; leaves drying maroon	*Discophora guianensis*
2*	Mature fruits 4-6 cm long, ovoid-globose, one-colored; pubescence lacking or of other color	3
3	Leaves drying black, seeds with elevated and sculptured ridges; inflorescences spikes (male inflorescences up to 25 cm long); pubescence yellow to ferruginous	*Calatola costaricensis*
3*	Leaves drying grayish-green; seeds with several small costae or smooth; inflorescence not spicate; glabrous or nearly so	*Oecopetalum greenmanii*

Calatola (neotrop. 7, CR 1, GD 1)
Dioecious trees and shrubs with black-drying leaves and large, ellipsoid to subglobose fruits with longitudinal ridges on the endocarp.

C. costaricensis Standl., Pl. 72e
Common names (Costa Rica): erepe, coquito (HAMMEL, in prep.)
Dioecious tree, up to 18 m tall; leaves oblong to elliptic, 10-27(-44) cm long, 4,5-10(-18) cm wide; inflorescences extra-axillary, spicate, male inflorescences up to 25 cm long, female inflorescences up to 2 cm long; fruits fleshy drupes, 6 cm long, 4 cm wide, green. In wet primary forests, from Nicaragua to Panama.

Discophora (neotrop. 2, CR 1, GD 1)
Pubescent trees and shrubs with green drying leaves. The oblong and flattened fruit is unmistakable in being covered with a large, white, fleshy appendage on the concave side and black colored and strongly five ribbed on the other side.

D. guianensis Miers, Pl. 72f
Tree or shrub, up to 12 m tall; leaves narrowly oblong or ovate, 18-25 cm long, 6-10 cm wide; inflorescences axillary, paniculate, densely golden strigose; petals cream yellow; fruits fleshy drupes, 10-20 mm long, 8-10 mm wide. In lowland and montane humid primary forests, from Costa Rica to Ecuador, Peru and Brazil.



Calatola costaricensis

HAMMEL, B. In prep. Icacinaceae. Manuál de las plantas de Costa Rica. Missouri Botanical Garden. Instituto Nacional de Biodiversidad. Museo Nacional de Costa Rica.

HOWARD, R.A. 1976. Icacinaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 63 (3): 399-418.

HOWARD, R.A. & R. DUNO DE STEFANO. 1999. Icacinaceae Pp.: 646-658 In: J.A. STEYERMARK, P.E. BERRY & B.K. HOLST (eds.): Flora of the Venezuelan Guayana Vol. 5.

Juglandaceae

Trees or rarely large shrubs with compound leaves and characterized by the presence of peltate scales on the leaf undersurface. **Leaves** alternate, opposite or whorled, pinnately compound, even or odd-pinnate, leaflets sessile or petiolulate, entire to serrate, stipules lacking; **inflorescences** terminal catkins or spikes, or the male and female catkins sometimes combined in a panicle; **flowers** unisexual, monoecious or rarely dioecious, inconspicuous, petals lacking, male flowers with 4-lobate calyx, stamens 3-numerous, female flowers with 4-lobate calyx, ovary inferior, 1-locular above to 8-locular below; **fruits** nuts or 2-3-winged samaras, seed 1. Mainly distributed in the temperate areas of Asia, Europe and North America but also extending into tropical regions. Cosmopol. 8/63, CR 3/8, GD 2/2.

The flowers of Juglandaceae are adapted to wind-pollination. An exception is found in the Old World species *Platycarya strobilacea*, whose flowers are known to be pollinated by insects (ENDRESS 1986). The fruits of Juglandaceae are either wind-dispersed (then mostly provided with wings), or dispersed by animals, which feed on the fruits.

The two commercially most important species of Juglandaceae, *Carya illinoiensis*, known as "hickory" and *Juglans regia*, the walnut, are widely cultivated in temperate areas for their edible fruits.

Key to the genera (after STONE 1993)

1	Fruits nuts, wingless, trilobate bract retained as minute scale at base of nut, prophyll absent	*Alfaroa*
1*	Fruit 3-winged samara due to enlargement of bract, prophyll present	*Oreomunnea*

Alfaroa (neotrop. 7, CR 5, GD 1)
Trees with opposite, even-pinnate leaves and rather small, thin walled nuts.

A. guanacastensis D. Stone
Tree, up to 27 m tall, sometimes with large buttresses; leaflets (6-)8-10(-16), entire; male inflorescences terminal panicles with 2-6 catkins, female inflorescences terminal, erect spikes, also androgynous panicles with 1-2 male catkins subtending a female one; fruit spheroid to oblong with the calyx persisting at the apex. Usually in premontane rainforests, endemic to Costa Rica.

ENDRESS, P.K. 1986. An entomophily syndrome in Juglandaceae: *Platycarya strobilacea*. - Veröff. Geobot. Inst. Eidg. Techn. Hochsch. Stift. Rübel 87: 100-111.
MANNING, W.E. 1960. Juglandaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 47: 90-92.
MANNING, W.E. 1978. The classification within the Juglandaceae. - Ann. Missouri Bot. Gard. 65: 1058-1087.
STONE, D.E. 1977. Juglandaceae. Flora Costaricensis. - Fieldiana Bot. 40.: 28-53.
STONE, D.E. 1993. Juglandaceae. pp: 348-358. In: K. KUBITZKI (ed.): The families and genera of vascular plants. Vol II. Magnoliid, Hamamelid and Caryophyllid families. Berlin: Springer Verlag.

Lamiaceae

A family of mostly annual or perennial herbs and a few shrubs or small trees, easily to recognize by the opposite leaves, squarish stems, and the pleasant aroma of the vegetative parts. **Leaves** opposite, simple, serrate, venation pinnate, stipules lacking; **inflorescences** axillary or terminal, cymose, bracteate, capituliform or verticillate; **flowers** zygomorphic, bisexual, sepals 5, united, usually bilabiate but sometimes regular, persistent, petals 5, united, bilabiate, stamens 2, or 4 and didynamous, ovary superior, 3-locular; fruits of 4 nutlets (in *Salvia* usually only 1 maturing), seeds 1 per nutlet. Cosmopol. 251/6700, CR 19/72, GD 4/10.

Key to the genera (after NOWICKE & EPLING 1969)

1	Stamens two	*Salvia*
1*	Stamens four	2
2	Middle lobe of lower corolla lip clearly dipper-shaped; calyx ± regular	*Hyptis*
2*	Middle lobe of lower corolla lip plane and spreading, calyx weekly or conspic ously zygomorphic	3
3	Lips of the calyx entire, the upper bearing an erect protuberance flattened contrary to the floral axis	*Scutellaria*
3*	Lips of the calyx variously toothed and without lateral projection of the upper lip	*Ocimum*

Hyptis (pantrop. + subtrop. ca. 300, CR 20, GD 7)
Herbs, shrubs and trees with an equally 5-dentate, tubular to campanulate calyx. The small flowers are usually arranged in axillary capitate inflorescences.

H. brevipes Poit.
Slender annual, up to 60 cm tall, stems appressed-hirsute; leaves mostly elliptic-lanceolate, 4-6 cm long, serrate, villous-hirsute; inflorescences capitate, the heads 1 cm or slightly more in diameter, petals white, corolla tube 2,5-3 mm long. Widely distributed in tropical America.

H. capitata Jacq.
Coarse, annual or perennial herb, 1-2 m tall, or often lower, stems sparsely villous with spreading or subappressed hairs or almost glabrous; leaves thin, ovate or broadly ovate, usually 5-12 cm long, serrate, sparsely pilose or glabrate; inflorescences capitate, the heads 2-2,5 cm in diameter; petals white, corolla tube 3-4 mm long. Common weed about dwellings and in waste places, widely distributed in tropical America, Asia and Polynesia.

H. verticillata Jacq.
Slender, densely branched shrub, usually 2,5 m tall or less, branches appressed-pilosulous; leaves lanceolate or oblong-lanceolate, 3-10 cm long, serrate, puberulent or glabrous; inflorescences dense verticles, these forming elongate, slender, much interrupted, leafy spikes or racemes; flowers very small, petals white, corolla tube 3 mm long. Widely distributed in tropical America.

Ocimum (pantrop. + subtrop. 150, CR 3, GD 1)
Herbs or low shrubs with verticillate flowers. The lower pair of the 4 didynamous stamens is appressed to the lower lip of the corolla and the calyx is deflexed in fruit.

O. campechianum Mill.
(syn. *O. micranthum* Willd.)·
Low, bushy herb, 60 cm tall or less, pilose; leaves ovate or elliptic, 3-5 cm long, dentate; flowers 2-3 mm long, fruiting calyx 4-5 mm long. Widely distributed in tropical America.

Salvia (cosmopol. 900, CR 21, GD 1)
Shrubs and herbs with only 2 fertile stamens. This genus is a vast one, especially well developed in Mexico and in the Andes.

S. occidentalis Swartz
Slender plants, decumbent or prostrate, rooting at the lower nodes; leaves small, ovate, mostly 2-5 cm long, serrate; inflorescences few-flowered, forming much elongate and interrupted spikes; petals blue, 5 mm long. One of the common weeds of Central America, especially around dwellings, widely distributed in tropical America.

Scutellaria (cosmopol. ca. 350, CR 5, GD 2)
Mostly herbs and subshrubs with blue or violet flowers with 4 fertile stamens.

S. costaricana H. Wendl., Pl. 72g
Plants herbaceous, branched, usually 1 m tall or often much lower, branches sparsely brown-puberulent; leaves mostly oblong or ovate-oblong, ca. 8-12 cm long, sinuate-dentate or almost entire, minutely puberulent along the vein; inflorescences racemose, short, of few or numerous flowers; petals bright red, 4-5 cm long, very slender. In Costa Rica and Panama.

S. glabra Leonard
Plants simple or branched, glabrous; leaves elliptic-ovate, 10-16 cm long, sinuate-dentate or undulate, inflorescences racemose, 6-10 cm long; petals bright red, 1,5-2 cm long. In Costa Rica and Panama.

EPLING, C.C. 1949. Revisión del género *Hyptis* (Labiatae). - Revista Mus. La Plata, Secc. Bot. 7 (30): 153-497.
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Lauraceae

A family of trees and shrubs, or rarely parasitic epiphytes (*Cassytha*), which are very important components of the neotropical lowland rainforests, but often difficult to identify. The two main characteristic features of this family are the stamens always dehiscing by valves, opening upward and the fruits frequently surrounded by a variously shaped, usually reddish cupule. **Leaves** alternate, subopposite or opposite, simple, entire or undulate, often clustered at the twig ends; **inflorescences** paniculate or racemose; **flowers** actinomorphic, bisexual or unisexual, 3-merous, perianth undifferentiated, tepals connate, in 2 rows, inconspicuous, usually whitish or greenish, stamens free, in 3 or 4 whorls, sometimes one or two whorls staminodial, ovary superior, 1-locular, style 1; **fruits** drupaceous, one-seeded. Pantrop. + subtrop. 52/2850, CR 18/137, GD 13/52.

Species of *Beilschmiedia* (e.g., *B. pendula*) are used as timber (NISHIDA 1999).

Key to the genera (after WERFF 1991)

1	Flowers bisexual or staminate	2
2	Stamens 3	3
3	Stamens with 4 anther cells	*Williamodendron*
3*	Stamens with 2 anther cells	4
4	Only stamens of whorl 1 fertile, the cells lateral and large, or lateral basal and small; inflorescences and flowers glabrous	*Aiouea* p.p.
4*	Only stamens of whorl 3 fertile, the cells extrorse, introrse or more or less apical, not lateral; inflorescences and/or flowers usually with varying amounts of pubescence	*Licaria*
2*	Stamens more than 3	5
5	Outer 6 stamens each with 2 anther cells	6
6	Flowers unisexual	*Endlicheria* p.p.
6*	Flowers bisexual	7
7	Leaves opposite	8
8	Outer tepals equal or less ? the size of inner tepals	*Caryodaphnopsis* p.p.
8*	Tepals equal	*Beilschmiedia* p.p.
7*	Leaves alternate or clustered	9
9	Outer tepals ca. ? as long as inner tepals	*Persea* p.p.
9*	Tepals equal or nearly so	10
10	Floral tube very shallow, scarcely visible at anthesis	*Beilschmiedia* p.p.
10*	Floral tube well developed, about as long as the tepals	11
11	Flowers (minutely) tomentellous, tomentose or with appressed pubescence, but never pruinose; filaments of stamens usually densely pubescent, poorly differentiated from anthers; leaves alternate or clustered	*Aniba*
11*	Flowers usually glabrous, infrequently with scattered hairs, sometimes pruinose; filaments of stamens usually glabrous and differentiated from anthers; leaves alternate	*Aiouea* p.p.
5*	Outer 6 stamens each with 4 anther cells	12
12	Flowers unisexual	13
13	Anther cells arranged in a low arch; anthers poorly differentiated from filaments	*Rhodostemonodaphne* p.p.
13*	Anther cells arranged in two rows; anthers clearly differentiated from the much narrower filament (rarely filaments very short)	*Ocotea* p.p.
12*	Flowers bisexual	14
14	Leaves opposite	*Caryodaphnopsis* p.p.
14*	Leaves alternate or whorled	15
15	Outer tepals about ? the size of the inner ones	*Persea* p.p.
15*	Tepals equal or nearly so	16

16	Staminal glands greatly enlarged, protruding between the outer 6 stamens and sometimes fused into a large, pillow-like mass; stamens of whorls 1 and 2 with at least 2 lateral anther cells	*Pleurothyrium*
16*	Staminal glands not enlarged, not protruding between outer stamens, free; outer stamens with introrse cells	17
17	Staminodia representing whorl 4 well developed, with a cordate or sagittate apex; filaments of stamens as long as anthers or longer	18
18	Leaves pinnately veined or tripliveined, usually tufts of hairs present in the axils of the lowermost veins	*Cinnamomum*
18*	Leaves pinnately veined, alternate or clustered; axillary tufts of hairs lacking	*Persea* p.p.
17*	Staminodia representing whorl 4 small or lacking, mostly without a cordate or sagittate tip; filaments of stamens shorter than or as long ac anthers (a few species of *Ocotea* have large staminodia with a cordate tip, but these have stamens with a very short filament)	19
19	Anther cells arranged in 2 vertical rows; stamens and inner face of tepals glabrous or variously pubescent, rarely papillose; tepals free at base, falling individually in old flowers; a few old stamens sometimes present on cupule of young fruits; tepals at anthesis erect or spreading	*Ocotea* p.p.
19*	Anther cells arranged in an arc; stamens and inner face of tepals papillose; tepals united at base, usually falling as a unit (together with stamens) in old flowers; stamens rarely present on cupule of young fruits; tepals at anthesis spreading	*Nectandra*
1*	Flowers pistillate	20
20	Staminodes straplike, the filaments about as wide as the anther; traces of locelli four on each anther	*Rhodostemonodaphne* p.p.
20*	Staminodes club-shaped, the filaments narrower than the anthers	21
21	Anthers with 4 remnants of locelli; leaves alternate	*Ocotea* p.p.
21*	Anthers with 2 remnants of locelli; leaves alternate or whorled	*Endlicheria* p.p.

Aiouea (neotrop. 21, CR 4, GD 2)
Trees or rarely shrubs, rather nondescript, with alternate, non-clustered leaves and small flowers in paniculate inflorescences. The fruit is an ellipsoid berry, mostly embedded in a small cupule.

A. obscura van der Werff, Pl. 73a
Tree, up to 10 m tall, glabrous; leaves narrowly elliptic, 15-18 cm long, 3-4 cm wide, domatia often present in the axils of the veins beneath; inflorescences terminal (in the axils of deciduous bracts), paniculate, up to 15 cm long; pedicels 8-10 mm long, perianth 6-parted, pale green, stamens 9; fruits with red cupule. Endemic to the Golfo Dulce region.

Beilschmiedia (pantrop. 215, CR 11, GD 3)
A genus characterized by the usually small fruits lacking a cupule, as well as the frequent occurrence of opposite leaves. The stamens are always bithecate.

B. pendula (Sw.) Hemsl.
Common name (Costa Rica): colorado (González & Poveda, in prep.)
Tree, up to 40 m tall; leaves elliptic to oblong-elliptic, appressed pubescent beneath; flowers greenish-yellow, 2,3-3,5 mm long, borne on terminally or axillary panicles; fruits purple to black, shiny, up to 5,5 cm long. In tropical moist and wet forests, from Honduras, the West Indies, Costa Rica and Panama to northern Venezuela, Colombia and Ecuador.

Caryodaphnopsis (neotrop. + trop. Asia 15, CR 1, GD 1)
The neotropical species of this genus were recently segregated from *Persea* and can be differentiated by their strongly unequal tepals and opposite leaves.

Cinnamomum (pantrop. + subtrop. ca. 350, CR 10, GD 3)
Trees and shrubs with very aromatic scent in the leaves and wood and with alternate or opposite, mostly 3-veined leaves. The paniculate inflorescences usually bearing bisexual flowers, mostly with 9 stamens.

C. neurophyllum (Mez & Pittier) Kosterm., Pl. 73b
Tree, up to 18 m tall, leaves elliptic to elliptic-oblong, 5,5-25 cm long, 2-9,5 cm wide; inflorescences 6-11 cm long; fruits 1,6-2,5 cm long, cupule small, with entire margin. From Mexico to Panama.

Nectandra (neotrop. ca.120, CR 19, GD 10)
The second largest neotropical genus, often difficult to distinguish from *Ocotea* is characterized by the cup-shaped cupula of the fruits as well as by the granular inner surface of the always spreading tepals. In vegetative condition most of the species of *Nectandra* can be recognized by the strongly parallel tertiary venation of the leaves.

N. umbrosa (HBK) Mez, Pl. 73c
Shrub or tree, up to 25 m tall; leaves elliptic to lanceolate or oblong; inflorescences axillary; flowers 3,2-6,5 mm in diameter, tepals elliptic to elongate, papillose inside; fruits subglobose berries. In rain forests and beach thickets, often in secondary forests, from Costa Rica to Colombia.

Ocotea (pantrop. + subtrop. 350, CR 52, GD 21)
The largest genus of Lauraceae in the Neotropics, vegetatively very variable can be recognized by erect or spreading tepals at anthesis and the fruits always subtended by a cupule of variable shape and size.

O. leucoxylon (Sw.) Laness., Pl. 73e
Tree, up to 15 m tall; leaves alternate, membranaceous; inflorescences axillary, paniculate, with 2,5 mm long, white to yellowish flowers; fruits globose, green to purple, up to 15 mm in diameter, subtended by a reddish-brown cupule. In lowland and premontane tropical wet forests, from Southern Mexico and the West Indies to South America.

O. nicaraguensis Mez, Pl. 73d
Tree, up to 15(-20) m tall; leaves alternate, leathery, very large, oblanceolate; inflorescences axillary, paniculate, somewhat racemose, with 2,2-3 mm long flowers; fruits ellipsoid, purple to black, with irregularly lobate cupule. In tropical evergreen forests, from southeastern Nicaragua to Panama.

Pleurothyrium (neotrop. 45, CR 8, GD 4)
Usually small shrubs and treelets, frequently with large, clustered leaves, often with a pronounced marginal vein. The fruit is seated in a rather deep cup-shaped cupule.

P. golfodulcensis W. C. Burger & N. Zamora, Pl. 73f,g
Tree, ca. 10 m tall, young branches densely hirsute; leaves alternate, basally often asymmetric; inflorescences axillary, racemose, flowers densely puberulent without; fruits subtended by a 2 cm long pinkish cupule. In lowland rain forests, endemic to the Golfo Dulce region.

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Lecythidaceae

A family of small to large trees, with almost unmistakable unique flowers and fruits. **Leaves** alternate, simple, entire or nearly so, often clustered at the twig ends, stipules minute or lacking; **inflorescences** racemose or paniculate, or flowers solitary; **flowers** axillary or terminal, sometimes cauliflorous, actinomorphic or zygomorphic, often conspicuous, medium sized to large, calyx often small and reduced, petals 4-8, sometimes lacking (e.g., *Asteranthos*), often white or reddish, stamens numerous, basally connate into a staminal ring, the ring actinomorphic or prolonged into a prominent and usually staminodial hood, which is often more or less coiled inwards, laying over the fertile stamens and the pistil, rarely the outermost stamens modified into a petaloid corona, ovary inferior or half inferior; **fruits** fleshy and berry-like or woody capsules, usually dehiscent with the smaller apical part falling off, like the lid of a pod, seeds one to many, sometimes winged. Pantrop. 20/285, CR 6/17, GD 5/10.

The family can be divided into 4 subfamilies: Planchonioideae, Foetidioideae, Napoleonoideae, Lecythidoideae. The latter is endemic to the Neotropics and present in the Golfo Dulce region.
The Lecythidaceae are predominantly represented in lowland tropical forests at mesic sites with rich soils. They are less successful in wetter habitats and only a few species are adapted to dry habitats (Prance & Mori 1979, Mori 1987). In the Neotropics they are most abundant in the lowland forests of the Amazon basin (Nevling 1958, Mori & Lepsch-Cunha 1995). Most species are found in the three upper forest strata, only few are represented in the understory, and no are found in the shrub layer (Prance & Mori 1979).

The flowers of most Lecythidaceae are only open for one day and only a few flowers open at the same time in an inflorescence (Prance 1976). There exist several studies on the pollination of Lecythidaceae (Prance 1976, Mori et al. 1978, Prance & Mori 1979, Mori 1987, Mori & Prance 1990, Knudsen & Mori 1996) which show that with a single exception the Lecythidaceae are pollinated by bees. The only exception is *Lecythis poiteaui* which is pollinated by bats (Mori et al. 1978, Prance & Mori 1979, Mori 1987, Mori & Prance 1990). There is a phylogenetic tendency from the more primitive actinomorphic flowers towards zygomorphic flowers bearing a staminal hood. The genera with the least specialized flowers provide pollen as attractant and are visited by a large variety of bees. These are the genera with actinomorphic flowers (e.g., *Gustavia*) or genera with open zygomorphic flowers (e.g., *Lecythis*) which are pollinated by bees with generalized foraging strategies (e.g. *Melipona*, *Trigona*). The genera with the most elaborate flower morphology (*Eschweilera*, *Couratari*) have fewer stamens and produce nectar as attractant. They have complex flower entrances, so that the nectar can be reached only by specialized bees.

The seeds or fruits of the Lecythidaceae are water-, animal-, or wind-dispersed. Based on fruit types the family can be split into two groups: in the first group, with indehiscent fruits (e.g., *Gustavia*), the pericarp is likely to be important for dispersal, in the second group, with dehiscent fruits (e.g., *Couratari*, *Eschweilera*, *Lecythis*), the seeds are dispersed by mammals, gravity or by wind (Prance & Mori 1979, Mori 1987). The fleshy mesocarp of the fruits of several species of Lecythidaceae is eaten by mammals. Various birds, monkeys and rodents are able to open the woody fruits of some other species in order to eat the fleshy aril around the seed. Other fruits expose their seeda on relatively long, pendulous funicles, after the terminal pot-shaped part of the fruits has been shed. The seeds are dispersed by bats, which eat the arils around the seeds (Mori 1987). Some Lecythidaceae have water-dispersed fruits, due to a persistent and buoyant calyx. The seeds of *Cariniana* and *Couratari* species are winged and wind-dispersed (Prance & Mori 1979).

Species of Lecythidaceae are commercially used in several ways. The timber of all species and the fibrous bark of most species have some uses in construction (Mori & Lepsch-Cunha 1995), but usually they are only of local interest. An exception is *Bertholletia excelsa*, the Brazil nut, whose edible seeds

are known worldwide. They are usually harvested from natural stands in Brazil, Peru and Bolivia (PRANCE & MORI 1979). Due to their high content of oil (up to 70 %), the seeds are also used in the production of cooking oil.

Key to the genera (after PRANCE & MORI 1979)

1	Androeceum actinomorphic	2
2	Petals 6-8(-18); stamens 500-1200, the anthers linear, 2-5 mm long, dehiscing by apical pores; placentae expanded, the ovules 7-93 per locule, horizontal or slightly descending; fruits usually with 2 or more seeds	*Gustavia*
2*	Petals 4; stamens 85-210, the anthers globose, less than 1 mm long, dehiscing by longitudinal slits; placentae not expanded, the ovules 2-4, pendulous; fruits with a single seed	*Grias*
1*	Androeceum zygomorphic	3
3	Androeceum hood coiled inwards, with an outwardly extended flap at the apex of the coil; fruits cylindric or campanulate; seeds with a wing around the circumference	*Couratari*
3*	Androeceum hood flat, or if coiled inwards, without an outwardly extended flap at the apex of the coil; fruits usually globose; seeds without wings	4
4	Androeceum coiled inwards, with blunt-tipped appendages at the apex of the coil, these differentiated from the more abundant, echinate hood appendages; ovary usually 2-locular	*Eschweilera*
4*	Androeceum flat or expanded at the apex but not coiled inwards, all hood appendages more or less equal; ovary 4-locular	*Lecythis*

Couratari (neotrop. 18, CR 2, GD 2)
Medium to giant emergent trees, often buttressed, characterized by the elongate or cylindric fruits with several winged seeds.

C. guianensis Aubl., Pl. 74a-c
Large tree, up to 50 m tall, the trunk buttressed up to 7 m; leaves coriaceous, entire, with stellate pubescence beneath; inflorescences terminal or axillary, racemose or paniculate, pedicels 1-2 cm long, flowers appearing without leaves, 6-merous, petals purple, androeceum rose-purple, asymmetrical, with a large sterile hood, which is strongly coiled inwards, the fertile stamens 15-25 in one row around the staminal ring; fruits cylindrical, lenticellate, hard and woody, with several winged seeds. In various types of forests, from Costa Rica to Amazonian Brazil. The dried inner bark is used as cigarette paper by the local people.

Eschweilera (neotrop. 90, CR 8, GD 5)
The largest genus in the Neotropics, usually consisting of large trees, distinguishable from *Lecythis* by the 2-locular ovary, the androphore hood being strongly coiled inwards and the seeds never pendent.

E. pittieri Kunth
Tree, up to 20 m tall; leaves elliptic oblong, 12-30 cm long, subcoriaceous with a 1-1,5 cm long petiole; inflorescences racemose, with several to many flowers; flowers 6-merous, petals white or

Eschweilera pittieri

yellow, androphore strongly bilateral asymmetrical, strongly coiled inwards with rather few fertile stamens; fruits very hard operculate, brown verruculose, 2,5-5 cm long, 3,5-6 cm wide. From Costa Rica to Colombia and in Ecuador.

Grias (neotrop. 6, CR 1, GD 1)
Trees with quite large actinomorphic flowers with 4 petals and with large clustered leafs at the ends of the branches.

G. cauliflora L., Pl. 74d,e
Tree, up to 30 m tall; leaves large, entire, coriaceous, oblanceolate, with short petioles; flowers cauli- and ramiflorous, fasciculate, in groups of 2-4, petals white or creamy-white, stamens numerous, in 3 concentric rows, basally connate, ovary (3-)4-locular; fruits brown, 38-90 mm long, 22-40 mm wide. In areas with high rainfall, in Jamaica and from Guatemala and Belize to northern Colombia.

Gustavia (neotrop. 41, CR 2, GD 1)
The second actinomorphic genus in our area, but with more petals than Grias and more or less globose fruits.

G. brachycarpa Pittier, Pl. 74f
Tree, up to 15 m tall; leaves clustered at the ends of the branches, elliptic to narrowly ovate, 9-22 cm long, glabrous, crenulate on the upper half of the leaf blade, petiole 1-2 cm long, stipules 4 mm long, early caducous, inflorescences axillary or below the leaves, with one or two flowers; flowers 6-merous, petals white, ovary 6-locular; fruits cylindrical, 25 mm long, 20 mm wide, with 6 wings and persistent calyx lobes. In lowland forests and swampy areas of the Pacific watershed of Panama and Costa Rica.

Lecythis (neotrop. 25, CR 2, GD 1)
Small to large trees, very similar to *Eschweilera* but usually with 4-locular ovary and pendent seeds, when the apical part of the fruit is fallen off.

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MORI, S.A. 1987. The Lecythidaceae of a lowland Neotropical forest: La Fumée Mountain, French Guiana. - Mem. New York Bot. Gard. 44.
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Lentibulariaceae

Annual or perennial aquatic, terrestrial or epiphytic herbs with special vegetative organs adapted for the capture and digestion of small organisms. **Leaves** rosulate or absent, often replaced by more or less leaf-like, entire or dissected photosynthetic organs, derived from modified stems; **inflorescences** terminal or lateral, pedunculate, racemose, simple or rarely branched, bracteate; **flowers** zygomorphic, bisexual, sepals sometimes free or usually connate, calyx deeply 2-4-5-parted, almost regular or bilobate, persistent and often accrescent, petals more or less 2-lipped, usually spurred, rarely saccate, stamens 2, inserted at the base of the corolla, ovary superior, 2-locular; **fruits** valvate, circumscissile or indehiscent capsules, seeds 1 or usually numerous, mostly small, of various shape. Cosmopol. 3/245, CR 1/10, GD 1/2.

Many of the species are probably autogamous, though in some cases hymenoptera, lepidoptera, diptera and hummingbirds have been observed as flower visitors (TAYLOR 1989).

Utricularia (cosmopol. 180, CR 10, GD 2)
Annual or perennial aquatic, terrestrial or epiphytic herbs, lacking true roots but with stems variously modified to function as rhizoids, stolons, and more or less leaf-like photosynthetic organs. All species are bearing small, complex, bladder-like traps for the capture and digestion of small organisms.

Key to the species of *Utricularia* (based on TAYLOR 1977)

1	Submerged aquatic herb	*U. gibba*
1*	Epiphytic herb	*U. endresii*

U. endresii Rchb. f.
Rather large species, sometimes 35 cm tall or even taller; basal leaves long-petiolate, lanceolate to lance-elliptic or oblanceolate, mostly 5-7 cm long, subobtuse to attenuate, long-attenuate to the petiole; inflorescences slender scapes, mostly 2-5-flowered; flowers long-pedicellate, calyx lobes ovate, 2-3 cm long, corolla as much as 4,5 cm long, bright purple.
The plant is often mistaken for an orchid, because of its epiphytic habit and its large and showy, very handsome, orchid-like flowers.

U. gibba L.
Submersed herb; leaves filiform, up to 2 cm long, provided with numerous utricles, utricles ovoid, 1-1,5 mm long, short stalked; inflorescences erect, emergent, 2-35 cm long, with 1-6 flowers; calyx lobes 2-3 mm long, corolla 6-12 mm long, yellow. From the southern United States through Central and South America, as well as in tropical Africa.

CROW, G.E. 1992. The genus *Utricularia* (Lentibulariaceae) in Costa Rica. - Brenesia 38: 1-18.
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Lepidobotryaceae

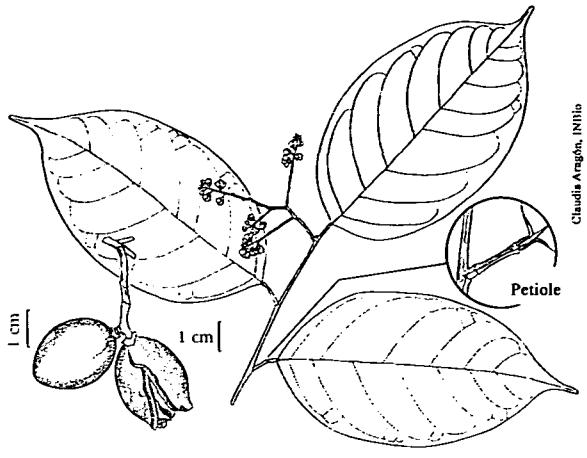
A small family of dioecious trees and shrubs with pulvinate, unifoliolate leaves, which can be easily confused with Leguminosae in the vegetative condition. **Leaves** alternate, entire, articulate with the petiolule, stipules and stipels present, caducous; **inflorescences** leaf-opposed; **flowers** unisexual, 5-merous, sepals free, petals free, stamens 10, with 5 longer and 5 shorter filaments, these fused basally into a short, nectar secreting tube (disk); **fruits** capsules, septicidally dehiscent, seed 1, black with orange aril. Neotrop. + trop Africa 2/2, CR 1/1, GD 1/1.

This was formerly regarded as a monotypic African family, being closely related to (and sometimes included in) Oxalidaceae (LÉONARD 1950). The recent discovery of the neotropical genus *Ruptiliocarpon* gave rise to the definite establishment of a distinct family. Its relationship is under debate. Due to several shared characters (e.g., dioecy; paired apical collateral ovules, etc.), the family is thought to be related to subfam. Phyllanthoideae (Euphorbiaceae) by HAMMEL & ZAMORA (1993).

Ruptiliocarpon (neotrop. 1, CR 1, GD 1)
The only neotropical genus, distinct from the African *Lepidobotrys* by the nearly identical male and female flowers and inflorescences (cryptic dioecy), which are arranged in panicles of spikes.

R. caracolito Hammel & N. Zamora, Pl. 74g
Common name (Costa Rica): cedro caracolito (HAMMEL & ZAMORA 1993)
Tree, up to 30(-40) m tall; leaves (leaflets) elliptic, entire, chartaceous, petiolule pulvinate, stipel 4-5 mm long, petiole basally pulvinate, stipules 1-1,5 mm long, early caducous; inflorescences mostly leaf-opposed, rarely terminal; flowers small, greenish, subtended by 3 bracts; fruits ovoid capsules, 2,5-3,5 cm long, 1,5-2,5 cm wide, with a bony endocarp, becoming seashell-shaped, when drying out, whence the common name is derived. Disjunct distribution, found in Costa

Rica (Osa Peninsula and nearby Golfito area) as well as in Colombia, Peru and Suriname.



Ruptiliocarpon caracolito

HAMMEL, B. & N. ZAMORA. 1993. *Ruptiliocarpon* (Lepidobotryaceae): A new arborescent genus and tropical American link to Africa, with a reconsideration of the family. - Novon 3: 408-417.

LÉONARD, J. 1950. *Lepidobotrys* Engl. Type d'une famille nouvelle de spermatophytes: Les Lepidobotryaceae. - Bull. Jard. Bot. Bruxelles 20: 31-40.

Loganiaceae

Scandent shrubs, lianas, suffrutices, or annual herbs, stems often bearing tendrils or spines. **Leaves** opposite, simple, entire or sometimes undulate, interpetiolar stipules present, sometimes reduced to an interpetiolar line in *Strychnos*; **inflorescences** of various shape, modified dichasia; **flowers** actinomorphic, bisexual, sepals 4-5, united, petals 4-5, united, rather funnelform, stamens as many as the petals, ovary superior, 2-locular; **fruits** septicidal capsules (*Spigelia*), explosively dehiscent or hard-shelled berries, seeds many. Cosmopol. 29/570, CR 9/25, GD 2/8.

Members of the family can be distinguished by the combination of opposite leaves with interpetiolar stipules or stipular lines and a superior, bilocular ovary.

The flowers are tubular and often very slender (especially *Strychnos*) and are probably pollinated by butterflies and moths. Some species of *Spigelia* are self-pollinated.

The seeds of *Spigelia* are dispersed by means of explosively dehiscent capsules. The seeds of *Strychnos* are endozoochorous. They are embedded in a fleshy sweet matrix and are probably taken by arboreal frugivores large enough to break open the thick and usually hard exocarp.

The seeds of *Strychnos* are extremely toxic, because they contain strychnin in the integuments. Several species (including *S. toxifera*) serve at least as one of the elements in the drug "curare", one of the most poisonous substances known. Introduced into the blood circulation in minute quantities, it paralyzes the motor nerves almost instantly, resulting in rapid death. Curare has been much used by South American Indians for poisoning their arrows, and it is thought to be used even today by indigenous peoples in some parts of Panama.

Key to the genera (after LEEUWENBERG 1971)

1 Fruit a capsule, secondary leaf veins about equal, plants herbaceous, sometimes subshrubs — *Spigelia*

1* Fruit a berry which is often large and thick-walled, leaves mostly triplinerved, plants woody, often large climbers with hooked tendrils — *Strychnos*

Spigelia (neotrop. + subtrop. 50, CR 5, GD 2)
Low, perennial herbs, almost glabrous, the stems simple or branched; leaves entire, acute or acuminate, often sessile; corolla tubular, small or large; capsule didymous, circumscissile.

S. anthelmia L.
Annual herb, up to 1 m tall, stem usually leafless below the apical whorl of two decussate leaf pairs; leaves opposite, broadly ovate to lanceolate-oblong, 3-18 cm long, 1-6,5 cm wide, glabrous or nearly so on both sides, (sub)sessile; inflorescences terminal, of 1-5 spikes; corolla white to pink or lavender; fruits capsules, explosively dehiscing, ca. 4 mm long, 5-6 mm wide, covered with small, spinelike protuberances. From Mexico to Peru and Brazil, naturalized in the Paleotropics. The second species occuring in the Golfo Dulce region, *S. humboldtiana* Cham. & Schltdl., is rather similar vegetatively, but can be distinguished from *S. anthelmia* by the smooth capsules.

Strychnos (pantrop. + subtrop. 190, CR 10, GD 6), Pl. 75a
Scandent shrubs, often provided with spines or tendrils; leaves opposite, entire, ovate or lanceolate, 3-5-nerved, acute; flowers white or yellowish, about 2 cm long, in terminal or axillary cymes, corolla with a long, slender tube and 5 short lobes; fruit globose, indehiscent, usually 4 cm or more in diameter, with few or numerous large, compressed seeds.

S. chlorantha Prog., Pl. 75b
Liana, leaves elliptic-ovate to lanceolate, 5-17,5 cm long, 2,5-5 cm wide, 3-pliveined; inflorescences terminal cymes, sparsely puberulent with short grayish hairs; corolla yellow to greenish-yellow; fruits ca 4 cm long, 6 cm wide, brown. Endemic to Costa Rica.

S. toxifera M. R. Schomb. ex Benth.
Liana with long reddish trichomes on most parts; leaves ovate to elliptic, 6-20 cm long, 3-8 cm wide, pliveined; inflorescences terminal cymes, densely reddish-pilose; flowers 5-merous, corolla white or yellow, salverform; fruits globose, 4-7 cm in diameter, gray-green turning bluish-green, seeds usually 10-15. From Costa Rica to Ecuador and Amazonian Brazil.

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Loranthaceae

A family of trees and shrubs, living as hemiparasites on roots or aerial stems, easy to recognize by its mostly opposite or whorled, coriaceous leaves. Plants terrestrial or epiphytic; **leaves** usually opposite or whorled, rarely subopposite or alternate, simple, coriaceous, margin entire or undulate, venation inconspicuous, stipules lacking; **inflorescences** paniculate, racemose or frequently spicate; **flowers** bisexual or functionally unisexual (then plants monoecious or dioecious), sessile, solitary or in groups of 2-3, tepals (4-)7, subtended by an entire or toothed calyculus, stamens (4-)7, epitepal, ovary inferior, unilocular; **fruits** berries, seed 1, embedded in sticky tissue. Most abundant in the tropics and subtropics, but also extending into temperate regions. Cosmopol. 68/900, CR 5/29, GD 4/13.

Common names, general throughout Latin America: liga (for species without colorful flowers), matapalo (more common and general) (KUIJT 1986).
The family is treated here in its narrow sense, splitting off the Viscaceae as a separate family, which is sometimes treated as a subfamily of Loranthaceae (RIZZINI 1960, 1982).
Within the family we can find root parasitic terrestrial plants as well as shoot parasitic hemiepiphytes or epiphytes. Many of the branch inhabiting tropical mistletoes possess so-called epicortical roots, which grow along the host branch and develop haustoria (KUIJT 1969).

Pollination studies in this family were conducted mainly on Australian taxa, whereas pollination biology of tropical American spp. is less explored. The main pollinators of the Loranthaceae are several groups of insects as well as nectarivorous birds (HAWKESWOOD 1981, REID 1986), mainly hummingbirds in the Americas and Dicaeidae in the Old World (KUIJT 1969). Many genera, like the neotropical *Psittacanthus* and *Tristerix*, with a red-colored, tubular corolla and copious nectar, are well adapted to bird pollination (FAEGRI & VAN DER PIJL 1966, GRAVES 1982). In many ornithophilous genera the pollen is transferred to the visitors by explosion of the anthers. This happens when the birds poke around while searching for nectar (KUIJT 1969, FEEHAN 1985). Several genera of Loranthaceae, especially those with inconspicuous flowers, are known to be insect-pollinated (KUIJT 1969).

The fruits of the mistletoes are commonly eaten by groups of usually unspecialized frugivorous birds. They disperse the seeds by depositing them onto the branch of another host tree. Due to the sticky tissue, the seeds adhere strongly to the host and are quite safe from being washed away by the rain (KUIJT 1969).

The extracts of some Loranthaceae are of local importance for medicinal uses (*Struthanthus*) (RIZZINI 1982). The sticky tissue of the fruits of *Loranthus europaeus* and some other mistletoes was used formerly as a bird-lime as well as to catch flies (KUIJT 1969).

Key to the genera (after BURGER & KUIJT 1983)

1	Flowers unisexual (aborted stamens or styles sometimes present)	*Struthanthus*
1*	Flowers bisexual (perfect)	2
2	Inflorescence a spike or raceme with decussate single flowers	*Oryctanthus*
2*	Inflorescence a spike or raceme with decussate triads or diads	3
3	Flowers less than 4 mm long; epicortical roots from base of plant	*Phthirusa*
3*	Flowers longer than 4 mm; lacking any epicortical or other roots	*Psittacanthus*

Oryctanthus (neotrop. 10, CR 5, GD 5)
Small hemiepiphytic shrubs with opposite leaves and the flowers emerging from depressions in the inflorescence axis. Somewhat similar to the Viscaceae genus *Phoradendron*, but the flowers evenly dispersed over the inflorescence axis instead of flower clusters being interrupted by clusters of bracts.

O. alveolatus (H.B.K.) Kuijt
Small shrub; leaves opposite to subopposite, ovate to suborbicular, 2-8(-10) cm long, 1,5-5(-9) cm wide, obtuse to rounded at base, glabrous, subsessile; inflorescences axillary or at the nodes on leafless terminal shoots resembling panicles, spicate, 1-4(-6) cm long; fruits ovate, 5 mm long, 3,5 mm wide, green, becoming reddish purple. A fariable and widespread species, in evergreen wet lowland forests, from Costa Rica to Brazil and Bolivia.

O. cordifolius (Presl.) Urban, Pl. 75d
Large shrub; leaves opposite, broadly ovate, 4-14 cm long, 3-12 cm wide, entire, subcordate at base, glabrous, subsessile; inflorescences axillary, of 1-3 spikes, 2-12 cm long; fruits ovoid, 5 mm long, dark maroon or black. In wet forests, from southern Mexico to Colombia.

O. occidentalis (L.) Eichler, Pl. 75c
Small shrub; leaves opposite to subopposite, elliptic to ovate, 3-9(-16) cm long, 2-8(-14) cm wide, obtuse to rounded at base, glabrous, subsessile; inflorescences axillary, spicate, 0,8-3 cm long; fruits cylindrical and usually constricted around the center, 2-3 mm long, ca. 1,7 mm wide, greenish to yellow. In moist and very wet forests, from the sea level up to 1000 m alt., ranging from Costa Rica to Colombia.
Due to the disjunct distribution and the corresponding vegetative differences, *O. occidentalis* can be subdivided into a Jamaican subspecies and another one with continental distribution, *O. occidentalis* ssp. *continentalis*, which occurs in the Golfo Dulce region (KUIJT 1987).

Phthirusa (neotrop. 40, CR 2, GD 1)
Hemiparasitic, erect or scandent shrubs, with opposite to alternate leaves and always bisexual flowers, hard to distinguish from *Struthanthus* and *Oryctanthus*.

P. pyrifolia (H.B.K.) Eichler
Hemiepiphytic shrub, often pendent, with flattened branches; leaves opposite, subopposite or rarely alternate, coriaceous; inflorescences axillary, solitary or paired spikes, 4-12 cm long; flowers small, sessile, dark red; fruits oblong to ellipsoid, 4-8 mm long. A common parasite and probably the most widespread species of this family (KUIJT 1986). In evergreen and deciduous forests, from southern Mexico and the West Indies to northern South America.

Psittacanthus (neotrop. 50, CR 9, GD 6)
A genus of hemiparasitic shrubs, characterized by its usually hummingbird-pollinated, large, showy flowers.
P. rhynchanthus (Benth.) Kuijt, Pl. 75e,f
Shrub with strongly 4-angled leafy branches; leaves opposite to subopposite, asymmetric; inflorescences terminal, rarely axillary, paniculate, 5-12 cm long; flowers ca. 4 cm long before anthesis, orange to red; fruits ellipsoid, black, 9mm long, 5 mm wide. In lowland forests, from southern Mexico to Venezuela.

Struthanthus (neotrop. 50, CR 12, GD 1)
Scandent or erect shrubs, often unisexual, with small whitish to greenish flowers. A genus in need for a revision, difficult to define due to its great variation of vegetative structures within the same species or even the same individual.
S. leptostachyus (H.B.K.) G.Don
Large shrub, the branches horizontal or scandent, epicortical roots present from the base or the stem; leaves opposite to subopposite, leaves of juvenile plants linear, those of mature plants broadly ovate-lanceolate to ovate, entire, glabrous; inflorescences axillary, spicate, 1-4, unisexual, 2-8 cm long; flowers unisexual, yellow, mostly in triads; fruits up to 6 mm long, 4 mm wide. in wet evergreen forests or partly deciduous, from Costa Rica to Peru.

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Lythraceae

A family of trees, shrubs and herbs, most abundant in the lowlands of the neotropical region. Rather nondescript, they only can be distinguished from other families by the combination of the following characters. **Leaves** simple, opposite, sometimes whorled, rarely alternate, entire, stipules sometimes present, minute; **inflorescences** simple or compound, racemose, paniculate, or flowers solitary; **flowers** actinomorphic or sometimes zygomorphic, 4-6(-21)-merous, hypanthium tubular, usually appendiculate between the calyx lobes, petals free, usually as many as the calyx lobes, sometimes reduced or absent, stamens 8-12-numerous, filaments of different length, ovary superior, sometimes stipitate, 1-2-

locular, style 1; **fruits** dehiscent or indehiscent capsules or nuts, seeds sometimes winged. Cosmopol. 27/600, CR 7/17, GD 4/7.

Several studies demonstrate that probably all species of *Lafoensia* (incl. *L. punicifolia*) are pollinated by bats (Sazima & Sazima 1975, 1977, Vogel 1958, 1969). Other genera are assumed to be melittophilous, or their pollination mode is still unknown.

Several species of two Old World genera (*Lawsonia, Lagerstroemia*) have been introduced into tropical America, where they are cultivated as ornamentals (Nevling 1958, Lourteig 1989). One of them, *Lagerstroemia speciosa,* is present in the Golfo Dulce region.

Key to the genera (A. ESTRADA)

1	Herbs or shrubs	2
2	Plants (leaves, stems, inflorescences) black-glandular, flowers in fascicles, actinomorphic, not spurred, hypanthium urceolate and not costate	*Adenaria*
2*	Plants not black-glandular; flowers single or in racemes, zygomorphic, spurred at the base, hypanthium tubular and costate	*Cuphea*
1*	Trees	3
3	Plants native; leaves with a domatium on apex; flowers with petals white or yellow; flowers 12-16-merous	*Lafoensia*
3*	Plants exotic; leaves without a domatium; flowers with petals usually pinkish to violet; flowers 6-9-merous	*Lagerstroemia*

Adenaria (neotrop. 1, CR 1, GD 1)
Monotypic genus.

A. floribunda H.B.K.
Shrub or tree, up to 2,5 m tall, young twigs with reddish bark; leaves lanceolate, 2-13,5 cm long, 0,6-5 cm wide, glandular punctate, stipules up to 1,5 mm long; inflorescences axillary, dense clusters of cymes; flowers 4-5-merous, tristylous, petals rose or white; fruits ovoid indehiscent capsules. From the southern United States to Argentina and southern Brazil.

Lafoensia (neotrop. 10, CR 1, GD 1)
Small to large trees or shrubs with opposite, glabrous leaves, large, showy flowers and large, woody, indehiscent capsular fruits.

L. punicifolia DC.
Small to medium-sized tree, up to 30 m tall; leaves elliptic or lanceolate, submarginal vein well developed; inflorescences terminal, racemose, or more frequently flowers solitary; flowers 12-24-merous, calyx pyriform, petals yellow, stamens 25-36, greatly exserted; fruits hard woody capsules, to 6,5 cm long, 4 cm wide, seeds reddish, winged. Distributed from Mexico to Panama and along the Andes to Bolivia.

Lagerstroemia (paleotrop. 53, CR 2, GD 1)
Small to large trees with subalternate or verticillate leaves and white, pink, or purplish petals. Most of the species possess dimorphic anthers (but not present in *L. speciosa*).

L. speciosa (L.) Persoon
Small to medium-sized tree; leaves oblong-elliptic; inflorescences terminal, paniculate; flowers (4-)6(-7)-merous, petals long clawed, stamens numerous; fruits dehiscing capsules, ellipsoid-globose, seeds ferruginous. Native to tropical Asia but also cultivated throughout tropical America.

Lafoensia punicifolia

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Magnoliaceae

A rather old family of trees and shrubs, well represented in the late Cretaceous and Tertiary, with many primitive characters, like the spirally arrangement of leaves and flower parts. **Leaves** spirally arranged, simple, entire or rarely 2-10-lobate, stipules large, sometimes adnate to the petiole, at first enclosing the young growths, later caducous; **flowers** axillary, usually solitary, on short shoots, bisexual or rarely unisexual, perianth simple, spirally arranged, tepals 6 or more, stamens numerous, free, spirally arranged, connective more or less produced into an apical appendage, ovary superior, sometimes on a gynophore, carpels rarely 1, mostly few to numerous, free or sometimes concrescent; **fruits** apocarpous, sometimes syncarpous, indehiscent or dehiscing longitudinally or rarely circumscissile, seeds large, 1-several in each fruiting carpel. Mostly found in Southeast Asia, from tropical to temperate zones, but also represented in the Neotropics with 2 genera. Cosmopol. 7/165, CR 2/3, GD 1/1.

The pollination of some North American species of *Magnolia* was studied by HEISER (1962) and THIEN (1974). All of his investigated species had protogynous flowers, and were pollinated by beetles feeding on stigmas, pollen, nectar and secretions of the petals. The beetles are usually attracted by the floral odor, which is similar to rotten fruits (GOTTSBERGER 1977). Species of *Talauma* are assumed to be pollinated in a similar way. GOTTSBERGER (1977) describes that fruit-eating beetles, attracted by the odor, crawl into the interior of the flowers, where they spend some time inside, feeding on the tepals and pollinating the flowers.

Talauma (pantrop ca. 45, CR 1, GD 1)
A genus with emphasis in Southeast Asia with more or less grooved petioles. The main characters are the (basally) connate carpels, becoming woody in fruit, and dehiscing circumscissile with the persistent basal part, bearing the suspended seeds.

T. gloriensis Pittier
Tree, up to 30 m tall; leaves up to 31 cm long and 16 cm wide, coriaceous, glabrous, entire; flowers greenish white to creamy white, tepals 9, 4-4,5 cm long; fruits ovoid, with the carpels up to 4 cm long. Distributed in Central America, from Costa Rica to Western Panama in an altitude at about 1000 m alt.

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Malpighiaceae

Trees, shrubs and lianas, usually easy to recognize to family because of the indumentum of T-shaped trichomes and the clawed flowers and the sometimes present extrafloral nectaries. **Leaves** simple, opposite, entire, petiole or lamina often bearing large glands, stipules present, sometimes intrapetiolar or inserted on the petiole; **inflorescences** axillary, paniculate, pseudo-racemose or umbellate; **flowers** bisexual, slightly zygomorphic (usually one petal differs in size, shape, color etc. from the others), sepals 5, nearly always 4 or all 5 of them bearing oil-secreting glands abaxially, petals 5, free, clawed, often yellow, stamens mostly 10, rarely some of them reduced, ovary superior, mostly 3-locular; **fruits** schizocarps of 3 samaras or 3 cocci, or drupaceous with 1-3 pyrenes, rarely dehiscent capsules. Distributed in several habitats, from rain forests to arid zones, mostly in the Neotropics, but also in the Old World. Cosmopol. 67/1100 CR 15/73, GD 11/23.

Nearly all neotropical species possess oil secreting glands (elaiophores) on the outside of the sepals, which serve as attractants for the pollinators (oil collecting Centridine bees) (VOGEL 1990).
The fruits of the Malpighiaceae are mostly wind-dispersed, a few species of *Spachea*, *Bunchosia* and *Malpighia* are endozoochorous (CUATRECASAS & CROAT 1980).

The wood of some Malpighiaceae has local importance and is used for making furniture or for construction, and the tannin-rich wood of some species is used as dying or tanning material (CUATRECASAS & CROAT 1980). The fruits of some species of *Malpighia* (e.g., *M. glabra*) are rich in Vitamin C and have an aromatic sour taste, therefore they are used in many neotropical countries as commercial fruits or in juices or jams. Some species of *Byrsonima* (e.g., *B. crassifolia*) provide edible fruits. The Amazonian species *Banisteriopsis caapii* contains a hallucinogen called "ayahuasca", which is used in some South American countries in religious ceremonies. The fruits of *Bunchosia cornifolia* are edible and therefore sometimes cultivated (CUATRECASAS & CROAT 1980).

Key to the genera (based on CUATRECASAS & CROAT 1980)

1	Fruit a schizocarp splitting into 3 samaras; receptacle pyramidal; usually lianas or climbing shrubs	2
2	Wings of the samaras generated from the accrescent sepals	*Dicella*
2*	Wings of the samaras not generated from the accrescent sepals	3
3	Dorsal wing of the samaras well developed, large, conspicuous; lateral wings short or absent	4
4	Stamens 10, subequal, fertile; style tips blunt, stigma apical, subapical or at the adaxial angle of the styles, or hooked; samara wing thickened on upper or lower margin	5
5	Samara wing thick on the upper margin, thin along the lower margin; styles subulate, the stigma capitulate, apical or subapical	*Banisteriopsis*
5*	Samara wing thin at the upper margin, thickened at the lower margin; styles usually thicker and unequal, dilated, spatulate-truncate or hooked at apex, the stigma at its adaxial angle	*Heteropterys*
4*	Stamens 10, unequal, only 4-6 fertile with thicker anthers; styles unequal, the apex enlarged, triangular-truncate, hooked or with foliaceous appendices, the stigma at the inner angle; samara wing thickened on upper margin, thin on lower margin	*Stigmaphyllon*
3*	Dorsal wing of the samaras obsolete or much reduced; lateral wing or wings well developed and larger than the dorsal wing	6
6	Lateral samara wing parted into four narrower wings disposed like an X, all equal or with the abaxial pair shorter than the upper pair or obsolete	*Tetrapterys*
6*	Lateral samara wing continued into a disk encircling the body, parted (open) at the adaxial line, or parted both at the adaxial and abaxial points, thus separating a wing to each side	*Hiraea*

1*	Fruit drupaceous, a loculicidal capsule or a smooth 3-coccoid schizocarp; receptacle flat; usually trees or erect shrubs	7
7	Fruit a schizocarp, splitting into 2-3 indehiscent, smooth, glabrous or pilose cocci	8
8	Styles slender and subulate, the stigmas minute; anthers longitudinally winged	*Lophanthera*
8*	Styles stout, truncate or subpeltate at the apex; anthers unwinged	*Spachea*
7*	Fruit drupaceous or capsular	9
9	Styles subulate, acute; drupe monopyrenous, 3-locular, 3-seeded; cotyledons spirally involute; receptacle hirsute	*Byrsonima*
9*	Styles spatulate, obtuse or truncate at apex; drupes (di)-tripyrenous; cotyledons almost flat or shortly hooked at the end; receptacle glabrous	10
10	Petals pink, red, lilac or white; bracteoles without a dorsal gland; pyrenes rough, with 3-5 dorsal ribs or crests; cotyledons hooked at apex; styles free; flowers in small axillary corymbs or subumbellate	*Malpighia*
10*	Petals yellow; bracteoles with a dorsal gland; pyrenes without crests or ribs; cotyledons straight, plano-convex; styles more or less united or free; flowers in axillary or terminal racemiform inflorescences	*Bunchosia*

Banisteriopsis (neotrop. 92, CR 7, GD 1)
A genus of lianas, usually with glands at the leaf base or along the margin, yellow or pink flowers and schizocarpic fruits, splitting into 3 samaras.

B. cornifolia H.B.K.
Liana, young twigs appressed pubescent with T-shaped trichomes; leaves elliptic, rarely ovate, rounded at the base, slightly pubescent beneath, petioles with 1 or 2 sessile glands near the apex; inflorescences axillary or terminal, multi-branched, petals yellow; fruits with 1-3 samaras, each with a single dorsal wing. Usually in primary tropical moist forests in Central America and northern South America, from southern Mexico to Peru.

Banisteriopsis cornifolia

Bunchosia (neotrop. 55, CR 11, GD 4)
Trees and shrubs with small and inconspicuous stipules and the leaves usually bearing a pair of glands on the lamina beneath.

B. cornifolia H.B.K., Pl. 76b-e
Small tree or shrub, up to 6 m tall; leaves elliptic to oblong-elliptic, 6-15(-35) cm long, 3-6(-14) cm wide, appressed pubescent, at least beneath; inflorescences axillary, pseudoracemose, 5-8 cm long; flowers 1-1,5 cm wide, sepals each bearing two large glands, stamens 8, subequal; fruits drupes, ovoid, up to 25 mm long, red, with usually 2 pyrenes. Usually in tropical moist forests, but also in tropical wet and dry forests, from Mexico to Colombia.

B. macrophylla Rose, Pl. 76a
Small tree or shrub, up to 6 m tall; largest leaves narrowly to widely elliptic, 20-45 cm long, (8-) 12-26 cm wide, velutinous beneath; inflorescences axillary, pseudoracemose, 4-22 cm long; sepals sometimes bearing two large glands, stamens 10; fruits drupes, ovoid, usually 3-lobate, 12-15 mm long, 15-20 mm in diameter, orange to red. From Nicaragua to Panama.

Byrsonima (ca. 130, CR 3, GD 2)
Common name (Costa Rica): nance (J. GONZALEZ pers. comm.)
Usually small trees and shrubs of dryer areas, but sometimes also large trees, always without leaf glands and with indehiscent fruits with fleshy exocarp.

B. crispa A. Juss.
Tree, up to 25 m tall; leaves elliptic, glabrous or

sparsely sericeous, stipules intrapetiolar; inflorescences 6-14 cm long, petals yellow; fruits yellow, globose 1-1,3 cm in diameter. In forests on noninundated ground, from Costa Rica to Colombia, Venezuela and Bolivia.

Heteropterys (neotrop. 120 + 1 sp. W-Africa, CR 8, GD 2)
Trees, shrubs or lianas, usually with impressed glands on the leaves and frequently with a pair of stipitate glands on the petiole. The fruits are schizocarps, splitting into 3 dorsally winged samaras.

H. panamensis Cuatrec. & Croat, Pl. 76f
Liana or rarely shrub, up to 2 m tall; leaves ovate or elliptic to suborbicular, 5-11 cm long, 3-6(-8) cm wide, glabrous or almost so above, sericeous beneath, 1 pair of large glands on the base of the lamina beneath; inflorescences paniculate, with flowers in corymbs or umbels, sericeous or subtomentose; the 4 lateral sepals with a pair of glands; fruits 32-55 mm long, appressed sericeous. From southern Mexico to Panama.

Hiraea (neotrop. 40, CR 7, GD 2)
Mostly lianas, characterized by the stipules conspicuously adnate or somewhat fused to the petiole and the samaras of the fruits each with one dorsal ridge or crest and two lateral wings.

H. fagifolia (DC.) A. Juss.
Liana, vegetative parts densely appressed pubescent with T-shaped trichomes; leaves up to 20 cm long, petiole with 2 glands at the apex, stipules 3-5 mm long; inflorescences of 4-flowered umbels, petals yellow; fruits of 3 samaras with membranaceous lateral wings. In tropical moist forests, from Mexico to Brazil and Peru.

Spachea (neotrop. 6, CR 1, GD 1)
Trees and shrubs with basally glandular leaves, pink or reddish flowers and the schizocarp splitting into 2 or 3 ellipsoid, hard cocci.

S. correae Cuatr. & Croat, Pl. 76g
Trees, up to 35 m tall; leaves usually clustered near the twig ends, elliptic, up to 10,5 cm wide, with several glands on the lower half of the lamina beneath; inflorescences terminal, densely ferruginous pubescent, peduncles with 2 flowers, sepals glandular; fruits ca. 5 mm long, with 2 cocci. In tropical wet forests in Costa Rica and Panama.

Stigmaphyllon (neotrop. 100, CR 8, GD 3)
Lianas and herbaceous climbers, usually with two large glands near the apex of the petiole and schizocarpic fruits with 3 samaras.

S. lindenianum A. Juss.
Liana, vegetative parts appressed pubescent with T-shaped trichomes; leaves ovate, cordate, truncate to abruptly acute at base, palmativeined, the petiole bearing 2 large, sessile glands at the apex; inflorescences dichasia of pseudoumbels, petals yellow, stamens 10, 4 of them sterile; fruits appressed pubescent, with 3 samaras, each with a dorsal wing. In tropical moist and wet forests, from Mexico to Venezuela.

Tetrapterys (neotrop. 90, CR 9, GD 4)
Shrubs and lianas, the leaves usually decussate and bearing glands on the petioles or on the base of the lamina, and dhe schizocarpic fruits with 3 samaras, these distinct in having large lateral and several smaller additional wings.

T. donnell-smithii Small
Liana; leaves oblong, elliptic or ovate, glabrous, glands at the base of the lamina or obsolete; flowers yellow. In tropical forests in Nicaragua, Costa Rica and Panama.

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Malvaceae

Mostly herbs, but also shrubs, subshrubs and trees with mucilaginous resin and fibrous bark, peeling off in stripes and with usually stellate indumentum, characterized by the frequent presence of a calycle, inserted at the base of the calyx, as well as by the filaments being united into a sometimes very long (e.g., *Hibiscus* spp.) staminal tube. Otherwise many of the species are lacking the typical "malvalean" pulvinus. **leaves** alternate, simple or lobed, usually somewhat ovate, always palmately veined, often with serrate margin, stipules present, persistent or caducous; **flowers** axillary, solitary or in inflorescences of various types, sepals and petals 5, stamens 5-numerous, ovary 3-numerous-locular; **fruits** capsules or schizocarps, rarely berries, dehiscent or indehiscent. Worldwide in various habitats in the tropics, subtropics and temperate zones. Cosmopol. 111/1800, CR 28/94, GD 10/17.

The rather few investigations on the pollination of the Malvaceae showed that their main pollinators are various bees and hummingbirds (GOTTSBERGER 1967, GEORGE 1980, PRENDERGAST 1982).

Many species are common ornamental plants, which have become of commercial importance (e.g., *Hibiscus* spp.). The fruits of *Abelmoschus esculentus* are eaten as a vegetable, while *A. moschatus* is mostly cultivated for the aromatic oil of the seeds which is used for beverages and perfumes.

Key to the genera (after FRYXELL, in prep.)

1	Individual flowers and fruits subtended by an involucel or epicalyx (this sometimes caducous)	2
2	Involucel trimerous	3
3	Involucellar bracts ovate-laciniate, concealing the bud; leaves palmately lobed; seeds lanate (bearing commercial cotton); plants shrubby	*Gossypium*
3*	Involucellar bracts subulate to liguliform, entire, not enclosing the bud; leaves ovate to shallowly lobed; seeds short-pubescent or glabrous; plants arborescent	*Hampea*
2*	Involucel of 5 or more elements	4
4	Fruits fleshy (baccate), usually red, sometimes white, the 5 carpels each 1-seeded; petals auriculate at base, usually red, forming a tubular corolla; the 10 styles and stigmas ± exserted	*Malvaviscus*
4*	Fruits not fleshy (a capsule or schizocarp), the carpel number various; petals not auriculate, the corolla sometimes tubular but usually campanulate to rotate; androecium and gynoecium included or exserted	5
5	Fruits capsular, 5-locular; seeds several per locule	6
6	Calyx asymmetrical, splitting laterally at anthesis and falling with the corolla; style single with 5 sessile stigmas, fruits elongate, often hispid	*Abelmoschus*
6*	Calyx symmetrical, persistent; styles 5, apically distinct, each with a capitate stigma; fruits ovoid to elongate, variously pubescent	*Hibiscus*
5*	Fruits schizocarpic, with 5-40 mericarps; seeds solitary	7
7	Leaves with 1-3 nectaries near base of principal veins beneath; fruits prominently glochidiate; involucellar bracts 5, alternate with the lobes of the calyx	*Urena*
7*	Leaves with nectaries absent; fruits armed with 3 barbed spines or unarmed (not glochidiate); involucellar bracts 4-16	*Pavonia*
1*	Individual flowers and fruits not subtended by an involucel	8
8	Mericarps (and styles and stigmas) 3-6, divided into an upper and a lower cell by a constriction; calyx 3-6 mm	*Wissadula*
8*	Mericarps (and styles and stigmas) 5-30, not divided into 2 cells; calyx usually larger	9
9	Flowers and fruits in head-like groups, subtended and enclosed by foliaceous floral bracts	*Malachra*
9*	Flowers and fruits solitary or aggregated into inflorescences of various types but not enclosed by specialized bracts	*Sida*

Abelmoschus (paleotrop. 15, CR 2 cultivated, GD 1 cultivated)
Usually annual herbs or sometimes shrubby, with large, usually solitary, axillary flowers. The fruits are elongate, loculicidally dehiscent capsules bearing numerous seeds in each locule.

A. moschatus Medic.
Herb or suffrutex, sparsely to densely long-hirsute, usually with simple, whitish hairs; leaves circular to subcircular, palmately 3-5-lobate, 10-20 cm long, 12-24 cm wide, irregularly serrate-dentate, appressed hirsute on both sides; flowers axillary, solitary, calyx 5-dentate, petals yellow with a dark purple spot at the base; capsules ovoid, 5-7 cm long, 2-3 cm in diameter, appressed hispid. Native to Southeast Asia, but cultivated throughout the tropics worldwide.

Hibiscus (cosmopol. 300, CR 8, GD 2)
A worldwide distributed genus, which is very heterogeneous, except for the constant features of 5-celled capsules and 5 capitate stigmas. Some of its species have obtained economic importance through their use in horticulture.

Malvaviscus (neotrop. 3, CR 6, GD1)
Shrubs or small trees, characterized by the red petals being slightly auriculate, as well as by the fleshy fruit which is very unusual in the family and furthermore present only in the extralimited genus *Anotea*.

M. arboreus Cav., Pl. 76h,i
Shrub or small tree up to 10 m; very variable in shape and size of vegetative and flower parts, hence it is subdivided into several varieties; leaves, 5-7-palmately-veined, with sinulate to serrate margin; calycle present, more or less equaling the calyx, petals deep pink to bright red, 2,3-5,5 cm long, staminal tube 3-6 cm long; fruit depressed obovoid. In various habitats in tropical and subtropical zones, from the Southern United States and the West Indies through northern South America to Brazil and Peru.

Malvaviscus arboreus

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Marcgraviaceae

A family of mostly hemiepiphytic or epiphytic lianas, with sprawling, climbing or pendulous and sometimes dimorphic branches (juvenile and adult stage). Easy to recognize by the youngest leaves typically coiled at the twig apex, resembling a terminal stipule. **Leaves** simple, alternate, entire to crenate, glabrous, often dark punctate, stipules lacking; **inflorescences** terminal or subterminal, spicate, racemose or umbellate, erect or pendulous, some of the bracts transformed into characteristic saccate or cup-

shaped nectaries of various shape; **flowers** actinomorphic, bisexual, sepals 4-5, free, persistent, petals 3-5, free or connate, stamens (3-)5(-numerous), filaments free or connate, ovary superior; **fruits** capsules, coriaceous, usually globose, irregularly dehiscent, seeds few to numerous. Neotrop. 5/108, CR 7/24, GD 4/10.

The basal groups of Marcgraviaceae are usually pollinated by insects. While the genera *Ruyschia* and *Caracasia* are thought to be myiophilous, the species of *Souroubea* are known to be psychophilous as well as sphingophilous (MACHADO & LOPES 2000). A study of *Souroubea guianensis* (MACHADO & LOPES ined.) found an unusual mode of pollen presentation in tapetal oil, but no observations on its pollinators (thought to be butterflies) were made. The evolutionary trend leads from condensed and spike-like inflorescences to brush-type inflorescences adapted to pollination by birds and to umbelliform inflorescences adapted to bat pollination (SAZIMA et al. 1993). Species of *Marcgravia* are visited by birds as well as by bats (with nocturnal and almost colorless flowers) (VOGEL 1957, SAZIMA & SAZIMA 1980, TSCHAPKA & HELVERSEN 1999). Flowers of *Norantea* are visited by hummingbirds and passerine birds, due to their red flowers and brush-like inflorescences (SAZIMA et al. 1993, PINHEIRO et al. 1995).

Key to the genera (after BEDELL 1985)

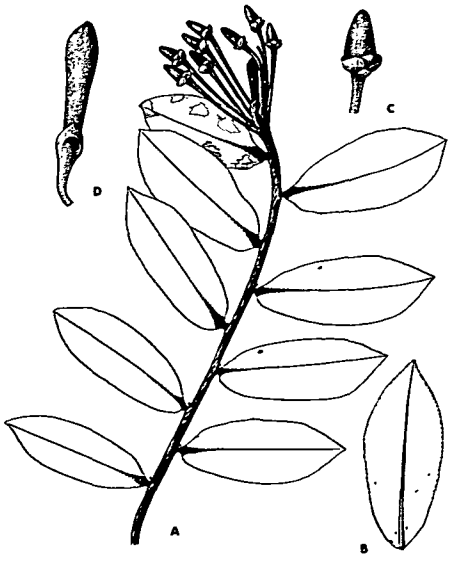
1	Inflorescence racemose or spicate	2
2	Inflorescence racemose; nectaries variously inserted on the pedicel	*Souroubea*
2*	Inflorescence spicate; nectaries inserted on the rhachis at the base of the flowers	*Sarcopera*
1*	Inflorescence umbellate or subumbellate	3
3	Inflorescence completely fertile; sepals and petals 5, petals free or variously connate; leaves spirally arranged	*Marcgraviastrum*
3*	Inflorescence in part sterile (central part); sepals and petals 4, petals calyptrately connate; leaves distichous	*Marcgravia*

Marcgravia (neotrop. 45, CR 10, GD 7)
A genus easy to recognize by the distichous leaf arrangement and the inflorescences in dense umbels. The branches are dimorphic, with an adult stage and a juvenile stage, which grows appressed to a tree trunk.

M. affinis Hemsl.
Liana; leaves elliptic, 7-9 cm long, 2,5-3,5 cm wide, often translucent and with numerous black dots on the blade beneath; inflorescences with 8-12 flowers and 2-4 nectaries; flower pedicels 2-2,5 cm long, nectary pedicels 10-15 mm long. In primary forests, from Costa Rica to Colombia.

M. brownei (Triana & Planch.) Krug & Urb.
Large epiphytic liana; leaves oblong, (10-)12-17 cm long, 3,5-5 cm wide; inflorescences with 15-30 flowers and 2-5 nectaries; flowers mostly slightly oblique on the pedicels, flower pedicels ca. 4,5 cm long, nectary pedicels 5-10 mm long. In primary forests and pastures, from Honduras to Ecuador, Peru and Bolivia.

M. pittieri , Pl. 77a-c
Epiphytic liana; leaves elliptic, 9-12 cm long, 2,5-3 cm wide; inflorescences with 15-25 flowers and 3-5 nectaries; flower pedicels 2-3 cm long, nectary pedicels 0,3-1 cm long. In primary forests, from Guatemala to Panama.



Marcgravia schippii
A. Habit. B. Leaf, abaxial view. C. Flower. D. Nectary.

M. schippii Standl., Pl. 77d
Large epiphytic liana; leaves oblong, 10-12 cm long, (2-)3-4 cm wide; inflorescences with 6-9

flowers and 0-1(-2) nectaries; flowers erect or slightly oblique on the pedicels, flower pedicels 4,5-6 cm long, nectary pedicels ca. 5 mm long. In and at the edge of primary forests, from Belize to Colombia and Venezuela.

Marcgraviastrum (neotrop. 15, CR 1, GD 1)
A segregate of *Norantea*, with the inflorescences of erect, contracted racemes with a greenish or cream colored nectary at the pedicel base.

M. subsessile (Benth.) Bedell
[syn. *Norantea subsessilis* (Benth.) Donn. Sm.]
Epiphytic liana; Leaves short petiolate, obovate, elliptic-obovate to oblong, leathery, coriaceous; inflorescences usually erect, umbelliform with 9-20 flowers, nectaries saccate, erect, less than 2 cm long; flowers large, pink to maroon, pedicels 4-7 cm long, petals variously connate; fruits subglobose, 1-1,5 cm long, 1,5-2 cm wide, reddish. On trees in pastures, along river margins and in primary wet forests, from Costa Rica to northern Ecuador.

Sarcopera (neotrop. 10, CR 2, GD 1)
A segregate genus from *Norantea* with spicate inflorescences and sessile flowers.

S. sessiliflora (Triana & Planch.) Bedell, Pl. 77f
(syn. *Norantea sessiliflora* Triana & Planch., *Norantea sessilis* L.O. Williams)
Liana; leaves 7-12 cm long, without glands; inflorescences mostly terminal, spicate, 20-30 cm long, nectaries cup to pouch-shaped; flowers sessile, reddish to orange. From Central America to Western Colombia and Ecuador.

Souroubea (neotrop. ca. 20, CR 5, GD 2)
Shrubs or lianas, sometimes epiphytic, mostly with obovate to oblanceolate leaves. The inflorescences are always racemose with the tubular nectaries inserted just below each flower.

S. sympetala Gilg
Shrub or liana, sometimes epiphytic; leaves chartaceous, often asymmetric, 8-14(-16) cm long, 3,5-6(-8) cm wide; inflorescences 15-33 cm long, rhachis densely pubescent, with 15-30 flowers; nectabies auriculate, the auricles about as long as the spur; petals connate, stamens 5. In and at the edge of primary wet forests, from Guatemala and Belize to Colombia, Peru and Venezuela.

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Melastomataceae

One of the largest neotropical families, consisting mainly of shrubs and small trees, but also a few vines, hemiepiphytes and epiphytes. The family is easy to recognize by the characteristic opposite leaves with 2-6 longitudinal veins subparallel to the midvein and with cross veins connecting these perpendicularly. A useful floral character are the various appendages of the anthers. **Leaves** simple, opposite, rarely whorled, sometimes unequal, 3-to several veined (1-veined in *Mouriri*); **inflorescences** axillary or terminal, cymose, racemose, paniculate or flowers solitary; **flowers** bisexual, usually 4-6-merous, hypan-

thium cup-shaped, bearing the perianth and stamens on a torus at or near the base of the calyx lobes, calyx united, small, mostly open in bud, persistent, petals free, mostly white or purple, stamens usually twice as many as the petals, rarely more, isomorphic or dimorphic, opening by terminal pores, connective prolonged below the thecae or below the insertion of the filament into one or more lobes, spurs or appendages of various types, ovary superior or inferior, 2-5-locular; **fruits** loculicidal capsules, more or less enclosed by the persistent hypanthium in genera with superior ovary, or berries in genera with inferior ovary. Temperate, tropical and subtropical, mainly in the Neotropics. Cosmopol. 188/4950, CR 34/277, GD 18/88.

The subfamily Memecyloideae (including the genus *Mouriri*) nowadays is separated from the Melastomataceae to form a distinct family, Memecylaceae (RENNER 1993).

Various types of ant domatia evolved in several species within various genera, among them the genera *Clidemia* (RENNER & RICKLEFS 1998), *Conostegia* (BENSON 1985, ALONSO 1998) and *Tococa* (MORAWETZ et al. 1991, NICKOL 1993, RENNER & RICKLEFS 1998), which also occur in the Golfo Dulce region. The formicaria of *Tococa guianensis* are hollow 2-parted chambers from the swollen leaf blade or petiole, harbor various species of ants. While one part of the chamber is inhabited by ants the other serves as a detritus chamber and stable for aphids. *Myrmelachista* ants have been observed clearing the vegetation surrounding *T. guianensis* (syn. *T. occidentalis*) by killing it with an herbicidal poison (MORAWETZ et al. 1991, RENNER & RICKLEFS 1998).

Most of the neotropical species of Melastomataceae are pollinated by numerous species of nectar- or pollen-collecting bees, while some species are also pollinated by hummingbirds, bats or rodents (RENNER 1989). The large flowers of *Bellucia* are pollinated by numerous species of bees: Anthophoridae, Oxaeidae and Apidae (RENNER 1986/87, 1990). Most flowers of *Blakea* are visited by various pollen-collecting bees (LUMER 1983). Exceptions, including *B. austin-smithii*, *B. chlorantha* and *B. penduliflora*, provide nectar instead of pollen and are pollinated by rodents rather than bees (LUMER 1980, LUMER & SCHOER 1986). *Clidemia capitellata* was observed to be pollinated by Halictid bees of the genus *Augochloropsis* (RENNER 1984, MELO et al. 1999). *Henriettea succosa* is visited by the pollen-collecting bees *Melipona scutellaris*, *Xylocopa* (*Neoxylocopa*) *suspecta*, *Xylocopa* sp. and *Augochloropsis* sp. (MELO & MACHADO 1996). *Miconia nervosa* is pollinated by bees of the genera *Paratetrapedia* and *Augochloropsis* (RENNER 1984). The primary pollinators of four species of *Mouriri* proved to be several species of euglossine bees, followed by species of *Xylocopa* and *Melipona* (BUCHMANN & BUCHMANN 1981, RENNER 1989).

The seeds of Melastomataceae are either wind-dispersed (capsular fruits) or endozoochorous (baccate fruits), mainly dispersed by frugivorous birds (RENNER 1986, 1989, STILES & ROSSELLI 1993, LOISELLE & BLAKE 1999). The fruits of *Bellucia* are eaten by mammals, especially monkeys (RENNER 1990). LUMER (1983) observed the dispersal of the seeds of *Blakea* species with fleshy reddish fruits by various birds, which deposit the sticky seeds onto tree branches when trying to rub them off. The seeds of the species of *Miconia* are mainly dispersed by birds, but also by rodents and other mammals (MAGNUSSON & SANAIOTTI 1987, GALETDI & STOTZ 1996, GOLDENBERG & SHEPHERD 1998). A few species, including *Miconia affinis* and *M. nervosa*, are probably dispersed by ants (BYRNE & LEVEY 1993, GROENENDIJK et al. 1996, DALLING & WIRTH 1998).

Key to the genera (A. ESTRADA)

1	Leaves 1-nerved; anthers opening by two lateral slits, one on each side, connective bearing a large gland on the middle of the anther (Tribe Memecyleae)	*Mouriri* (*M. gleasoniana*)
1*	Leaves with 1-4(-6) pairs of longitudinal veins arcuately subparallel to the midvein; anthers opening by a terminal or nearly terminal pore or pores, minutely or not at all glandular	2

2	Fruit a capsule, ovary usually superior, free from the hypanthium	3
3	Herbs or small subshrubs	4
4	Stems tetragonal	5
5	Flowers with conspicuous magenta petals, 1,5-2 cm long; fruit oblong or elliptic 0,8-1,5 cm long; ovary 4-locular	*Arthrostemma*
5*	Flowers with small, whitish petals, less than 0,5 cm long; fruit round, small, less than 0,5 cm in diameter; ovary 2-locular	*Aciotis*
4*	Stems terete	6
6	Leaves strongly dimorphic; seeds not cochleate	*Centradenia*
6*	Leaves essentially isomorphic; seeds cochleate	7
7	Leaves with appressed pilose hairs; inflorescences with whitish flowers; hypanthium without ribs	*Tibouchina* p.p.
7*	Leaves without appressed hairs; inflorescences with magenta flowers; hypanthium with eight longitudinal ribs	*Schwackaea*
3*	Trees or lianas	8
8	Lianas	*Adelobotrys*
8*	Trees	9
9	Leaves with asperous hairs or scales, adnate to the epidermis on upper leaf surface; flowers with relatively large petals; calyx with setose hairs; anther connective ventrally bilobate; seeds cochleate	*Tibouchina* p.p.
9*	Leaves without hairs or scales; flowers with inconspicuous petals, calyx with hairs, anther connectives dorsally spurred; seeds not cochleate	*Graffenrieda*
2*	Fruit a berry, ovary wholly or partly inferior	10
10	Epiphytic or hemiepiphytic shrubs, flowers individually subtended by two pairs of conspicuous and decussate bracts inserted at the base of the hypanthium; anthers coherent in a ring, each theca opening by a separate pore (Tribe Blakeae)	11
11	Anthebs relatively short and thick, oblong or elliptic, blunt or broadly rounded at the summit, opening by two well-separated apical pores	*Blakea*
11*	Anthers relatively slender, linear to lanceolate or subulate, opening by two close-together, tiny apical pores	*Topobea*
10*	Shrubs or trees (except *Clidemia epiphytica*), flowers not individually subtended by decussate bracts; anthers separate at anthesis (exp. *Bellucia*), in most species opening by a single pore (Tribe Miconieae)	12
12	Flowers single, in fascicles or in cymose or paniculate, axillary, lateral or pseudo-lateral inflorescences	13
13	Petals acute or acuminate	14
14	Flowers in fascicles from leafless nodes below the existing leaves; fruits without ribs	*Henriettea* p.p.
14*	Inflorescences from nodes (pseudo-lateral inflorescences) of the existing leaves; fruits longitudinally costate when dry	*Ossaea* p.p.
13*	Petals obtuse or rounded	15
15	Flowers relatively large, anthers broadly oblong or dolabriform, more or less coherent in a ring, opening by two minute pores; fruits relatively large	*Bellucia*
15*	Flowers relatively small, anthers linear to oblong or subulate, separate at the anthesis, opening by a single pore; fruits relatively small	16
16	Flowers in fascicles or cymose from the axils of existing leaves	*Clidemia*
16*	Flowers solitary or in fascicles from leafless nodes below the existing leaves	*Henriettea* p.p.
12*	Flowers in paniculate terminal inflorescences	17
17	Petals acute or acuminate	18
18	Inflorescences with flowers sessile along one side of the lateral branches (secundiflorous); fruits round; seeds rounded and tiny muricate	*Leandra*
18*	Inflorescences with flowers not sessile along one side of the lateral branches; fruits longitudinally costate when dry; seeds angulate and smooth	*Ossaea* p.p.
17*	Petals obtuse, rounded or retuse	19

19	Formicaria present at the summit of the petioles of the larger leaves	*Tococa*
19*	Formicaria absent	20
20	Calyx calyptrate in bud, deciduous at the torus at anthesis	*Conostegia*
20*	Calyx open in bud, the lobes persistent at anthesis but often minute	*Miconia*

Aciotis (neotrop. 30, CR 2, GD 1)
Herbs or subshrubs with fragile, tetragonal stems and small, 4-merous flowers in terminal panicles and capsular fruits.
FREIRE FIERRO (1998) mentions the occurrence of fleshy capsules and berry-like fruits within this genus (e.g., *A. caulialata*).

A. caulialata (Ruiz & Pav. ex E.A. López) Triana
Erect herbs or subshrubs, up to 1 m tall, stem often prominently winged; leaves oblong-ovate to ovate, 4-10(-17) cm long, 1,5-4,5(-8) cm wide, pubescent on both sides with fine, eglandular trichomes; flowers sparsely puberulent with glandular trichomes, petals white. In lowland rain forests, in wet disturbed sides along rivers and in forest margins, from Guatemala to Peru and Brazil.

Adelobotrys (neotrop. 25, CR 1, GD 1)
Lianas, or rarely shrubs or trees with 5-merous, often white to pink flowers in terminal panicles, characterized by the connective provided with a dorsal spur, bearing a linear and sometimes bifid appendage.

A. adscendens (Sw.) Triana, Pl. 78a
Liana, up to 8 m tall, with bifid indumentum; leaves ovate to elliptic-ovate, entire to serrulate, fine ciliolate, 5-7-nerved; inflorescences umbelliform 20-40 cm long, many flowered; flowers 5-merous, petals white to pink; fruits capsules. Widespread, in very wet forests, from southern Mexico and Jamaica to Amazonian Peru, Bolivia and Brazil.

Arthrostemma (neotrop. 4, CR 2, GD 1)
Small genus of glabrous or glandular-pilose herbs with quadrangular stems. The terminal, few-flowered paniculate inflorescences bearing reddish to pink, 4-mer ous flowers.

A. ciliatum Pav. ex D. Don
Herb, up to 6 m tall, glandular-pilose, glabrescent; leaves ovate to ovate-lanceolate, membranaceous, inconspicuously ciliolate-serrulate, 5-7-nerved. Common weed on open sites and forest margins, from southern Mexico and the Antilles to Bolivia.

Blakea (neotrop. 100, CR 17, GD 3)
Mostly epiphytic trees and shrubs, sometimes scandent with 6-merous flowers and baccate fruits. Differing from similar *Topobea* by the anthers being laterally compressed and usually coherent, with two minute discrete pores.

B. gracilis Hemsl., Pl. 78b
Common name (Costa Rica): San Miguel (LUMER 1983).
Large epiphytic shrub or tree; leaves elliptic to elliptic-ovate, 4,5-8,8 cm long, glabrous on both sides; petals white, pinkish at the apex. Usually in montane areas but also occurring in lowland wet forests, from Nicaragua to Panama.

B. litoralis, Pl. 78c
Epiphytic shrub, up to 5 m tall; leaves elliptic-ovate or obovate, 4-12 cm long, 1,5-5,2 cm wide, glabrous, but inconspicuously verrucose on both sides; petals pink. From Nicaragua to Costa Rica.

B. subpeltata Cogn.
Liana or epiphytic shrub; leaves ovate to obovate-elliptic, 7-12 cm long, glabrous above, sparsely furfuraceous-puberulent beneath; petals white to pinkish. Endemic to Costa Rica.

Clidemia (neotrop. 117, CR 35, GD 15)
A rather large genus of almost always pubescent erect trees and shrubs or rarely climbers with axillary or sometimes ramiflorous inflorescences and baccate fruits.

C. capitellata (Bonpl.) D.Don
Shrub, up to 3 m tall, young stems, leaf venation, inflorescences and hypanthium pubescent with stellate and glandular hairs; leaves ovate to elliptic-ovate, 5-7-veined, moderately to densely hirsute on both sides, margin ciliate-serrulate; inflorescences pseudolateral, spike-like or pyramidal, sometimes with few lateral branches, 5-14 cm long; flowers 5-merous, petals white; fruits 6-9 mm in diameter, blue to purplish. Widely distributed, usually along rivers and in forest margins, from southern Mexico and the Antilles to Bolivia and Brazil.

C. crenulata Gleason, Pl. 78d,e
Shrub, up to2(-5) m tall, young twigs, petioles, inflorescences and hypanthium covered with fine, partly glandular indumentum; formicaria present, ca. 1 cm long, ellipsoid, in pairs, inserted just below the nodes of the branchlets; leaves ovate to elliptic-ovate, sparsely to moderately setose, (5-) 7-9-veined, margin crenulate; inflorescences cymose, few-flowered, 1 cm long; flowers 4-merous, petals white; fruits 7-9 mm in diameter, blue to purplish. From Belize and Guatemala to Colombia and northern Ecuador.

C. densiflora (Standl.) Gleason, Pl. 78h
Shrub, up to 3 m tall, young branchlets, petioles, leaf venation beneath and hypanthium densely covered with clavate, roughened hairs; leaves elliptic, glabrous above, sparsely to moderately furfuraceous beneath, 3-5-veined, margin entire to obscurely undulate-serrulate; inflorescences axillary, fasciculate; flowers 4-merous, petals white to pink; fruits 5-6 mm in diameter, orange. In wet forests and gallery forests, from Belize and Guatemala to Colombia (Chocó).

C. dentata D.Don, Pl. 78f,g
Shrub, up to 4(-6) m tall, branchlets petioles, venation beneath, inflorescences and hypanthium moderately hirsute with fine hairs, underlain by stellate hairs; leaves elliptic-ovate to ovate-lanceolate, sparsely strigulose above, sparsely appressed setulose beneath, 5-plinerved, margin ciliate-denticulate; inflorescences pseudolateral, cymose, 2-3 cm long; flowers 5-merous, petals white; fruits 7-9 mm in diameter, dark-blue. In wet forest margins, from Mexico to Bolivia and southern Brazil.

C. epiphytica (Triana) Cogn., Pl. 79a,b
Epiphytic or woody vine climbing, appressed to tree trunks, branchlets sparsely to moderately fine setose; leaves ovate, strongly dimorphic in each pair, essentially glabrous on both sides, margin irregularly serrulate, 3-veined (small leaves) to 7-9-veined (large leaves); inflorescences cymose, few-flowered; flowers 4-merous, petals white; fruit 3,5-4 mm in diameter, violet-blue. In lowland rain forests, from Guatemala to Amazonian Peru.

C. gracilis Pittier
Shrub, up to 2 m tall, young stems strongly flattened, branchlets, leaf venation beneath and inflorescences arachnoid and shortly stellate pubescent with fine ferruginous hairs; leaves strongly dimorphic in each pair, ovate lanceolate (large) or elliptic to lanceolate (small), glabrous above, shortly stellate and furfuraceous to glabrous beneath, margin entire, 3-veined (small) to 5-veined (large); inflorescences axillary, cymose, 8-15 cm long; flowers 4-merous, petals white; fruits 5-6 mm in diameter, deep blue. In rain forests, usually along river margins, from Nicaragua to Colombia.

C. hammelii Almeda
Shrub or small tree, up to 5 m tall; young branchlets, vegetative buds, and inflorescences sparsely to moderately covered with smooth, spreading hairs, underlain by stellulate-furfuraceous or short asperous-headed hairs; leaves of same node slightly unequal in size, margin entire to inconspicuously crenulate, 5-7 veined or 5-7-pliveined, small pocket-domatia present in the axils between the midvein and the first lateral veins; inflorescences pseudolateral modified dichasia, 3-6 cm long; flowers 5-merous, petals white or pale pink; fruits dark purple at maturity. At river banks, in rain forests on shaded sites and in light gaps, from northeastern Costa Rica to western Colombia.

C. sessiliflora (Naudin) Cogn.
Shrub, up to 5 m tall, branchlets, petioles, leaf venation beneath, inflorescences and hypanthium stellulate-furfuraceous; leaves oblong-lanceolate to oblong-elliptic, sparsely and rather deciduously glandular-granulose on both sides, margin serrulate, 3-5-pliveined; inflorescences axillary, clusters of 4-10 flowers; flowers 4-merous, petals white; fruits orange. From Costa Rica to Ecuador, Peru and Bolivia.

C. setosa (Triana) Gleason, Pl. 79c
Herbs or small shrubs, up to 1,2 m tall, branches moderately to densely covered with fine hairs; leaves slightly dimorphic, ovate to oblong-ovate, glabrous to moderately hirsute on both sides, margin entire or serrulate, ciliate, 5-7(-9)-veined, formicaria present at the apex of the petiole, 15-20 mm long, rarely lacking; inflorescences axillary, cymose, 3-8 cm long, long pedunculate; flowers 4-merous, petals white; fruits 5-7 mm in diameter, purplish-black. In lowland rain forests and cloud forests, from southern Mexico to Panama.

Conostegia (neotrop. 43, CR 25, GD 9)
Shrubs and trees with terminal paniculate inflores-

cences and baccate fruits, differing from *Miconia* by the calyx being calyptrate rather than open in bud.

C. lasiopoda Benth.
Tree, up to 7 m tall, young branchlets, leaf blade beneath and petioles moderately to densely covered with forked and dendritic hairs; leaves elliptic, to elliptic-obovate, margin entire to undulate-denticulate, almost glabrous above, 3-5-veined; inflorescences 4,5-9 cm long; petals 7, white. In rain forests and swamp forests, often along rivers, from Nicaragua to Colombia (Chocó).

C. subcrustulata (Beurl.) Triana, Pl. 79d
Shrub, up to 3 m tall, young branchlets, leaf venation beneath, inflorescences and hypanthium sparsely to moderately stellate pubescent; leaves ovate to elliptic-ovate, sparsely hirsutulous above, margin ciliate-serrulate, 7-9-pliveined; inflorescences 11-17 cm long; petals 5, pink. In rain forests, from Nicaragua to Panama.

Henriettea (neotrop. 67, CR 6, GD 4)
Small trees and shrubs with the flowers in fascicles or solitary, usually in the axils of the fallen leaves.
According to ALMEDA (1991) the genus is treated here in its wider sense, including the genus *Henriettella*.

Key to the species of *Henriettea* (after WURDACK 1988, ALMEDA 1991)

1	Flowers 4-merous	*H. odorata*
1*	Flowers 5-merous	2
2	Leaves with formicaria at the base of the lamina	*H. cuneata*
2*	Leaves without formicaria	3
3	Lamina verrucose-strigulose above, sparsely to moderately covered with simple trichomes beneath (sometimes with glandular tip)	*H. tuberculosa*
3*	Lamina variously pubescent, but not verrucose-strigulose above, sparsely to copiously pubescent beneath, with stellate, stellate-hirsute and minutely glandular trichomes	*H. succosa*

H. cuneata (Standl.) L.O. Williams
Small tree or shrub, up to 10 m tall; leaves elliptic to ovate- elliptic, 14-30 cm long, 6,5-12 cm wide, denticulate, 5-7-pliveined, formicaria present at the base of the lamina; flowers in fascicles; fruits berries, globose, 4-5 mm in diameter, orange. In wet forests, usually along riversides, from Belize and Guatemala to Panama.

H. odorata (Markgr.) Almeda, Pl. 79e
Tree, up to 16 m tall; leaves elliptic to slightly obovate-elliptic, entire, 15-28 cm long, 7-12 cm wide, prominently 5-plinerved; flowers in fascicles, petals white to yellow; fruits berries, seeds numerous. Collections are known from Costa Rica and Ecuador.

H. succosa (Aubl.) DC.
Small tree or shrub, up to 13 m tall; leaves elliptic to ovate- elliptic, 8,5-19 cm long, 5,5-11,5 cm wide, 3-plinerved, margin entire and ciliate; flowers fasciculate, petals white to pinkish; fruits berries, globose, ca. 15-18 mm in diameter, reddish-purple. Widely distributed in lowland forests and along riversides, from southern Mexico to the Guianas and eastern Brazil.

H. tuberculosa (Donn. Sm.) L.O. Williams
Small tree or shrub, up to 12 m tall; leaves elliptic to oblanceolate, 8-15 cm long, 2,4-5,8 cm wide, 5-plinerved, margin entire, ciliate, flowers in fascicles, petals white; fruits berries, globose, 3-5 mm in diameter, orange. In wet forests usually along riversides, from Nicaragua to Colombia.

Leandra (neotrop. 175, CR 9, GD 5)
Mostly shrubs, but also some trees and woody climbers with baccate fruits and terminal inflorescences, distinct in flower by having acute petals.

L. granatensis Gleason
Small tree or shrub, up to 5 m tall, vegetative parts densely pubescent, with appressed hairs; leaves ovate, 10-33 cm long, 6-12,5 cm wide, margin ciliate-serrulate, sparsely pubescent on both sides; inflorescences 7-19 cm long; flowers 5-merous, sessile, petals white to pinkish; fruits 4-5 mm in diameter, dark red to blackish blue. In lowland forests, from Nicaragua to Ecuador and Venezuela.

L. grandifolia Cogn.
Small tree or shrub, up to 5 m tall, vegetative parts pubescent, with reflexed hairs; leaves ovate to

elliptic-ovate, 9,3-26,6 cm long, 5-11,5 cm wide, margin ciliate-serrulate, sparsely pubescent on both sides; inflorescences 7-19 cm long; flowers 5-merous, sessile or subsessile, petals white; fruits 5-6 mm in diameter, red to dark purple. In lowland forests, from Nicaragua to Panama.

L. mexicana (Naudin) Cogn., Pl. 79f
Shrub, up to 3 m tall, covered with a mixture of glandular and eglandular hairs; leaves ovate to subcordate, 7,5-20 cm long, 4,5-17,8 cm wide, margin serrulate; inflorescences 6,5-12 cm long; flowers (6-)7-merous, sessile or subsessile, petals pinkish; fruits 4-5(-7) mm in diameter, red to purplish-black. Usually in secondary forests, but also in primary forests along riversides, from southern Mexico to Colombia.

Miconia (neotrop. ca. 1000, CR 100, GD 35)
One of the largest genera and thus considerable polymorphic, consisting of trees, shrubs and some woody vines, with terminal multi-flowered, paniculate inflorescences and baccate fruits.

M. affinis DC.
Small tree or shrub, up to 6(-15) m tall; young branchlets puberulous with minute stellate hairs; leaves oblong-elliptic to elliptic, entire to undulate serrulate, glabrous above, sparsely stellulate-puberulous beneath, glabrescent, 3-5(-7)-nerved; inflorescences 6-14 cm long; flowers 5-merous, petals white, ovary 3-locular; fruits 3-5 mm in diameter. In lowland rain forests and gallery forests, from southern Mexico and Trinidad to Amazonian Peru and Brazil.

M. centrodesma Naudin
Small tree or shrub, up to 4 m tall, vegetative parts and inflorescences sparsely stellate pubescent to glabrous; leaves elliptic to elliptic-ovate, entire to obscurely ciliolate-serrulate, glabrous on both sides, puberulous along the veins, 5-plinerved; inflorescences 4-10 cm long, submultiflorous; flowers 4-merous, petals white, ovary (2-)3-locular; fruits 3-5 mm in diameter. In lowland and middle elevation rain forests, along riversides, from Guatemala to Bolivia and southeastern Brazil.

M. gracilis Triana
Small tree or shrub, up to 5(-10) m tall, vegetative parts and inflorescences moderately ferruginous furfuraceous to glabrous; leaves elliptic to oblong-elliptic, entire, glabrous on both sides, 3-nerved; inflorescences 5-10 cm long, few-flowered; flowers 5-merous, subsessile or short pedicellate, petals white, ovary (2-)3-locular; fruits 4-5 mm in diameter. In lowland rain forests, from Nicaragua to Ecuador.

M. lacera (Bonpl.) Naudin
Shrub, up to 4 m tall; branchlets, petioles, leaf-venation and inflorescences moderately fine-setose with reddish-purple hairs; leaves lanceolate to elliptic-ovate, margin ciliate-serrulate, sparsely long-strigulose on both sides, with 1-5 mm long hairs, 3-5-nerved; inflorescences 5-10 cm long; flowers 5-merous, sessile, petals white to pink, ovary 3-locular; fruits 5-6 mm in diameter. In lowland and middle elevation rain forests, along riversides, from southern Mexico and the West Indies to Amazonian Peru and Brazil.

M. nervosa (Sm.) Triana, Pl. 80a
Small tree or shrub, up to 6 m tall, young branchlets, leaf-venation beneath and inflorescences densely strigulose with short appressed hairs; leaves elliptic, entire or slightly undulate-serrulate, sparsely fine strigulose above, sparsely to moderately appressed setulose beneath, 5-7-plinerved; inflorescences 5-16 cm long, rather few-flowered; flowers 5-merous, sessile, petals white, ovary 3-locular; fruits 5-6 mm in diameter. In lowland and middle elevation rain forests, along riversides, from southern Mexico and Trinidad to Bolivia and Brazil.

M. schlimii Triana, Pl. 80b,c
Small tree or shrub, up to 8 m tall, young branchlets, petioles, leaf-venation beneath and hypanthium moderately ferruginous stellate-tomentose, leaves lanceolate to elliptic-ovate, margin ciliate, slightly to conspicuously undulate-dentate, glabrous above, stellate puberulous beneath, 3-5 (-7)-plinerved; inflorescences 3-8 cm long, rather few-flowered; flowers 5-merous, short pedicellate, petals white, ovary 5-locular; fruits 8-10 mm in diameter. Mostly on rather open, secondary sites, from Guatemala and Belize to northern Colombia and Venezuela.

M. serrulata (DC.) Naudin
Small tree or shrub, up to 8 m tall, branchlets, petioles, leaf blade beneath, inflorescences and hypanthium densely covered with stellate hairs; leaves oblong-elliptic to elliptic-ovate, denticu-

late, glabrous above, 5-7(-9)-nerved; inflorescences 20-40 cm long, multiflorous; flowers 6-merous, sessile, petals white to cream, externally densely stellulate puberuloes, ovary 4-5-locular; fruits 6-8 mm in diameter. In lowland rain forests and gallery forests, from southern Mexico to Bolivia and southeastern Brazil.

M. trinervia (Sw.) D.Don, Pl. 80d,e
Tree up to 16 m tall, young branchlets, young leaves, inflorescences and hypanthium moderately puberulent, with stellate-lepidote hairs, branchlet nodes with a well-developed interpetiolar ridge; leaves elliptic to elliptic-oblong, entire, glabrous above, inconspicuous stellate-lepidote beneath, 3-plinerved; inflorescences 15-25 cm long, multiflorous; flowers 5-merous, sessile, petals white, ovary 3-locular; fruits 4-6 mm in diameter. In lowland and montane rain forests, from southern Mexico and Jamaica to Amazonian Peru, Bolivia and Brazil.

Mouriri (neotrop. 81, CR 8, GD 6)
Usually glabrous trees or shrubs, unique in family with prominent primary vein and numerous fine parallel secondary veins.

M. gleasoniana Standl. ex Standl. & Steyerm., Pl. 80f,g
Shrub or tree, up to 18,5 m tall; leaves narrowly-elliptic to ovate elliptic or oblong-elliptic, glabrous; inflorescences axillary, 1,6-9,2 mm long, 1-7-flowered; petals pink, ovary 5-locular; fruits globose to depressed-globose, reddish, crowned by the persistent calyx. From Mexico to Costa Rica.

Ossaea (neotrop. 91, CR 8, GD 5)
Shrubs and small trees with small axillary inflorescences. Distinct in flower by having acute petals, usually bearing an exterior tooth.

O. robusta (Triana) Cogn.
Shrub, up to 5 m tall, young branchlets, petioles, primary leaf veins beneath and inflorescences puberulous with short pinoid hairs; leaves elliptic to ovate-elliptic, undulate-denticulate, glabrous above, 5-plinerved; inflorescences paniculate, 4-6 mm long, submultiflorous, pseudo-lateral; flowers (4-)5-merous, mostly subsessile, petals white; fruits dry berries. From Costa Rica to Peru.

Tococa (neotrop. 54, CR 2, GD 1)
Shrubs or subshrubs or rarely small trees, with baccate fruits and usually with conspicuous swollen hollow formicaria at the petiole apex or at the blade base.

T. guianensis Aubl., Pl. 80h,i
Shrub, up to 6 m tall, young stems flattened, sparsely setose to glabrous; formicarium developed on the petiole, just below the blade base; leaves often unequal in size, ovate to oblong-ovate, entire to obscurely serrulate, ciliolate; inflorescences terminal, paniculate, 8-16 cm long, rather few-flowered; flowers sessile or subsessile, 5-merous, petals pale pinkish. In lowland rainforests and on open sites, along river margins, from southern Mexico to Bolivia and Brazil.

Topobea (neotrop. 62, CR 11, GD 3)
Mostly epiphytic trees and shrubs. Habit, flowers and fruits similar to *Blakea*, but the anthers linear to lanceolate or subulate with approximate, often confluent dorso-apical pores.

T. maurofernandeziana Cogn., Pl. 81a,b
Terrestrial or epiphytic tree, up to 5 m tall; leaves elliptic to elliptic-oblong to ovate, 11,5-23 cm long, 7-18,5 cm wide, glabrous above, sparsely pubescent to almost glabrous beneath; inflorescences axillary in the upper leaves, fasciculate; petals pink; fruits yellow to orange. In primary and secondary rain forests, from Mexico to Panama.

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STILES, F.G. & L. ROSSELLI. 1993. Consumption of fruits of the Melastomataceae by birds: how diffuse is coevolution? - Vegetatio 107-108: 57-73.
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Meliaceae

The Meliaceae are one of the most important timber families, distributed worldwide in the tropics and subtropics. Trees, treelets or rarely shrubs; **leaves** alternate, usually even pinnate, rarely odd pinnate, 1-3-foliolate or digitately compound, usually entire, stipules lacking, indumentum, if present, usually of simple hairs; **inflorescences** axillary, rarely cauliflorous, paniculate or racemose, with bisexual or unisexual flowers, calyx usually 3-5(-7)-lobate, petals 3-7, free or basally united, stamens 8-12, filaments frequently united into a staminal tube, intrastaminal disk often present, ovary superior, 2-13-locular; **fruits** loculicidal or septicidal capsules or rarely drupes. Pantrop. + subtrop. 51/565, CR ca. 10/37, GD 5/15.

Key to the genera (after PENNINGTON 1981)

1	Loculi with 1-2 ovules, fruit a loculicidal capsule or drupe (subfamily Melioideae)	2
2	Leaves 2-3 pinnate	*Melia*
2*	Leaves usually pinnate, less frequently 1-3-foliolate or rarely digitate	3
3	Anthers inserted at apex of filaments or on margin of staminal tube	*Trichilia*
3*	Anthers inserted within throat of staminal tube	*Guarea*
1*	Loculi with 3 or many ovules, these biseriate; fruit a septifragal capsule (subfamily Swietenioideae)	4
4	Staminal tube of completely united filaments; anthers 8-12, inserted within throat of staminal tube; nectary annular, never in the form of an androgynophore	*Carapa*
4*	Stamens 5, filaments free but adnate to an androgynophore below; anthers inserted apically on filaments	*Cedrela*

Carapa (neotrop. + Africa 2-3, CR 2, GD 1)
Trees and treelets with leaves composed of 6-10 pairs of leaflets and with large, pendulous, septifragal capsules containing 8-35 unwinged and unarillate seeds.

C. guianensis Aubl., Pl. 81c-e
Common names (Costa Rica): cedro bateo, cedro macho (PENNINGTON 1981), caobilla, bateo (JIMÉNEZ, in prep.)
Trees or treelets; leaves paripinnate, clustered at the twig ends, leaflets entire; inflorescences axillary or subterminal, multibranched, flowers unisexual, white to creamy, sessile or subsessile, usually 4-merous; capsules 4-valved with 1-2 seeds per valve. Usually on swampy ground widely distributed in the Neotropics, from Central America and the Caribbean Islands to Amazonian Ecuador and Brazil.
This species is of local importance as a timber tree, especially in Venezuela and Surinam and was once planted in Brazil and some Caribbean islands (PENNINGTON 1981).

Cedrela (neotrop. 8, CR 4, GD 1)
Trees with 5-merous unisexual flowers and pendent or erect septifragal capsules, which are opening by 5 valves to release winged seeds.

C. odorata L., Pl. 81f,g
Leaves paripinnate, rarely imparipinnate with (5-) 6-12(-15) pairs of leaflets; inflorescences terminal or subterminal, pendulous, multibranched with unisexual, sessile or short-pedicelled, 5-merous flowers, calyx cupular, petals greenish-white; fruits pendulous, 2-4 cm long, brownish or brownish-gray. In lowland deciduous forests, usually on well drained soils, from Mexico through Central America, the Caribbean Islands and South America to northern Argentina.
This tree is an important timber supplier ("spanish cedar"), because of the reddish brown wood of high quality, which was formerly used especially for the production of cigar-boxes and which is still used for several purposes.

Guarea (neotrop. + Africa 40, CR 9, GD 5)
Small to large dioecious trees, usually with pinnate leaves with a terminal bud, 3-7-merous flowers and 2-10-valved capsular fruits with several arillate seeds.

G. grandifolia DC.
Tree, up to 50 m tall; leaves to 140 cm long with up to 22 pairs of leaflets; inflorescences thyrsoid, axillary to ramiflorous, 10-40(-50) cm long, flowers white to cream-colored; capsules reddish-brown, globose, ellipsoid to obovoid, 5-8-valved, seeds covered with a thin, orange aril. In lowland rain forests on non-flooded ground, from Mexico to the Amazon basin.

Trichilia (neotrop. + Africa 84, CR 14, GD 7)
Small to large trees, frequently with imparipinnate leaves, the unisexual, or rarely bisexual flowers in axillary inflorescences and 2-3(-4)-valved loculicidal fruits with several arillate seeds.

T. septentrionalis C.DC., Pl. 81h
Tree, up to 20 m tall; leaves imparipinnate, (15-) 20-40(-56) cm long, with 7-11, usually opposite leaflets; inflorescences axillary, 10-40 cm long, flowers unisexual, greenish-cream colored, sepals (4-)5, free, petals 5-7, free, staminal tube present; capsules red, oblong, obovoid or ellipsoid, 1,3-3,2 cm long, 3-valved, with 1-2 seeds. Lowland rain forests on non-flooded ground, from Costa Rica and northern South America to Amazonian Peru and Brazil.

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PENNINGTON, T.D. & B.T.STYLES. 1975. A generic monograph of the Meliaceae. - Blumea 22 (3): 419-540.
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STYLES, B.T. 1972. The floral biology of the Meliaceae and its bearing on tree breeding. - Silvae Genet. 21: 175-182.

Memecylaceae, see **Melastomataceae**

Menispermaceae

A family of almost exclusively woody or subwoody climbers, but also some shrubs and a few trees that are usually cauliflorous. **Leaves** simple, entire, alternate, usually palmately veined, petiole often with characteristical apical pulvinus, stipules lacking; **inflorescences** racemes or panicles; **flowers** always unisexual (plants dioecious), mostly minute, yellow or white, sepals usually 6, free or basally united, petals (0-)6(-9), often connate, stamens 3- many, female flowers sometimes with staminodia, ovary superior, of 1-6 free carpels; **fruits** consisting of 1-6 drupes per flower. Distributed in the tropics and subtropics worldwide, with some species extending into temperate areas. Cosmopol. 72/450, CR 7/19, GD 6/7.

Despite of the small flowers it seems certain that the Menispermaceae depend (if no cryptic parthenogenesis exists) on insects for pollen transport (BARNEBY & KREKOFF 1971, cf. OTT 1995), but specific studies are lacking.

The fruits are frequently red or orange and eaten (and dispersed) by birds (OTT 1995).
Many species of Menispermaceae are used by indigenous people, mostly in South America but also in Malaysia and the East Indies, to produce arrow poisons such as curare (from the bark of several species, but mostly *Chondodendron* spp.), and to prepare fish poison (KRUKOFF & MOLDENKE 1938).

Key to the genera (after JIMÉNEZ, in prep.)

1	Flowers with 4(-5) sepals; petals united, forming a cup or disk, stamens 4; leaves sometimes peltate; fruits globose, ca. 5 mm in diameter	*Cissampelos*
1*	Flowers with 6-18 sepals; petals free; stamens 6; fruits oblong to globose, 10-50 mm long	2
2	Petals lacking; drupes sessile or shortly stipitate	*Abuta*
2*	Petals present; drupes not sessile	3
3	Fruits drupes, 2-5 cm long, leaf blade glabrous, usually shiny, with fine tertiary reticulation	*Anomospermum*
3*	Fruits less than 2,5 cm long; leaf blade glabrous or pubescent, peltate or deeply lobate	4
4	Leaves usually with domatia in the axils of the secondary veins	*Odontocarya*
4*	Leaves without domatia	5
5	Trees or shrubs (very rarely woody vines); inflorescences short, spicate or paniculate	*Hyperbaena*
5*	Vines or subwoody vines, inflorescences solitary, racemiform panicles	*Curarea*

Abuta (neotrop. 32, CR 3, GD 2)
Lianas, usually with long petiolate leaves, distinct in the palmate venation with 3-5 basal veins. The flowers and fruits are always sessile to shortly stipitate.

A. panamensis (Standl.) Kruk. & Barn.
Liana, up to 35 m tall; leaves elliptic to ovate or oblong, 6-24 cm long, 3-14 cm wide, glabrous to minutely puberulent; inflorescences solitary or fasciculate, racemose, up to 20 cm long, pubescent to tomentose; sepals 6, fleshy, orange, petals

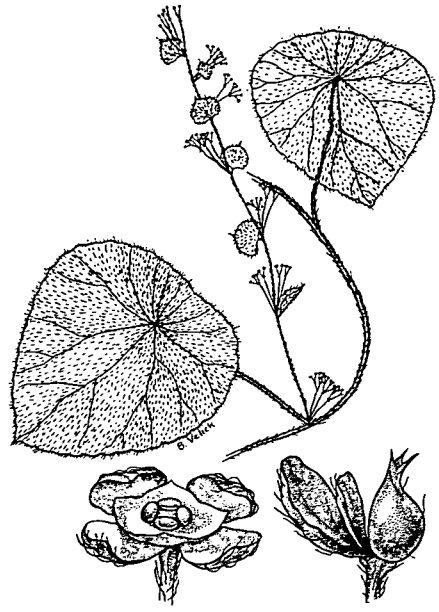
lacking, stamens 6, female flowers with 6 staminodia; fruits obovoid drupes, 2,5-4,5 cm long, 1,4-2 cm wide, glabrous or puberulent, yellow-orange. In moist forests, from Mexico to Panama.

Cissampelos (pantrop. 20, CR 5, GD 1)
With one exception (the erect herb *C. ovalifolia*) this genus consists of herbaceous or subwoody climbers. Vegetatively very variable, but often with cordate leaves and the fruit consisting of only one, usually red drupe.

C. tropaeolifolia DC., Pl. 81i
Subherbaceous climber, up to 10 m tall, sericeous or sometimes glabrous; leaves peltate, ovate to suborbicular, entire to crenate, palmately veined; inflorescences axillary, usually with large foliaceous inflorescence bracts, the male inflorescences multi-flowered, fasciculate dichasia, the female ones composed of several individual flowers; male flowers greenish-white to cream-colored, sepals 4, petals united, corolla patelliform or cupuliform, anthers 4, female inflorescences sepal 1, petal 1, carpel one; fruit drupe, red, obovoid, 4-6 mm long, 4-5 mm wide. In wet forests, from Mexico to northern South America.

Odontocarya (neotrop. 30, CR 2, GD 1)
A genus of subwoody vines with papery bark and always axillary or cauliflorous, racemose or pseudo-racemose inflorescences, centered in western Amazonia.

O. truncata Standl.
Vines with glabrous and conspicuously lenticellate branches; leaves ovate, cordate to truncate at the base, with conspicuous nectaries in the axils of the main nerves of the leaf-underside; inflorescences racemose; flowers yellowish-green, 6-merous; fruits drupes, oblong-ellipsoid, 17-22 mm long, 12-14 mm wide, yellow to orange-yellow. Near the coast or on coastal waterways, from Costa Rica to northern Colombia (Chocó).



Cissampelos tropaeolifolia

BARNEBY, R.C. 1970. Revision of neotropical Menispermaceae tribe Tinosporeae. - Mem. New York Bot. Gard.: 20 (2): 81-158.

BARNEBY, R.C. & B.A. KRUKOFF. 1971. Supplementary notes on American Menispermaceae VIII. A generic survey of the American Triclisieae. - Mem. New York Bot. Gard.: 22 (2): 1-90.

JIMENEZ, Q. In prep. Menispermaceae. Manuál de las plantas de Costa Rica. Missouri Botanical Garden. Instituto Nacional de Biodiversidad. Museo Nacional de Costa Rica.

KRUKOFF, B.A. & H.N. MOLDENKE. 1938. Studies of American Menispermaceae, with special reference to species used in preparation of arrow poisons. - Brittonia 3 (1): 1-74.

OTT, C. 1995. Menispermaceae. Die Familie der Mondsamengewächse. - Palmengarten 59 (2): 124-126.

RHODES, D.G. 1962. Menispermaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 49: 157-172.

RHODES, D.G. 1975. A revision of the genus *Cissampelos* (Menispermaceae). - Phytologia 30 (6): 415-484.

Menyanthaceae

Annual or perennial aquatic or semiaquatic herbs. **Leaves** alternate, simple or 3-foliolate (*Menyanthes*), linear, cordate, often orbicular, peltate, petioles with a basal sheath, stipules lacking; **inflorescences** racemes, fasciculate or flowers solitary or in pairs; **flowers** actinomorphic, bisexual or unisexual, sometimes heterostylous, usually 5-merous, sepals free or basally united, persistent in fruit, corolla tubular,

yellow, white or pinkish, filaments attached to the tube, ovary superior to half-inferior, 1-locular; **fruits** capsules, regularly dehiscing by 2-4 valves or irregularly dehiscing, or sometimes berries, seeds few to numerous, sometimes winged. In tropical and temperate regions worldwide. Cosmopol. 5/40, CR 1/2, GD 1/1.

The flowers of the Menyanthaceae are pollinated by insects (HAMASHIMA 1979).

Nymphoides (cosmopol. 20, CR 2, GD 1)
Perennial aquatic herbs with entire or crenate, usually broadly ovate or orbicular, floating leaves, white to yellow flowers and indehiscent capsular fruits.

N. indica (L.) Kuntze
Herb, stem erect, up to 160 cm long, green, vertically septate near the apex with several continuous air spaces; leaves succulent, coriaceous, orbicular to subovate, cordate, 2-20 cm in diameter; inflorescences fasciculate, many-flowered; corolla 1-1,8 cm long, white; capsules ellipsoid, 4-6 mm long. Widely distributed in Central and South America and the Antilles, as well as in the Old World.

ELIAS, T. 1969. Menyanthaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 56: 29-32.
CHUANG, T.I. & R. ORNDUFF. 1992. Seed morphology and systematics of Menyanthaceae. - Amer. J. Bot. 79 (12): 1396-1406.
HAMASHIMA, S. 1979. On the flower dimorphism and effective pollination in *Nymphoides indica*. - J. Jap. Bot. 54 (10): 319-320.

Mimosaceae, see Fabaceae-Mimosoideae

Molluginaceae

Usually annual or perennial herbs but also some subshrubs, mostly with crowded, alternate leaves forming false whorls in a basal rosette as well as along the stems. **Leaves** simple, entire, alternate, often crowded, never succulent, stipules sometimes present and then small and caducous; **inflorescences** terminal, sometimes axillary, cymose or rarely flowers solitary; **flowers** actinomorphic, bisexual, rarely unisexual (then plants dioecious), small and inconspicuous, usually greenish-white, sepals (4-)5, free or connate, petals 0-5-many, free, stamens (3-)4-5(-many), basally connate; ovary superior, 3-5-locular; **fruits** mostly capsules, dehiscent, rarely achenes, splitting into 2 cocci, or nutlets. Distributed in the tropics and subtropics worldwide with a primary distribution center in southern Africa. Pantrop. + subtrop. 13/130, CR 1/1, GD 1/1

The family is included in the Aizoaceae by some authors, but can be distinguished from that by the verticillate leaf arrangement and the lack of succulence.

Pollination studies on this family are rare, but according to BOGLE (1970), several species of *Mollugo* are self-pollinated or pollinated by insects.

The seeds of some species of *Mollugo* are wind-dispersed (BOGLE 1970).
Some species of Molluginaceae (including *Mollugo* spp.) are of local importance as vegetables or used in folk medicine (BOGLE 1970).

Mollugo (pantrop. + subtrop. ca. 35, CR 1, GD 1)
A widespread erect or creeping weed with inconspicuous flowers lacking petals and with narrow linear leaves.

M. verticillata L.
Annual herb, up to 0,5 m tall; leaves pseudoverticillate, 4-6 in one whorl, linear-oblong; inflorescences axillary, cymose; flowers 2-3 cm long, white, sepals persistent; fruits capsules, loculicidally dehiscent, subtended by the persisting sepals. Weedy plants of secondary growth, often on open, sandy sites, distributed in the tropics worldwide.

BOGLE, A.L. 1970. The genera of Molluginaceae and Aizoaceae in the southeastern United States. - J. Arnold Arbor. 51: 432-463.
BURGER, W. 1983. Aizoaceae. Flora Costaricensis. - Fieldiana Bot. 13, n.s.: 213-217.
ENDRESS, M.E. & V. BITTRICH. 1993. Molluginaceae. Pp.: 419-426. In: K. KUBITZKI (ed.): The families and genera of vascular plants. Vol II. Magnoliid, Hamamelid and Caryophyllid families. - Berlin: Springer Verlag.
NEVLING, L.I., Jr. 1961. Aizoaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 48: 80-85.

Monimiaceae

AA primitive family of small trees and shrubs, usually with a lemon-like odor originating from the vegetative parts. **Leaves** mostly opposite, simple, entire or frequently serrate, glabrous or pubescent, sometimes with stellate hairs, stipules lacking; **inflorescences** small axillary cymes, rarely flowers solitary; **flowers** unisexual (plants monoecious or dioecious), minute, with few to many tepals, these often connate and reduced to an undulate or entire annulus, male flowers with 2-many stamens, female flowers usually fewer and larger than the male ones, carpels many, free, often embedded in the fleshy hypanthium; **fruits** consisting of several one-seeded achenes, free or embedded in the hypanthium. Distributed worldwide in the tropics. Pantrop. + subtrop. 34/440, CR 2/20, GD 2/5

The Monimiaceae is a taxonomically poorly known family. Its largest neotropical genus, *Siparuna,* was last revised by PERKINS (1901). Recent studies (RENNER et al 1997) show that the family is polyphyletic. At present the families Atherospermataceae (7 genera), Monimiaceae s.str. (18 genera, e.g. *Mollinedia*), and Siparunaceae (2-3 genera, *Siparuna*) are classified separately. Here, however, the family is treated in its old, broad sense.

Several studies on the pollination of the Monimiaceae have shown that flies, bees and small beetles are the main pollinators within this family, and are primarily attracted by floral odor and flower color (LORENCE 1985, FEIL & RENNER 1991, FEIL 1992). Because of the specific flower morphology of *Siparuna*, one can assume that all species are insect-pollinated (PERKINS 1901). A pollination study on several Ecuadorean species of *Siparuna* (FEIL 1992) has shown that the flowers of all investigated species where visited by small Cecidomyiidae flies during the night. The flies, belonging to the genera *Asynapta*, *Clinodiplosis*, *Dasineura* and to the tribes Oligotrophini and Porricondylinae, are likely attracted by the lemon-like odor of the flowers. They place their eggs in the stamens of the male flowers and apparently transfer pollen on subsequent visits to female flowers. The mode of pollination in *Mollinedia* is still little known. GOTTSBERGER (1977) described Thysanoptera as pollinators of *Mollinedia* species with urceolate receptacle. The insects deposit their eggs in the buds and thus effect pollination.

The family is of little economic interest, only a few species (e.g., *Mollinedia schottiana*) have reached some importance as sources of timber and some aromatic species are used for making medicinal teas (DUKE 1962).

Key to the genera (after DUKE 1962)

1	Anthers oblong, valvately dehiscent; tepals of the pistillate flowers 4-several, usually persistent, the fruits enclosed in the hypanthium; leaves glabrous or with simple or stellate hairs	*Siparuna*
1*	Anthers hippocrepiform, longitudinally dehiscent; tepals of the pistillate flowers 4, soon deciduous, the fruits not enclosed in the hypanthium; leaves glabrous or with simple hairs	*Mollinedia*

Mollinedia (neotrop. 90, CR 5, GD 2)
Dioecious trees or shrubs, the usually glabrous or glabrate leaves are entire or irregularly dentate with a few marginal teeth.

M. costaricensis Donn. Sm.
Shrub or small tree, up to 7 m tall; leaves subentire or with up to 25 irregular teeth on each side, narrowly to broadly ovate or obovate, 8-18 cm

long, 4-9 cm wide, appressed strigillose with simple hairs, rarely glabrescent; male inflorescences axillary, of 1-6 cymes, 3-5-flowered, male flowers 4-merous, stamens few to numerous, female flowers axillary, paired or solitary, tepals 4, caducous; fruits ellipsoid drupes, corrugated, 8-13 mm long, 5-8 mm wide, usually puberulent. From Panama to Costa Rica.

Siparuna (neotrop. 125, CR 15, GD 3)
A taxonomically complicated genus, of monoecious or dioecious shrubs and small trees, often with stellate pubescence, widespread in the Amazon region, but also abundant in the Andes and Central America.

S. thecaphora (Poepp. & Endl.) A. DC., Pl. 82a-c (syn. *S. andina* (Tul.) A. DC.)
Dioecious shrub or small tree, up to 4 m tall; leaves broadly ovate to obovate, coriaceous, glabrous; inflorescencec few-flowered or flowers solitary; flowers glabrous or nearly so, yellowish to orange, stamens 8-40; fruits pale green to pink. Restricted to Central America, reaching from Mexico to Panama.

S. pauciflora (Beurl.) A. DC.
Common name (Costa Rica): limoncillo (DUKE 1962).
Dioecious shrub or small tree, up to 10 m tall; leaves almost entire, 15-40 cm long, gray stellate tomentose; inflorescences several-flowered cymes, axillary or frequently cauliflorous; male flowers with connate tepals, stamens (8-)12-30, female flowers with connate tepals, the ovules embedded in the hypanthium; fruits in globose aggregates, yellowish-green. From Costa Rica to Colombia and Peru.

DUKE, J.A. 1962. Monimiaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 49: 225-239.

FEIL, J.P. 1992. Reproductive ecology of dioecious *Siparuna* (Monimiaceae) in Ecuador: a case of gall midge pollination. - Bot. J. Linn. Soc. 110 (3): 171-203.

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GOTTSBERGER, G. 1977. Some aspects of beetle pollination in the evolution of flowering plants. Pp.: 211-226. In: K. KUBITZKI (ed.): Flowering plants: Evolution and classification of higher categories: 211-226. - Berlin: Springer Verlag.

LORENCE, D.H. 1985. A monograph of the Monimiaceae (Laurales) in the Malagasy region (Southwest Indian Ocean). - Ann. Missouri Bot. Gard. 72: 1-165.

PERKINS, J.R. 1901. Beiträge zur Kenntnis der Monimiaceae III. Monographie der Gattung *Siparuna*. - Bot. Jahrb. Syst. 28: 660-705.

RENNER, S.S., A.E. SCHWARZBACH & L. LOHMANN. 1997. Phylogenedic position and floral function of *Siparuna* (Siparunaceae: Laurales). - Int. J. Pl. Sci. 158 (Suppl. 6): 89-98.

Moraceae

One of the most important tropical woody families, consisting of trees, shrubs, climbers and a few herbs, always with a white or colored milky or watery latex, sometimes rather inconspicuous but at least visible in the young parts. Another useful feature, which is present in about half of the genera, are the connate stipules, forming a hood over the terminal bud. **Leaves** alternate, spiral or distichous, rarely opposite or verticillate, mostly simple, rarely palmately lobed, entire, dentate or serrate, stipules present, free or connate; **inflorescences** axillary, racemose, cymose or capitate and then sometimes cup-shaped, sometimes 1-flowered; **flowers** unisexual, plants monoecious or dioecious, 4-merous, perianth usually 4, sometimes lacking, free or connate, stamens mostly 4, free or connate, ovary superior or inferior, 1-locular; **fruits** achenes or more often drupes, often surrounded by the fleshy perianth or embedded in the fleshy receptacle, often the whole inflorescence forming a syncarp. Mainly in the tropics worldwide, with some representatives in the subtropics and in temperate areas. Cosmopol. 38/1100, CR 18/96, GD 15/50.

A highly specific pollination system has evolved in *Ficus*, namely a mutualism between agaonid wasps and the flowers, which are located in the inner layer of the urceolate receptacle. This system can also

be considered as an elaborate parasitism, because the wasps lay their eggs into the short-styled flowers, but deposit the pollen on the stigmas of the long-styled flowers, which cannot be destructed by the insects (BRONSTEIN & MCKEY 1989, BERG 1990). Genera with urticaceous stamens (e.g., *Maclura*, *Trophis*), which release the pollen by an explosive mechanism, are thought to be anemophilous (ROHWER 1993).

Several species of *Brosimum* (e.g., *B. guianense*) are important timber woods, while the seeds of some species are cooked and eaten (BERG 1972). The edible fruits of the Asian genus *Artocarpus* (breadfruit) contain starch, for which they are sometimes cultivated in the Neotropics. The latex of several species of *Ficus* and *Castilla* is locally used as a substitute for rubber. The latex of *F. insipida* and some other species is used as a vermicide.

Key to the genera (after GONZÁLEZ, in prep.)

1	Plants herbaceous	*Dorstenia*
1*	Plants trees or shrubs	2
2	Leaves spirally arranged	*Ficus*
2*	Leaves distichous	3
3	Stipule scar completely circulating the twig	4
4	Twigs, leaves and stipules with small and short spines	*Poulsenia*
4*	Spines lacking	5
5	Stipules completely united at the node	6
6	Stipules with parallel veins, leave margin denticulate or entire; inflorescences usally sessile, reniform or compressed	*Castilla*
6*	Stipules without parallel veins, leave margin entire; inflorescences usually pedunculate, globose	*Brosimum* p.p.
5*	Stipules free	7
7	Leave margin dentate or serrate	8
8	Female inflorescence 1-flowered; leaf surface usually covered with hispid hairs, showing a scabrous texture, leaves asymmetric	*Olmedia*
8*	Female flowers with a various number of flowers; leaf surface glabrous or pubescent, if hairs present, the texture not scabrous, leaves generally symmetric	*Perebea* p.p.
7*	Leave margin entire	9
9	Female inflorescences usually one-flowered	*Pseudolmedia*
9*	Female inflorescences usually with several flowers	10
10	Fruits immersed into the receptacle, which is covered by parts of the perianth and the pseudobracts, in form of spiny or triangular, enlarged and hard structures; sap sometimes reddish or orange	*Naucleopsis*
10*	Fruits on the surface of the receptacle; sap white	*Perebea* p.p.
3*	Stipule scar not completely circulating the twig	11
11	Leave margin entire	12
12	Inflorescences bisexual or unisexual, flowers arranged in globular capitulae	*Brosimum* p.p.
12*	Inflorescences unisexual, flowers arranged in discoid capitulae, spikes racemes or flowers 2 per axil	13
13	Male flowers arranged in discoid capitulae; petioles usually bearing scales	*Maquira*
13*	Male flowers arranged in spikes; petioles usually smooth	14
14	Leaves usually somewhat asperous beneath; male and female flowers arranged in spikes	*Trophis* p.p.
14*	Leaves smooth beneath; male flowers in spikes, female flowers in racemes or 2 flowers solitary in the leaf axils	*Clarisia*
11*	Leave margin dentate or serrate	15
15	Female flowers arranged in globose capitulae	16
16	Spines usually present along the twigs, style simple	*Maclura*
16*	Spines lacking, style bifid, petioles usually reddish	*Batocarpus*
15*	Female flowers arranged in spikes	17
17	Female flowers with large and slender stigma	*Trophis* p.p.
17*	Female flowers with short and stout stigma	*Sorocea*

Batocarpus (neotrop. 4, CR 1, GD 1)
large trees distinct in the rather large leaves, which are somewhat scabrous beneath and often irregularly serrate as well as in the globose female inflorescences.

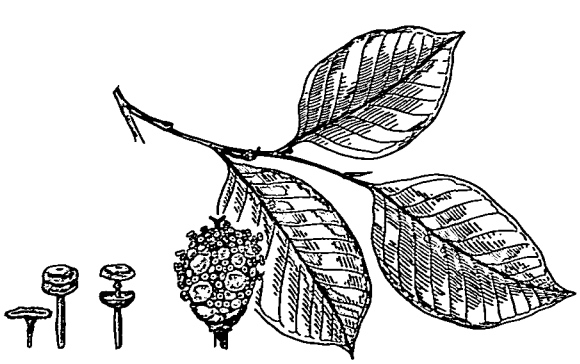
B. costaricensis Standl. & L.O. Williams
Dioecious tree, up to 30 m tall, latex yellow or whitish; leaves elliptic oblong, distichous, serrate, 9-24 cm long, 5-12 cm wide, stipules paired, 8 mm long; male inflorescences axillary, solitary, spicate, up to 22 cm long, female inflorescences globose or elllipsoid heads, up to 2 cm in diameter; fruits syncarpous, globose or ellipsoid, up to 6 cm in diameter. In wet forests, from Costa Rica to Peru and Brazil.

Brosimum (neotrop. 13, CR 6, GD 5)
Common names (Central America): ojoche, ramon, breadnut (BURGER 1977)
A genus of bisexual or unisexual trees with white or yellow latex, rather easy to distinguish from others by the globose fruits and the female inflorescences of 1-several flowers, immersed in a globose receptacle.

Key to the species of *Brosimum* (after BERG, 1972)

1	Stipules full amplexicaul, connate	*B. utile*
1*	Stipules not full amplexicaul, free	2
2	Costa impressed above; venation of the stipules prominent, subflabellate-furcate; perianth of the staminate flowers well-developed; dioecious	*B. lactescens*
2*	Costa prominent to plane or occasionally slightly impressed above; venation of the stipules otherwise; perianth of the staminate flowers lacking or vestigial (except in *B. costaricanum*); dioecious or monoecious	3
3	Perianth of the staminate flowers well developed; dioecious	*B. costaricanum*
3*	Perianth of the staminate flowers vestigial or lacking; monoecious or dioecious	4
4	Leaves scabridulous beneath	*B. guianense*
4*	Leaves smooth beneath	*B. alicastrum*

B. alicastrum Sw.
Common names (Costa Rica): ojoche (GONZÁLEZ, in prep.), ojoche, ojeche, berga, ramon, breadnut (BURGER 1977)
Dioecious tree, up to 35 m tall, often with buttresses, latex white to yellow; leaves elliptic to oblong 5-17 cm long, 2,5-8 cm wide, entire or rarely denticulate, stipules paired, nearly fully amplexicaul; inflorescences unisexual, 1-2 per axil, globose to ellipsoid, male inflorescences 4-10 mm in diameter, female inflorescences 2-4 mm in diameter; perianth lacking, or sometimes 1 minute present, stamen 1; infructescences globose, 1,5-2 cm in diameter, yellow to brownish and orange. In wet and dry tropical forests, from Mexico, Cuba and Jamaica to Colombia, Guyana and Brazil (Acre).



Brosimum alicastrum

Brosimum costaricanum

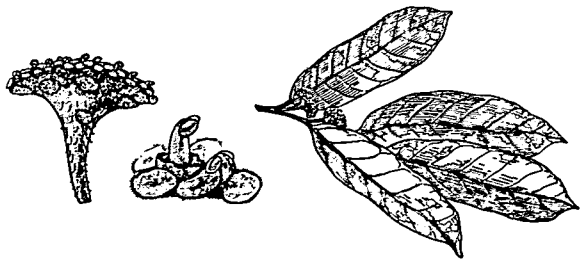
B. costaricanum Liebm., Pl. 82d
Common names (Costa Rica): ojochillo, ojoche amarillo (GONZÁLEZ, in prep.)

Dioecious tree, up to 30 m tall, with buttresses, latex white; leaves lanceolate to oblong, 4-14 cm long, 1,5-4,5 cm wide, entire, stipules paired, not fully amplexicaul; inflorescences unisexual, male inflorescences globose, ca. 6 mm in diameter with numerous flowers, female inflorescences globose, 2-5 mm in diameter; male flowers with 3-4 tepals, stamens 2-4; infructescences globose, 10-12 mm in diameter. In wet forests in Costa Rica and Panama.

B. guianense (Aubl.) Huber

Common names (Costa Rica): ojochillo, lengua de ciervo (GONZÁLEZ, in prep.)

Monoecious tree or shrub, up to 18 m tall, latex white to yellow; leaves elliptic, to elliptic-oblong, sometimes somewhat asymmetric, 3,5-13,5 cm long, 1,5-4,5 cm wide, entire, stipules paired, not fully amplexicaul; inflorescences 1 per axil, usually bisexual, hemispheric, discoid or turbinate, 5-8 mm in diameter; with few to many male flowers and 1-several female flowers; perianth 3-4-lobate, stamen 1; infructescences globose or subturbinate, up to 15 mm in diameter, sometimes lobate (when more than 2 fruits developed). In primary and secondary rain forests, from Mexico and the Antilles to Peru, Bolivia and Brazil.



Brosimum guianense

B. lactescens (S. Moore) C.C. Berg, Pl. 82e

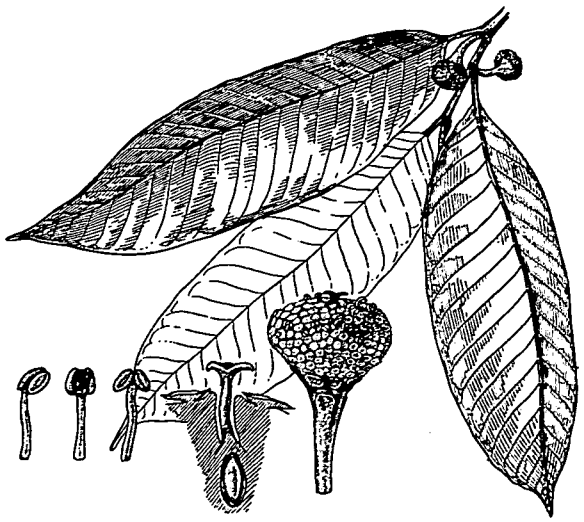
Common names (Costa Rica): ojoche blanco, leche de vaca (GONZÁLEZ, in prep.), (Central America): ojoche (BERG 1972)

Dioecious tree, usually up to 35 m tall, with buttresses, latex white, yellow or greenish; leaves elliptic to elliptic-oblong, 6-28 cm long, 3-11 cm wide, entire, stipules paired, not fully amplexicaul; inflorescences unisexual, male inflorescences 1-2 per axil, globose, 3-11 mm in diameter with numerous flowers, perianth (3-)4, free or connate, stamens 2-4, female inflorescences usually 1 per axil, globose to ovoid, 2-6 mm in diameter, with 1-5(-13) flowers; infructescences subglobose or lobed (when more than 2 fruits developed), 1-2(-3) cm in diameter, yellow to reddish. In wet forests, from Mexico to Colombia, Paraguay and Brazil.

B. utile (Kunth) Oken, Pl. 82f,g

Common names (Costa Rica): vaco (GONZÁLEZ, in prep.)

Monoecious tree, up to 50 m tall, with buttresses, latex white; leaves elliptic to elliptic-oblong, 10,5-40 cm long, 7-14 cm wide, entire, stipules united, densely covered by sericeous hairs; inflorescences usually bisexual, rarely unisexual, usually 1 per axil, globose, to subglobose, up to 6 mm in diameter with few to many male flowers, these sometimes lacking and 1(-3) female flowers; perianth (0-)1-5, stamens 1(-2); infructescences globose, ca. 3 cm in diameter, brown. In wet forests, from Costa Rica to Venezuela and Brazil.



Brosimum utile

Castilla (neotrop. 3, CR 2, GD 1)

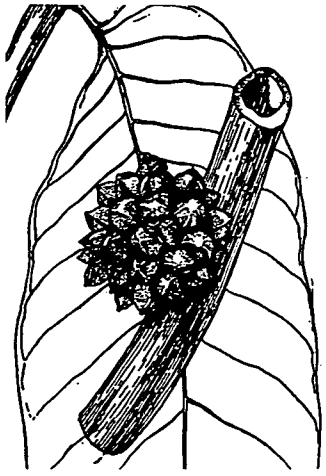
Common name (Costa Rica): hule (GONZÁLEZ, in prep.)

A small genus of monoecious or dioecious trees with white latex and connate and fully amplexicaul stipules. The infructescence is a more or less fleshy syncarp.

C. tunu Hemsl., Pl. 83a-c

Dioecious tree, up to 40 m tall, with buttresses; leaves elliptic to elliptic-oblanceolate, 14-40 cm long, 4-16 cm wide, entire, stipules 2-10 cm long, densely pubescent; male inflorescences 1-2 per

axil, reniform, 15-20 mm long, female inflorescences 1 per axil, discoid, sessile; infructescences 2-3,5 cm in diameter. In wet forests, from Belize to Colombia.



Castilla tunu

Clarisia (neotrop. 3, CR 3, GD 2)
Dioecious trees with white latex, early caducous stipules and rather nondescript leaves. The globose fruits are subtended by the persistent, fleshy perianth.

C. biflora Ruiz & Pav., Pl. 83d
Tree up to 45 m tall; leaves elliptic to elliptic-oblong, 5-19 cm long, 2-6 cm wide; inflorescences 1-2 per axil, male inflorescences spicate, 2-6 cm long; fruits subglobose > 20 mm in diameter. In dry and wet forests, from Mexico to Brazil.

Dorstenia (pantrop. 105, CR 3, GD 1)
One of the few herbaceous genera of Moraceae, which is further characterized by the broadly discoid or cup-shaped receptacle, in which the numerous minute flowers are inserted.

D. choconiana S. Watson, Pl. 83e,f
Herb, 20-50 cm tall; leaves of two different forms: pinnatisect with (2-)3(-6) lobes per side or entire, rhomboid, ovate or oblong; inflorescences solitary, cup-shaped, up to 3 cm in diameter. In wet forests, from Guatemala to Panama. This is the only caulescent species of Costa Rica.

Ficus (pantrop. + subtrop. ca. 750, CR 53, GD 23), Pl. 83g,h
Common names (Costa Rica): higueron, matapalo, chilamate (GONZÁLEZ, in prep.)
The largest and most widespread genus of the Moraceae, consisting of monoecious trees, shrubs and hemiepiphytic climbers, with white latex and well-developed terminal stipules. The unique inflorescence is bearing the flowers inside the urceolate receptacle, which has a small apical opening, the ostiole. The inflorescences and the fleshy fruits are called figs. *Ficus* is one of the main tree-strangler genera.

F. bullenei I.M. Johnst.
Usually hemiepiphytic tree, up to 20 m tall; leaves obovate to ovate, 8-23 cm long, 4-11 cm wide, stipules densely appressed reddish-brown pubescent; figs pedunculate, borne in pairs in the leaf axils, 8-12 mm in diameter, stamen 1. In wet forests, from Costa Rica to Ecuador and Venezuela.

F. citrifolia Mill., Pl. 84a
Usually hemiepiphytic tree or shrub, up to 15 m tall, with thick milky latex; leaves oblong-ovate to oblong-elliptic, 5-23 cm long, 2-10 cm wide, stipules glabrous; figs pedunculate, borne in pairs in the leaf axils, 8-15 mm in diameter, stamen 1. In wet forests, from Mexico to Paraguay.

F. colubrinae Sdandl.
Usually hemiepiphytic tree or shrub, up to 12 m tall; leaves elliptic to obovate, 4-11 cm long, 2-6 cm wide, stipules glabrous or densely pubescent; figs sessile, borne in pairs in the leaf axils, 4-8 mm in diameter, stamen 1. In wet forests, from Guatemala to Panama.

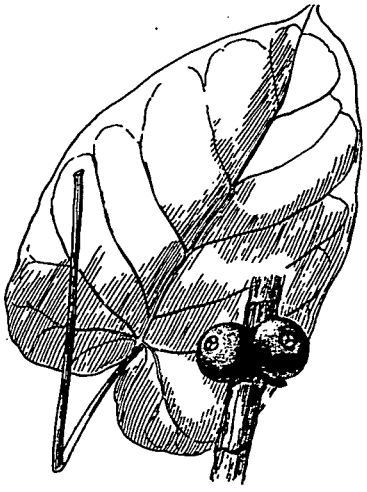
F. costaricana (Liebm.) Miq., Pl. 84b
Usually hemiepiphytic tree or shrub, up to 12 m tall; leaves ovate oblong or elliptic, 5-19 cm long, 2,5-8 cm wide, stipules usually glabrous or sparsely to densely pubescent; figs sessile, borne in pairs in the leaf axils, 10-12 mm in diameter, stamen 1. In wet forests, from Guatemala to Panama.

F. insipida Willd., Pl. 84c
Tree, up to 25 m tall; leaves ellipdic to elliptic-oblong or ovate, 8-27 cm long, 3-12 cm wide, stipules glabrous; figs pedunculate, borne singly in the leaf axils, 15-30 mm in diameter, stamens 2. In wet forests, from Mexico to southern Brazil.

F. maxima Mill., Pl. 84d
Tree up to 28 m tall; leaves elliptic to oblong, 3-27 cm long, 1,5-9 cm wide, stipules glabrous or minutely puberulous, caducous; figs pedunculate, borne singly in the leaf axils, 9-15 mm in diame-

ter, stamens 2. In wet forests, from Mexico to Peru and Brazil.

F. nymphaeifolia Mill., Pl. 84e
Tree, sometimes hemiepiphytic, up to 35 m tall; leaves ovate, 14-28(-35) cm long, 8-20 cm wide, stipules glabrous or minutely puberulous, caducous; figs sessile, borne in pairs in the leaf axils, 17-22 mm in diameter, stamen 1. In wet forests, from Nicaragua to Peru and Brazil.



Ficus nymphaeifolia

F. tonduzii Standl., Pl. 84f
Tree up to 25 m tall; leaves broadly elliptic to ovate, 9-32 cm long, 3,5-17 cm wide, stipules glabrous; figs sessile, borne singly in the leaf axils, 11-25(-35) mm in diameter, stamens 2. In wet forests, from Honduras to Ecuador.

F. zarzalensis Standl., Pl. 84g
Tree, sometimes hemiepiphytic, up to 45 m tall; leaves elliptic, oblong to ovate, 5-16 cm long, 3,5-8,5 cm wide, stipules covered with yellowish hairs; figs pedunculate, borne in pairs in the leaf axils, 9-15 mm in diameter, stamen 1. In wet forests, from Costa Rica to Colombia and Peru.

Naucleopsis (neotrop. 20-25, CR 3, GD 2)
A genus of dioecious or rarely monoecious trees, The genus can be recognized vegetatively by the stipule scars completely surrounding the twig, the distichous leaf arrangement and the reddish and very bitter tasting sap.

N. ulei (Warb.) Ducke, Pl. 85a
Tree up to 20 m tall; leaves oblanceolate, 39-51 cm long, 10-15 cm wide, stipules whitish pubescent, mostly subpersistent; male inflorescences up to 8 per axil, 2-5 mm in diameter, with 10 or more flowers, female inflorescences 7-12 mm in diameter with 20-30 flowers; infructescences 5-7 cm in diameter. In wet forests, from Costa Rica to Ecuador, Peru and eastern Brazil.

Perebea (neotrop. 9-10, CR 3, GD 2)
Monoecious and dioecious trees or shrubs with white or occasionally reddish latex and always dentate or denticulate leaves. The inflorescences are conspicuously disk-shaped, the persistent perianth is becoming fleshy in fruit.

P. hispidula Standl., Pl. 85b
Tree or shrub, up to 10 m tall, latex white; leaves elliptic to elliptic-oblong, 6-21 cm long, 2-7 cm wide, margin serrate to nearly entire; male inflorescences 3-5 mm in diameter, with 5-20 flowers, female inflorescences solitary, discoid, 2-5(-12) mm in diameter. In wet forests, from Costa Rica to Peru and Brazil.

Sorocea (neotrop. 16, CR 4, GD 4)
Dioecious shrubs or trees with white latex, alternate leaves and small spicate or racemose inflorescences.

S. affinis Hemsl.
Small tree or shrub, up to 10 m tall; leaves elliptic to elliptic-oblong, 3-18 cm long, 1-7 cm wide, serrate or almost entire, stipules puberulent; male inflorescences racemes, 1-2 per leaf axil, 1,5-3 cm long, female inflorescences racemes, 1-2 per leaf axil, 1-4 cm long; fruits globose, 4-8 mm in diameter. In wet forests, from Guatemala to Panama.

Sorocea affinis

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Muntingiaceae

This family has been recently established by BAYER et al. (1998). It includes 3 genera: *Muntingia*, *Dicraspidia* and *Neotessmania*. The first two occur in the GD area and are here still included in Elaeocarpaceae (*Muntingia*) and Tiliaceae (*Dicraspidia*) (see there).

BAYER, C., M.W. CHASE & M.F. FAY. 1998. Muntingiaceae, a new family of dicotyledons with malvalean affinities. - Taxon 47: 37-42.

Myristicaceae

An important tropical family of trees and shrubs, which can be recognized by the tiny, unisexual flowers with fused stamens, the red sap in the trunk and branches, and the two-valved fruits, containing a single, large, arillate seed with a ruminate endosperm. **Leaves** alternate, petiolate, simple, entire, sometimes stellate-pubescent, venation pinnate, stipules lacking; **inflorescences** axillary, paniculate, or flowers in subspicate racemes or fascicles; **flowers** actinomorphic, unisexual (plants dioecious), perianth 3- or 4-merous, stamens 3-8, equal or twice as much as the petals, filaments partly or completely connate into a tube, ovary superior, 1-locular, style and stigma 1; **fruits** drupes, 2-valved, dehiscent; seed 1, arillate. Distributed throughout the tropics worldwide, the tree relevant genera are common in lowland forests. Pantrop. 19/400, CR 4/9 + 1/1 introduced, GD 3/6.

Very little is known about the pollination and breeding systems of the Myristicaceae. *Myristica fragrans*, the nutmeg tree, native to Southeast Asia, has nocturnal flowers which are likely pollinated by small beetles foraging for pollen (ARMSTRONG & DRUMMOND 1986). This is also the case in the Australian species *M. insipida*, which is visited mainly by diurnal weevil beetles (ARMSTRONG & IRVINE 1989).

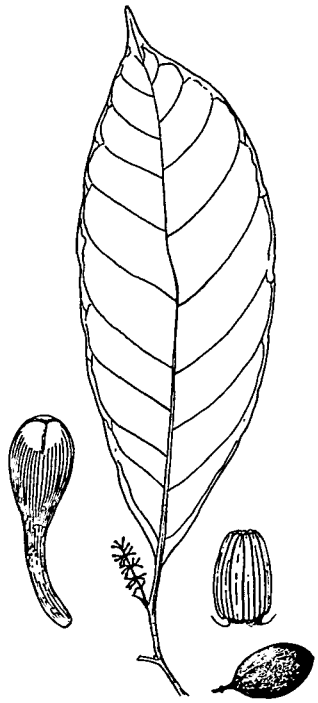
The endozoochorous seeds are mainly dispersed by arboreal frugivores. Fruits and seeds fall frequently to the ground and may then be dispersed by rodents and other animals. The fruits of *Virola sebifera* are eaten by birds, including motmots, toucans, and trogons (CHAPMAN 1931), while the arils around the seeds are eaten by spider and howler monkeys (HLADIK & HLADIK 1969, CARPENTER 1934, OPPENHEIMER 1968).

Myristica fragrans is cultivated in the Neotropics. The dried arils as well as the seeds are pulverized and used as an aromatic spice for dishes.

Key to the genera (after KÜHN & KUBITZKI 1993)

1	Aril entire or only apically laciniate, sometimes to about halfway	*Compsoneura*
1*	Aril deeply laciniate, i.e. to or almost to the base	2
2	Anthers free, or only basally adnate to the apex of the column	*Otoba*
2*	Anthers adnate adaxially to the column	*Virola*

Compsoneura (neotrop. 14, CR 2, GD 1)
Dioecious trees and shrubs, with the main vegetative character of a more or less parallel venation of the leaves. The ellipsoid fruits are smooth or circumcarinate, with the seeds surrounded by an endire or slightly laciniate aril.



Compsoneura sprucei

C. sprucei (A. DC.) Warb., Pl. 85c
Tree or shrub, up to 13 m tall; leaves glabrous, oblong to obovate, 9-30 cm long, 3,5-10 cm wide; inflorescences axillary, racemose, with several fascicles of 3-15 (male) or 1-8 (female) flowers; capsules ellipsoid, 20-37 mm long, 13-21 mm wide, yellowish. In tropical lowland forests, from southern Mexico to Peru and Brazil.

Otoba (neotrop. 6, CR 2, GD 1)
Dioecious trees, characterized by the glaucous or tannish leaf undersurface and the indumentum of T-shaped trichomes. The seeds of the almost globose fruits are surrounded by a deeply laciniate, red aril.

O. novogranatensis Moldenke, Pl. 85d
Common names (Costa Rica): hoja dorada, fruta dorada (QUESADA et al. 1997)
Tree, up to 35 m tall; leaves elliptic, 9-33 cm long, glaucous beneath; inflorescences axillary, racemose, 3-16 cm long; flowers yellow, 4 mm long; capsules 2-3,5 cm long. From Nicaragua to Colombia and Ecuador.

Virola (neotrop. 45, CR 5, GD 4)
The largest neotropical genus, consisting of dioecious trees and shrubs with an indumentum of stellate hairs. The seeds of the usually ovoid fruits possess a conspicuously laciniate, red aril, similar to *Otoba*.

Key to the species of *Virola*

1	Both sides of the lamina pubescent, on the upper side only along the midvein	*V. koschnyi*
1*	Lamina totally glabrous above	2
2	Indumentum of pedunculate hairs	*V. sebifera*
2*	Indumentum of sessile hairs	3
3	Capsules more than 25 mm long; perianth tardily 3-parted	*V. guatemalensis*
3*	Capsules less than 25 mm long; perianth parted almost to the base	*V. surinamensis*

V. guatemalensis (Hemsl.) Warb.
Common names (Costa Rica): bogamaní, fruta dorada (QUESADA et al. 1997).
Tree, up to 30 m tall; leaves oblong to narrowly obovate, sparsely pubescent with stellate hairs beneath; male inflorescences axillary, paniculate, 5-12 cm long, many-flowered, female inflorescences racemose, 5-9 cm long, few-flowered; capsules ovoid-ellipsoid, 27-36 mm long. From southern Mexico to Colombia.

V. koschnyi Warb., Pl. 85e
Common name (Costa Rica): fruta dorada (QUESADA et al. 1997).
Tree, up to 40 m tall, often with buttresses; leaves obovate to lanceolate, stellate pubescent on both sides; male inflorescences axillary, paniculate, 2-4 cm long, female inflorescences racemose; capsules subglobose to ellipsoid, 30-35 mm long. Common in lowland tropical moist and tropical wet forests, from Mexico to Colombia.

V. sebifera Aubl., Pl. 85f,g
Common name (Costa Rica): fruta dorada (QUESADA et al. 1997).
Tree, up to 30(-40) m tall; leaves usually oblong to obovate-oblong, stellate pubescent beneath; male inflorescences supra-axillary, paniculate, 6-12 cm long, female inflorescences racemose, 3-7 cm long, or flowers solitary; capsules oblong, 10-23 mm long. From Nicaragua to Peru, Bolivia and Brazil.

V. surinamensis (Rol. ex Rottb.) Warb.
Common names (Costa Rica): fruta dorada, candelo (QUESADA et al. 1997).
Tree, up to 30 m tall; leaves narrowly oblong, stellate pubescent beneath; male inflorescences paniculate, 7-17 cm long, female inflorescences 2-11 cm long; capsules ovoid to subglobose, 13-21 mm long. In tropical lowland forests, from Costa Rica to Ecuador and Peru.

Virola sebifera

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Myrsinaceae

Trees and shrubs, easy to recognize to family by the alternate leaves with nonpellucid glandular punctations, which are also present on the flower parts. **Leaves** often clustered at the branch ends, simple, entire, crenulate or serrate (e.g., *Ardisia*, *Cybianthus*, *Parathesis*), stipules lacking; **inflorescences** axillary, terminal or cauliflorous, racemose, paniculate or fasciculate; **flowers** bisexual or unisexual, usual-

ly 4(-5)-merous, small, sepals free or connate, glandular punctate, persistent in fruit, petals white, pink or green, basally connate, glandular punctate, stamens opposite the petals, filaments free or connate with the petals, ovary superior, 1-locular; **fruits** drupes or berries, glandular punctate, seed 1. Widely distributed in the tropics worldwide, as well as in the subtropics and a few species in temperate areas. Cosmopol. 33/1225, CR 7/88, GD 4/12.

Several Myrsinaceous genera are thought to be primarily pollinated by bees, but particular studies are rare. *Ardisia escallonioides*, which was studied by PASCARELLA (1997) is pollinated by several members of the bee families Halictidae and Apidae, which forage for pollen, collecting it through buzz-pollination as well as through other, less effective ways.

Key to the genera (after LUNDELL 1971, GENTRY 1993)

1	Inflorescences racemose or with racemose branches, when paniculate then usually with large clustered leaves and a more or less pachycaul growth form (the former genus *Weigeltia*)	*Cybianthus*
1*	Inflorescences paniculate, the flowers in umbels, corymbs or racemes	2
2	Sepals and petals valvate; petals densely pubescent	*Parathesis*
2*	Sepals and petals imbricate, often convolute in bud; petals glabrous	3
3	Flowers unisexual or bisexual; style of staminate flowers short, subequaling the abortive ovary, the style of carpellate flowers elongate, much exceeding the ovary; ovules few, uniseriate; sepals and petals contorted in bud	*Stylogyne*
3*	Flowers bisexual; style long and slender; ovules usually numerous, pluriseriate; sepals and petals imbricate or contorted in bud	*Ardisia*

Ardisia (pantrop. + subtrop. excl. Africa 250, CR 51, GD 7)
A large and heterogeneous genus of small trees and shrubs. In flower they can be recognized by the mostly 5-merous, white to pink or lilac-colored flowers, arranged in almost terminal paniculate inflorescences.

A. dodgei Standl.
Tree up to 15 m tall; leaves not clustered at the end of the branchlets, elliptic-lanceolate, 20-22 cm long, petiole 8 mm long; inflorescences short, dense, with many flowers, subtended by conspicuous pinkish bracts; flowers rather large, white to pink. From Costa Rica to Colombia.

A. dunlapiana P.H. Allen
Tree up to 15 m tall; leaves not clustered at the end of the branchlets, lanceolate to elliptic-lanceolate, 7,5-15 cm long, glabrous, petiole narrowly winged; inflorescences paniculate, 7,5-10 cm long; flowers small, pinkish-tan-colored. Endemic to Costa Rica.

A. opegrapha Oerst.
Shrub or small tree; leaves membranaceous, elliptic-lanceolate, broadly elliptic or oblanceolate, 12-25 cm long, 3,5-7,5 cm wide, entire or subentire, glabrous, densely lineate punctate beneath; inflorescences pinnately-paniculate, pink; flowers small, dark pink to purple, black-punctate with linear glands. From Nicaragua to Panama.

A. pittieri Mez, Pl. 86a
Tree up to 6 m tall; leaves clustered at the end of the branchlets, cuneate-oblanceolate to elliptic oblong, 15-60 cm long, brown lepidote beneath, petioles up to 1,5 cm long; inflorescences paniculate; flowers rose-pink-colored. In Costa Rica and Panama.

Cybianthus (neotrop. 150, CR 4, GD 1)
A large and very variable genus of shrubs and trees, usually with racemose inflorescences and often finely rufescent leaves, these sometimes large and terminally clustered.

C. schlimii (Hook. f.) G. Agostini, Pl. 86c
Shrub or small tree, up to 2 m tall; leaves apically clustered, subchartaceous, up to 55 cm long, 15 cm wide, entire to serrulate; inflorescences axillary, paniculate, up to 25 cm long; flowers 3-merous, perianth black punctate; fruits globose. From Costa Rica to Colombia, Ecuador and Peru.

Parathesis (neotrop. 84, CR 18, GD 3), Pl. 86b
Vegetatively rather similar to *Ardisia*, but the branchlets or leaves often stellate pubescent. Fur-

ther distinguishing characters are the always 4-merous, densely pubescent flowers and the conspicuously ribbed fruits.

P. acostensis J.F. Morales
Shrub, up to 2 m tall, densely stellate tomentose with sessile ferruginous hairs; leaves elliptic - oblong, undulate-crenate; inflorescences paniculate, pyramidal, many-flowered. Endemic to Costa Rica.

Stylogyne (neotrop. 60, CR 2, GD 1)
Small trees and shrubs, bisexual or unisexual, strongly glandular punctate. The small flowers are arranged in corymbose or paniculate inflorescences.

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GENTRY, A.H. 1993. A field guide to the families and genera of woody plants of northwest South America (Colombia, Ecuador, Peru). - Washington: Conservation International.
LUNDELL, C.L. 1966. The genus *Parathesis* of the Myrsinaceae. - Contr. Texas Res. Found., Bot. Stud. 5.
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PASCARELLA, J.B. 1997. Pollination ecology of *Ardisia escallonioides* (Myrsinaceae). - Castanea 62 (1): 1-7.
RICKETSON, J.M. & J.J. PIPOLY III. 1997c. Nomenclatural notes and a synopsis of Mesoamerican *Stylogyne* (Myrsinaceae). - Sida, Contr. Bot. 17 (3): 591-597.

Myrtaceae

A very common family of trees and shrubs, easy to recognize to family by the presence of opposite, pellucid punctate leaves, without any significant odor. **Leaves** simple, entire, stipules lacking, the lateral veins usually prominent, often strongly parallel and ending in a submarginal collecting vein; **inflorescences** axillary or subterminal, racemose, cymose, paniculate, fasciculate or flowers solitary; **flowers** bisexual, 4-5-merous, often with sweet-aromatic scent, subtended by 2 bracteoles, sepals free or connate, then calyx calyptrate and mostly splitting irregularly at anthesis, petals usually white, rarely lacking, stamens (4-8-)numerous, often conspicuously long or colored, ovary inferior, 2-5(-18)-locular; **fruits** berries, drupes or loculicidal capsules, seeds 1-numerous. Mostly in the tropics but extending into temperate areas worldwide. Cosmopol. 129/4620, CR 19/79, GD 7/15.

The Myrtaceae is probably the most important family of neotropical wet forests and dominant in some areas (MORI et al. 1983).

The main attractant for visitors of the flowers of Myrtaceae subfam. Myrtoideae is the pollen (NIC LUGHADHA & PROENCA 1996), while nectar is the more common attractant in the mainly paleotropical subfamily Leptospermoideae (BEARDSELL et al. 1993). Pollinators of Myrtaceae are mainly bees, especially Collatidae in Australia, where they are strongly associated with the Myrtaceae (ARMSTRONG 1979), and mainly Meliponinae, Bombinae, and Halictidae in the Neotropics (NIC LUGADHA & PROENCA 1996). Besides, several species of Myrtaceae are exclusively visited by bats and/or birds (HOPPER 1980, CROME & IRVINE 1986).

Fruit dispersal in the fleshy-fruited Myrtaceae (Myrtoideae) is mainly by animals, especially by frugivorous birds as well as by bats and other mammals (NIC LUGHADHA & PROENCA1996). Species with capsular fruits (Leptospermoideae) are mainly wind-dispersed.
Several species of *Eugenia* (e.g. *E. uniflora*, *E. brasiliensis*) have edible fruits with a high vitamin content, but none of them is widely cultivated. The fruits of *Psidium guajava* ("guayaba") have a white to reddish, sweet tasting pulp with a high content of vitamin C. They are mostly used for making juices and jams. This species is widely cultivated in the tropics. To a lesser extent, the Central American *P. friedrichsthalianum* ("cås"), which has smaller fruits with a bitter-sour taste, is also cultivated in parts of tropical America. The fruits of *Myrciaria floribunda* and some other species of this genus, known as "jaboticaba" in Brazil, are cultivated and eaten raw, or made into jams and marmalades. Some species

of the Old World genus *Syzygium,* such as *S. jambos* or *S. malaccense* provide edible fruits *S. aromaticum*, the clove tree, is a famous spice plant. Another myrtaceous spice plant is *Pimenta dioica*, known as "allspice". The Australian genus *Eucalyptus*, famous for its fast growth, is often cultivated in the Neotropics as a timber tree.

Key to the genera (ARMANDO ESTRADA)

1	Inflorescence a panicle with many flowers; flowers usually 5-merous; embryo usually with folded leafy cotyledons (subtribe Myrciinae)	2
2	Calyx completely closed in bud (calyx lobes indistinct), falling as a calyptra at anthesis and often deciduous; fruit usually crowned by a circular scar	*Calyptranthes*
2	Calyx open in bud with 5 calyx lobes clearli distinguishable and usually persistent; fruit crowned by the calyx lobes	*Myrcia*
1	Inflorescence usually with a few flowers, never a panicle; flowers 4-5 merous; embryo with thick, fleshy cotyledons or these completely fused	3
3	Inflorescence dichasially branched or reduced to a single flower; calyx almost completely closed in bud, open only as a small pore (calyx lobes indistinct), tearing irregularly at anthesis; fruit with many seeds; seed coat hard (Tribe Myrtinae)	*Psidium*
3	Inflorescence a raceme or reduced to single flowers or borne ramiflorously sessile fascicles (inflorescence dichasially branched in Myrcianthes); flower uniformly 4 merous, lobes calyx free; fruit only with 1-2 seeds; seed coat membranaceous (Tribe Eugeniinae)	4
4	Inflorescence dichasially branched	*Myrcianthes*
4	Inflorescence not dichasially branched	5
5	Flowers in sessile fascicles	6
6	Flowers in fascicles from the axils of existing leaves; calyx falling at or just after anthesis (or sometimes persisting in a dried state and easily removed), leaving a scar on the fruit; calyx open in bud; fruit smooth	*Myrciaria*
6	Flowers in fascicles from leafless nodes below the existing leaves (ramiflorously); calyx persisting after anthesis and on the fruit; calyx closed in bud; fruit costate	*Plinia*
5	Flowers single, in pedicellate fascicles or in racemes	*Syzygium*

Calyptranthes (neotrop. 130, CR 6, GD 1)
Trees and shrubs, easy to recognize in flower by the calyx circumscissile at anthesis with a caducous apical part, leaving a ring at the apex of the fruit. Vegetative characters are the usually dichotomous branching and the indumentum of mostly T-shaped trichomes.

C. chytraculia (L.) Sw.
Small tree or shrub, glabrescent; leaves elliptic, less than 12 cm long; inflorescences cymose-paniculate, brown pubescent with T-shaped trichomes, inflorescences of several 1-5 flowered glomerules, the ultimate flowers mostly sessile; petals lacking; fruits globose berries, glabrous. In Central America, from southern Mexico to Panama and in Jamaica.

Myrciaria (neotrop. 40, CR 2, GD 1)
Trees and shrubs, characterized by the sessile to subsessile flowers arranged in axillary or rarely ramiflorous glomerate clusters.

M. floribunda (Willd.) O. Berg, Pl. 86d
Shrub or small tree, up to 10 m tall; leaves 2-5(-7) cm long, elliptic to lanceolate, glabrate; inflorescences glomerules of 2-5 flowers; flowers 4-merous; fruits globose berries, 8-15 mm in diameter,

Myrciaria floribunda

edible, seed 1. Common, usually in the understory of rain forests, gallery forests, as well as in open habitats, from Mexico and the Antilles to Peru and Brazil.

Psidium (neotrop. 100, CR 7, GD 2)
Trees and shrubs with rather large flowers in axillary dichasially branched inflorescences or solitary. The fruit is a hard shelled and multiseeded berry with a sometimes edible, fleshy pulp.

Key to the species of *Psidium* (after AMSHOFF 1958)

1	Plants glabrous	*P. friedrichsthalianum*
1*	Plants pubescent	*P. guajava*

P. friedrichsthalianum (O. Berg) Nied., Pl. 86e,f
Common name (Costa Rica): cas
Shrub or small tree, up to 9 m tall; leaves membranaceous to chartaceous, glabrous; calyx closed in bud, splitting irregularly 2-3-fid at anthesis, petals ca. 1,5 cm long. Distributed throughout Central America, sometimes cultivated.

P. guajava L., Pl. 86g
Common name (Costa Rica): guayaba
Shrub or small tree; leaves chartaceous, glabrescent; calyx closed in bud, splitting irregularly 4-5-fid at anthesis, petals 1,5-2 cm long. Native to Tropical America, most abundant in pastures and thickets, cultivated in the tropics worldwide.

Syzygium (pantrop. ca. 1000, CR 32, GD 6)
The largest genus of Myrtaceae, rather variable, but always with 4-merous flowers, bilocular ovary and the fruits nearly always single-seeded.

S. malaccense (L.) Merr. & L.M. Perry, Pl. 87a,b (syn. *Eugenia malaccensis* L.)
Tree up to 18 m tall; leaves opposite, elliptic-lanceolate or oblanceolate, 15-45 cm long, 9-20 cm wide; inflorescences cauliflorous and ramiflorous, fasciculate; petals usually 4, pinkish-purple to dark-red, stamens rather long, numerous, pinkish-purple; fruits fleshy, edible, with sweetish taste, oblong or obovoid, 5-10 cm long, pinkish to reddish. Native to Malaysia, now cultivated throughout the tropics worldwide.

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CROME, F.H.J. & A.K. IRVINE. 1986. "Two bob each way": The pollination and breeding system of the Australian rain forest tree *Syzygium cormiflorum* (Myrtaceae). - Biotropica 18: 115-125.
HOPPER, S.D. 1980. Pollination of the rain forest tree *Syzygium tierneyanum* (Myrtaceae) at Kuranda, Northern Queensland. - Austral. J. Bot. 28: 223-237.
LANDRUM, L.R. & M.L. KAWASAKI. 1997. The genera of Myrtaceae in Brazil: an illustrated synoptic treatment and identification keys. - Brittonia 49 (4): 508-536.
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MCVAUGH, R. 1969. Myrtaceae. In: B. MAGUIRE & coll. (ed). The Botany of the Guayana Highland - part XII. - Mem. New York Bot. Gard. 18 (2): 55-286.
MORI, S.A., B.M. BOOM, A.M. DE CARVALHO & T.S. DOS SANTOS. 1983. Ecological importance of Myrtaceae in an Eastern Brazilian wet forest. - Biotropica 15: 68-70.
NIC LUGHADHA, E. & C. PROENCA. 1996. A survey of reproductive biology of the Myrtoideae (Myrtaceae). - Ann. Missouri Bot. Gard. 83: 480-503.
SOBRAL, M. 1993. Sinopse de *Myrciaria* (Myrtaceae). - Napaea 9: 13-41.

Nyctaginaceae

Erect or scandent trees, shrubs or herbs, differing greatly from each other in vegetative and flowering characters. A common feature is the persistent perianth tube, which envelopes the thin walled fruit, forming a somewhat fleshy pseudofruit, a so-called anthocarp. Stems often swollen at the nodes, some-

times spiny, glabrous or puberulent. **Leaves** alternate, opposite to subopposite or whorled, often unequal, simple, entire, stipules lacking; **inflorescences** axillary or terminal, variously branched, usually cymose or paniculate; **flowers** subtended by 1-3 bracts, these often enlarged and sometimes petaloid, forming an involucre, flowers actinomorphic or rarely zygomorphic, bisexual or unisexual, perianth uniseriate (sometimes appearing biseriate because of the petaloid bracts), tepals (3-)4-5(-7), connate, forming a campanulate, urceolate to narrowly cylindrical tube, the basal part of the perianth persisting and enclosing the fruit, stamens 1-10(-40), usually basally connate, filaments mostly unequal, ovary superior, unilocular; **fruits** achenes or thin-walled nutlets. In the tropics and subtropics worldwide, extending into temperate zones, most abundant in the New World. Cosmopol. 30/390, CR 7/15, GD 4/5.

All genera occurring in the Esquinas forest have opposite leaves.

The main pollinators of the Nyctaginaceae are bees. Day-flowering species of *Mirabilis* ar visited by *Bombus vagans* and various small and medium-sized bees (BITTRICH & KÜHN 1993), while nocturnal species (with salverform, white flowers with red nectar guides) are usually visited by Sphingidae (VOGEL 1954). A combination of two different pollinators is frequently found: bees or hummingbirds visiting the flowers in the evening and in the morning, and hawkmoths visiting the flowers during the night (BAKER 1961; CRUDEN 1970, 1973; GRANT & GRANT 1983; MARTINEZ DEL RIO & BURQUEZ 1986). *Abronia* is visited in the daytime by Bombidae and Bombyliidae as well as by butterflies, while nocturnal visitors are Noctuidae and hawkmoths (TILLETT 1967, KEELER & FREDERICKS 1979). *Bougainvillea*, with its conspicuous colored bracts, is pollinated by butterflies (VOGEL 1954).

The fruits of Nyctaginaceae are dispersed by animals, water or wind. Several species have hairy or sticky fruits, which adhere to mammals (epizoochorous dispersal mode). Other species have winged fruits and sometimes the whole persistent perianth serves as a wing, supporting dispersal by wind (BITTRICH & KÜHN 1993).

Several species (e.g., *Bougainvillea* spp., *Mirabilis jalapa*) are cultivated as ornamentals because of their showy flowers (BURGER & KUIJT 1983, BITTRICH & KÜHN 1993, WOODSON & SCHERY 1961). The roots of various species of *Mirabilis* are used in local medicine: *M. jalapa* has purgative effects, *M. multiflora* is used to suppress appetite and to counteracts swellings (BITTRICH & KÜHN 1993).

Key to the genera (after BURGER & KUIJT 1983)

1	Herbs, woody only at the base	*Boerhavia*
1*	Trees, shrubs or subshrubs	2
2	Stems frequently armed with spines (but not all stems have spines); small shrubs, trees, climbers or woody lianas; fruit often borne on very long stalks, with longitudinal ranks of viscid-tipped glands	*Pisonia*
2*	Stems never with spines, small shrubs or trees, but not climbers; fruit sessile or stalked, lacking stalked viscid glands	3
3	Male flowers campanulate with the stamens well exserted from the broad perianth opening, female flowers with the stigmas exserted at anthesis and the pistil born on a short stalk; fruit becoming dark purple or black, longitudinally ridged when dry; laminae rarely more than 15 cm long, drying dark in color; small to large trees (rarely shrubs)	*Guapira*
3*	Male flowers tubular to ellipsoid, the stamens included within the perianth tube, female flowers with the stigmas only rarely exserted, pistil sessile or narrowed at the base; fruit becoming yellow, orange or purple, occasionally longitudinally striate when dry; laminae to 30 cm long, drying pale or dark; small subshrubs to small trees (rarely more than 8 m tall)	*Neea*

Boerhavia (pantrop. + subtrop. ca. 50, CR 3, GD 1)
Weedy, annual or perennial herbs, often basally woody, with opposite to subopposite leaves. The leaves of one pair are often very unequal in size. The minute flowers have a single perianth whorl, which forms basally a connate calyx-like part and a distal, 5-lobed, colored, petal-like part.
B. diffusa *L.*
Decumbent or ascending herb, up to 1 m tall, sparsely puberulent; leaves of different size, ovate to ovate-oblong or ovate-rhomboid, 1,5-6 cm long, 1-5 cm wide, undulate, sparsely puberulent on both sides; inflorescences terminal, up to 1 cm long; flowers ca. 2 mm long, pinkish to purplish; fruits narrowly obovoid to narrowly obtriangular, 3,5-4 mm long. In open, usually disturbed sites, throughout the Neotropics.

Neea (neotrop. 83, CR 5, GD 2)
Shrubs or small to medium sized unisexual trees, usually with conspicuously narrow, elongate and tubular male flowers, rather similar to several Rubiaceae (e.g. *Psychotria*) but the female flowers usually much smaller than the male ones. The inflorescence branches are usually brightly reddish to purple colored.
N. amplifolia Donn. Sm., Pl. 87c
Few-branched subshrub or small tree, up to 2(-7) m tall; leaves obovate to broadly elliptic-oblong, entire, glabrous or minutely puberulent beneath; inflorescences terminal, rarely more than 6 cm in flower, accrescent up to 10 cm in fruit; male flowers 5-9 mm long, female flowers 2-4 mm long; fruit a rounded to ellipsoid berry, short pedicellate. In shady areas in moist evergreen forests, from Nicaragua to Panama.

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KEELER, K.H. & M.S. FREDERICKS. 1979. Nocturnal pollination of *Abronia fragrans*. - Southw. Naturalist. 24: 692-693.
MARTINEZ DEL RIO, C. & A. BURQUEZ. 1986. Nectar production and temperature dependent pollination in *Mirabilis jarapa* L. - Biotropica 18 (1): 28-31.
TILLETT, S.S. 1967. The maritime species of *Abronia* (Nyctaginaceae). - Brittonia 19: 299-327.
VOGEL, S. 1954. Blütenbiologische Typen als Elemente der Sippengliederung. - Bot. Studien Heft 1.
WOODSON, R.E. & R.W. SCHERY. 1961. Nyctaginaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 48: 51-65.

Nymphaeaceae

A small family of annual or perennial herbs, with well developed rhizome, living partially or totally submersed or sometimes free-floating. **Leaves** simple, alternate, linear, sagittate, cordate or orbiculate, long petiolate, palmately veined; **flowers** axillary, solitary, long pedunculate, usually emergent, actinomorphic, frequently large and showy, sepals 3-6 (-12), free, variously colored, petals numerous, often brightly colored, stamens numerous, sessile or filaments very long, ovary superior or inferior, carpels partially to totally fused; **fruits** berries, inner tissue spongy, seeds numerous. Cosmopol. 6/75, CR 1/7, GD 1/1.

The flowers of Nymphaeaceae are entomophilous. Species of *Nuphar* are pollinated by beetles of the genus *Donacia* (SCHNEIDER & MOORE 1977). Diurnal species of *Nymphaea* are mostly bright colored and visited by bees foraging for pollen (PRANCE & ANDERSON 1976; SCHNEIDER & CHANEY 1981; SCHNEIDER 1982a, 1982b; CAPPERINO & SCHNEIDER 1985). The nocturnal species of *Nymphaea* have white flowers which are visited by beetles of the genus *Cyclocephala* (CRAMER et al. 1975, PRANCE & ANDERSON 1976, PRANCE 1980, WIERSEMA 1987). The animals are attracted by the white color and the sweet fragrance of the flower. They become entrapped during the night, pollinating the flower and tak-

ing up new pollen. In the same way the large nocturnal flowers of the Amazonian water lily, *Victoria amazonica* are pollinated by *Cyclocephala* beetles (PRANCE & ARIAS 1975).

Nymphaea (cosmopol. ca. 50, CR 7, GD 1)
Perennial herbs with orbicular to sagittate and usually floating leaves. The petals and the outermost stamens of the long pedunculate and showy flowers are mostly white or yellow-colored.

N. glandulifera Rodschied
(syn.: *N. blanda* G. Mey.)
Perennial, aquatic herb; leaves long petiolate, subcordate, 5-15 cm long, 3-10 cm wide, entire, sagittate; flowers nocturnal, up to 10 cm in diameter, white; fruits 1-2 cm long, 1,5-2,5 cm wide, irregularly dehiscent, seeds numerous. In Central America and northern South America.

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SCHNEIDER, E.L. & P.S. WILLIAMSON. 1993. Nymphaeaceae. Pp.: 486-493. In: K. KUBITZKI (ed.): The families and genera of vascular plants. Vol II. Magnoliid, Hamamelid and Caryophyllid families. - Berlin: Springer Verlag.

WIERSEMA, J.H. 1987. A monograph of *Nymphaea* subgenus *Hydrocallis* (Nymphaeaceae). - Syst. Bot. Monogr. 16: 1-112.

Ochnaceae

Trees and shrubs or rarely herbs (*Sauvagesia*) with alternate, stipulate leaves and the woody taxa often with conspicuous yellow flowers. **Leaves** simple or rarely compound (only in extralimited spp.), alternate, entire to serrate, stipules usually prominent, sometimes early caducous; **inflorescences** terminal or axillary, paniculate, racemose, cymose or rarely flowers solitary; **flowers** actinomorphic, bisexual, receptacle often enlarged in fruit, sepals (4-)5(-10), free or basally connate, petals (4-)5(-10), free, stamens 5-numerous, staminodes sometimes present (*Sauvagesia*), ovary superior, often borne on a gynophore, 1-many-locular, sometimes deeply lobed, style 1; **fruits** drupes, capsules, berries or drupaceous mericarps on an enlarged receptacle, seeds sometimes winged. Distributed throughout the tropics worldwide. Pantrop. 28/370, CR 4/12, GD 3/6.

Most species of Ochnaceae have poricidal anthers, which can be interpreted as an adaptation to buzz-pollination by bees (KUBITZKI & AMARAL 1991). Genera lacking poricidal anthers are probably also buzz-pollinated. This seems obvious when observing the peculiar position of the staminodia, which form a pseudo-poricidal tube with a small apical opening around the stamina (AMARAL 1991).

Species with fleshy fruits are well adapted to bird dispersal by the usually red or black-colored fruits and also by the persisting sepals and/or peduncles (AMARAL 1991). Species with capsular fruits are probably wind dispersed. This is the case in species with winged seeds (AMARAL 1991), but detailed studies are still lacking.

Key to the genera (after DWYER 1967)

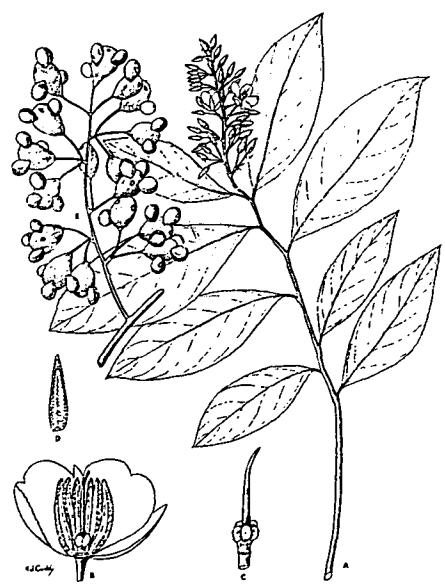
1	Trees or erect shrubs; flowers lacking coronal segments, yellow	2
2	Large trees with leaves up to 1 m long, clustered or whorled at the ends of the branches; panicles up to 1 m long; leaves rounded or obtuse at the apex	*Cespedesia*
2*	Shrubs or at most small trees; leaves up to 30 cm long, mostly well-spaced along the branches; panicles up to 20 cm long; leaves acute or acuminate at the apex	*Ouratea*
1*	Herbs or sprawling subshrubs; flowers with an obvious interior corona, white, pink, rarely yellow	*Sauvagesia*

Cespedesia (neotrop. 1, CR 1, GD 1)
Monotypic genus.

C. *spathulata* (Ruiz & Pav.) Planch.
(syn.: *C. macrophylla* Seem.)
Tree, up to 15 m tall, branches often with conspicuous leaf-scars; leaves fasciculately clustered at the twig apex, obovate to obovate-elliptic, to 1 m long, 18-25 cm wide, undulate, glabrous, stipules appressed, subligneous, up to 7 cm long; inflorescences terminal, paniculate, with several fascicles of 3-4 flowers; flowers yellow, stamens numerous; fruits narrowly falcate, up to 6,5 cm long, ca. 1 cm wide. From Nicaragua to Peru, Bolivia and Brazil.

Ouratea (pantrop. 150, CR 7, GD 4)
Trees and shrubs, very distinctive in fruit, with usually 3-5 drupaceous mericarps sessile on the swollen and fleshy, red-colored receptacle and the secondary veins ascending and well pronounced.

O. lucens (Kunth) Engl., Pl. 87d
Leaves 5,5-22 cm long, 2-7,5 cm wide, apex acute, usually short acuminate; inflorescences terminal, racemiform, 2,5-14 cm long. From Mexico throughout Central America to northern Colombia.



Ouratea lucens
A. Habit. B. Flower, long. section. C. Pistil. D. Stamen

O. valerii Standl.
Leaves large, up to 50 cm long, and 15 cm wide, apex obtuse; inflorescences terminal, paniculate, rather large, 10-25 cm long, with numerous flowers. Endemic to Costa Rica.

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KUBITZKI, K. & M.C.E. AMARAL. 1991. Transference of function in the pollination system of the Ochnaceae. - Pl. Syst. Evol. 177 (1-2): 77-80.
SASTRE, C. 1988. Synopsis generis *Ouratea* Aublet (Ochnaceae). - Bull. Mus. Nat. Hist. Nat. 4e sér. 10, sect. B, Adansonia 1: 47-67.

Olacaceae

A small and vegetatively rather nondescript family of trees, shrubs and lianas, sometimes parasitic, which is a common feature within the order Santalales. **Leaves** alternate, usually entire, stipules lacking; **inflorescences** axillary, rarely cauliflorous or ramiflorous, of various shape, **flowers** usually bisexual, 3-7-merous, often small and inconspicuous, calyx united, sometimes accrescent in fruit and becoming conspicuously colored, petals free or connate, stamens in 1-3 whorls, ovary superior, rarely semi-inferior or inferior; **fruits** drupes, with fleshy pericarp, or the enlarged disk or the accrescent calyx becoming fleshy, seed 1. In lowland rain forests as well as in dry areas. Cosmopol. ca. 27/c.180, CR 5/13, GD 4/8.

The name of the family is derived from the type genus *Olax*, which literally means "odor "in Greek, because the wood of *Olax zeylanica* is said to have a disagreeable smell (SLEUMER 1984).

Because of its hard wood, the sometimes deeply fenestrated trunk of *Minquartia guianensis* is used for telephone poles (SLEUMER 1984, HIEPKO 1993).

Key to the genera (after SLEUMER 1984)

1	Bark and leaves with distinct resin canals (or cavities) and/or laticifers	2
2	Bark and leaves with both resin canals (or cavities) and laticifers; endosperm with amylum and fatty substances or with amylum only (tribe Couleae)	*Minquartia*
2*	Bark and leaves entirely with laticifers (these usually well visible with the naked eye on the undersurface of leaves, though sometimes scarce and inconspicuous there); endosperm with amylum and fatty substances or with the latter only (tribe Heisterieae)	3
3	Flowers in sessile fascicles	*Heisteria*
3*	Flowers in pedunculate cymes	*Chaunochiton*
1*	Bark and leaves without resinous canals or laticifers	*Ximenia*

Alternative key to the genera, based on habit, leaves and inflorescence characters

1	Lianas or (sub)scandent shrubs	*Heisteria* p.p.
1*	Erect shrubs or trees	2
2*	Flowers and fruits in spikes; leaves prominently dark punctate beneath with resinous dots	*Minquartia*
2*	Flowers and fruits in racemes, panicles, or fascicles; leaves not dark punctate beneath	3
3	Flowers and fruits fascicled, rarely solitary	*Heisteria* p.p.
3*	Flowers and fruits in racemes or (corymbose) panicles, rarely solitary	4
4	Ramal thorns usually present	*Ximenia*
4*	Ramal thorns always absent	*Chaunochiton*

Chaunochiton (neotrop. 5, CR 1, GD 1)
Small to large trees with narrow, 5-merous flowers and wind dispersed drupes, which are partly or entirely enveloped by the large brownish calyx.

C. kappleri (Sagot ex Engl.) Ducke, Pl. 87e,f
Common name (Costa Rica): manglillo (BURGER 1983).
Tree, up to 20 m tall; leaves lanceolate ovate to oblong-ovate, sometimes obovate or suborbicular; inflorescences axillary or (sub)terminal panicles; drupes subglobose-ovoid, only the base enveloped by the papery calyx. In rain forests and wet forests on sandy, non inundated ground in Costa Rica, Colombia, the Guianas and Amazonian Brazil.

Heisteria (cosmopol. 33, CR 8, GD 5)
Shrubs or small trees, often with pellucid-punctate leaves and the calyx in fruit becoming large accrescent, slightly fleshy and brightly colored.

H. acuminata (Humb. & Bonpl.) Engl., Pl. 87g
Shrub or treelet, up to 6(-15) m tall; leaves oblong to elliptic-oblong or lanceolate-oblong, glabrous; flowers usually rather few, in axillary cushions or on short axes; drupes usually oblongoid, smooth or with a few tubercles, red to bluish-black at maturity, calyx accrescent in fruit, blood red. From Costa Rica to Amazonian Bolivia and Brazil.

H. scandens Ducke
(Sub)scandent shrub or liana, up to 30 m tall; leaves usually distichous, glabrous; flowers to 8-20 in axillary fascicles; drupes (sub)globose or obovoidly so, reddish to orange, calyx green in fruit. In the understory of lowland rain forests on non inundated ground, from southeastern Costa Rica to Peru and Amazonian Brazil.

Minquartia (neotrop. 1, CR 1, GD 1)
Monotypic genus.

M. guianensis Aubl., Pl. 87h,i
Common names (Costa Rica): manú negro (SLEUMER 1984); manu, crillo, nispero, negro, cricamola, black manwood (BURGER 1983).
Small to large tree, the vegetative parts containing milky latex; young branches rusty tomentulous; leaves oblong, with finely parallel tertiary venation; inflorescences many-flowered axillary spikes, flowers cream-colored, usually 5-merous, stamens 10; fruits drupes ellipsoid, purplish black at maturity, without accrescent calyx. In non-inundated as well as seasonally inundated tropical lowland forests and gallery forests on clayic or sandy soil in Central America and northern South America, from Nicaragua to Bolivia and Brazil.

BURGER, W. 1983. *Olacaceae*. Flora Costaricensis. - Fieldiana Bot. 13, n.s.
HIEPKO, P. 1993 *Olacaceae*. In: GORTS VAN RIJN (ed.): Flora of the Guianas, ser. A, fasc. 14. Koeltz Scientific Books.
SLEUMER, H. 1984. *Olacaceae*.-Fl. Neotrop. Monogr. 38.

Oleaceae

A family of evergreen or deciduous trees, shrubs and vines. **Leaves** opposite or rarely alternate, exstipulate, simple, trifoliate, or pinnate; **inflorescences** dichasial cymes but usually appearing as a raceme panicle, or fascicle; **flowers** actinomorphic, bisexual, rarely unisexual, often strongly fragrant, calyx usually 4-lobate or 4-parted, rarely absent, petals mostly 4, free or united, sometimes absent, stamens 2, alternating with the carpels, or sometimes 4 and dhen alternating with the petals, usually attached to the corolla tube, ovary superior, 2-locular; **fruits** capsules, berries, drupes, or samaras, seeds 1-4. Subcosmopol. 24/600, CR 5/14, GD 1/1.

Chionanthus (pantrop. + subtrop. 100, CR 2, GD 1)
A genus of evergreen or sometimes deciduous trees or shrubs with opposite, simple, often coriaceous leaves with entire margins distributed chiefly in the tropics and subtropics of Africa, Asia, and the Americas. Domatia are often present on the underside of the leaves, appearing as tufts of hairs in the vein axils. The paniculate, fasciculate, or racemose inflorescences are inserted axillary but are often produced distally on the branches. The name *Chionanthus* has mostly been applied to a few temperate species of North America and China, whereas all tropical and subtropical members have been referred to *Linociera*. However, according to STEARN (1976), there are no reliable characters to distinguish between these two genera.

C. panamensis (Standl.) Stearn
Tree up to 15 m tall; leaves elliptic, up to 10 cm long; inflorescences paniculate, up to 10 cm long, many-flowered; flowers showy, petals 4, tubular, white, stamens 2; fruits compressed, elliptic drupes, ca. 2 cm long, 1 cm wide, white. In lowland forests in Costa Rica and Panama.

D'ARCY, W. 1976. Oleaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 63: 553-564.
GREEN, P.S. 1991. Notes on Oleaceae for Flora Mesoamericana. - Kew Bull. 46 (2): 273-276.
GREEN, P.S. 1994. A revision of *Chionanthus* (Oleaceae) in South America and the description of *Priogymnanthus*, gen. Nov. - Kew Bull. 49 (2): 261-286.

STAHL, B. 1992. Oleaceae. In: G. HARLING & L. ANDERSSON (eds.): Flora of Ecuador 43.
STEARN, W.T. 1976. Union of *Chionanthus* and *Linociera* (Oleaceae). - Ann. Missouri Bot. Gard. 63: 355-357.

Onagraceae

Mostly herbs but also some trees and shrubs, rather poorly represented in the Neotropics. They can be distinguished by their usually herbaceous habit in combination with an inferior ovary and the stipules when present often gland-like. **Leaves** simple, alternate, opposite or sometimes whorled, stipules small and caducous or lacking; **inflorescences** axillary or terminal, racemose or flowers solitary; **flowers** mostly bisexual, (2-)4(-7)-merous, small to large, hypanthium cup-shaped or tubular, well prolonged beyond the ovary (except in *Ludwigia*), stamens as many or twice as many as the petals, rarely less, ovary inferior, usually 4-locular; **fruits** capsules, berries or nuts, seeds 1-many, small. Distributed worldwide, most abundant in North America. Cosmopol. 18/650, CR 7/35, GD 2/4.

More than 50 % of the species of Onagraceae are self-pollinating (RAVEN 1979). The main pollination mode of the outcrossing species is melittophily (RAVEN 1979). Species of *Ludwigia* are thought to be primarily pollinated by rather unspecialized insects, predominantly by bees (ESTES & THORP 1974, RAVEN 1979, EYDE 1981). In their treatment of *Ludwigia* section *Myrtocarpus* s.l., RAMAMOORTHY & ZARDINI (1987) mention that most of its species are visited primarily by bees and to a lesser extent by syrphid flies or butterflies, while the small-flowered species of this section (e.g. *L. latifolia*) are predominantly autogamous. The large, showy flowers of the North American *Ludwigia peploides* are visited by various pollen collecting and nectar collecting bees (ESTES & THORP 1974). Pollination by hummingbirds is known in about 89 species of Onagraceae (RAVEN 1979), among them some primitive species of *Fuchsia* and *Lopezia* (BREEDLOVE 1969, RAVEN 1979, RAMAMOORTHY & ZARDINI 1987). To a lesser extent there is also pollination by hawkmoths (e.g. *Oenothera* spp.) (GREGORY 1963, 1964), by small moths (e.g., *Oenothera canescens*) (RAVEN 1979), and by syrphid and tachinid flies (e.g., *Fuchsia* spp., *Lopezia* spp.) (BREEDLOVE 1969, RAVEN 1979).

Seed dispersal in *Ludwigia*, which has dehiscent capsular fruits, is usually autochorous (SALISBURY 1972, EYDE 1978, PENG & TOBE 1987). The genus *Fuchsia* has bird dispersed fleshy fruits.
The economical importance of the Onagraceae is quite low. A few species of *Fuchsia* are cultivated as ornamentals.

Key to the genera (after MUNZ 1959)

1	Sepals persistent; floral tube not prolonged beyond the ovary; fruit a capsule	*Ludwigia*
1*	Sepals deciduous after anthesis; floral tube prolonged beyond the ovary; fruit a berry	*Fuchsia*

Fuchsia (neotrop. 105, CR 7, GD 1)
Trees, shrubs and lianas with alternate, opposite or whorled leaves and always with brightly colored, usually pendent flowers, solitary or in racemose or paniculate inflorescences.

Ludwigia (cosmopol. 82, CR 18, GD 3)
Trees shrubs or mostly herbs of wet places, sometimes floating, with alternate or opposite leaves and solitary, yellow or white, mostly 4-merous flowers.

Key to the species of *Ludwiga* (after MUNZ 1974)

1	Seeds multiseriate in each locule of the capsule, free (not enclosed in persistent endocarp)	2
2	Raphe distinctly smaller than body of seed; capsule almost round	*L. latifolia*
2*	Raphe so much enlarged as to be almost equal to body of seed; capsule cylindrical	*L. octovalvis*
1*	Seeds uniseriate in lower part of the capsule and each enclosed in persistent endocarp, multiseriate and not so enclosed in upper part	*L. hyssopifolia*

L. hyssopifolia (G. Don) Exell
Annual herb, up to 3 m tall, subglabrous; leaves lanceolate to ovate, subentire; petals yellow, 2-3 mm long; capsules subterete, 1,5-3 cm long, sublinear, but enlarged in upper part. From the southeastern United States and the West Indies to Peru and Brazil, as well as in Africa and the East Indies.

L. latifolia (Benth.) H. Hara
Herb, shrub or small tree, up to 3(-5) m tall, subglabrous, young branchlets finely puberulent; leaves ovate to broadly lanceolate, subentire; flowers 1-2 in the upper leaf axils, petals yellow, 4-6 mm long; capsules subglobose to oblong, 0,6-1,3 cm long. Along rivers, in seasonal swamps or inundated areas, from Nicaragua and Trinidad to Bolivia, western Ecuador and eastern Brazil.

L. octovalvis (Jacq.) P.H. Raven
Herb or shrub, up to 2,5 m tall, subglabrous to hairy; leaves oblong to lance-ovate or lance-linear, subentire with occasional swollen marginal glands; flowers solitary in the upper leaf axils, petals deep yellow, 10-20 mm long, scarcely clawed; capsules cylindric to clavate-cylindric, obtusely 4-angled, 2,5-5 cm long. From the southern United States to Argentina as well as in the Paleotropics.

BERRY, PE. 1982. The systematics and evolution of *Fuchsia* sect. *Fuchsia* (Onagraceae). - Ann. Missouri Bot. Gard. 69 (1): 1-198.

BREEDLOVE, D.E., BERRY, P.E. & P.H. RAVEN. 1982. The Mexican and Central American species of *Fuchsia* (Onagraceae) except for sect. *Encliandra*. - Ann. Missouri Bot. Gard. 69 (1): 209-234.

ESTES, J.R. & R.W. THORP. 1974. Pollination in *Ludwigia peploides* ssp. *glabrescens* (Onagraceae). - Bull. Torrey Bot. Club 101: 272-276.

EYDE, R.H. 1978. Reproductive structures and evolution in *Ludwigia* (Onagraceae). II. Fruit and seed. - Ann. Missouri Bot. Gard. 65: 656-675.

EYDE, R.H. 1981. Reproductive structures and evolution in *Ludwigia* (Onagraceae). III. Vasculature, nectaries, conclusions. - Ann. Missouri Bot. Gard. 68: 379-412.

GREGORY, D.P. 1963. Hawkmoth pollination in the genus *Oenothera*. - Aliso 5: 357-384.

MUNZ, P.A. 1944. Studies in Onagraceae XIII: The American species of *Ludwigia*. - Bull. Torrey Bot. Club. 71: 152-165.

MUNZ, P.A. 1974. Onagraceae. In: G. HARLING & L. ANDERSSON (eds.): Flora of Ecuador 3.

MUNZ, P.A. 1959. Onagraceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 46: 195-221.

PENG, C-I. & H. TOBE. 1987. Capsule wall anatomy in relation to capsular dehiscence in *Ludwigia* sect. *Microcarpum* (Onagraceae). - Amer. J. Bot. 74: 1102-1110.

RAMAMOORTHY, T.D. & E.M. ZARDINI. 1987. The systematics and evolution of *Ludwigia* sect. *Myrtocarpus* sensu lato (Onagraceae). - Monogr. Syst. Bot. Missouri Bot. Gard. 19: 1-120.

RAVEN, P.H. 1963. The Old World species of *Ludwigia* (including *Jussiaea*), with a synopsis of the genus (Onagraceae). - Reinwardtia 6 (4): 327-427.

RAVEN, P.H. 1979. A survey of reproductive biology in Onagraceae. - New Zealand J. Bot. 17: 575-593.

SALISBURY, E.J. 1972. *Ludwigia palustris* (L.) Ell. in England with special reference to its dispersal and germination. - Watsonia 9: 33-37.

Oxalidaceae

Herbs, shrubs or rarely trees with pinnately or palmately compound leaves, rarely unifoliolate. **Leaves** alternate, subopposite or spirally clustered in an apical or basal rosette, stipules sometimes present; **inflorescences** cymose, paniculate, umbellate or flowers solitary; **flowers** small to large, actinomorphic, 5-merous, sepals 5, free, persistent, petals 5 (often lacking in cleistogamous flowers), free or sometimes slightly connate at the base, sometimes shortly clawed, stamens 10, basally connate, equal, or markedly unequal (the outer whorl usually with shorter filaments), staminodes sometimes present, 5, ovary superior, 5-locular; **fruits** 5-lobate capsules or berries. Cosmopol. 6/775, CR 3/12 + 2 spp. cultivated, GD 3/2 + 2 spp. cultivated.

Species of *Averrhoa* are cultivated throughout the tropics for their edible "star fruits" with an aromatic sour taste. *Oxalis tuberosa* is an important crop of the Andean area and is grown for its high starch con-

tent. The leaves of *Oxalis* have a sour taste due to the presence of oxal acid. Native people administer them to small children to battle intestinal parasites.

Key to the genera (after BURGER 1983)

1	Trees, leaves pinnate; fruit over 5 cm long, fleshy and edible; plants grown in gardens and parks	*Averrhoa*
1*	Herbs or small (to 3 m) subshrubs; fruit a small dehiscent capsule; ornamental and wild plants	2
2	Leaves usually 3-foliolate; capsule dehiscing by longitudinal slits, carpels (mericarps) remaining attached to the central axis of the fruit	*Oxalis*
2*	Leaves long-pinnate with many small leaflets; capsules loculicidal in a radial form, carpels remaining attached only at the base	*Biophytum*

Averrhoa (paleotrop. 2, CR 2 cultivated, GD 2 cultivated)
Usually small trees with alternate and imparipinnate leaves and fleshy, elongate fruits, usually with 5 longitudinal ridges.

A. carambola L., Pl. 88a,b
Tree, up to 10 m tall; leaves with 7-11(-15) leaflets, rhachis 10-16 cm long, ferruginous-tomentose, leaflets opposite or alternate, ovate, 6-9 cm long, 3-4 cm wide, acuminate, rounded at base, mostly glabrous but strigillose on and near veins beneath and near margins, dark green above; inflorescences axillary, reddish; flowers 5-merous, on articulate pedicels, sepals ca. 3 mm long, petals ca. 5 mm long, rotate, the petals +/- obovate, maroon, stamens 10, in 2 series, the outer 5 fertile, short, alternating with the staminodia; fruits berries, ovoid, or ellipsoid, 8-14 cm long, yellow, usually with 5 ribs (star-like in cross section). Native to tropical Asia, but cultivated throughout the tropics and presumably naturalized in Central America.

Biophytum (pantrop. 50, CR 2, GD 1)
A genus of herbs or small subshrubs, easy to recognize for its terminal rosette of paripinnate leaves with many pairs of leaflets.

B. cf. ***dendroides*** (H.B.K.) DC., Pl. 88c
The species found in the GD is apparently *B. dendroides*, which was not known from Costa Rica until recently. BURGER (1983) reported that the "apparent absence of *B. dendroides* from Costa Rica is puzzling", because it ranges from Mexico to Ecuador, but recently two collections were obtained in the northwestern Costa Rican provinces Guanacaste and Alajuela (INBIO 1995). *B. dendroides* differs from the similar *B. falcifolium* by the shape of the leaflets and from *B. panamensis* by the lesser number of leaflets (13-16 pairs) (see LOURTEIG 1980).

Oxalis (cosmopol. 700, CR 10, GD 1)
Herbs or subshrubs with alternate to subopposite, trifoliolate leaves and small, narrow, angulate, capsular fruits.

O. corniculata L.
Slender annual herb, prostrate or procumbent, much-branched; leaves 3-foliolate, long petiolate, leaflets small, 4-12(-20) mm long, broadly obovate; inflorescences cymose or umbelliform, (1-) 2-7-flowered; flowers small, yellowish, often pinkish or whitish within, fruits subcylindrical and 5-ribbed, 5-25 mm long, 1-3 mm wide. Native to the Mediterranean area, but now distributed worldwide.

BURGER, W. 1991. Oxalidaceae. Flora Costaricensis. - Fieldiana Bot. 28, n.s.: 2-16.
INBIO. 1995. *Biophytum dendroides*. In: Manual de la Flora de Costa Rica. (WWW document) URL http://www.mobot.org/manual.plantas/028743/S028749.html. (7.9.2000).
LOURTEIG, A. 1979. Oxalidaceae extra-austroamericanae. II. *Oxalis* L. Sectio *Corniculatae* DC. - Phytologia 42: 57-198.
LOURTEIG, A. 1980. Oxalidaceae. In: R.E. WOODSON, R.W. SCHERY et al.: - Flora of Panama. Ann. Missouri Bot. Gard. 67 (4): 823-850.

Papaveraceae

A primarily north temperate family of annual to perennial herbs, or rarely soft-wooded trees (*Bocconia*). Easy to recognize by the presence of colored (mostly orange) or colorless latex in all parts. **Leaves** alternate, rarely opposite or whorled, usually deeply lobed or variously divided, stipules lacking; **inflorescences** terminal, cymose, racemose or flowers solitary; **flowers** actinomorphic, bisexual, sepals 2, free, caducous, petals 4-6, caducous, absent in *Bocconia*, stamens usually numerous, rarely 4-6-12, free, ovary superior, usually unilocular; **fruits** capsules, dehiscing by valves or pores, sometimes indehiscent or fruits splitting into mericarps, seeds 1-numerous, frequently arillate. Mainly distributed in the temperate zones of the northern hemisphere worldwide, but also extending into tropical zones. Cosmopol. 23/230, CR 4/3, GD 1/1.

Most genera of Papaveraceae are insect-pollinated, with hymenoptera and diptera as the main pollinators (HANNAN 1981, LYON 1992, KADEREIT 1993). The North American species *Argemone aurantiaca* is mainly pollinated by various hymenoptera and coleoptera (SCHNEIDER & NICHOLS 1984). Only the genera *Bocconia* and *Macleaya*, with specific flower characters such as pendulous stamens, thin filaments and absent petals, are assumed to be wind-pollinated (KADEREIT 1993, LIDEN 1995).

Species with capsular fruits are usually self-dispersed, wind-dispersed or a combination of both. The seeds of Papaveraceae frequently have an aril. Some of them are dispersed by ants while others with bright orange arils (e.g., *Bocconia*) are supposedly dispersed by birds.

Only a few species of Papaveraceae are of economic use. The commercially most important species, *Papaver somniferum*, the opium poppy, is used in local traditional medicine or for the production of narcotics. Several species in various genera are used as ornamentals.

Bocconia (neotrop. 9, CR 1, GD 1)
Common name (Costa Rica): guacamayo
Small, soft wooded rosette-trees, usually of higher elevations, with orange latex, characteristic entire or lobed, serrate to serrulate leaves and apetalous flowers.

B. frutescens L., Pl. 88d,e
Small tree or shrub, up to 8 m tall; leaves entire to deeply lobate, up to 45 cm long and 30 cm wide; inflorescences cymose, much-branched, many-flowered, sepals ca. 10 mm long, purplish to brownish; fruits ellipsoid capsules, dehiscing by 2 valves, seed with prominent orange aril. Widespread in the Neotropics, from Mexico and the West Indies to central South America.

HANNAN, G.L. 1981. Flower color polymorphism and pollination biology of *Platystemon californicus* (Papaveraceae). - Amer. J. Bot. 68 (2): 233-243.
HUTCHINSON, J. 1920. *Bocconia* and *Macleaya*. - Kew Bull. 1920: 275-282.
KADEREIT, J.W. 1993. Papaveraceae. Pp: 494-506. In: K. KUBITZKI (ed.): The families and genera of vascular plants. Vol II. Magnoliid, Hamamelid and Caryophyllid families. - Berlin: Springer Verlag.
LIDEN, M. 1995. Papaveraceae. In: G. HARLING & L. ANDERSSON (eds.): Flora of Ecuador 52.
LYON, D.L. 1992. Bee pollination of facultatively xenogamous *Sanguinaria canadensis* L. - Bull. Torrey Bot. Club 119 (4): 368-375.
SCHNEIDER, E.L. & D.M. NICHOLS. 1984. Floral biology of *Argemone aurantiaca* (Papaveraceae). - Bull. Torrey Bot. Club 111 (1): 1-7.
TURNER, B.L. 1995. A new species of *Bocconia* (Papaveraceae) from Oaxaca, Mexico. - Phytologia 79 (4): 313-316.
WOODSON, R.E. & R.W. SCHERY. 1948. Papaveraceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 35: 71-75.

Passifloraceae

A medium sized-family of mainly vines and some trees, shrubs and herbs, with some species producing edible fruits and showy flowers. The family is considered closely related to the Cucurbitaceae and Loasaceae. **Leaves** alternate, simple, entire or palmately lobed, petioles often with extrafloral nectaries, stipules usually small and deciduous; **inflorescences** axillary, cymose and often reduced to 1-2 flowers; **flowers** large, actinomorphic, bisexual or rarely unisexual, with cupulate to tubular hypanthium, showy and with nectariferous disc, calyx of 4-5 sepals, often petaloid, appendaged and persistent, corolla of 4-5 petals, distinct or basically connate, spreading, with fringed corona of 1 to several whorls of filaments, greenish white or brightly colored, stamens 5, sometimes arising from a raised stalk (androgynophore), ovary superior, unilocular, gynoecium with 3 styles, sometimes arising from an androgynophore; **fruits** berries, sometimes loculicidal capsules, seeds compressed, arillate. Pantrop. + subtrop. 17/575, CR 1/46 + 1 cultivated, GD 1/16.

Certain aspects of the complex floral structure are the most distinctive features of the family. Different terms have been used to describe the floral parts. The terminology of HARMS (1893) and KILLIP (1938) is used here. The corona usually consists of numerous elongate extensions. They are often of a different color than the sepals and petals and are arranged in one to ten filament series or rows. The operculum is normally a membranaceous structure below the corona and encloses the nectar. It represents a "closed door" to non-pollinating visitors. The nectary is a low, narrow ring below the operculum, at the bottom of the tube. The limen is not always present and may be similar to the nectar ring or it may be a cup-shaped membrane.

The extrafloral nectaries on the leaves and petioles are rich in amino acids (DURKEE 1978) which are preferred by visiting ants (FOWLER 1988). The nectaries protect the plant by attracting predaceous insects that eat herbivorous insects (BENSON & AL 1976, BENTLEY 1977), and they also appear to attract parasitic hymenoptera that parasitize the juvenile stages of herbivores (GILBERT 1977, GILBERT & SMILEY 1979).

Heliconius butterflies (Heliconiinae) lay their eggs on the tendrils and leaf tips of Passifloras (e.g., *P. vitifolia*), and the larvae eat the young leaves and tendrils. This egg placement is probably a defense against ant predation (BENSON & AL. 1976). The plant itself produces "pseudo eggs", very similar to those of *Heliconius* eggs, to deter the butterflies from laying their own eggs (GILBERT 1980, GILBERT 1991). Other insects lay their eggs on the older parts of the leaves.

The pollination system is variable. *P. foetida* has purple-white flowers (2-3 cm in diameter) and is pollinated by *Ptiloglossa* bees (Colletidae), *P. vitifolia* with its large red flowers is pollinated by hummingbirds, and there is one species in Brazil, *P. mucronata*, which is pollinated by phylostomoid bats (*Glossophaga soricina, Carollia perspicillata, Anoura caudifer,* SAZIMA & SAZIMA 1978, 1987).

Between 50 to 60 species of *Passiflora* species produce edible fruits, but few are cultivated (passion fruit, maracujá). *P. quadrangularis*, the giant granadilla, is cultivated throughout the tropics for its juicy edible fruits, even *P. edulis* is cultivated and used for beverages, candy and sweets. About 20 species are grown for their attractive and unusual flowers suggesting a crucifixion scene, hence the name "passion flower".

Passiflora (pantrop. 430, CR 47, GD 16)
The only genus of Costa Rica and by far the largest genus in the family, easy to recognize by the usually conspicuous 5-parted flowers with a corona and an androgynophore, even by the petiolar glands and by the usually undivided tendrils. The genus is divided into various subgenera, according to the floral structure (see HOLM NIELSEN & AL. 1988).

P. ambigua Hemsl.
Glabrous liana; leaves broadly elliptic to lanceolate, 9-18 cm long, 6-10 cm wide, serrate to serrulate, petiole with 2 large, ovoid glands, stipules filiform; flowers solitary, 8-12 cm in diameter,

maroon, rose or purple; fruits broadly ovoid, 10-12 cm long, greenish-yellow. In rather open habitats, from southern Mexico to Panama.

P. coriacea Juss.
Vine, almost glabrate; leaves peltate, deeply 3-lobed, 3-7 cm long, 6-25 cm wide, petioles with 2 glands, stipules narrowly linear; inflorescences terminal, racemose, composed of axillary partial inflorescences with 1-2 flowers; flowers apetalous, 2,5-3,5 cm in diameter, yellowish green; fruits globose, 1-2 cm in diameter, deep blue. From Mexico to Peru and Bolivia.

P. quadrangularis L., Pl. 89a-c
Glabrous vine, stem prominent quadrangular, striate, winged; leaves broadly ovate, 10-20 cm long, 8-15 cm wide, entire, petioles with ca. 3 pairs of ovoid glands, stipules foliaceous; flowers solitary, purplish, up to 9 cm in diameter; fruits glabrous, ca. 20-30 cm long, 12-15 cm wide, yellow with purplish spots, edible. Mainly in secondary forests, cultivated throughout the tropics.

P. vitifolia H.B.K., Pl. 89d,e
Woody liana, ferruginous puberulent; leaves deeply trilobate (understory leaves may be unlobed), 7-15 cm long, 8-17 cm wide, inconspicuously serrulate, petioles with 2-several minute glands, stipules subsetaceous; flowers solitary, 9-17 cm in diameter, red, borne mainly on the lower branches or on non-vegetative shoots in the understory; fruits 3-7 cm long, puberulent, brownish red to green, densely puberulent. In primary and secondary forests occasionally in cultivation, from Nicaragua, Cuba and Jamaica to Venezuela and Peru.

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Phytolaccaceae

A heterogeneous family of mostly herbs or woody or herbaceous climbers, but also some shrubs and trees, often somewhat succulent and always with entire leaves. **Leaves** alternate, rarely opposite, simple, stipules lacking or minute and inconspicuous; **inflorescences** terminal or axillary, usually solitary, racemose or spicate, or paniculate with spicate or racemose branches; **flowers** actinomorphic or rarely weekly zygomorphic, bisexual or unisexual by abortion, perianth usually of 1 whorl, tepals 4-5, free or basally connate, usually persisting in fruit, mostly greenish to whitish, stamens (2-)4-numerous, free, in one or two whorls, opposite or alternate the tepals, often borne on a hypogynous disk, ovary superior,

rarely inferior, unilocular, **fruits** berries, drupes or capsules, seeds 1-numerous. Mainly in the Neotropics, but with some representatives in the Old World and a few species in temperate regions. Pantrop. 18/65, CR 8/12, GD 4/4.

The flowers of Phytolaccaceae are pollinated either by wind or by nectar-foraging insects. An exception is the genus *Agdestis* which is likely pollinated by diptera, due to its strongly fetid flowers (ROHWER 1993).

Species with fleshy fruits, mostly from the subfamily Phytolaccoideae, are usually dispersed by birds. Species with dry fruits sometimes have developed wings, which support wind-dispersal.

Some Phytolaccaceae, especially of the genus *Phytolacca*, are used as a substitute for soap and for medicinal purposes, because of their content of saponins. The leaves of several species of *Phytolacca* (e. g. *P. americana*) are eaten as salad or vegetable, while their fruits are used as a spice or as food coloring.

Key to the genera (after BURGER 1983)

1	Flowers subsessile on long, open spikes; fruit a narrow achene with 4 sharply retrorse spines at the top, partly enclosed by the dry persisting appressed perianth; usually found below 500 m elevation	*Petiveria*
1*	Flowers borne on easily seen pedicels in open racemes or panicles; fruit without spines, usually globose, persisting perianth not ascending appressed	2
2	Perianth of 5-10 parts; ovary with 2-15 stigmas	3
3	Succulent subshrubs, 0,3-4 m tall; ovary with 5-15 locules and 5-15 stigmas, fruit a fleshy berry with 5-15 seeds; stamens 6-30; common plants from 0-3300 m elevation	*Phytolacca*
3*	Small semisucculent herbs to 0,8 m tall; ovary with 1 locule and 2 stigmas, fruit small and globose with spiny ridges forming a reticulum on the surface; stamens usually 5 (3-9); uncommon plants, below 500 m elevation	*Microtea*
2*	Perianth of 4 parts; ovary with a single stigma	*Trichostigma*

Microtea (neotrop. 9, CR 1, GD 1)
Decumbent or spreading annual herbs with subspicate inflorescences, bearing minute flowers. The fruits are small, subglobose 1-seeded drupes.
M. debilis Sw.
Decumbent herb, up to 50 cm tall, stems sharply angled; leaves usually ovate, elliptic or rhomboid, 1-4 cm long, 1-2,8 cm wide, glabrous; inflorescences terminal or extra-axillary, racemose, 1,5-4 cm long, many-flowered; flowers white; fruits subglobose drupes, 1-1,5 mm in diameter. From Guatemala and the West Indies to Peru and Brazil.

Phytolacca (pantrop. + subtrop. 25, CR 4, GD 1)
Common names (Costa Rica): jaboncillo, calalu, tinta (BURGER 1983)
Mostly weedy and succulent herbs and subshrubs with racemes. the fruits are globose, several-seeded berries.
P. rivinoides Kunth & Bouché, Pl. 89f
Herb or subshrub, 1-2(-5) m tall, young twigs and petioles often reddish or pinkish; leaves 5-17(-21) cm long, 2-7(-9) cm wide; inflorescence terminal, racemose; tepals white to red, not persisting in fruit; fruits 6-8 mm in diameter, with several longitudinal ribs, purple. In open and disturbed habitats, from Mexico and the West Indies to Bolivia.

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Picramniaceae, see Simaroubaceae

Piperaceae

The Piperaceae are important members of the understory of the tropical rainforests and are an easily recognizable family due to its unique floral and vegetative structures. Erect or climbing shrubs, small trees or herbs, terrestrial or epiphytic, often succulent; **leaves** sometimes with aromatic odor, alternate, opposite, verticillate or basally inserted, entire, stipules lacking or adnate to the petiole; **inflorescences** spikes, white, greenish or reddish, axillary, terminal, or opposite the leaves; **flowers** small, bisexual (all the American species), without a perianth, each in the axil of a small, peltate or subpeltate bract, stamens usually 2-6, ovary superior, unilocular; **fruits** drupaceous, dry or fleshy, with a small, solitary seed. In the tropics and subtropics of both hemispheres. The principle centers of diversity are situated in the middle of northern South America, Central America, southern Asia and Malaysia. Pantrop 8/3000, CR 3/229,GD 2/56.

The Piperaceae are assumed to be pollinated by wind and rain, but some of the species (e.g., *Piper auritum*, *Piper friedrichsthalii*, *Piper peltatum*) are known to be visited and presumably pollinated by insects (*Trigona*-bees, Coleoptera etc.) (SEMPLE 1974).

Fruit dispersal studies are lacking, but the fruits of *Piper* are probably eaten by birds, whereas those of *Peperomia* probably adhere to the bodies of birds and other animals (YUNCKER 1957).

Economically, the Piperaceae are of little interest, except for one species, *Piper nigrum*. It occurs in the Old World tropics and is well known worldwide as the source of black, white and green pepper. Of some local importance are several species used for medicinal or alimentary purposes, or as a kind of narcotic or stimulans such as *Piper betle*, whose leaves are used as an additive to the betel nut masticate (BORNSTEIN 1991).

Key to the genera (based on STEYERMARK 1984)

1	Plants herbaceous, succulent, usually epiphytic, usually with swollen nodes, leaves alternate, opposite, whorled or basally inserted; floral bracts usually rounded at the apex, stigma 1	*Peperomia*
1*	Plants usually woody, sometimes climbing, rarely epiphytic; leaves always alternate; nodes usually thickened; floral bracts usually triangular, concave, inflexed or narrowed from the tip to the pedicel; stigmas usually 3, sometimes 2 or 4	*Piper*

Peperomia (pantrop. + subtrop. 1000, CR 115, GD 15)
Perennial or annual herbs, mostly epiphytic and nearly always with more or less succulent leaves. Distributed worldwide in the tropics, but most abundant in the New World, growing in various habitats.

P. glabella (Sw.) A. Dietr.
Plant with black gland dots, best visible on dried specimens; leaves alternate, succulent, 3-5-palmativeined, glabrous, except the apex and the superior margins ciliate; inflorescence simple, mostly terminal, greenish to cream-colored. In lowland rainforests up to 1300 m alt. in the Antilles, Central America and South America.

P. rotundifolia (L.) H.B.K., Pl. 89g
Small epiphytic herb; leaves alternate, succulent, conspicuously orbicular to obovate, basally 3-veined, the margins ciliate; spikes simple, erect, 1-4 cm long, greenish to purple; fruits brown, subglobose or subglobose-ovoid. Usually on stems or tree trunks in wet forests, widely distributed in the Neotropics, from southern Mexico to Argentina and Brazil.

P. saintpauliella Grayum, Pl. 89h
Terrestrial or epilithic herb; leaves pellucid punctate, in a basal rosette, broadly ovate to orbicular, cordate to subsagittate at base; inflorescences

solitary, basally inserted, with pinkish flowers. Usually growing on rocks near forest creeks, endemic to the Golfo Dulce region.

Piper (pantrop. ca. 2000, CR 113, GD 41)
A genus consisting mostly of terrestrial shrubs with conspicuously thickened nodes and the always leaf-opposed inflorescences.

P. aduncum L., Pl. 90a
Shrub or small tree, up to 8 m tall; leaves lanceolate to narrowly elliptic or very narrowly ovate, 12-22(-25) cm long, 4-8(-9) cm wide, base unequal, rounded or cordulate, apex long acuminate, scabrous on both sides, with 4-6 pairs of secondary veins, petioles 2-5(-8) mm long; inflorescences erect in early stages, curved spikes, 6-16 cm long; fruits obovoid, ca. 1 mm in diameter, glabrous. Very common and widespread, distributed throughout the Neotropics.

P. arboreum Aubl.
Shrub or small tree; leaves oblong-ovate to lanceolate, 10-22(-30) cm long, 2-10(-14) cm wide, base strongly unequal, apex acute to obtuse, with 6-11 pairs of secondary veins, petioles 6-12(-24) mm long; inflorescences erect, becoming pendulous in fruit; fruits obovoid, 1-1,5 mm long, glabrous. In moist, semi-deciduous and deciduous forests, from Mexico to Paraguay. This species can be further divided in two subspecies (ssp. *arboreum* and ssp. *tuberculatum*), both of them occurring in the Golfo Dulce region.

P. auritum H.B.K., Pl. 90b
Shrub or small tree, up to 6 m tall; leaves oblong-elliptic, 20-55 cm long, 12-30 cm wide, ciliate, basally deeply cordate and unequal lobed, with 4-6 pairs of secondary veins, petioles 4-10 cm long; inflorescences erect, whitish; fruits obovoid, 0,6-0,8 mm wide, glabrous. Common species, usually in secondary growth on moist ground in Central America, from Mexico and the Lesser Antilles to northern Colombia.

P. biauritum C.DC.
Shrub, up to 2 m tall; leaves elliptic to ovate, 11-25 cm long, 5-12 cm wide, base asymmetric, both sides covered with long white hairs, with 4-5 pairs of secondary veins, petioles 4-9(-20) mm long; inflorescences erect, reddish, 7-12 cm long; fruits 0,8-1 mm wide. On moist slopes in Costa Rica and Panama.

P. cenocladum C.DC.
Shrub or small tree, up to 5 m tall; leaves usually distichous, elliptic to oblong or narrowly ovate, 15-35 cm long, 8-17 cm wide, base unequal to subequal, cordate, minutely puberulent on the veins beneath, with 4-5 pairs of secondary veins, petioles 4-8 cm long; inflorescences erect to pendent, 8-18(-30) cm long; fruits ca. 1 mm in diameter. In wet evergreen forests, endemic to Costa Rica.

P. fimbriulatum C.DC., Pl. 90c
Shrub or small tree, up to 6 m tall; leaves usually distichous, elliptic to oblong or narrowly ovate, 16-35 cm long, 8-16(-20) cm wide, very unequal at base, cordate, sometimes peltate, densely brownish puberulent on the veins beneath, with 4-6 pairs of secondary veins, petioles 4-8 cm long; inflorescences 15-40 cm long, pendent; fruits 1-2 mm in diameter. In evergreen forests, from Costa Rica to western Panama.

P. friedrichsthalii C.DC.
Small tree or shrub, up to 4(-6) m tall; leaves lanceolate, 7-16 cm long, 1,5-3(-4,5) cm wide, acute and slightly unequal at base, with 4-7 pairs of secondary veins, petioles 2-5 mm long; inflorescences up to 18 cm long, arching, peduncle erect, floral bracts densely white ciliate; fruits obovoid, 0,8-1 mm wide, glabrous. Growing on open sites in moist forests, from Costa Rica to Peru.

P. hispidum Sw., Pl. 90d,e
Shrub, up to 4 m tall; leaves usually distichous, ovate to elliptic oblong, 7-18(-21) cm long, 3-10 cm wide, base obtuse or rounded, unequal, sparsely to densely pubescent beneath, yellowish green with 3-5 pairs of secondary veins, petioles 4-18 mm long; inflorescences 6-12 cm long, erect or slightly curving; fruits 0,8-1 mm wide, pubescent. In secondary growth, widely distributed throughout the Neotropics, from southern Mexico to Bolivia and Brazil.
The stems of this species are often hollow and may harbour ants (BURGER 1971).

P. obliquum Ruiz & Pav.
Shrub or small tree, up to 8 m tall; leaves usually distichous, narrowly ovate to oblong, 20-45 cm long, 12-26 cm wide, basally unequal, cordate, glabrous above, usually densely puberulent on the veins beneath, with 4-6 pairs of secondary veins, petioles 4-9 cm long; inflorescences 20-60 cm long, pendent; fruits angular or globose, 1-2 mm in diameter, glabrous to puberulent. In moist ever-

green forests, from Guatemala to Colombia, Venezuela and the Guianas.

P. peltatum L., Pl. 90f
[syn. *Pothomorphe peltata* (L.) Miq.]
Herb or small shrub, up to 1,5(-2) m tall; leaves membranaceous, broadly ovate to suborbicular 20-30(-42) cm long, 15-26(-40) cm wide, peltate, palmativeined, petiole 10-26 cm long; inflorescences erect, axillary, umbellate, with 3-12 spikes, the umbels solitary or 2-3 at each node. In evergreen forests, usually on rather open sites, widely distributed from Mexico to Brazil.

P. sagittifolium C. DC.
Erect herb, up to 1 m tall; leaves spirally arranged, narrowly elliptic to narrowly obovate or oblong, 15-25(-32) cm long, 5-12 cm wide, base unequal, mostly sagittate, glabrous above, minutely puberulent on the veins beneath, petioles 1-3,5(-5) cm long; inflorescences erect, 3-6 cm long; fruits round, 2-3 mm in diameter. In wet forests, endemic to the pacific part of Costa Rica and adjacent Panama.

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Podostemaceae

Small aquatic herbs growing attached to rocks in rivers and waterfalls, unmistakeable by the unique thalloid habit, for which the plants can be confused with mosses or algae. **Leaves** alternate, di- or tristichous, very small and entire or large and dissected, sheaths sometimes present; **inflorescences** spike-like, fascicles of flowers or flowers solitary, often enclosed by a small spathe; **flowers** actinomorphic or zygomorphic, bisexual, tepals 2-numerous, basally connate, stamens 1-numerous, alternate with the tepals, ovary superior, 1-3-locular, often with a gynophore; **fruits** capsules, loculicidally dehiscing by 2-3 valves, seeds 2-numerous. Distributed worlwide in the tropics, with a few species in temperate regions. Cosmopol. 47/280, CR 2/7, GD 2/?.

Studies on the pollination biology are scanty. Members of the family have been reported to be pollinated by insects, wind or water. Only the temperate species *Podostemum ceratophyllum* was investigated in detail by PHILBRICK (1981, 1984), who found that it is autogamous. While anthesis in the family usually occurs, when the flowers are emerged, in this species the flowers may open in submersed condition.

Some species of the Podostemaceae are locally used as food, salt substitute or as a liver treatment (SCHULTES 1988, PHILBRICK & NOVELO 1995). Some species are also used as a cattlefood during dry seasons (VAN ROYEN 1951).

Key to the genera (after ROYEN 1950)

1 Flower buds enclosed between a few leaves; perianth distinct; ovary 3-celled; leaves entire ..... *Tristicha*

1* Flower buds enclosed in a membranaceous spathe; perianth reduced to minute scales; ovary 2-celled; leaves much divided *Marathrum*

Marathrum (neotrop. 25, CR 6, GD ?), Pl. 90g
Small to medium-sized stemless herbs, with pinnately divided leaves, or at least entire with a few lobes, sometimes with fleshy petiole. The 1-numerous flowers are inserted solitary or in fascicles between the leaf bases.

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Polygalaceae

A rather small family of herbs, shrubs, lianas and trees, vegetatively nondescript, but with zygomorphic flowers, somewhat resembling the structure of the fabacean flowers. **Leaves** alternate, opposite or verticillate, simple, stipules lacking; **inflorescences** usually racemose; **flowers** bisexual, zygomorphic, sepals 5, unequal, the 2 inner ones often large and petaloid, petals 3(-5), if 3, the lower usually keel-shaped and often appendaged, the 2 upper ligulate or ovate, usually adnate to the lower petal and connate to the staminal sheath, if 5, connate above the middle into a tube and adnate with the sepals, subequal, stamens 8(-10), filaments connate into a tube, often adnate to the petals, ovary superior, 2(-5)-locular; **fruits** loculicidal capsules, drupes, berries or samaras, seeds usually arillate. Subcosmopol. 17/950, CR 4/22, GD 2/2.

Key to the genera (after LEWIS & HERRERA-MACBRYDE 1969)

1 Calyx free, the sepals unequal with the 2 inner sepals (wings) larger, petaloid; petals 3; ovary 1-locular *Securidaca*
1* Calyx adnate to the corolla, the sepals more or less unequal, not petaloid; petals 5; ovary (2-)4-5-locular *Moutabea*

Moutabea (neotrop. 10, CR 1, GD 1), PL. 90h
A genus of shrubs, trees and lianas with white or yellow, only slightly zygomorphic flowers and baccate fruits. Vegetatively this genus can be recognized by its thick-coriaceous leaves.

M. longifolia Poepp. & Endl.
Liana; leaves oblong to obovate, glabrous, glossy above, ca. 17 cm long, 7 cm wide; inflorescences terminal and axillary, racemose; flowers tubular, white to cream-colored; fruits yellow at maturity. From Costa Rica to Bolivia and Peru.

LEWIS, W.H. & O. HERRERA-MACBRYDE. 1969. Polygalaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 56 (1): 9-28.

Polygonaceae

Trees, shrubs, lianas or annual or perennial herbs, usually easy to recognize for its connate stipules, forming a tubular, membranaceous to hyaline, sheath-like ochrea, surrounding the stem. The ochrea is often caducous, leaving a rim-like scar or rarely lacking. Stem often striate or sulcate, nodes sometimes swollen, internodes sometimes hollow; **leaves** simple, alternate, rarely opposite or whorled, entire to crenate; **inflorescences** axillary or terminal, spicate, racemose or paniculate, bearing fascicles or cymules of flowers; **flowers** actinomorphic, bisexual or unisexual, usually small, tepals 2-6, in one or two whorls, but these usually not clearly differentiated, united into a tube, often persistent and accrescent in fruit, stamens (4-)6-9, free or connate, often basally adnate to the perianth, nectary disk often present, ovary superior, 1-locular; **fruits** achenes or small nuts, often 3-angled, often surrounded by the persistent perianth. Distributed worldwide in all types of habitats. Cosmopol. 46/1100, CR 9/37, GD 3/10.

The Polygonaceae are primarily entomophilous with an evolutionary trend towards anemophily, but a mixture of both pollination types occurs (HESS 1979).
In some genera (e.g., *Triplaris*) the persistent perianth forms conspicuous wings, serving as devices for wind dispersal. In some other species the persistent perianth becomes fleshy (e.g., *Coccoloba*).

The economic importance of the family is low. *Fagopyrum*, the buckweed, and *Rheum*, the rhubarb, are cultivated as crops. In Central America *Polygonum* spp. and *Muehlenbeckia* spp. are often cultivated as ornamentals (DUKE 1960).

Key to the genera (after BURGER 1983)

1	Plants herbaceous, stems not woody except sometimes near the base; flowers bisexual	*Polygonum*
1*	Plants with woody stems, trees, shrubs or climbers; flowers unisexual	2
2	Achenes enclosed but not greatly exceeded by a dry or succulent perianth, the fruiting perianth without long distal wings; perianth usually 5-parted; trees, shrubs or climbers	*Coccoloba*
2*	Achenes enclosed and exceeded by a thin, dry, expanded perianth, the fruiting perianth with 3 conspicuous long thin distal wings; perianth 6- (rarely 3-) parted; trees	*Triplaris*

Coccoloba (neotrop. + subtrop. 120, CR 15, GD 7)
Common name (Central America): papaturro (BURGER 1983)
A large genus of usually unisexual trees and shrubs, which can be recognized by the flowers always having 5 tepals and the brightly colored and fleshy fruiting perianth covering the achenes.
C. lehmannii Lindau
Tree, up to 10 (-20) m tall; leaves 9-18 cm long, 4,5-9 cm broad, obtuse or slightly rounded at the base; inflorescences terminal, racemose. From Costa Rica to Colombia, Peru and Venezuela.
C. standleyana P.H. Allen, Pl. 91a,b
Tree, up to 20 m tall; leaves large, 35-50 cm long, 20-30 cm broad, deeply cordate at the base; inflorescences terminal, paniculate. Endemic to Costa Rica (Puntarenas).

Polygonum punctatum

According to HOWARD (1959) and BURGER (1983), this species probably should be included in *C. belizensis* Standl.

Polygonum (cosmopol. ca. 150, CR 8, GD 2)
Annual or perennial, often aquatic or semiaquatic herbs, climbers or rarely shrubs, characterized by the mainly narrow entire leaves and the conspicuous ochrea.

P. punctatum Elliott, Pl. 91c
Annual or perennial herb, up to 1 m tall; leaves narrowly elliptic to lanceolate, minutely strigose, pellucid punctate; inflorescences spicate or racemose or weekly paniculate, 5-20 cm long, bearing fascicles of flowers; tepals pellucid punctate, white to pale-green; fruits achenes, 3-angled. Widely distributed, from southern Canada to Argentina and also found in Asia.

BRANDBYGE, J. 1993. Polygonaceae. Pp: 531-545. In: K. KUBITZKI (ed.): The families and genera of vascular plants. Vol II. Magnoliid, Hamamelid and Caryophyllid families. - Berlin: Springer Verlag.
BURGER, W. 1983. Polygonaceae. Flora Costaricensis. - Fieldiana Bot. 13, n.s.: 99-138.
DUKE, J.A. 1960. Polygonaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 47: 323-359.
HESSE, M. 1979. Entwicklungsgeschichte und Ultrastruktur von Pollenkitt und Exine bei nahe verwandten entomo- und anemophilen Angiospermen: Polygonaceae. - Flora 168: 558-577.
HOWARD, R.A. 1959. Studies in the genus *Coccoloba* VII. A synopsis and key to the species in Mexico and Central America. - J. Arnold Arbor. 40: 176-220.

Portulacaceae

Herbs or shrubs and a few small trees, usually with succulent, spirally arranged leaves, as well as succulent stems. **Leaves** simple, spirally arranged, sometimes alternate or opposite, entire, glabrous, often small, stipules sometimes present, often replaced by hairs spines or scales; **inflorescences** axillary or terminal, cymose, racemose, rarely paniculate or flowers solitary; **flowers** actinomorphic, bisexual, rarely unisexual, sepals 2-3, rarely more, free or basally connate, petals 4-5(-18), free or basally connate, often brightly colored, white to yellow or red, stamens 4-5-numerous, free, often opposite the petals and adnate to them, ovary superior to inferior, unilocular; **fruits** usually capsules, opening by 3-5(-8) terminal valves or circumscissile, rarely nuts, dehiscing irregularly near the base, seeds (1-)2-many, sometimes arillate. Usually plants of dry habitats in the tropics and subtropics of the southern hemisphere. Cosmopol. 32/380, CR 3/5, GD 1/1.

The pollination biology of Portulacaceae is poorly investigated. Several species, including some subspecific taxa of *Portulaca oleracea,* are known to be cleistogamous (CAROLIN 1993, DANIN et al. 1978). The leaves of *Portulaca oleracea* are often used as a vegetable.

Portulaca (pantrop. + subtrop. 40, CR 2, GD 1)
Small, succulent herbs with brightly colored flowers, widely distributed in the tropics and subtropics worldwide. It can be distinguished from other genera by its circumscissile capsule and its sessile or subsessile flowers subtended by an involucre.
P. oleracea L.
Common name (Central America): verdolaga (BURGER 1983)
Small prostrate or ascending herb; leaves alternate or opposite, often clustered at the ends of the branches, 0,4-4 cm long, 0,3-2 cm wide, stipules of minute ridges with slender whitish hairs; inflorescences of terminal clusters of flowers, or flowers solitary; flowers sessile, petals yellow; fruit ovoid, 4-8 mm long, 3-4 mm wide. In open habitats in the tropics and subtropics worldwide.

BURGER, W. 1983. Portulacaceae. Flora Costaricensis. - Fieldiana Bot. 13, n.s.: 217-222.
CAROLIN, R.C. 1993. Portulacaceae. Pp: 544-555. In: K. KUBITZKI (ed.): The families and genera of vascular plants. Vol II. Magnoliid, Hamamelid and Caryophyllid families. - Berlin: Springer Verlag.

DANIN, A., I. BAKER & H.G. BAKER. 1978. Cytogeography, and taxonomy of the *Portulaca oleracea* L. polyploid taxonomy. - Israel J. Bot. 27: 177-211.
ELIASSON, U.H. 1996. Portulacaceae. In: G. HARLING & L. ANDERSSON (eds.): Flora of Ecuador 55.

Proteaceae

A family of the southern hemisphere, consisting of trees, shrubs and a few herbs, usually with dense capitate or spike-like inflorescences. **Leaves** simple (unifoliolate) or compound, alternate, opposite or whorled, usually coriaceous, entire, serrate or variously lobed, stipules absent; **inflorescences** axillary or terminal, capitate, spike-like, racemose or umbellate, rarely flowers solitary; **flowers** actinomorphic or zygomorphic, bisexual or unisexual, usually fragrant, one perianth whorl of usually 4 tepals, free or connate, stamens 4, opposite the tepals, nectariferous disk or petaloid nectar scales usually present, ovary superior, 1-locular; **fruits** woody nuts, samaras or drupes, seeds 1-numerous, sometimes winged. Distributed mainly in dry habitats mostly in South Africa and Australia with only a few representatives in the Neotropics. Pantrop. + subtrop. 77/1600, CR 4/7, GD 2/2.

All American genera of Proteaceae belong to the subfamily Grevilleoideae, which is characterized by flowers always placed in pairs (SLEUMER 1954, PRANCE & PLANA 1998).

Several studies exist on the pollination of Australian or South African Proteaceae. They are mostly pollinated by insects, birds or mammals (e.g., CARPENTER 1978, LAMONT 1982, WIENS et al. 1983, LAMONT et al. 1985, COLLINS & SPICE 1986, COLLINS & REBELO 1987, HATTINGH & GILIOMEE 1989, CARTHEW 1993, DAY et al. 1997, DALGLEISH 1999.) Investigations on the American genera are still lacking.

Several species, mainly of the genera *Banksia* and *Protea*, are cultivated as ornamentals because of their showy inflorescences. *Macadamia* spp. is cultivated in Australia for its seeds (Macadamia nuts) which are eaten roasted or cooked and salted.

Key to the genera (after BURGER 1983)

1 Leaves isomorphic, always simple and entire, the tertiary veins becoming prominent on both surfaces when dry; anthers borne on prominent filaments; fruit round and not splitting open — *Panopsis*

1* Leaves heteromorphic, immature and flowerless shoots usually with pinnately compound leaves and mature or flowering shoots usually with simple leaves; anthers sessile or subsessile on the perianth parts; follicles somewhat flattened and splitting open along the edge — *Roupala*

Panopsis (neotrop. 20, CR 1, GD 1)
Bisexual trees with simple and alternate, opposite or whorled leaves, which can be distinguished from other genera by its, hard, indehiscent and usually globose fruit.
P. suaveolens (Klotzsch & H. Karst.) Pittier
Common names (Costa Rica): palo de papa, papa (BURGER 1983)
Tree, up to 15(-25) m tall; leaves alternate to opposite, entire, up to 15 (-17) cm long and up to 6(-9) cm wide, glabrous; inflorescences racemose, terminal or axillary, 6-16 cm long, multi-flowered, rhachis ferruginous-strigillose; perianth 7-8 mm long; fruits woody nuts, ellipsoid to ovoid, 3,5-6 cm long. From Costa Rica to Colombia, Venezuela and Ecuador.

Roupala (neotrop. > 90, CR 3, GD 1)
Bisexual shrubs and trees with alternate and heteromorphic, simple or compound leaves and with small, 2-valved and 2-winged follicles.

BURGER, W. 1983. Proteaceae. Flora Costaricensis. - Fieldiana Bot. 13, n.s.: 8-14.
CARTHEW, S.M. 1993. An assessment of pollinator visitation to *Banksia spinulosa*. - Austral. J. Ecol. 18 (3): 257-268.

COLLINS, B.G. & J. SPICE. 1986. Honey eaters and the pollination biology of *Banksia prionotes* (Proteaceae). - Austral. J. Bot. 34 (2): 175-186.

COLLINS, B.G. & T. REBELO. 1987. Pollination biology of the Proteaceae in Australia and Southern Africa. - Austral. J. Ecol. 12 (4): 387-422.

DALGLEISH, E. 1999. Effectiveness of invertebrate and vertebrate pollinators and the influence of pollen limitation and inflorescence position on follicle production of *Banksia emula* (Family Proteaceae). - Austral. J. Bot. 47 (4): 553-562.

DAY, D.A., B.G. COLLINS & R.G. REES. 1997. Reproductive biology of the rare and endangered *Banksia brownii* Baxter ex R. Br. (Proteaceae). - Austral. J. Ecol. 22 (3): 307-315.

EDWARDS, K.S. & G.T. PRANCE. 1993. New species of *Panopsis* (Proteaceae) from South America. - Kew Bull. 48: 637-662.

HATTINGH, V. & J.H. GILIOMEE. 1989. Pollination of certain *Leucadandron* species (Proteaceae). - S. African J. Bot. 55 (4): 387-393.

LAMONT, B. 1982. The reproductive biology of *Grevillea leucopteris* (Proteaceae) including reference to its glandular hairs and colonizing potential. - Flora 172 (1): 1-20.

LAMONT, B.B., B.G. COLLINS & R.M. COWLING. 1985. Reproductive biology of the Proteaceae in Australia and Southern Africa. - Proc. Ecol. Soc. Austr. 213-224.

CASCANTE- MARIN, A. 2000. Las especies costaricenses del género *Panopsis* (Proteaceae) - Brenesia 53: 17-27.

NEVLING, L.I., JR. 1960. Proteaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 47: 199-205.

PRANCE, G.T. & V. PLANA. 1998. The American Proteaceae. - Austral. Syst. Bot. 11 (3-4): 287-299.

SLEUMER, H.O. 1954. Proteaceae Americanae. - Bot. Jahrb. Syst. 76 (2): 139-211.

WIENS, D., J.P. ROURKE, B.B. CASPER, E.A. RICKART, T.R. LAPINE, C.J. PETERSON & A. CHANNING. 1983. Nonflying mammal pollination of Southern African Proteas: a non-coevolved system. - Ann. Missouri Bot. Gard. 70: 1-31.

Quiinaceae

A small family of trees, shrubs and a few lianas with linear, sometimes subfoliaceous interpetiolar stipules, which are usually persistent. **Leaves** simple or imparipinnately compound, opposite or whorled, entire to serrate, usually glabrous; **inflorescences** axillary or terminal, racemose or paniculate; **flowers** small, unisexual or bisexual, sepals 4-5, free, petals 4-8, stamens 15-numerous, free or basally connate, ovary superior, 2-13-locular, rarely 3, free carpels; **fruits** berries or sometimes capsules, globose, seeds 1-4, usually brown tomentose. Neotrop. 4/45, CR 2/4, GD 1/3.

Quiina (neotrop. 25, CR 3, GD 3)
Polygamodioecious trees with simple, entire margined leaves and orange to red fruits. The stipules vary from minute and rather inconspicuous to subfoliaceous and several cm long.

Q. cruegeriana Griseb.
Tree, up to 15 m tall, somewhat anisophyll, leaves elliptic, 17,5-37 cm long, 5,7-12 cm wide, stipules 3-9 mm long, inflorescences axillary, up to 6 short racemes, few-flowered; flowers 2,5-3,5 mm in diameter, sepals and petals usually 5, petals yellow to orange or sometimes white; fruits berries, 6-7 mm in diameter. From Costa Rica and the West Indies to Peru and Brazil.

Q. schippii Standl.
(syn. *Q. macrophylla* Tul.)
Tree, up to 10 m tall; leaves elliptic to narrowly elliptic, stipules linear, 10-30 mm long; inflorescences spicate, 1-5 cm long; flowers 1,5 mm in diameter, white, sepals and petals 4; fruits berries, ca. 1 cm in diameter, reddish. In tropical wet forests in Central America, from Honduras and Belize to Panama.

D'ARCY, W.G. 1980. Quiinaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 67: 965-968.

SCHNEIDER, J. 1998. El genero *Quiina* (Quiinaceae) con especial referencia a las especies de Venezuela. - Acta Bot. Venez. 21 (1): 1-74.

Rafflesiaceae

A small and curious family of parasitic herbs, without chlorophyll and with the flowers emerging directly from the stems or the roots of the host plant. Stems mostly thalloid and hidden inside the host, rarely

fleshy aerial shoots present. **Leaves** bract-like or absent; **inflorescences** racemose, spicate, ore flowers solitary; **flowers** actinomorphic, bisexual or (functionally) unisexual (plants then monoecious or dioecious), small to very large, up to 1 m in diameter (neotropical species only up to 3,5 cm in diameter), tepals 4-10, free or often basally connate, stamens 8-numerous, united into a tube or forming a conical synandrium or arranged around a fleshy stylar column, ovary inferior, rarely half-inferior or superior, unilocular; **fruits** fleshy berries, irregularly dehiscent, seeds minute, numerous. Mainly in the tropics and subtropics of the Old World, with 4 genera occurring in the Neotropics, one of them endemic and a few species extending into the Mediterranean area. Cosmopol. 9/50, CR 2/2, GD 1/1.

The flowers of the Rafflesiaceae are predominantly sapromyiophilous, representing the carrion flower type. The flowers of the most eminent genus *Rafflesia*, which is restricted to South East Asia, attract Calliphoridae flies by imitating rotten meat with unpleasant odor and dark reddish color (BEAMAN & al. 1988, BÄNZIGER 1991). Quite similar is the situation in *Bdallophyton*, a neotropical genus (not occurring in the Golfo Dulce region), whose flowers attract Calliphoridae flies with a reddish morbid color, yeasty odor and a supply of nectar (GOMEZ 1983, GARCIA-FRANCO & RICO-GRAY 1997). Other genera of Rafflesiaceae, which produce nectar, like *Cytinus* or *Pilostyles*, are visited by various kinds of bees and wasps (HARMS, 1935, VATTIMO 1971, MEIJER 1993). The flowers of *Apodanthes casearíae* are visited by *Trigona* bees (GOMEZ 1983).

The baccate fruits of Rafflesiaceae have a slimy pulp around the seed and a juicy or papery exotesta, which is consumed by animals. The fruits of *Apodanthes* are eaten by *Thraupis* birds (GOMEZ 1983), those of *Bdallophyton* are taken by rodents, feeding on the seeds (GOMEZ 1983). The fruits of the genus *Pilostyles* are likely dispersed by rats, mice and ants (KUMMEROW 1962, SIUC 1997).

Apodanthes (neotrop. 1-7, CR 1, GD 1)
Minute stem parasites on the branches of Flacourtiaceae, with scale-like leaves and the solitary flowers inserted terminal on a short aerial shoot.
A. casearíae Poit., Pl. 91d,e
Small leafless herb, parasitic on the trunk and roots of various species of Flacourtiaceae; flowers unisexual, solitary, 4-6 mm long, subtended by a thickened receptacle, which is subtended by several bracts, tepals 4, white; fruits berries, yellow to orange. From Costa Rica and Panama to northwestern South America.
This species was observed mainly on the trunk of *Casearia arborea*.

BÄNZIGER, H. 1991. Stench and fragrance: Unique pollination lure of Thailands largest flower, *Rafflesia kerrii* Meijer. - Nat. Hist. Bull. Siam Soc. 39: 19-52.

BÄNZIGER, H., U. MASCHWITZ & G. ZIZKA. 1993. Rafflesiaceae: eine faszinierende und rätselhafte Pflanzenfamilie. - Palmengarten 57 (2): 65-74.

BEAMAN, R.S., P.J. DECKER & J.H. BEAMAN. 1988. Pollination of *Rafflesia* (Rafflesiaceae). - Amer. J. Bot. 75 (8): 1148-1162.

ELIASSON, U.H. 1994. Rafflesiaceae. In: G. HARLING & L. ANDERSSON (eds.): Flora of Ecuador 51.

GARCIA FRANCO, J.G. & V. RICO GRAY. 1997. Reproductive biology of the holoparasitic endophyte *Bdallophyton bambusarum* (Rafflesiaceae). - Bot. J. Linn. Soc. 123 (3): 237-247.

GENTRY, A.H. 1973. Rafflesiaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 60: 17-21.

GOMEZ, L.D. 1983. Rafflesiaceae. Flora Costaricensis. - Fieldiana Bot. 13, n.s.: 89-93.

HARMS, H. 1935. Reihen Santalales, Aristolochiales, Balanophorales. Geschichtliche Entwicklung der Ansichten über die Umgrenzung der Reihen und ihre Zusammensetzung. In: ENGLER, E & K. PRANTL (eds.): Die natürlichen Pflanzenfamilien 2. Ausgabe, 16 b: 1-4.

KUMMEROW, J. 1962. *Pilostyles berterii* Guill., eine wenig bekannte Rafflesiaceae in Mittelchile. - Z. Bot. 50: 321-337.

MEIJER, W. 1993. Rafflesiaceae. Pp.: 557-563. In: K. KUBITZKI (ed.): The families and genera of vascular plants. Vol II. Magnoliid, Hamamelid and Caryophyllid families. - Berlin: Springer Verlag.

SIUC COLLEGE OF SCIENCE. 2001. Parasitic plant connection (WWW document) URL: www.science.siu.edu/parasitic-plants. (29.3.2001).

VATTIMO, I. DE. 1971. Contribuicao ao conhecimento da tribo *Apodanthea* R. Br., Parte I. Conspecto das especies (Rafflesiaceae). - Rodriguesia 26: 37-62.

Rhamnaceae

Trees, shrubs and lianas with uniformly simple leaves and frequently armed with spines, which resemble modified stipules. **Leaves** alternate or opposite, entire or serrate, sometimes with glands at the base of the lamina, stipules usually present, mostly caducous; **inflorescences** axillary, cymose or racemose, umbellate or sometimes flowers solitary; **flowers** actinomorphic, bisexual or unisexual, small, sepals 4-5, connate, petals 4-5, free, mostly cucullate, enveloping the stamens, stamens 4-5, opposite the petals, intrastaminal disk mostly present, ovary superior to inferior, 2-4-locular; **fruits** capsules or drupes with 2-4 pyrenes or rarely with a winged or unwinged schizocarp, seeds 2-4. Cosmopol. 49/900, CR 8/22, GD 4/5.

Most genera of Rhamnaceae have small and inconspicuous flowers which are pollinated by various pollen or nectar foraging insects, including bees, wasps, flies, butterflies and beetles. This pollination mode occurs in species of *Discaria* (PRIMACK 1979, WEBB 1985, MEDAN 1991), *Rhamnus* (JOHNSTON & JOHNSTON 1978, GUITIAN 1995), *Trevoa* (MEDAN & D'AMBROGIO 1998) and *Ziziphus* (ACKERMAN 1961, TEAOTIA & CHAUHAN 1963, GALIL & ZERONI 1967, MEHROTRE & GUPTA 1985, ZIETSMAN 1990). Species of Rhamnaceae with capsular fruits often have an autochorous mode of seed dispersal, which may be wind in species with winged seeds, and water in non-winged species (PRIMACK 1979). Some species with fleshy, drupaceous fruits may be dispersed by birds (JOHNSTON & JOHNSTON 1978).
In some Central American countries, *Gouania lupuloides* is used for dental care and as a substitute for hops in beer brewing (J. GONZALEZ pers. comm.).

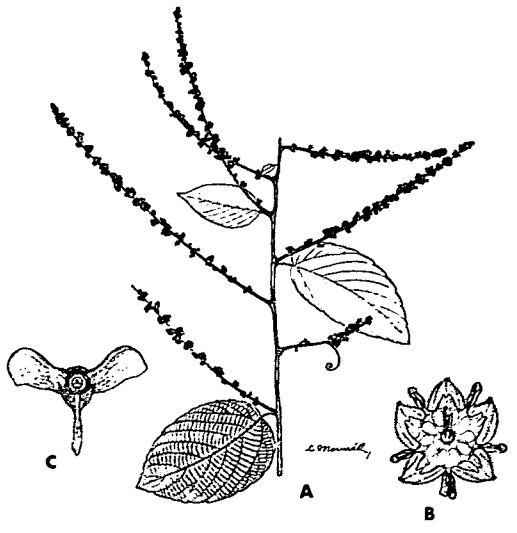
Key to the genera (after GONZALEZ, in prep.)

1	Leaves opposite or subopposite	*Colubrina* p.p.
1*	Leaves alternate	2
2	Lianas	*Gouania*
2*	Trees and shrubs	3
3	Leaves with the secondary veins 3-veined; fruits with 1 seed	*Ziziphus*
3*	Leaves with the secondary veins pinnate; fruits usually with more than 1 seed	4
4	Fruits capsules, dehiscent	*Colubrina* p.p.
4*	Fruits drupaceous, indehiscent	*Rhamnus*

Colubrina (pantrop. + subtrop. 31, CR 4, GD 1)
Trees or shrubs, sometimes spiny, with alternate or opposite leaves, sometimes with 2 glands near the base of the lamina. The flowers are white or greenish-yellow to yellow.

C. spinosa Donn. Sm.
Tree or shrub, up to 10 m tall; leaves alternate, entire, elliptic or ovate-elliptic, 6-17 cm long, 3-8 cm wide; inflorescences cymose, sessile; fruits 5-8 mm long. In wet forests, from Nicaragua to Panama.

Gouania (pantrop. + subtrop. 50-70, CR 5, GD 2)
Lianas, climbing with coiled tendrils, which are borne in the axils of the terminal leaf of the short branches. The alternate leaves are usually serrate-margined and mostly bear glands at the base of the lamina and/or on the teeth.



Gouania lupuloides
A. Habit. B. Flower. C. Fruit

G. lupuloides (L.) Urb., Pl. 91f
Liana, tendrils at the base of the inflorescences; leaves ovate, ovate-elliptic to narrow-elliptic, glabrous to densely pubescent; inflorescences spike-like, 8-18 cm long, with several sessile or subsessile glomerules, each 5-8-flowered; flowers mostly bisexual; fruits schizocarps with 3 wings, sparsely pubescent, seeds 3. A very variable species, distributed from Mexico and the Antilles to northern South America.

ACKERMAN, W.L. 1961. Flowering, pollination, self-sterility and seed development of Chinese jujube. - Proc. Amer. Soc. Hort. Sci. 77: 265-269.
GALIL, J. & M. ZERONI. 1967. On the pollination of *Ziziphus spina-christi* (L.) Willd. in Israel. - Israel J. Bot. 16: 71-77.
GONZALEZ, J. In prep. Rhamnaceae. Manuál de las plantas de Costa Rica. Missouri Botanical Garden. Instituto Nacional de Biodiversidad. Museo Nacional de Costa Rica.
GUITIAN, P. 1995. Reproductive biology of *Rhamnus legionensis* ROTHM., a dioecious species endemic to the northwest Iberian peninsula. - Flora 190 (4): 345-352.
JOHNSTON, M.C. 1971. Revision of *Colubrina* (Rhamnaceae). - Brittonia 23 (1): 2-53.
JOHNSTON, M.C. & L.A. JOHNSTON. 1978. *Rhamnus*. - Fl. Neotrop. Monogr. 20.
MEDAN, D. 1991. Reproductive phenology, pollination biology and gynoecium development in *Discaria americana* (Rhamnaceae). - New Zealand J. Bot. 29 (1): 31-42.
MEDAN, D. & A.C. D'AMBROGIO. 1998. Reproductive biology of the andromonoecious shrub *Trevoa quinquenervia* (Rhamnaceae). - Bot. J. Linnean Soc. 126 (3): 191-206.
MEHROTRA, N.K. & M.F. GUPTA. 1985. Pollination and fruit set studies in ber (*Ziziphus mauritiana*). - J. Res, Punjab Agr. Univ. 22: 671-674.
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Rhizophoraceae

Trees and shrubs, rather heterogeneous with opposite leaves and caducous stipules. **Leaves** simple entire to serrate; **inflorescences** axillary, cymose or racemose or flowers solitary; **flowers** actinomorphic, bisexual, sepals, 4-8(-14), united, persistent, petals as many as the sepals, free, stamens 8-numerous, ovary superior, half-inferior or inferior, 1-6-locular; **fruits** leathery or fleshy berries or drupes, dehiscent or indehiscent, crowned by the persistent calyx, seeds 1-several, sometimes germinating within the fruit (*Rhizophora*). In the tropics and subtropics worldwide, most abundant in the Old World. Pantrop. 15/120, CR 2/5, GD 2/3.

Although almost all mangrove plants are pollinated by animals, including the Old World rhizophoraceous genera *Bruguiera*, *Ceriops* and *Kandelia*, the flowers of most *Rhizophora* spp. are assumed to be wind pollinated (TOMLINSON et al. 1979, TOMLINSON 1986, NOSKE 1993, SUN et al. 1998). *Cassipourea* is probably pollinated by insects (CROAT 1978).

The wood of *Rhizophora* spp. is used as firewood and for making charcoal, while young shoots are used to make red dye (GREGORY 1958). The bark of some Rhizophoraceae is used for obtaining tannins (GREGORY 1958, TOMLINSON 1986).

Key to the genera (after GREGORY 1958)

1 Leaves coriaceous, punctate beneath; ultimate branchlets thick; inflorescences axillary and cymose, stamens 8, cuneate, sessile or subsessile, the anthers many-locular; ovary half-inferior, 2-locular; fruit a dry indehiscent berry, the seed germinating in attached fruits; plants of mangrove swamps with characteristic adventitious aerial and prop roots *Rhizophora*

1* Leaves membranaceous, not punctate beneath; ultimate branchlets slim; flowers fascicled in the leaf axils or solitary; stamens 15-25 on slender filaments, the anthers 4-locular; ovary nearly superior, 3-locular; fruit a fleshy septifragal capsule; not plants of the mangrove association, roots subterranean *Cassipourea*

Cassipourea (neotrop. ca. 40, CR 3, GD 1)
Trees and shrubs, usually of non- or only temporarily inundated areas, with the flowers in axillary fascicles or solitary.

C. elliptica (Sw.) Poit.
Tree or shrub, up to 13(-17) m tall; leaves elliptic to ovate, entire to sometimes serrate in the upper half, glabrous, interpetiolar stipules 4-5 mm long, soon caducous; flowers usually numerous, 4-5-merous, petals white, stamens 15-25, ovary 3-locular; fruits elliptic to ovoid capsules, crowned by the persistent calyx. Widespread in moist forests, also along rivers and near beaches in the West Indies and Central America, from Guatemala to Panama.

Cassipourea elliptica

Rhizophora (pantrop. 8-9, CR 2, GD 2)
A genus of trees and shrubs with high saltwater tolerance, with several distinct characters like stilt roots and viviparous fruits, which are adaptations to its habitat of the mangrove associations worldwide.

Key to the species of *Rhizophora* (after Hou 1960)

1 Inflorescences once or rarely twice branched, usually 2-flowered, occasionally 3- or 4-flowered; flower bud usually slightly 4-angular in the herbarium, the tip slightly curved, one of the calyx lobes slightly longer than the others and cucullate *R. mangle*

1* Inflorescences much-branched, many-flowered; flower bud straight, smooth, calyx lobes equal in length *R. racemosa*

R. mangle L., Pl. 91g,h
Tree, up to 25 m tall; leaves 7-15 cm long, 2-9 cm wide, covered with black dots beneath, midvein and petiole yellowish-green; inflorescences dichotomous, 4-9(-13) cm long; flowers rather large, whitish-yellow; hypocotyl green, becoming brown, up to 30 cm long. In completely inundated zones of the mangroves, with rather high salt concentration, widely distributed from the southern USA and the Antilles to Brazil, as well as in western Africa and in several Pacific islands.

R. racemosa G. Mey., Pl. 5b, 91i
Tree, up to 25 m tall; leaves 7-21 cm long, 3-6 cm wide, black dots lacking, midvein and petioles of young leaves reddish, becoming yellowish green; inflorescences cymose, 4-8(-12) cm long; flowers rather small, yellow to white; hypocotyl green, up to 50(-65) cm long. In temporarily inundated zones of the mangroves, less salt tolerant than *R. mangle*, ranging from Mexico to Ecuador, as well as in western Africa.

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Rosaceae

Herbs, shrubs and trees, characterized by usually 5-merous flowers, an enlarged hypanthium and usually serrate leaves. **Leaves** alternate, rarely opposite, simple or compound, stipules usually present, often conspicuous, often adnate to the petioles; **inflorescences** mostly cymose or flowers solitary; **flowers** actinomorphic, bisexual, hypanthium hollow to flat, sepals (3-)5(-10), free, petals (3-)5(-10), rarely lacking, disk usually present, stamens usually numerous, carpels superior to inferior, free or connate and then ovary up to 5-locular; **fruits** drupes or aggregations of follicles or achenes on a fleshy receptacle. Mainly in temperate regions of the northern hemisphere, but extending into the tropics and subtropics worldwide. Cosmopol. 95/2825, CR 12/41, GD 1/1.

The family contains many important fruit trees, most of them belonging to the genus *Prunus*. Some of them are also cultivated in the Neotropics, usually at higher elevations.

Prunus (cosmopol. > 200, CR 7, GD 1)
One of the few genera occurring in the tropical lowlands. Trees and shrubs, sometimes spiny, and usually with entire leaves, which can easily been recognized by the usual presence of extrafloral glands on the petiole, near the base of the lamina.

P. subcorymbosa Ruiz ex Koehne
Leaves 9,5-14 cm long, 4,2-6,6 cm wide; inflorescences 2-4,5 cm long; stamens ca. 20; fruits drupes, ovoid, ca. 20 mm long, 16 mm wide. From Costa Rica to Peru.

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Rubiaceae

A family mostly consisting of bisexual or rarely monoecious shrubs and trees, but also herbs, vines and lianas. **Leaves** simple, entire, opposite in pairs or more rarely in whorls up to three, petiolate or sessile, sometimes unequal at one node, sometimes with domatia on the leaf blade beneath, stipules nearly always present, but often early caducous, usually interpetiolar, connate, very different in shape (bifid, fimbriulate, linear, lanceolate, foliaceous, tubular, etc.); **inflorescences** terminal or axillary, cymose, paniculate, verticillate, capitate or flowers solitary, involucral bracts occasionally present and enlarged and/or colored; **flowers** bisexual, more rarely unisexual (plants monoecious or dioecious), radially symmetrical, mostly 4–5-merous, calyx tube usually present, lobes rudimentary to well-developed, equal or occasionally 1 or 2 lobes enlarged and/or colored, corolla usually with 4–5 lobes, salverform, rotate, funnelform or tubular in shape, stamens usually as many as petals, alternating with them, free, mostly borne within the corolla tube, often heterostyly present, ovary inferior, with (1–)2(-8) locules; **fruits**

capsular, baccate or drupaceous, capsules often with many (> 100) seeds and opening septicidally and/or loculicidally or rarely circumscissile, berries often large and with the seeds imbedded in a fleshy pulp, drupes mostly with 2 pyrenes, seeds sometimes winged or tufted hairs apically. Distributed worldwide, but most prevalent in the subtropical and tropical regions of the world. Cosmopol. 630/10200, CR 86/430, GD 51/159.

With about 10.700 species and 637 genera (ROBBRECHT 1988), Rubiaceae is one of the largest plant families in the world. Members of this family are easily recognizable by the entire and decussate leaves and the nearly omnipresent interpetiolar stipules.

Most members of the Rubiaceae are zoophilous (OPLER 1983). Nectar is usually produced by the epigynous disk at the base of the corolla-tube. According to the variation in flower size and shape within the family, there is great variation in the pollinator spectrum. VOGEL (1954) reports melitto-, psycho-, phalaeno- and sphingophily in the family, less common are ornitophily and chiropterophily (ROBBRECHT 1988). A recent study on the flower biolgy of *Pentagonia tinajita*, *P. wendlandii* and *Isertia haenkeana* of the Golfo Dulce region was carried out by CSEKITS (in prep.). The flowers of *Pentagonia tinajita* are visited by euglossine bees (*Euglossa tridentata*), while those of *P. wendlandii* are visited by hummingbirds (mostly *Phaethornis* spp.). Hummingbirds are also the legitimate visitors of the flowers of *Isertia haenkeana*. The birds (*Amazilia* spp., *Phaethornis* spp., *Thalurania* spp., *Florisuga* spp.) are attracted by the intensely colored flowers and the large amount of nectar. The flowers of *Faramea occidentalis* are probably moth-pollinated (CROAT 1978). The flowers of *Posoqueria latifolia* are pollinated by hawkmoths (BEACH 1983, PUFF 1995). The flowers of some *Psychotria* species have long corolla tubes, which open in the evening and are pollinated by sphingid moths (BAWA & BEACH 1983).

The pulp of the fruit of *Posoqueria latifolia* is sweet and edible. *Alibertia edulis* also has edible fruits and is sometimes cultivated.

Keys to the genera (valid only for the GD taxa)

Plants herbs	Key I
Plants twining or climbing vines or lianas	Key II
Plants shrubs, treelets or trees	Key III
Plants epiphytic	Key IV

Key I: Plants herbs

Stipules with base fused and several awns or several linear lobes	Key I/A
Stipules reduced to a recurved appendage, often fleshy to succulent	Key I/B
Stipules triangular in shape but rounded or bidentate at apex	*Geophila*
Stipules with a single narrow awn	*Coccocypselum*

Key I/A: Stipules with base fused and several awns or several linear lobes

1	Leaf blades 15–30 cm long	*Amphidasya* (*A. ambigua*)
1*	Leaf blades 1–8 cm long	2
2	Stems quadrangular	3
3	Fruits with circumscissile or transverse dehiscence at the top (breaking away and exposing the seeds)	*Mitracarpus*
3*	Fruits with longitudinal dehiscence	4
4	Mature fruits splitting into 2 cocci, one of which does not open and the other of which splits longitudinally along the inner face, or with the mature fruits opening at the base and occasionally opening slightly at the apex	*Hemidiodia*
4*	Mature fruits splitting into 2 cocci, both of which open along the inner face, or open broadly at the top to release both seeds	*Spermacoce*
2*	Stems terete	5

5	Stems with stiff thin spreading hairs	*Richardia*
5*	Stems glabrous or with a few hairs at the node	*Oldenlandia*

Key I/B: Stipules reduced to a recurved appendage, often fleshy to succulent

1	Fruits with many seeds, tertiary venation on underside of leaf clearly visible	*Hoffmannia* p.p.
1*	Fruits with 2 seeds/pyrenes, tertiary venation on underside of leaf not clearly visible	*Psychotria* p.p.

Key II: Plants twining or climbing vines or lianas

1	Stipules ovate to ligulate or leaf-like and with midvein, 5–18 mm long	2
2	Stipules ovate to ligulate, nearly always reflexed, vine	*Sabicea*
2*	Stipules leaf-like, never reflexed, liana	*Malanea*
1*	Stipules broadly triangular or with a short tubular sheath and one awn, 1–5 mm long	3
3	Leaf blades broadly ovate to elliptic, secondary veins slightly loop-connected distally	*Chiococca*
3*	Leaf blades narrowly elliptic-lanceolate, secondary veins not loop-connected distally, strongly ascending	*Manettia*

Key III: Plants shrubs, treelets or trees

Stipules with base fused and several linear lobes	*Amphidasya* p.p.
Stipules appearing as four per node	Key III/A
Stipules leaf-like, with midvein; trees	Key III/B
Stipules triangular or ovate, 10–70 mm long	Key III/C
Stipules lanceolate (sides at least 3 x longer than broad at the base), 10–80 mm long	Key III/D
Stipules with triangular base and aristate, caudate or acute tip or stipules linear, to 12 mm long	Key III/E
Stipules bidentate to bilobate or with 2 awns	Key III/F
Stipules rounded or blunt, eventually with 1 to several teeth along the distal edge	Key III/G
Stipules sheathy and sometimes with a short mucronate tip	Key III/H
Stipules reduced to a recurved appendage, often fleshy to succulent	Key III/I

Key III/A: Stipules appearing as four per node

1	Leaf base auriculate, petioles 0–8 mm long	*Condaminea*
1*	Leaf base cuneate to rounded, but never auriculate, petioles 20–90 mm long	*Isertia*

Key III/B: Stipules leaf-like, with midvein; trees

1	Stipules rounded at apex	*Macrocnemum*
1*	Stipules acute at apex	2
2	Stipules stiff and longitudinally striate, leaf base rounded to slightly auriculate	*Borojoa*
2*	Stipules neither stiff nor striate, leaf base cuneate to attenuate	*Guettarda*

Key III/C: Stipules broadly triangular or ovate, 10–70 mm long

1	Leaf margins sinuous or slightly to deeply lobed or pinnatifid, leaves 35–100 cm long	*Pentagonia*
1*	Leaf margins entire, leaves 7–48(-60) cm long	2
2	Petioles 0–10 mm long	3
3	Stipules glandular at the base within; flowers bisexual	*Simira*
3*	Stipules lacking glands; flowers unisexual	*Alibertia* p.p.
2*	Petioles 10–50 mm long	4
4	Secondary veins 9–20/side	5
5	Stipules persistent	*Raritebe*
5*	Stipules deciduous	6
6	Petioles 2-13 mm long; inflorescences cymose with 1-9 flowers	*Genipa*

6*	Petioles 12-44 mm long; inflorescences paniculate with several flowers in corymbs, cymules or racemes	*Sommera*
4*	Secondary veins 5–10/side	7
7	Peduncles 0–2 cm long, small trees	8
8	Inflorescences axillary	*Hippotis*
8*	Inflorescences terminal	*Posoqueria* p.p.
7*	Peduncles 5–20 cm long, shrubs	*Psychotria borucana*

Key III/D: Stipules lanceolate (sides at least 3 x longer than broad at the base), 10–80 mm long

1	Plants (except older stems) densely hirsutulous, leaves clustered at the distal part of branchlets	*Duroia*
1*	Plants glabrous or minutely puberulent on underside of leaves, leaves arranged along the stems	2
2	Petioles 0–6(-10) mm long	3
2*	Petioles 10–50 mm long	4
3	Stipules caducous but circular scars around the stems remaining, secondary veins 12–16/side and loop connected near margin	*Faramea* p.p.
3*	Stipules persisting, broad triangular to deltoid and longitudinally striate, secondary veins 6–12/side, not loop connected	*Alibertia* p.p.
4	Secondary veins 5–10/side	*Chimarrhis*
4*	Secondary veins 9–20/side	5
5	Inflorescences racemiform, 20–80 cm long, one calyx lobe red and clearly enlarged	*Warszewiczia*
5*	Inflorescences open pyramidal panicles with opposite branching, 12–25(-30) cm long, calyx lobes all obscure	*Psychotria panamensis*

Key III/E: Stipules with a triangular base and an acute to caudate tip or stipules linear, to 12 mm long

1	Stipules with a triangular or sheathy base and an acute to caudate tip, 1–12 mm long	2
1*	Stipules linear with base only thickened, as many as leaves/node, up to (4-)6 mm long	*Hamelia*
2	Leaves of one node clearly or slightly anisophyllous, spines present	*Chomelia*
2*	Leaves of one node isophyllous, spines absent (except in *Machaonia*)	3
3	Leaves clustered at the twig ends	*Alseis*
3	Leaves not clustered at the twig ends	4
4	Flowers white, corolla tube > 17 cm long; endemic to the Osa Peninsula	*Osa*
4*	Flowers variously colored, corolla tube < 17 cm long	5
5	Trees	6
6	Stipules persisting	*Tocoyena*
6*	Stipules deciduous	*Cinchona*
5*	Shrubs or treelets	7
7	Stipules with a short (to 1 mm long) base and a single slender awn (2–5 mm long)	*Psychotria erecta*
7*	Stipules with a base longer than 1 mm	8
8	Stipules rounded or triangular at the apex and with a short narrow awn; branches occasionally spiny	*Machaonia*
8*	Stipules with an acuminate to caudate tip; branches never spiny	9
9	Inflorescences spike-like, racemiform, spiciform to thyrsiform	*Gonzalagunia*
9*	Inflorescences cymose or paniculate	10
10	Fruits dry capsules	*Rondeletia*
10*	Fruits baccate	*Ixora*

Key III/F: Stipules bidentate to bilobate or with 2 awns

1	Stipules bidentate (triangular in shape)	2
1*	Stipules bilobate or with 2 short to long awns	3
2	Secondary veins 7–10/side	*Coussarea*

2*	Secondary veins 12–16/side	*Psychotria grandis*
3	Stipules deeply bilobate (with U-shaped sinus between lobes) and closely appressed at stem, lobes 5–10 mm long	*Palicourea guianensis*
3*	Stipules bilobate or with 2 awns (in case of U-shaped sinus between lobes, lobes not longer than 2 mm)	*Psychotria*

Key III/G: Stipules rounded, eventually with one to several teeth along the distal edge

1	Stipules with 1 to several teeth along the distal edge	2
1*	Stipules without teeth	3
2	Stipules persisting and tubular to fan-like	*Psychotria cooperi*
2*	Stipules caducous and forming a cap over the shoot apex	*Rudgea*
3	Leaves with domatia, stipules 3–8 mm long	4
4	Leaf base cuneate to obtuse or rounded	*Chione*
4*	Leaf base rounded and slightly auriculate	*Coussarea curvigemmia*
3*	Leaves without domatia, stipules 7–45 mm long	5
5	Inflorescences of solitary, sessile flowers	*Hillia*
5*	Inflorescences never of solitary flowers, flowers pedicellate	6
6	Stipules ovate and stiff, 7-18 mm long	*Posoqueria* p.p.
6*	Stipules obovate or oblong to falcate, not stiff, 15-45 mm long	7
7	Stipules glabrous to minutely puberulent	*Ladenbergia*
7*	Stipules densely puberulent	*Bathysa*

Key III/H: Stipules sheathy and sometimes with a short mucronate tip

1	Stipules forming a cap over the shoot apex in early stages	*Cosmibuena*
1*	Stipules not forming a cap over the shoot apex	2
2	Leafs of one node clearly anisophyllous, stipules brown	*Randia*
2*	Leafs of one node isophyllous, stipules green	3
3	Secondary veins 8–23/side and building a prominent collecting vein about 3–12 mm from the leaf margin	*Faramea* p.p.
3*	Secondary veins 4–7/side, no collecting vein	*Psychotria eurycarpa*

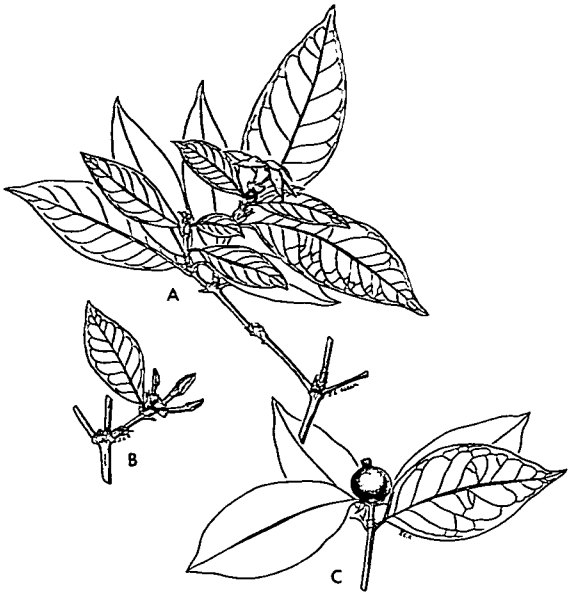
Key III/I: Stipules reduced to a recerved appendage, often fleshy to succulent

1	Fruits with many seeds, tertiary venation on underside of leaf clearly visible	*Hoffmannia* p.p.
1*	Fruits with 2 seeds/pyrenes, tertiary venation on underside of leaf not clearly visible	*Psychotria*

Key IV: Plants epiphytic

1	Seeds winged at either end	*Cosmibuena*
1*	Seeds with tufted hairs at one end	*Hillia*

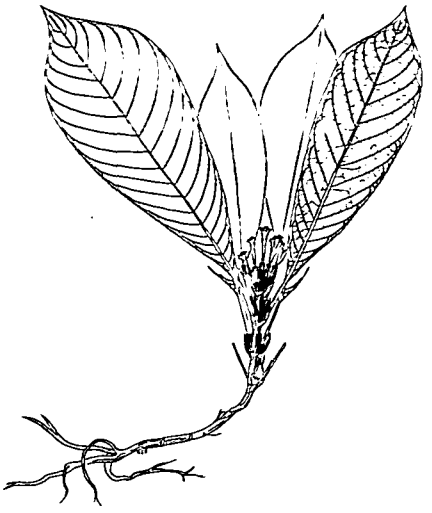
Alibertia (neotrop. 35, CR 3, GD 2)
Dioecious treelets or shrubs with usually coriaceous leaves and triangular stipules. In opposition to the solitary (or paired) pistillate flowers, the staminate flowers are arranged in clusters. Bracts present and the fleshy globose fruits with the persistent calyx lobes contain few to several compressed seeds, imbedded in a pulpy placenta.
A. edulis (L.C. Rich.) A. Rich. ex DC, Pl. 92a
Treelet to 5 m tall; leaves coriaceous and usually shiny, 5–15 cm long, stipules 8–15 mm long, intrapetiolar, usually overlapping, petioles 2–8 mm long, domatia often present in vein axils beneath; inflorescences subtended by stipule-like bracts; calyx tube ca. 5 mm long, corolla white, tube 1,5–3 cm long, lobes to 2 cm long, anthers minutely apiculate; fruits globose, 2–3 cm in diameter, persisting calyx tube ca. 5 mm long, seeds slightly flattened longitudinally. In dry, partly deciduous to evergreen forests, from Mexico and the West Indies to the Amazon Basin and Bolivia.



Alibertia edulis
A. Flowering branch. B. Flower buds. C. Fruit

Amphidasya (neotrop. 7, CR 1, GD 1)
Low herbaceous to shrubby genus with relatively large, obovate to oblanceolate leaves and conspicuous, deeply lobed stipules with several unequal awns (rarely with entire stipules). The axillary or terminal inflorescences bear long tubular flowers. The fleshy and indehiscent fruits with persistent, unequal and somewhat foliaceous calyx lobes enclose numerous seeds.

A. ambigua (Standl.) Standl., Pl. 92b
Shrub to 40 cm tall, leaves clustered distally, 12–28 cm long, apex abruptly narrowed and with short tip, stipules to 3,5 cm long; inflorescences with 4–20 closely clustered, sessile or subsessile flowers; calyx lobes often unequal, corolla white, narrow, tube 35–50 mm long; fruits 8–12 mm long, with persisting calyx lobes. In the undergrowth of steep and shady slopes of evergreen forests, from Costa Rica to Colombia.



Amphidasia ambigua

Borojoa (neotrop. 8, CR 2, GD 2)
Dioecious trees with triangular to leaf-like stipules and sometimes with domatia at the undersides of the leaves. The inflorescences are always terminal, bearing unisexual flowers, the pistillate flowers solitary and the sessile staminate flowers congested in heads of few to many. The globose, berry-like fruits with a thick walled and fleshy pericarp contains the flattened seeds, arranged in horizontally rows and imbedded in a mucilaginous pulp.

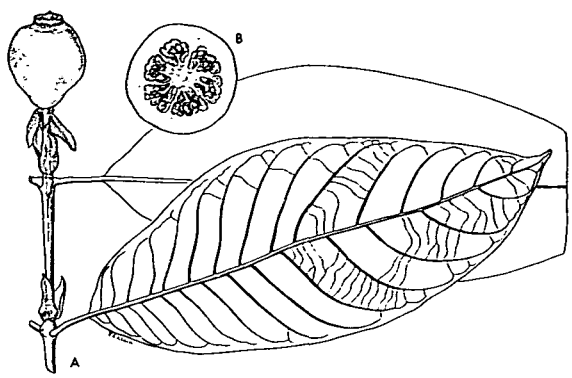
Key to the species of *Borojoa*

1	Inflorescences with 2-6 male flowers; fruits 4,5-7 cm in diameter	*B. panamensis*
1*	Inflorescences with numerous male flowers; fruits 8–12 cm in diameter	*B. patinoi*

B. panamensis Dwyer
Tree, to 18 m tall; leaves to 30 cm long and 15 cm wide, stipules connate to the middle and often wider above the middle, acuminate, tuft domatia in vein axils beneath; inflorescences with 2–6 male flowers and solitary female flowers, subtended by paired bracts; corolla white, sericeous, tube ca. 12 mm long, lobes ca. 10 mm long; fruits 4,5–7 cm in diameter, glabrous, pericarp 8–12 mm thick, persisting calyx tube ca. 4 mm long, seeds 4–5 mm long. In evergreen forests, from northeastern Costa Rica to Panama.

B. patinoi Cuatrec., Pl. 92c
Tree up to 15 m tall; leaves to 38 cm long and 20 cm wide, stipules elliptic to ovate (leaf-like), stiff, striate, acuminate, with median keel, pit domatia in vein axils beneath; inflorescences with numerous male flowers in terminal heads, female flow-

ers solitary, subtended by paired bracts, male flowers: tube to 18 mm long, lobes 6–7 mm long; fruits 8–12 cm in diameter, bracts persistent, glabrous. In evergreen wet forests, from Costa Rica (Osa Península) to Colombia.



Borojoa patinoi
A. Branch with leaves and fruit. B. Fruit cross section

Chimarrhis (neotrop. 14, CR 2, GD 2)
Trees with the leaves usually crowded at the twigs apices and with caducous triangular stipules, leaving circular scars. The paniculate or corymbose inflorescences bearing small, white, protogynous and odoriferous flowers. The fruits are small, woody and 2-valved capsules, containing numerous compressed or angulate seeds.

C. latifolia Standl.
Tree, to 30 m tall, wood yellowish, branchlets glabrous and with prominent leaf scars; leaves 15–45 cm long, to 16 cm wide, stipules long acuminate, 2–7(-8) cm long, stipule scars often turning dark; inflorescences axillary, corymbose, 8–15 cm long, peduncles to 6 cm long, densely flowered; corolla white, tube ca. 2 mm long, pubescent within, lobes rounded; fruits obovoid-oblong, to 5 mm in diameter, apex truncate, seeds ca. 1 mm long. In wet lowland rain forests of southern Costa Rica and Panama.

Chiococca (neotrop. 6, CR 5, GD 2)
Woody climbers (rarely shrubs or trees) with persistent, usually cuspidate stipules and axillary (rarely terminal) inflorescences with the small and campanulate flowers opposite or arranged along one side. Characteristic features of this genus are the connate stamens with pilose filaments inserting near the base of the tube, as well as the laterally compressed drupes, usually white at maturity.

C. alba (L.) Hitchc., Pl. 92d
Shrub or vine with climbing twigs; leaves ovate-elliptic, 3–13 cm long, 1–6 cm wide, stipules with a basal sheath and an acuminate to caudate tip, to 6 mm long; inflorescences paniculate or racemiform, 4–11 cm long, flowers usually borne along one side of the rhachis, solitary or in groups of 3; corolla funnelform, white to yellowish or flushed with rose; fruits flattened laterally, white at maturity, 4–8 mm in diameter, calyx persisting, ca. 1 mm long. Along open forest edges and disturbed areas, in both evergreen rain forest areas and in seasonally deciduous forests, from the southern United States (Texas and Florida) and the West Indies, through Central America to Argentina.

C. belizensis Lundell
Vine or liana; leaves subcoriaceous, elliptic to lanceolate, 5–12 cm long, 2–5 cm wide, stipules with a short basal sheath and an acuminate to caudate tip, to 3 mm long; inflorescences paniculate to racemiform, 3-8 cm long, 2–4 cm wide; corolla funnelform, yellow, tube 5–8 mm long, lobes 2–4 mm long; fruits 7–10 mm in diameter. In moist forests, from southern Mexico to Panama.

Chione (neotrop. ca. 15, CR 1, GD 1)
Shrubs or trees with short and caducous stipules, forming a hood over the shoot apex. Domatia sometimes present in the vein axils beneath. The terminal cymose or corymbose inflorescences are inserted solitary or up to 3. The ellipsoid drupe contains two elongate pyrenes.

C. sylvicola (Standl.) W. Burger
Shrub or tree, up to 20 m tall; leaves 7–21 cm long, 3–11 cm wide, shiny, pit domatia present in the vein axils beneath, stipules obtuse to rounded, 3–7 mm long, early caducous; inflorescences paniculate to corymbose, to 12 cm long; flowers with sweet scent, corolla white; fruits to 22 mm long, red to purple (black) at maturity. In evergreen rain forests, from southeastern Nicaragua to northwestern Colombia.

Chomelia (neotrop. 20, CR 8, GD 5)
Shrubs or trees occasionally with spines and reduced branches (short shoots). Further characteristics of this genus are usually acuminate stip-

ules, white to yellowish flowers with a narrow and usually externally sericeous elongated tube and drupaceous ellipsoid fruits.

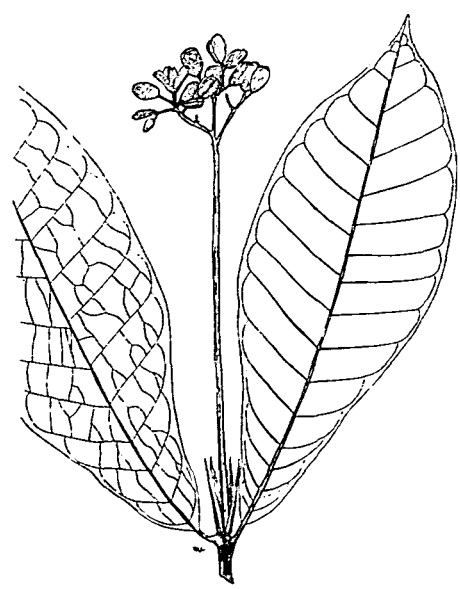
Coccocypselum (neotrop. 20, CR 3-4, GD 1-2)
Usually pubescent and prostrate herbs with linear (or sometimes subulate) stipules and capitate, sessile to long pedunculate inflorescences, consisting of 3–20 flowers with a 4-merous, white to purple or blue corolla. The fruits are baccate, aerenchymateous, often hollow and bright blue and contain many flattened or angled seeds.

C. herbaceum P.Browne, Pl. 92e-g
Herb, to 25 cm tall, whole plant densely villous or hirsute with spreading hairs; leaves to 5 cm long, stipules linear awns (two per node), to 5 mm long; inflorescences capitate, with 3–6 flowers, peduncle 0–6 cm long; corolla violet to purple, tube white and 5–7 mm long; fruits ovoid to ellipsoid, 9–20 mm long, deep blue, seeds 1–1,5 mm wide, wrinkled, lens-shaped. In moist to wet forests, from Mexico to South America.
The species is treated here in its widest sense, including *C. hirsutum*, which differs in the pedunculate inflorescences, while those of *C. herbaceum* are sessile or subsessile (cf. BURGER & TAYLOR 1993: p. 104).

Coccocypselum herbaceum s.l.

Condaminea (neotrop. 3, CR 1, GD 1)
Shrubs or small trees with sessile to short petiolate, relatively large leaves and deeply lobed stipules, sometimes appearing as four per node. The terminal and solitary open paniculate inflorescences bearing thick and fleshy flowers with a barbate throat, basically puberulent filaments and sagittate anthers. The woody and 2-valved capsules show a circular calyx scar at the apex and contain many seeds.

C. corymbosa (Ruiz & Pav.) DC.
Shrub or treelet, to 7 m tall; leaves obovate to oblanceolate, to 62 cm long, stipules united at the base and with two leaf-like lobes at each side (appearing as four per node), to 8 cm long; inflorescences spreading paniculate, to 45 cm long, peduncle 15–20 cm long; corolla white with purplish tube, slightly fleshy, greenish white within, lobes rounded distally, becoming reflexed; fruits obovoid, 10–18 mm long, circular calyx scar present distally, seeds to 1 mm long. In evergreen forests, from Costa Rica to Venezuela and in Peru and Bolivia.



Condaminea corymbosa

Coussarea (neotrop. ca. 100, CR 9, GD 6)
Shrubs or trees, having suborbicular, obtuse to acute stipules and often coriaceous leaves. The terminal and umbellate or paniculate inflorescences are many-flowered. White flowers with undeveloped or very small calyx lobes. The fleshy drupes becoming white or blue-black at maturity.

C. hondensis (Standl.) C. M. Taylor & W. Burger
Shrub or treelet, to 6 m tall, branchlets tetragonal; leaves ovate-elliptic, to 27 cm long, stipules ovate and often bidentate, to 10 mm long; inflorescences paniculate to corymbiform, to 15 cm long, the distylous flowers clustered in distal groups; corolla salverform, white, tube ca. 2 cm long, lobes ca. 1,5 cm long; fruits ellipsoid, 12–18 mm long, red at maturity. In evergreen rain forests in Costa Rica and Panama.

Duroia (neotrop. 20, CR 1, GD 1)
Dioecious shrubs or treelets with deciduous stipules forming a hood over the shoot apex and with white to yellow corolla lobes, often with a thick or fleshy texture. The female flowers are arranged to 1–3 in terminal inflorescences, while the male flowers are arranged in subcapitate clusters. The baccate and globose to oblong fruits with a thick and fleshy cortex and 1–4 locules contain many large suborbicular seeds. The South American species house ants in the hollowed stems (BURGER & TAYLOR 1993).

D. costaricensis Standl., Pl. 92h
Shrub or treelet, to 10 m tall, hirsutulous; leaves densely crowded at the tips of branchlets, oblong to obovate, stipules triangular, to 45 mm long, densely hirsute, forming a cap over the shoot apex caducous, leaving a circular scar around the stem; male inflorescences with 8–15 flowers, female inflorescences with 1–3 flowers; fruits oblong to ovoid, subsessile, sericeous with yellowish hairs, to 25 mm long, seeds horizontally flattened, ca. 5 mm long. In lowland rainforests around Golfo Dulce, endemic to Costa Rica.

Faramea (neotrop. 125, CR 13, GD 7)
Shrubs or treelets, the stipules often forming a tubular sheath around the stem or short triangular to long aristate at apex (with two awns per node). The oblong to lanceolate leaves are often held in a single plane. The terminal inflorescences as well as the monomorphic or distylous flowers often have a pale blue to purplish color. The baccate or drupaceous fruits encloses one (rarely two) nearly kidney-shaped seed or pyrene.

F. occidentalis (L.) A.Rich.
Tree treelet or shrub, 2–10 m tall, often dichotomously or trichotomously branched; leaves narrowly elliptic to oblong, to 20 cm long, stipules triangular with a terminal linear awn (4–12 mm long); inflorescences umbelliform or trichotomous, to 12 cm long and wide, distal flowers usually in groups of 3; flowers with sweet scent, corolla white; fruits globose to subglobose, to 10 mm long, bluish-black at maturity, persisting calyx to 2 mm long. In tropical wet forests, from southern Mexico and the West Indies to tropical South America.

F. sessifolia P. Allen, Pl. 92i
Shrub or treelet, to 7 m tall, glabrous, branchlets quadrangular and flattened at the nodes; leaves oblong, to 30 cm long, stipules triangular, to 25 mm long; inflorescences paniculate, to 15 cm long with opposite branches, peduncles whitish; corolla bluish, tube ca. 6 mm long, lobes ca. 3 mm long; fruits obovate to oblong, ca. 5 mm long, to 9 mm wide, with 8 longitudinal ridges, becoming black at maturity. In lowland rain forests, endemic to southwestern Costa Rica.

F. stenura Standl.
Treelet, to 7 m tall; leaves narrowly oblong to obovate, to18 cm long, stipules sheathy, to 10 mm long, with a single slender awn; inflorescences paniculate, pyramidal, blue, to 5,5 cm long, bracts to 5 mm long and purplish; corolla pale to deep blue, tube to 8 mm long; fruits flattened distally and rounded basally, to 8 mm long and 15 mm wide, smooth. In lowland rain forests, from Mexico to western Panama.

F. suerrensis (J. D. Smith) J. D. Smith
Shrub or treelet, to 6 m tall, branchlets usually quadrangular; leaves narrowly elliptic to oblong, to 22 cm long, stipules forming a short tube around the stem (3–5 mm long) with a mucronate tip (1 mm long); inflorescences in corymbose panicles, bright blue, to 15 cm long, many flowered; corolla bright to deep blue, tube to 10 mm long, lobes to 5 mm long; fruits kidney-shaped, flattened to slightly depressed distally, to 11 mm long and 16 mm wide, blue at maturity. In lowland rain forests, from southern Nicaragua to northwestern Colombia.

Genipa (neotrop. 7, CR 2, GD 1)
Trees with triangular stipules (basally fused) and chartaceous to coriaceous leaves. Also easy to recognize by its single to few flowered inflorescences, large, carnose, white to yellowish flowers

(villous at the base and in the throat) and the fusiform stigmas. The large, baccate, fleshy and ovoid to subglobose fruits with persistent calyx lobes contain many compressed seeds.

G. americana L., Pl. 93a
Tree or treelet, to 25 m tall, bark smooth; leaves obovate to oblanceolate, to 35 cm long, stipules triangular to ovate, to 20 mm long; inflorescences terminal, cymose, to 10 cm long; corolla white to cream, sericeous on both sides; fruits obovoid to subglobose, to 11 cm in diameter, persisting calyx to 6 mm long, pedicels to 5 cm long in fruit, seeds to 12 mm long. In wet evergreen rain forests as well as in seasonally dry deciduous forests, from southern Florida, Mexico, the West Indies, Central and South America to Paraguay.

Geophila (pantrop. ca. 20, CR 3, GD 3)
Creeping herbs, usually rooting at the nodes, with long petiolate, often rounded or cordate leaves and ovate to triangular, entire or bidentate stipules. The few-flowered heads or cymes are subtended by an involucre of small bracts and the white corolla with valvate lobes is pilose in the throat. Juicy berries usually contain two planoconvex pyrenes (nutlets) with a ventral sulcus.

G. macropoda (Ruiz & Pav.) DC, Pl. 93b
Herb, to 16 cm tall, with creeping stem and erect petioles, usually rooting at the nodes, often with 2 ridges along the stem; leaves cordate, to 6 cm long, stipules ovate to triangular (sometimes bidentate), to 8 mm long; inflorescences capitate with usually 3–7 flowers, peduncle puberulent, elongate in fruit; corolla white, 6–7 mm long; fruits ovoid, sessile, to 10 mm long, black, pyrenes 4–7 mm long. In lowland rain forests, from southern Mexico to Bolivia and Paraguay.

Gonzalagunia (neotrop. 15, CR 8, GD 5)
Shrubs or small trees, often with pendent branches, usually pubescent stems and distichous leaves with strongly ascending secondary veins. The interpetiolar stipules are usually triangular with a narrow distal awn. The genus is also well characterized by the long and spicate (mostly terminal) inflorescences with white to pink flowers and a very short calyx tube with equal or unequal lobes (these persisting in fruit). The baccate, subglobose and fleshy or spongy fruits include 2–4 cocci with 4-many minute seeds inside.

G. brenesii Standl., Pl. 93c,d
Shrub, to 3 m tall; leaves sessile to subsessile, leaves elliptic to lanceolate, to 20 cm long and 6 cm wide, sometimes pubescent beneath, stipules acuminate, to 10 mm long; inflorescences terminal, spiciform, to 70 cm long, lateral branches with 2–6 flowers; corolla white to pink, tube to 10 mm long; fruits globose, 3–5 mm long, white, sparsely pubescent, calyx lobes persistent. In rain forests, often in disturbed areas along roadsides, endemic to Costa Rica.

G. ovatifolia (J. D. Smith) B. L. Robinson
Shrub, to 3 m tall; leaves ovate, to 11 cm long, appressed pubescent along the veins beneath, stipules to 8 mm long; inflorescences terminal, spicate, to 35 cm long, with the flowers solitary (in the distal half) or in cymules of 2–5 along the central rhachis; corolla white, ca. 6 mm long; fruits globose, ca. 3 mm long, white, pubescent, calyx lobes persistent. In wet forests, from Nicaragua to Colombia.

G. rudis (Standl.) Standl.
Shrub or treelet, to 4 m tall; leaves lanceolate, to 10 cm long and 3,5 cm wide, stipules ca. 6 mm long, brown; inflorescences terminal or axillary, to 10 cm long, flowers solitary or in cymules of 2–4; corolla white, tube narrow, to 7 mm long, lobes narrow and spreading, to 5 mm long, puberulent on both sides; fruits globose, fleshy, 3–5 mm long, white, pubescent, calyx lobes persistent. In evergreen forests, from Costa Rica to eastern Panama.

Guettarda (pantrop. ca. 80, CR 10, GD 6)
Shrubs or trees with triangular to leaf-like stipules, subparallel tertiary leaf-venation and axillary, often dichotomous inflorescences (one or two per node), bearing the sessile flowers along one side. Also well characterized by the often undulate corolla lobes and the drupaceous and globose fruits, with a fleshy to carnose exocarp and a woody to stony endocarp.

G. crispiflora Vahl, Pl. 93e
Tree or treelet, 4–20 m tall, younger branchlets quadrangular; leaves clustered at the twig apex, elliptic to lanceolate, domatia sometimes present, stipules leaf-like, with midvein, to 20 mm long, acuminate and densely sericeous; inflorescences of 2 diverging cincinnoid branches, to 50 mm long, minutely whitish tomentulose; flowers ses-

sile, corolla tube to 18 mm long, narrow, lobes to 8 mm long, spreading and with a crisped and undulate margin, white; fruits subglobose, with 4 prominent longitudinal ribs, 6–8 mm long, pubescent, with a white, mealy pulp, becoming purple. In wet to cloud forests, from Nicaragua and the West Indies to Ecuador, Peru and Bolivia

Hamelia (neotrop. 16, CR 6, GD 5)
Usually shrubs or small trees with short linear stipules and the leaves decussate or in whorls up to five. It can be distinguished also by the thyrse-like inflorescences with helicoid branches and the flowers arranged along one side. The yellow, orange to red flowers are mostly tubular with short and imbricate corolla lobes and sagittate anthers. At the top of the ovoid to oblong fleshy fruits a scar from the calyx as well as a conical disk is visible.

H. axillaris Sw.
Shrub or treelet, to 4 m tall; leaves opposite, rarely verticillate, to 17 cm long and 7,5 cm wide, often puberulent beneath and with domatia (tufts of hairs) in the vein axils; inflorescences axillary or terminal, compound dichasia with often scorpioid and spreading branches with 3-15 flowers; corolla funnelform, yellow, tube to 13 mm long; fruits ovoid to subglobose, ca. 6 mm long, black at maturity. In evergreen forests, from southern Mexico and the West Indies to Venezuela and Bolivia.

H. magnifolia Wernh.
Shrub or treelet, to 6 m tall, branchlets tetragonal; leaves opposite, rarely verticillate, ovate, to 25 cm long, glabrous; inflorescences terminal and paniculate, to 15 cm long and wide, many flowered, flowers arranged along one side of the branches; corolla tubular, somewhat narrowed below the middle, yellow, tube to 13 mm long, lobes to 3 mm long; fruits oblong to broadly ellipsoid, to 10 mm long, red at maturity. In evergreen wet forests in Costa Rica and Panama.

H. patens Jacq., Pl. 93f,g
Shrub or treelet, 2–6 m tall, twigs glabrous to sparsely pubescent; leaves usually (2-)3(-5) per node, often unequal at the same node, elliptic, to 18 cm long, glabrous to pubescent beneath, domatia sometimes present in the vein axils beneath, stipules as many as leaves per node; inflorescences terminal, to 12 cm long and 14 cm wide, open panicles with helicoid dichasia, peduncles often orange to coral red; corolla tubular, longitudinally ribbed, orange to red, tube to 20 mm long; fruits ellipsoid to oblong, to 13 mm long, red, becoming black at maturity, ovarian. In evergreen to partly deciduous forests, usually in secondary vegetation, from southern Florida, the West Indies and Mexico to northern Argentina and Paraguay (except Guiana, the Amazon Basin, northeastern and central Brazil).

Hoffmannia (neotrop. ca. 45, CR 30, GD 9)
Mostly shrubs (occasionally with herbaceous and succulent habit), small trees or rarely herbs, the stipules often short, triangular and succulent and the inflorescences axillary to cauliflorous The flowers with imbricate corolla lobes usually have white anthers and a bilobate or clavate stigma. The baccate, 2-locular fruits often become spongy at maturity and contain numerous foveolate or reticulate seeds.

H. cf. ***liesneriana*** Standl.
Herb or subshrub, to 1,5 m tall, glabrous, stems quadrangular, usually unbranched and decumbent; leaves to 22 cm long and 12 cm wide, stipules to 3 mm long; inflorescences axillary, 2–8 cm long, on lower, leafless nodes (1–3/node) near the ground, the flowers in clusters or along helicoid branches, peduncles 1–6 cm long; corolla salverform, purple to reddish brown, tube ca. 3 mm long, lobes 4–7 mm long, reflexed at anthesis; fruits ellipsoid, to 8 mm long, becoming red. In lowland rain forests, from central to southeastern Costa Rica.

Isertia (neotrop. 13, CR 3, GD 2)
Shrubs or trees with subterete to quadrangular branchlets and sometimes conspicuous, deeply divided stipules, appearing as four per node. The terminal and solitary paniculate or racemose inflorescences bear bisexual flowers with an elongated tube and a villous throat. The baccate and globose fruits with a fleshy exocarp contain 2–6 pyrenes, each of them enclose numerous seeds with a foveolate testa. Species of the Esquinas Rainforest are additionally characterized by the highly symmetric partial inflorescences.

Key to the species of *Isertia* (after BURGER 1983)

1 Leaf blades usually dull greenish or grayish beneath, usually acute at the base and decurrent on the petiole; corolla yellow to orange or red, corolla tubes to 28 mm long; fruit oblate, ca. 7 mm in diameter — *I. haenkeana*

1* Leaf blades usually whitish gray beneath, subtruncate to obtuse at the base and not conspicuously decurrent on the petiole; corolla white, corolla tubes to 55 mm long; fruit ellipsoid, ca. 10 mm in diameter — *I. laevis*

I. haenkeana DC., Pl. 93h,i
Shrub, to 4 m tall, branches quadrangular with rounded edges; leaves to 45 cm long, stipule lobes triangular, to 15 mm long, persisting; inflorescences to 20 cm long, and 12 cm wide, with the partial inflorescences in dichasia, consisting of dichotomous branches with a terminal flower and 2 lateral, serpicoid branches, each of them with 4–9 sessile or subsessile flowers, peduncles and pedicels orange to red; corolla tubular, bright yellow, turning orange to reddish, tube to 30 mm long, with a prominent ring of reddish hairs near the mouth; fruits globose, to 6 mm long, usually with 5 or 6 cartilaginous lobes and 5–6 pyrenes. In evergreen lowland wet forests, usually in secondary growth, from Mexico to Colombia and Venezuela.

I. laevis (Triana) B.M. Boom, Pl. 93j
Tree, to 12 m tall; leaves to 60 cm long, stipule lobes leaf-like, to 45 mm long; inflorescences pyramidal, to 35 cm long and 15 cm wide, with many lateral branches of partial inflorescences; flowers fragrant, corolla tube to 55 mm long, white, villous in the throat, lobes to 14 mm long; fruits ellipsoid to subglobose, to 14 mm long, becoming black at maturity. In primary to secondary evergreen rain forests, from Costa Rica to Panama, along the Andes to Bolivia and adjacent Amazon Basin.

Macrocnemum (neotrop. ca. 20, CR 1, GD 1), Pl. 93k
Shrubs or trees with oblong to obovate stipules, and often with domatia on the leaves. The paniculate inflorescences bearing flowers in distal cymes. The corolla is villous inside, often wider than long and has imbricate lobes spreading at anthesis. The capsular, bisulcate fruits (dehiscing loculicidally into 2 valves), containing winged seeds.

Palicourea (neotrop. > 200, CR 27, GD 3)
Shrubs or trees with bilobate or bidentate stipules, terminal and paniculate inflorescences and basically bifid anthers. Closely related to *Psychotria* but separated from it by the often basically gibbous, often yellow, orange or red corolla tube, the ring of hairs within the corolla tube and the often brightly colored peduncles and branches of the terminal inflorescences (especially at fruit maturity). The fleshy and blue, purple to black fruits contain usually two hemispherical pyrenes with several longitudinal ribs on the rounded back and usually with one longitudinal sulcus on the flattened inner face.

P. guianensis Aubl., Pl. 94a,b
Shrub or small tree, 2–6(-10) m tall, glabrous; leaves ovate, to 35 cm long and 15 cm wide, stipules deeply bilobate, lobes to 12 mm long, rounded distally and separated by a U-shaped sinus; inflorescences pyramidal or thyrsiform, to 18 cm long and 12 cm wide, peduncles red-orange, turning purple at fruit maturity; corolla yellow to orange, tube to 25 mm long, contracted in the middle and slightly inflated distally; fruits ellipsoid, to 8 mm long, purple to black, with persisting calyx and prominent longitudinal ribs when dry. In evergreen and partly deciduous forests, from southern Mexico and the West Indies to Bolivia.

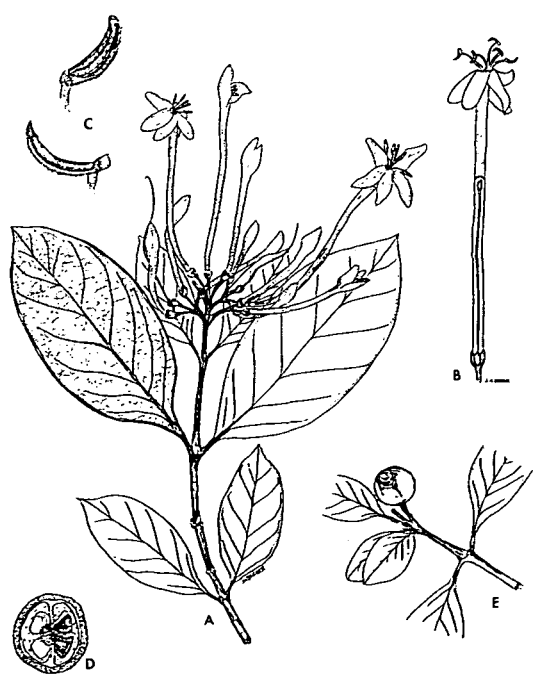
Pentagonia (neotrop. 20, CR 8, GD 5)
Usually small trees with unbranched stems and often large, entire or pinnately lobed to pinnatifid leaves, distally clustered and with a typical lineolate-parallel minor venation. The stipules are triangular in shape and colleters are often visible adaxially. The axillary and short pedunculate inflorescences bear bracteolate flowers with a usually carnose corolla, valvate corolla lobes and usually basally villous stamina. The baccate and 2-locular fruits, often with a persisting calyx tube, contain many seeds, imbedded in a pulp.

P. tinajita Seem., Pl. 94c
Treelet, to 4 m tall; leaves pinnately lobed, lobes

5–15 cm long (becoming more shallow distally), usually obovate, to 70 cm long, 20–40 cm wide, stipules to 5,5 cm long; inflorescences sessile to subsessile, densely fasciculately crowded in the leaf axils, often enclosed by the stipules; corolla cream to greenish, tube 20-25 mm long, lobes 6–10 mm long; fruits globose or ovoid, to 30 mm long, calyx lobes persisting. In lowland primary rainforests, from central Costa Rica to western Panama.

P. wendlandii Hook., Pl. 94d,e
Shrub or small treelet, up to 3 m tall; leaves entire, narrowly obovate to obovate-oblong, 50-100 cm long, 25-50 cm wide, stipules 2,5-6,5 cm long; inflorescences up to 5 cm long, peduncle ca. 5 mm long; corolla yellow, tube ca 25 mm long, lobes 4-7 mm long; fruits oblong rotund, to 45 mm long, calyx lobes persisting. In lowland primary rainforests, from Costa Rica to central Panama.

Posoqueria (neotrop. 12, CR 5, GD 4)
Shrubs, treelets or trees with ovate or triangular and early deciduous stipules and coriaceous leaves. The short and terminal inflorescences bear long tubular, white flowers. The baccate and globose to ovoid fruits contain numerous rounded and angled or flattened seeds, which are imbedded in a gelatineous pulp.



Posoqueria latifolia

P. latifolia (Rudge) R. & S., Pl. 94f-h
Treelet, to 9 m tall, glabrous; leaves to 38 cm long, 22 cm wide, coriaceous, stipules ovate (rounded distally in young stadium), stiff, to 15 mm long; inflorescences 2–5 cm long, with 7–18 flowers; flowers sweet-scented, papillate and glabrous outside, corolla tube narrow, to 15 cm long, lobes 12–20 mm long and rounded; fruits globose to ovate, ca. 5 mm long, yellow to orange at maturity, seeds numerous, imbedded in a greenish pulp. In lowland rainforests to partly deciduous forests, from southern Mexico to Peru, Bolivia and Amazonian Brazil. In Costa Rica it is common along streams and riverbanks.

Psychotria (pantrop. 800-1500, CR 115, GD 40)
One of the largest genera of the family, consisting of shrubs and trees (rarely epiphytes or lianas), mostly with bifid stipules, these often with sheathy base, but also triangular, ovate or tubular. The inflorescences are mostly terminal or sometimes axillary and paniculate or aggregated in heads. The bracts are small to conspicuous and involucrate (the here-included former genus *Cephaelis* is distinguished from *Psychotria* by large involucrate bracts an the flowers clustered in congested heads). The flowers are often distylous flowers with the corolla lobes white to yellow and valvate. The fleshy or aerenchymatous and variously colored drupes usually enclosing 2(-5) plano-convex pyrenes, these often with a ventral sulcus and longitudinal ridges.

P. acuminata Benth.
Shrub, to 2,5 m tall, glabrous; leaves chartaceous, to 17 cm long, apex with a caudate tip (to 3 cm long), stipules with a sheathy tube and 2 narrow awns, ca. 4 mm long; inflorescences paniculate, to 6 cm long; flowers sessile to subsessile, distylous, corolla white to cream, ca. 6 mm long, lobes rounded distally; fruits rounded, ca. 4 mm long, 5–7 mm in diameter, blue to purple at maturity, pyrenes ca. 2,5 mm long. In lowland rainforests, from Mexico and the West Indies to Peru.

P. borucana (A. R. Molina) C.M. Taylor & W.C. Burger, Pl. 95a
Shrub or subshrub, 1,5–3 m tall, glabrous; leaves coriaceous, broadly elliptic, to 30 cm long and 14 cm wide, stipules ovate, to 18 mm long, with parallel venation; inflorescences terminal, capitate, to

5 cm wide, peduncles 7–20 cm long; flowers densely clustered and subtended by 2 ovate and lavender bracts (1–2 cm long), corolla tubular, white to lavender, tube to 18 mm long, lobes ca. 3 mm long and acute; fruits rounded to oblong, ca. 8 mm in diameter, becoming purple at maturity, pyrenes with several ribs. In evergreen lowland rainforests, from Costa Rica to Peru.

P. capitata Ruiz. & Pav., Pl. 95b
Shrub or treelet, 1,5–3 m tall; leaves to 20 cm long and 9 cm wide, stipules deeply bilobate, to 25 mm long, yellowish-green or purple, caducous; inflorescences paniculate or racemose, to 13 cm long and 6 cm wide, peduncles 3–7 cm long, white at anthesis; flowers sessile in distal cymes of 2–4, subtended by white bracteoles at anthesis, corolla white to cream, throat yellow, tube 4–7 mm long, lobes 1–3 mm long; fruits subglobose, ca. 6 mm in diameter, purple to black at maturity, pyrenes ribbed. In tropical and premontane wet forests, from Belize to Peru and Brazil.

P. chagrensis Standl.
Shrub, 1–2 m tall; leaves usually clustered distally, oblanceolate to obovate, to 8 cm long and 3 cm wide, stipules basically tubular and with an ovate lobe, to 10 mm long; inflorescences terminal, fasciculate or capitate, sessile, to 18 mm long, bracts to 1 cm long; corolla funnelform, white, to 10 mm long; fruits oblong-ellipsoid, ca. 8 mm long, becoming red or purple at maturity, persisting calyx ca. 2 mm long, pyrenes with several ribs, ca. 5 mm long. Understory plant of wet forests, from southern Nicaragua to Colombia and Peru, also in disjunct areas of Mexico and Guatemala.

P. chiapensis Standl., Pl. 95c,d
Common name (Costa Rica): coco bolito (Dwyer 1980)
Shrub or treelet, to 6 m tall; leaves obovate to oblanceolate, to 20 cm long and 8 cm wide, stipules with 2 acute lobes; inflorescences in terminal heads or corymbiform, 5–12 cm long, 5–8 cm wide, peduncles 2–6 cm long; flowers sessile, corolla white, fragrant, tube to 4,5 cm long, densely villous within; fruits oblong to elliptic, to 18 mm long, purple to black at maturity, pyrenes 2, ca. 10 mm long, dorsally with 3 ribs. In evergreen lowland rain forests, from southern Mexico to Peru.

P. deflexa DC.
Shrub, to 3 m tall; leaves to 16 cm long, stipules with s short sheath and 2 narrowly triangular awns per side, to 8 mm long; inflorescences terminal, narrowly pyramidal panicles, 4–11 cm long; corolla white, tube to 3 mm long, lobes ca. 1 mm long; fruits oblate and somewhat bilobate, ca. 3 mm long, longitudinally ridged, purple at maturity, pyrenes with 3–4 ridges and transverse ribs. In wet or partly deciduous forests, from Mexico to Peru and Bolivia.

P. elata (Sw.) Hammel, Pl. 95f,g
Shrub or treelet, 2,5–5 m tall, glabrous, twigs often slightly quadrangular; leaves to 25 cm long and 10 cm wide, stipules with 2 ovate lobes, ca. 5 mm long; inflorescences terminal, capitate and hemispherical, heads (including bracts) to 4 cm long and 7 cm wide, peduncles 2–10 cm long, 2 basal bracts ovate, orange to red, to 55 mm long and 45 mm wide; flowers sessile, corolla tubular, white, tube ca. 15 mm long, lobes ca. 3 mm long; fruits obovoid, juicy, to 15 mm long, black and shiny at maturity, pyrenes 3–6 mm long and longitudinally ribbed. In evergreen forests, also common along forest edges and in secondary growth, from Mexico and the West Indies to Colombia.

P. erecta (Aubl.) Standl. & Steyerm.
Shrub, 1,5–4 m tall, younger stems appressed puberulent; leaves elliptic, to 18 cm long, margin puberulent, stipules with a broad base and a narrow awn, to 5 mm long; inflorescences axillary (2–6 per node), 1–3 cm long, ca. 1 cm wide, peduncles 2–10 mm long and puberulent; flowers sessile to subsessile, corolla white, tube ca. 4 mm long, lobes ca. 2 mm long; fruits ellipsoid, 8–10 mm long, dark blue, pyrenes 5–7 mm long and longitudinally ribbed. In evergreen rain forests, from Mexico and the West Indies to Bolivia.

P. grandis Sw.
Shrub or treelet, to 7 m tall; leaves obovate to oblanceolate, to 35 cm long and 14 cm wide, stipules ovate to triangular, to 25 mm long; inflorescences terminal, pyramidal panicles, to 25 cm long and 16 cm wide, with two or four (on lower nodes, 2 shorter and 2 longer) opposite branches, peduncles to 20 cm long; corolla white, tube to 4 mm long, lobes ca. 2 mm long; fruits ellipsoid to subglobose, to 7 mm long, ca. 5 mm in diameter, orange to red, pyrenes ca. 5 mm long, longitudi-

nally ribbed. In wet and evergreen forests, from Mexico to northern South America.

P. macrophylla Ruiz. & Pav., Pl. 95h
Herb or subshrub, to 1,5 m tall; leaves to 30 cm long and 14 cm wide, stipules succulent, triangular, ca. 3 mm long, slightly bilobate at the apex; inflorescences axillary, usually 1 per node, pyramidal panicles, to 15 cm long, becoming 25 cm long in fruit, peduncles to 10 cm long; flowers subsessile, corolla white, tube to 4 mm long, lobes to 2 mm long; fruits oblong, to 7 mm long, ca. 5 mm in diameter, white and aerenchymateous at maturity, pyrenes ca. 6 mm long, with 4–5 longitudinally ridges. Understory plants of wet and evergreen forests, from southern Mexico to Bolivia.

P. officinalis (Aubl.) Raeusch. ex Sandw.
Shrub or treelet, to 4 m tall; leaves to 19 cm long, stipules with a sheathy base and 2 acute lobes, separated by an angular to U-shaped sinus, ca. 5 mm long; inflorescences terminal and paniculate, to 6 cm long and 4 cm wide, lateral branches 1–2 cm long with the flowers in distal clusters of 3–6, bracts greenish-yellow lanceolate, becoming purple at fruit maturity; flowers sessile, corolla white, tube ca. 4 mm long, lobes ca. 2 mm long; fruits subglobose, to 6 mm long, becoming purple or black, pyrenes 2–3 mm long, with 4–5 ridges. In evergreen rain forests, from southern Mexico and the West Indies to the Guianas and northeastern Brazil.

P. pilosa Ruiz. & Pav., Pl. 95e
Shrub, 2–3 m tall, whole plant densely pubescent with yellowish hairs; leaves, to 28 cm long cm long and 12 cm wide, sometimes purple beneath, stipules bilobate, thickened at the base, to 15 mm long, lobes scarious distally; inflorescences terminal or axillary, pyramidal to cylindrical panicles with densely clustered flowers, to 25 cm long and 6 cm wide, peduncles 2–16 cm long, becoming pendent; flowers sessile enclosed by bracteoles, corolla white to greenish, ca. 4 mm long; fruits rounded to ellipsoid, pubescent, ca. 5 mm long, blue to violet, pyrenes 2–3 mm long, ribbed. In evergreen rain forests, from Nicaragua to Peru.

P. poeppigiana Müll. Arg., Pl. 95i,j
Shrub, 2–4 m tall, whole plant densely villous with yellowish hairs; leaves to 25 cm long and 10 cm wide, stipules with a tubular base and 2 narrow triangular awns per side (sometimes crossed), to 15 mm long; inflorescences terminal, capitate and hemispherical, heads (including bracts) 2–3 cm long and 7 cm wide, peduncles 2–10 cm long, basal bracts 2, ovate, red, to 40 mm long and broad; flowers sessile; corolla tubular, yellow, tube to 14 mm long, lobes ca. 3 mm long; fruits obovoid, fleshy, to 18 mm long, 4–8 mm in diameter, bright blue at maturity, pyrenes 3–6 mm long, longitudinally ribbed. In evergreen forests, from Mexico to Brazil and Bolivia.

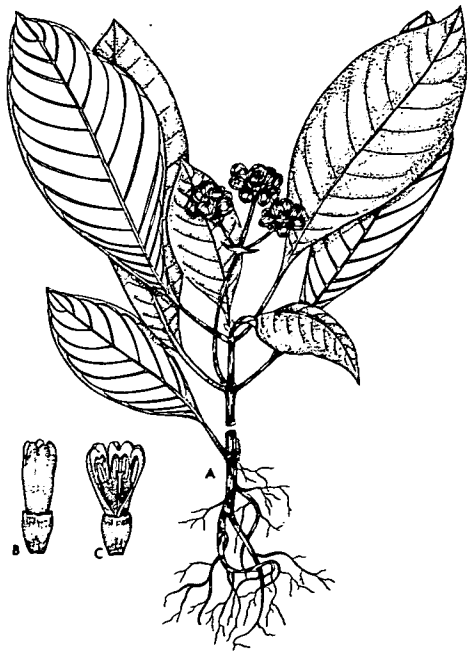
P. racemosa (Aubl.) Raeusch., Pl. 96a,b
Shrub, 1–3 m tall, younger stems puberulent; leaves to 22 cm long and 7 cm wide, tuft domatia in vein axils beneath, stipules with a tubular base and 2 narrow awns per side, ca. 20 mm long; inflorescences usually terminal, pyramidal panicles, to 9 cm long and 4 cm wide, peduncles 1–2 cm long, bracts linear, to 5 mm long; flowers sessile or subsessile, corolla salverform, ca. 4 mm long, greenish to white; fruits oblate to globose, fleshy, 4–6 mm long, purple to black at maturity, pyrenes usually 5, 3–5 mm long and dorsally ribbed. In evergreen forests, from southern Mexico to Brazil and Bolivia.

P. solitudinum Standl., Pl. 96c,d
Shrub or treelet, 2,5–6 m tall, glabrous; leaves broadly elliptic, to 25 cm long and 12 cm wide, stipules with a tubular base and 2 rounded lobes, separated by a U-shaped sinus, ca. 6 mm long; inflorescences terminal, open pyramidal panicles, to 25 cm long and 20 cm wide, with spreading lateral branches, peduncles 3–8 cm long, bracts 3–5 mm long; flowers sessile, corolla urceolate, yellow, ca. 8 mm long, with distally raised appendages; fruits subglobose, ca. 6 mm long, to 7 mm in diameter, bright blue at maturity, pyrenes with ridges. In evergreen wet forests, from southern Costa Rica to Colombia.

P. suerrensis Donn. Sm.
Shrubs, to 3 m tall; leaves elliptic to slightly ovate, to 22 cm long, to 8 cm wide, stipules with a truncate sheath (to 3 mm long) and two lateral linear lobes (to 6 mm long); inflorescences terminal, solitary, subcapitate, (hemispheric), to 4 cm long, to 5 cm wide, bracts to 3 cm long; flowers sessile, distylous, corolla tubular-funnelform, tube to 13 mm long, white to pinkish; fruits subglobose or oblong, to 5 mm long, blue to purple or black,

pyrenes smooth or with ridges. In lowland rain forests, from Honduras to central Panama.

P. uliginosa Sw., Pl. 96e
Herb or subshrub, to 1,5 m tall, glabrous; leaves to 35 cm long and 13 cm wide, stipules succulent, to 6 mm long, rounded distally; inflorescences axillary, usually 1 per node, pyramidal panicles, to 5 cm long, becoming 10 cm long in fruit, peduncles to 6 cm long; flowers sessile, corolla white, ca. 4 mm long; fruits oblong, to 10 mm long, to 8 mm in diameter, red at maturity, pyrenes ca. 8 mm long, with 1 prominent ridge and 2 thickened margins. In wet and evergreen rain forests, from southern Mexico and the West Indies to Ecuador and the Guianas.



Psychotria uliginosa.
A. Habit. B. Flower. C. Flower opened to show interior

Randia (neotrop. + subtrop. ca. 100, CR 18, GD 7)
Monoecious or sometimes dioecious shrubs, small trees or rarely lianas, occasionally with axillary or extra-axillary spines and triangular to basically tubular stipules. The leaves are opposite or often on short shoots along the main branches. The flowers are solitary or arranged in fascicles or cymes, with the calyx lobes sometimes foliaceous, and white and often fragrant corollas. The baccate, 1-2-locular fruits contain discoid seeds, embedded in a pulp.

R. gentryi Dwyer, Pl. 96f
Tree, to 5 m tall, unarmed; leaves of one node vary greatly in size, larger leaves elliptic to oblong or lanceolate, to 20 cm long and 7 cm wide, smaller leaves cordate, rounded distally and auriculate at the base, 2–3 cm long and wide, stipules sheathy, with a short tip, dark brown when dry, to 6 mm long; inflorescences axillary; flowers subsessile, calyx with numerous minute red glands outside, corolla white, carnose, tube ca. 2 cm long; fruits oblong, to 3,5 cm long and 3 cm wide, ribbed. In evergreen wet forests, from Costa Rica to Colombia.

Rondeletia (neotrop. 130, CR 14, GD 2)
Shrubs or trees, the stipules variable in shape (triangular in species of the Esquinas Rainforest), the inflorescences paniculate or thyrsoid and the flowers with expanded and often unequal calyx lobes and imbricate corolla lobes. The globose or rotund 2-locular capsules are septicidally or loculicidally dehiscent, containing numerous minute winged seeds.

R. urophylla Standl.
Shrub or treelet, to 8 m tall; leaves sometimes unequal at one node, ca. 20 cm long and 7 cm wide, stipules triangular and long acuminate, to 10 mm long; inflorescences terminal, ca. 16 cm long, to 6 cm wide, narrow thyrsoid panicles, peduncles to 6 cm long; calyx with 4 unequal lobes (2 shorter, and 2 larger), corolla tube 7–10 mm long; fruits to 4 mm long. Endemic to the Golfo Dulce region.

Rudgea (neotrop. 150, CR 9, GD 3)
Shrubs or small trees, characterized by rounded stipules with one to several distal teeth or appendages along the distal edge, short petiolate or sessile leaves and terminal, solitary and paniculate, umbellate or capitate inflorescences with white flowers. The baccate or dry fruits include 2 (rarely 1) plano-convex and 1-seeded pyrenes.

R. cornifolia (Humb. & Bonpl. ex R. & S.) Standl.
Shrub or treelet, 1,5–6(-10) m tall, nodes conspicuously thickened leaves to 15 cm long, pit domatia present at the undersides of leaves, stipules oblong or broader than long, with several stiff teeth along the truncate distal margin, to 6 mm long; inflorescences pyramidal, 3–7 cm long, 2–5 cm wide, peduncles 1–5 cm long; flowers subses-

sile, 3–5 in distal cymes, corolla white, tube 3–6 mm long; fruits ellipsoid to subglobose, fleshy, white, 6–9 mm long. In evergreen and wet rain forests, from eastern Mexico to Brazil and Bolivia.

R. raveniana W. Burger
Shrub or treelet, 1,5–6 m tall; leaves elliptic to slightly obovate, to 22 cm long and 10 cm wide, stipules united to form a collar or cap, 1–3 mm long, rarely with several apical teeth (1–2 mm long and early caducous); inflorescences terminal, paniculate-cymose, 5–7 cm long, peduncles to 30 mm long; corolla white, tube 10–14 mm long; fruits ellipsoid, ca. 20 mm long, 8 mm in diameter, persisting calyx 2–4 mm long. In evergreen forests, endemic to southern Costa Rica.

Rustia (neotrop. 15, CR 2, GD 2)
Trees with large and entire or bifid stipules and medium to large-sized leaves, sometimes with oil glands on the blade. The terminal and long paniculate inflorescences have opposite branches and bear flowers with campanulate to funnelform corollas. The capsular and subglobose to obovate fruits open loculicidally and contain many minute seeds, angular or with a marginal wing.

R. occidentalis (Benth.) Hemsl.
Shrub or treelet, 1–6 m tall; leaves oblanceolate, to 32 cm long and 11 cm wide, stipules acute, to 25 mm long; petioles usually thickened at the base; inflorescences paniculate or racemiform, 5–15 cm long, to 8 cm wide in fruit, peduncles to 3 cm long; corolla violet or pink, tube 6–9 mm long; fruits broadly obovoid to subglobose, to 12 mm long and 8 mm in diameter. In evergreen wet and rain forests, from Costa Rica to Colombia.

Sabicea (neotrop. + Africa 120, CR 2, GD 2)
Shrubs or vines with climbing and twining branches, usually with appressed or spreading hairs and the leaves opposite or verticillate. The ligulate stipules are often recurved and the axillary inflorescences bear the flowers in heads or corymbs. A further characteristic feature is the pubescence of the corolla throat as well as of the persistent calyx lobes.

Key to the species of *Sabicea*

1	Inflorescences pedunculate; flowers 8-10 mm long	*S. panamensis*
1*	Inflorescences sessile or subsessile; flowers ca. 6 mm long	*S. villosa*

S. panamensis Wernh., Pl. 96g
Vine, whole plant strigose to appressed pubescent; leaves elliptic to lanceolate, to 16 cm long, stipules to 10 mm long and 8 mm wide, often recurved, persistent; inflorescences to 4 cm in diameter, corymbose; corolla tube 6–8 mm long, white, corolla lobes 2–4 mm long; fruits globose, to 10 mm in diameter, pink to red or becoming purplish, white strigose. In evergreen forests, from Guatemala to Belize and Colombia.

S. villosa (Willd.) ex Roem & Schult., Pl. 96h
Vine, whole plant with spreading hairs; leaves elliptic to ovate to 14 cm long, stipules to 10 mm long and 8 mm wide, often recurved, persistent; inflorescences capitate, to 2 cm in diameter; flowers sessile, corolla tube 4–6 mm long, white; fruits globose, to10 mm in diameter, pink to red, villous with yellowish hairs. In evergreen rain forests, from southern Mexico and the West Indies to Brazil and Peru.

Simira (neotrop. + Africa 35, CR 1, GD 1)
Trees or shrubs with the wood often turning red or purple when exposed to air, recognizable also for the triangular, often basically glandular stipules and the leaves having a truncate base and often a slightly lobed tip. Paniculate or congested and capitate inflorescences bear many fragrant flowers with sagittate anthers. The usually globose, woody and 2-locular capsules split into 4 valves, each of them contain numerous seeds with a membranaceous marginal wing.

S. maxonii (Standl.) Steyerm., Pl. 97a,b
Trees, to 20 m tall, cut wood often turning pink; stipules triangular, to 4,5 cm long; petioles 3–15 mm long, leaves to 65 cm long and 40 cm wide, sometimes lobed distally, base rounded to slightly auriculate, secondary veins 12–18/side; inflorescences much-branched panicles, 6–20 cm long, to 16 cm wide; calyx to 3 mm long, lobes with a cil-

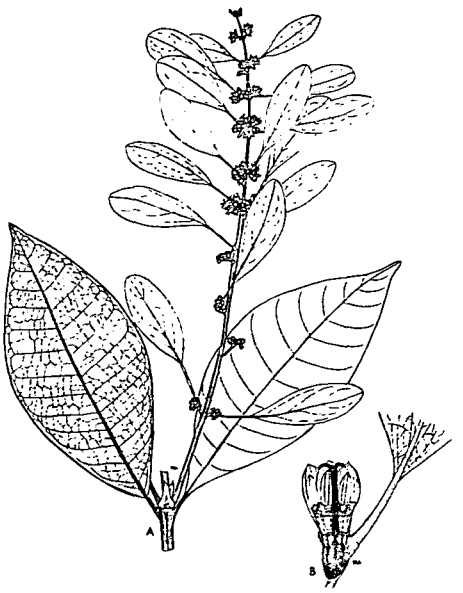
iolate margin, corolla cream, greenish or yellow to orange, tube ca. 5 mm long, lobes ca. 3 mm long, filaments pubescent and expanded at the base, anthers purplish; fruits globose or oblong, 5–9 cm in diameter, thick-walled and lignose, seeds 12 to 25 mm long. In evergreen rain forects, from southern Nicaragua to central Panama.

Spermacoce (neotrop. + subtrop. 150, CR 12, GD 3)
Herbs or subshrubs with quadrangular stems and characteristic, basically fused stipules with several unequal awns. The axillary or terminal inflorescences bear monomorphic or distylous flowers with valvate white or lavender corolla lobes. The capsular fruits split into 2 cocci (both or only one of them dehiscing adaxially) and expose 2 seeds with a longitudinal ventral sulcus.

S. assurgens Ruiz & Pav.
Herb, to 80 cm tall, stems sometimes with ridges; leaves lanceolate, to 7 cm long and 3 cm wide, stipules with a basal sheath and several unequal awns, to 6 mm long; inflorescences axillary or terminal, 3–12 mm long and broad, sessile or subsessile with the flowers densely crowded, bracts leaf-like and 1–5 mm long; corolla white, tube ca. 2 mm long; fruits ellipsoid, ca. 2 mm long. In evergreen and partly deciduous weedy areas, throughout tropical and subtropical regions worldwide.

Warszewiczia (neotrop. 4, CR 1, GD 1)
Trees or shrubs with decussate or sometimes verticillate leaves. The flowers are arranged in cymes, along an elongated central axis of the terminal or axillary racemiform inflorescences. Sometimes one calyx lobe of a flower cluster is colored and expanded. The woody 2-valved capsules contain many seeds with a narrow margin around the edge.

W. coccinea (Vahl) Klotzsch, Pl. 97c,d
Shrubs or trees, to 12 m tall, branches minutely puberulent to pilose; leaves to 55 cm long and 20 cm wide, stipules triangular to lanceolate, to 4,5 cm long; inflorescences racemiform 20–80 cm long, with cymose flower clusters opposite or subopposite along the central rhachis; calyx lobes to 1 mm long, except for one large, foliaceous, long stipitate and bright red sepal lobe per flower cluster, corolla orange, tube 3–5 mm long; fruits 3–5 mm long, subglobose, septicidally dehiscent, seeds to 1 mm long. In evergreen lowland forests in secondary growth or light gaps, from southern Nicaragua to Peru and Bolivia.



Warszewiczia coccinea
A. Habit. B. Flower opened to show interior

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Rutaceae

A family consisting of trees, shrubs and rarely herbs, always with aromatic odor, originating from numerous glands with essential oils, which are almost visible in the pellucid punctations of the leaves. **Leaves** of various shape, alternate or opposite, rarely simple, mostly unifoliolate, trifoliolate or imparipinnately compound, lacking stipules, margin entire or serrate; **inflorescences** axillary or terminal, often cymose, but also panicles, racemes or spikes; **flowers** bisexual or unisexual, then plants monoecious or dioecious, usually 3-5-merous, perianth free or connate, intrastaminal disk present, stamens as many, or twice as many as the petals, sometimes numerous with free or connate filaments, ovary superior, of (1-) several free or variously connate carpels; **fruits** capsules, drupes, berries, samaras, or consisting of (1-) 2-5 (-several) follicles. Distributed throughout the world, with emphasis on the temperate and tropical regions of the southern hemisphere. Cosmopol. 153/1800, CR 19/44, GD 8/12.

Edible fruits are found in several species of the genus *Citrus*, which are cultivated throughout the world.

Key to the genera (based on JIMÉNEZ, in prep.)

1	Leaves simple and opposite	*Ravenia*
1*	Leaves compound, alternate or opposite	2
2	Leaves opposite, sometimes subopposite, trifoliolate or imparipinnate compound	*Amyris* p.p.
2*	Leaves alternate	3
3	Leaves generally unifoliolate	4
4	Fruits drupaceous or baccate; flowers solitary, in racemes or in small axillary cymes; leaf blade up to 20 cm long	5
5	Fruits ovoid to oblong drupes, 1,6-2,4 cm long; inflorescences axillary cymes, 1,5-3,5 cm long	*Stauranthus*
5*	Fruits globose or pyriform berries, generally larger than 4 cm in diameter; flowers axillary, solitary, 2-5 cm in diameter	*Citrus*
4*	Fruits capsular; inflorescences axillary or terminal panicles; leaf blade more than 25 cm long	*Conchocarpus*
3*	Leaves trifoliolate or pinnately compound	6
6	Leaves pinnately compound	7
7	Leaves usually imparipinnate; fruits consisting of 1-5 follicles	*Zanthoxylum*
7*	Leaves paripinnate; fruits fleshy red berries	*Murraya*
6*	Leaves trifoliolate	8
8	Fruits ellipsoid to subglobose drupes	*Amyris* p.p.
8*	Fruits capsular	*Galipea*

Amyris (neotrop. 40, CR 5, GD 1)

Trees or shrubs, with opposite or alternate, unifoliolate to imparipinnate compound leaves. Characteristics of the genus are the drupaceous, indehiscent fruits and the minute, white to yellowish-white flowers.

A. brenesii Standl.

Tree or shrub, up to 3 m tall, glabrate; leaves subopposite to alternate, 3-foliolate, leaflets elliptic to oblong elliptic, 15-21 cm long, 5,5-10,5 cm wide; inflorescences paniculate, ca. 5 cm long; fruits ovoid, 1,5-2 cm long, seed 1. From Nicaragua to Costa Rica.

Citrus (paleotrop. ca. 20, CR 4, GD 1)
A worldwide cultivated genus of shrubs and small trees native to tropical Asia, with a large number of varieties. It is well characterized by the possession of axillary spines, as well as by the unifoliolate leaves, having a more or less winged petiole.
C. sinensis (L.) Osbeck
Common name (Latin America): naranja
Shrub or tree, up to 8 m tall; axillary spines 2-3 mm long; leaflets 3,3-9 cm long, with crenulate margin; flowers solitary, calyx 5-lobate, stamens numerous; fruits globose, flattened or depressed apically, yellow, green to orange, up to 12 cm in diameter, with sweet, edible endocarp. Native to northern Burma, southeastern China and Indo-China, this species is now also cultivated throughout the Neotropics.

Conchocarpus (neotrop. 45, CR 1, GD 1)
Small trees or shrubs with entire, glabrous, unifoliolate or palmately compound leaves. The greenish or whitish flowers are arranged in terminal thyrses or dichasia.
C. guyanensis (Pulle) Kallunki & Pirani, Pl. 97e
(syn.: *Ticorea unifoliolata* T. S. Elias)
Tree, up to 10 m tall; leaves unifoliolate, ovate-elliptic, 7-25,5 cm long, 3,5-12 cm wide, inflorescences usually terminal, corymbiform, up to 30 cm long; flowers cream to light-green; fruits capsules of 1-5 mericarps, oblong to reniform, 1,8-2,2 cm long, 1,2-1,5 cm wide. From Nicaragua to Colombia.

Zanthoxylum (pantrop. ca.250, CR 15, GD 5)
The largest genus of the *Rutaceae* and rather heterogeneous, consisting of trees and shrubs with usually pinnate compound leaves and often with spines or prickles on the branches and the trunk.
Z. acuminatum (Sw.) Sw.
(syn. *Z. juniperum* Poepp.)
Common names (Costa Rica): lagarto, lagartillo (JIMÉNEZ, in prep.).
Tree, up to 25 m tall; leaves usually paripinnate, with 3-6 pairs of opposite leaflets; inflorescences terminal, paniculate or corymbose; flowers white, petals 3; fruits of several globose follicles. Widely distributed in lowland and montane rainforests, from Mexico to South America.
Z. ekmanii (Urb.) Alain, Pl. 97f
Common names (Costa Rica): lagarto amarillo, lagarto (JIMÉNEZ in prep.).
Tree, up to 30 m tall; leaves imparipinnate, with 5-11 leaflets, with conspicuous stellate hairs beneath; inflorescences terminal, paniculate, up 30 cm long; flowers small, greenish to yellowish; fruits of several follicles, 5 mm wide. Widely distributed in lowland and montane rainforests, from Mexico to South America.

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Sabiaceae

A small family of trees, shrubs and a few lianas, vegetatively variable and without distinct characteristics, which are distinguishable from other families by the unusual position of the petals and stamens, which stand opposite the sepals. **Leaves** alternate to subopposite, simple to pinnately compound and often with variable number and arrangement of leaflets, margin entire to serrate, stipules lacking; **inflo-**

rescences terminal, axillary, ramiflorous or cauliflorous, paniculate, racemose to cymose; **flowers** bisexual or sometimes unisexual, then plants monoecious, small, zygomorphic, sepals 3-5, persistent, petals (4-)5 (-6), two smaller and two larger ones, stamens 5, only two of them fertile, inserted at the base of the petals, disk usually present, ovary superior, 2-locular; **fruits** drupes, usually persistent for a long time after maturity, seed 1. Distributed disjunctly between tropical Southeast Asia and tropical America, usually in montane areas. Pantrop. 3/80, CR 1/14, GD 1/6.

Little is known about pollination in Sabiaceae. BEUSEKOM (1971) mentions, without further explanation, that *Meliosma* is probably self-pollinated.
A few Asian species of *Meliosma* are cultivated as ornamentals (GENTRY 1980).

Meliosma (pantrop. 55, CR 14, GD 6)
Trees and shrubs, usually with alternate and simple leaves, with dentate margins and mostly with thickened petiole bases, often clustered at the twig apices. The usually ramiflorous inflorescences are of pyramidal shape, bearing numerous inconspicuous flowers.

M. allenii Standl. & L.O. Williams
Tree, up to 15 m tall, young branchlets sparsely appressed puberulous; leaves alternate, entire, oblong-elliptic to oblong-obovate, 13-33 cm long, 3,5-14 cm wide, glabrous; inflorescences axillary, pyramidal-paniculate, with several flowers clustered in fascicles; flowers sessile, petals 1,5-1,8 mm long, greenish-yellow to yellow-orange; fruits obovoid-globose, ca. 2 cm long, 1,5-2 cm in diameter. Endemic to the Golfo Dulce region and adjacent Panama.

M. grandiflora C.V. Morton ex A.H. Gentry
Tree, 10 m tall, branchlets glabrous; leaves alternate, entire, oblong-elliptic to obovate-elliptic, 5-13 cm long, 2-4,7 cm wide, glabrous; inflorescences axillary, paniculate, 8-13 cm long, with several flowers; flowers relatively large, pedicel 1,5-3 mm long, petals 5-6 mm long, white to orange; fruits obovoid to pyriform, 2-2,5 cm long. Usually in montane areas, from Costa Rica to Panama.

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Sapindaceae

This is one of the most important tropical liana families, although it also contains trees, shrubs and a few herbs. The climbing genera are easily recognizable by the usually forked and coiled tendrils and sometimes by the presence of milky latex. **Leaves** alternate to opposite or subopposite (except the alternate-leafed *Matayba apetala*) simple or variously compound, stipules present or absent; **inflorescences** paniculate or racemose; flowers densely packed on the inflorescences, usually small, mostly zygomorphic, sometimes dioecious, sepals 4-5, petals 0-5, usually with appendages inside, stamens (5-)8(-10), ovary superior, (1-)3(-4)-locular; **fruits** capsular or drupaceous, sometimes baccate, indehiscent or variously dehiscent, often consisting of 2-3 samaras, seeds globose, frequently arillate. Distributed in various habitats in the tropical and subtropical regions worldwide, but most prominent in the Old World. Pantrop. + subtrop. 131/1450, CR 22/105, GD 10/29.

The family is divided into two subfamilies: Sapindoideae, characterized by one ovule per locule, and Dodonaeoideae, with 2-several ovules per locule.
The fruits of several Sapindaceae are of commercial interest. The fruits of some species of *Sapindus* are used for making soap. The Old World species *Litchi chinensis* and *Nephelium lappaceum*, as well as the

New World species *Blighia sapida,* have edible fruits, although the latter must be handled with caution because it can be fatal if consumed unripe or overripe. The seeds of *Paullinia cupana*, a liana of the Brazilian and Venezuelan Amazon, known as guaraná, contain 4 % caffeine. They are used for soft-drinks or alcoholic beverages. The crushed stems of some species of *Paullinia* and *Serjania* are locally used in the New World tropics as a barbasco or fish poison.

Key to the genera (based on CROAT 1976)

1	Plants scandent, commonly bearing tendrils	2
2	Fruit a samara, usually three together, with terminal or basal wings	3
3	Seed bearing part of the fruit positioned at the apex of the samara; leaves with 3-many leaflets; flowers slightly irregular	*Serjania*
3*	Seed bearing part of the fruit positioned at the base of the samara; leaves with 3 leaflets; flowers regular	*Thinouia*
2*	Fruit not a samara, often alate dorsally	4
4	Fruit a thick walled capsule; seeds subtended by an aril; stems ligneous even above	*Paullinia*
4*	Fruit membranaceous; seeds never arillate, stems herbaceous above	*Cardiospermum*
1*	Plants erect, never bearing tendrils, milky latex absent	5
5	Leaves bipinnate, with numerous small leaflets	*Dilodendron*
5*	Leaves once-pinnate, sometimes with only 2 or 3 leaflets	6
6	Leaves 3-foliolate with a terminal leaflet; sepals 4; persistent style eccentric on the fruit	*Allophylus*
6*	Leaves with several leaflets, usually without a terminal leaflet; sepals or calyx lobes usually 5; persistent style terminal or subterminal on the fruit	7
7	Fruit indehiscent, baccate	*Talisia*
7*	Fruit dehiscent, capsular	8
8	Sepals united	*Matayba*
8*	Sepals distinct	9
9	Sepals not petaloid, seeds arillate	*Cupania*
9*	Sepals petaloid, seeds exarillate	*Vouarana*

Allophylus (pantrop. + subtrop. c. 190, CR 4, GD 3)
Small trees and shrebs with entire or serrate trifoliolate leaves and characteristic racemose inflorescences.

A. cominia (L.) Sw.
Tree or sometimes shrub, up to 20 m tall; leaflets elliptic, lanceolate-elliptic to obovate, 6-20 cm long, 4-8 cm wide, pubescent along the veins above, densely pubescent beneath; inflorescences paniculate; fruits 5-7 mm in diameter. In very wet forests, from Mexico to Costa Rica.

Cupania (neotrop. ca. 45, CR 10, GD 3)
Shrubs and trees with even- or odd-pinnate leaves, usually with serrate leaflets, but sometimes entire and then distinguishable from the somewhat similar *Matayba* only in fertile condition by the distinct sepals.

C. rufescens Triana & Planch., Pl. 97g
Tree or shrub, up to 11(-15) m tall, glabrate; leaves with 3-11 leaflets, leaflets 3-12 cm long, 1,5-4,5 cm wide, subentire to dentate, glabrous above, velutinous beneath; inflorescences axillary or terminal, paniculate-racemose; flowers white to cream; capsules 3-lobate, 1,2-1,6 cm long, 1,8-2,2 cm wide, short stipitate. In wet forests, from Mexico to Venezuela and Brazil.

Matayba (neotrop. ca. 45, CR 7, GD 2)
Shrubs and trees with even-pinnate leaves and entire leaflets that are further characterized by 5-merous flowers with connate sepals and 1-3-lobate capsular fruits.

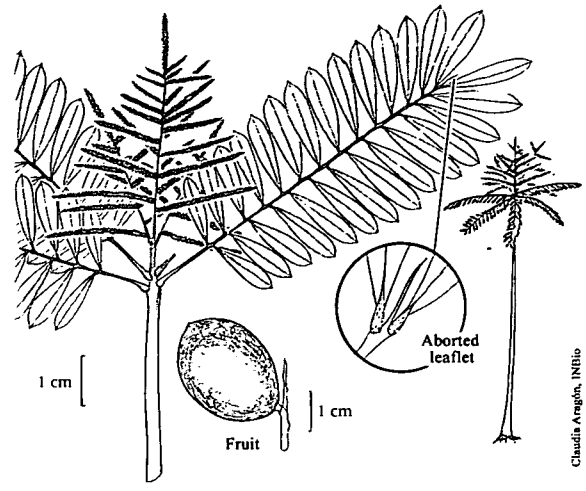
M. oppositifolia (A.Rich.) Britton
Large shrub, up to 12 m tall; leaves subopposite with 4-10 sessile, glabrous leaflets; inflorescences axillary, paniculate, with numerous small flowers; capsule ca. 1 cm long, bi- trilobate. In moist or wet forests or thickets, from Guatemala to Costa Rica, also in Cuba and Puerto Rico.

Paullinia (neotrop. 194, CR 33, GD 13), Pl. 97h
A large genus consisting only of woody vines, showing all of the features which characterizes the sapindaceous lianas. Distinct in fruit by its coriaceous, 3-valved capsule containing 1-3 arillate seeds.

P. serjaniifolia Triana & Planch.
Leaves 8-30 cm long, bipinnately compound, usually with 11 leaflets, the rhachis sometimes winged; inflorescences racemose, frequently borne on leafless nodes just below the leaves, sometimes axillary; flowers white, nearly glabrous; capsules globose, 2-3 cm long, 2,5-3,3 cm wide, red, broadly 3-winged with 1 basally arillate, shiny black seed. In wet and moist forests, from Costa Rica to Colombia.

Talisia (neotrop. 40, CR 2, GD 2)
A quite variable genus of large shrubs and trees with pinnately compound leaves and indehiscent baccate fruits, which are usually 1-seeded by abortion.

T. allenii Croat
Shrubs or slender tree, up to 10 m tall; leaves up to 1 m long, with 10-14 leaflets and with the petioles and petioluli pulvinate at the base; inflorescences terminal or subterminal; flowers white; fruits narrowly ovoid, 2-2,8 cm long, 1,2-1,8 cm wide. In moist forests in Costa Rica and Panama.



Talisia allenii

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Sapotaceae

Woody plants, often canopy trees or emergents (40-45 m height), but also small trees or shrubs. Characteristic features of the family are the indumentum of malpighious hairs, present in all but one (*Delpydora*) genera and the usually white, slow-flowing milky latex, which is at least present in the twigs, petioles or fruits. **Leaves** alternate, often spirally arranged, rarely opposite, often clustered at the twig ends, always simple with entire margin (except the serrate margined spp.: *Chrysophyllum imperiale* and *C. subspinosum*), stipules lacking or sometimes present (*Chromolucuma*), but then mostly small and early caducous; **inflorescences** usually fascicles of small pedicellate flowers, often arising at the twig ends just below the leaves; **flowers** always actinomorphic, bisexual or sometimes unisexual, then plants usu-

ally dioecious, calyx in one or two whorls, stamens opposite the corolla lobes, staminodes often present; **fruits** typically 1-many-seeded berries, with a fleshy or dry pericarp. Predominantly plants of moist lowland forest below 1000 m alt., but also represented in semi-arid zones. Pantrop. 53/c. 1100, CR 10/63, GD 9/41.

The *Sapotaceae* are subdivided into 5 tribes: the Mimusoideae (Paleotropics except for *Manilkara* with several species in South America), the Isonandreae (Asia and the Pacific Islands), the Sideroxyleae (pantropics), the Chrysophylleae (pantropics, but predominantely neotropical), and the small tribe Omphalocarpeae (ocurring in Africa, Madagascar and Papua-New Guinea) (PENNINGTON 1991).
Several species, especially those with the "*Manilkara*-type" flower, as well as some species of *Madhuca,* are possibly bat-pollinated. Others with tubular flowers and included stamens (e.g., *Pouteria*) attract bees and other small insects (PENNINGTON 1990), but detailed pollination studies within this family are still lacking.

Key to the genera (based on PENNINGTON 1990)

1	Calyx of two whorls of usually 3 sepals	*Manilkara*
1*	Calyx of a single whorl of 4-6 sepals, sometimes spirally arranged; if in two whorls, then 2+2	2
2	Corolla lobes often divided into 3 segments; stamens exserted; staminodes present, well developed; seed nearly always with basal or basi-ventral scar	*Sideroxylon*
2*	Corolla lobes simple; stamens included or exserted; staminodes present, but poorly developed, or absent; seed with adaxial scar (sometimes extending around the base)	3
3	Stipules present, well developed, leaving a conspicuous scar	*Chromolucuma*
3*	Stipules absent (minute stipules present in *Pouteria congestifolia*)	4
4	Staminodes present, as many as the corolla lobes	5
5	Leaves usually alternate and distichous, secondary and tertiary venation often closely parallel, hence leaf appearing finely striate	*Micropholis*
5*	Leaves usually spirally arranged, venation not closely parallel and leaves never finely striate	6
6	Leaves spirally arranged, corolla and staminodes not carnose, stamens nearly always included, stamens and staminodes not inflexed against the style	*Pouteria* p.p.
6*	Leaves alternate and distichous or weakly spirally arranged, corolla tube and staminodes carnose, stamens exserted, stamens and staminodes strongly inflexed	*Sarcaulus*
4*	Staminodes fewer than the corolla lobes or absent	7
7	Corolla rotate or broadly cyathiform, stamens exserted	8
8	Leaves spirally arranged, usually minute punctate beneath; inflorescence mostly axillary	*Elaeoluma*
8*	Leaves often opposite or verticillate, not punctate; usually cauliflorous or ramiflorous	*Pradosia*
7*	Corolla tubular, campanulate or globose, stamens included	9
9	Ovary usually 2-locular, embryo with plano-convex cotyledons and included radicle, endosperm absent	*Pouteria* p.p.
9*	Ovary usually 5-locular, embryo with thin foliaceous cotyledons, radicle exserted, copious endosperm	*Chrysophyllum*

Chromolucuma (neotrop. 2, CR 2, GD 2)
Monoecious or dioecious trees, very distinct in the yellow latex and the rather large, persistent stipules. The large, spirally arranged leaves having thickened petiole bases.

C. rubriflora Ducke
Tree; leaves clustered, oblanceolate, 23-45 cm long, 7,8-15 cm wide, glabrous, secondary veins parallel, stipules narrowly lanceolate, 2-4 cm long; inflorescences fasciculate, many-flowered; flowers unisexual, plants monoecious, calyx orange, corolla ca. 5 mm long, white; fruits broadly ellipsoid, 4-8 cm long, ferruginous brown, seed 1. From Costa Rica to Colombia, Venezuela and Amazonian Brazil.

Elaeoluma (neotrop. 4, CR 1, GD 1)
Trees and shrubs with spirally arranged leaves that are characteristically minutely punctate beneath. The fruit is a one-seeded berry, the radicule well exserted. The genus consists of four species with one species extending into Central America.

E. glabrescens (Mart. & Eichl.) Aubrév.
Tree, young shoots, lower leaf surface and inflorescence usually subglabrous; flowers in 3-25-flowered fascicles, axillary and below the leaves, tubular, white to yellowish, with 5 petal lobes; fruit 2-4 cm long, glabrous. Commonly growing along riversides and in periodically or permanently flooded forest, occasionally in white sand savanna, from Costa Rica to Amazonian Peru and Brazil to Mato Grosso and Goiás.

Manilkara (pantrop. 38, CR 3, GD 2)
Large trees with spirally arranged leaves with straight parallel secondary and tertiary venation that are clustered at the shoot apex. The genus is further characterized by the calyx consisting of two whorls of usually 3 sepals, as well as usually 6 corolla lobes and stamens.

M. zapota (L.) Royen
Common name (Costa Rica): chico, chico zapote (PENNINGTON 1990).
Tree; leaves elliptic to oblong-elliptic, lacking stipules; flowers solitary, tubular with 6 petal lobes; fruit an ovoid berry with sweet pericarp. This species is widely cultivated throughout the Neotropics for its edible fruit. Its origin is still uncertain, although it is believed to be natively distributed from Mexico to Nicaragua (PENNINGTON 1990).

Micropholis (neotrop. 38, CR 3, GD 3)
Trees or shrubs, lacking stipules and with conspicuous fine and strongly parallel venation. The flowers are always (4-) 5-merous and are arranged in axillary or ramiflorous fascicles.

M. melinoniana Pierre, Pl. 98a
Tree to 40 m tall, with large buttresses; leaves alternate and distichous, oblong or elliptic, flowers unisexual, greenish white to cream; fruit 4-7 cm long, broadly ellipsoid, yellow, orange, reddish or purple. In lowland tropical rain forest and seasonal semi-evergreen forest, from southern Mexico to Amazonian Ecuador, Peru and Brazil. The fruits are edible and the wood is locally used for construction and railway sleepers (PENNINGTON 1990).

Pouteria (pantrop. ca. 325, CR 36, GD 24)
The largest genus of the Sapotaceae and very heterogeneous, characterized vegetatively by the mostly spirally arranged leaves, lacking stipules (except in *P. congestifolia*) and the slightly swollen lower part of the petiole (although this feature is often very inconspicuous). The frequently unisexual flowers are arranged in axillary or ramiflorous fascicles.

P. torta (Mart.) Radlk., Pl. 98b,c
Common name (Costa Rica): zapote de monte, zapotillo (PENNINGTON 1990).
Tree, leaves oblanceolate, glabrous above, pubescent, tomentose or glabrous beneath, clustered at the twig ends; fascicles clustered below the leaves, flowers bisexual, 4-merous; fruit 3-7 cm long, ellipsoid, ovoid or globose. Distributed throughout the Neotropics, from Mexico (Veracruz) to Paraguay.
In our area *P. torta* is represented by two of the four subspecies. These are always characterized by verrucose fruits, which are densely covered with hairy projections (spines).

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Scrophulariaceae

Annual, biennial or perennial herbs, vines or shrubs, some genera hemiparasitic and also few holoparasites. **Leaves** opposite, alternate, whorled or sometimes all basal, entire to pinnately or palmately lobed or compound, stipules lacking; **inflorescences** spicate, racemose, thyrsoid-paniculate, or the flowers solitary or fascicled in the leaf axils, bracts foliaceous to reduced; **flowers** bisexual, usually 5-merous or often 4-merous by reduction, bilabiate, sometimes nearly regular,,sepals (1-2)-4-5, persistent, distinct or variously united, regular or irregular, petals 4-5, united, corolla often bilabiate, tubular, campanulate, or sometimes rotate, sometimes spurred or saccate, stamens commonly 2-4, rarely 5 (*Capraria*), epipetalous, rarely appearing basal, alternate with the corolla lobes, sometimes some of the fertile stamens reduced to staminodes, ovary superior, 2-locular; **fruits** capsules, septicidally and/or loculicidally dehiscent (4-valved), sometimes opening by pores or irregularly bursting apically. Cosmopol. 268/5100, CR 34/79, GD 5/7.

The Scrophulariaceae display a great diversity in flower shape and color, which reflects the wide range of pollinators within the family. The flowers usually provide nectar as a reward. Pollinators include bees, wasps, flies, moths, butterflies and hummingbirds (KAMPNY 1995). Besides cross-pollination, self-pollination occurs, such as in the naturalized species *Matisia japonica* (KIMATA 1977).

Scoparia dulcis is used in a medicinal tea and as a broom to repel flies.

Key to the genera

1	Lianas or scandent shrubs, usually hemiepiphytic; fruits berries	*Schlegelia*
1*	Herbs or shrubs, not scandent; fruits capsules	
2	Lower leaves alternate	*Capraria*
2*	Lower leaves opposite, verticillate, or rosulate	2
3	Calyx lobes fused, often ribbed	*Mazus*
3*	Calyx lobes free to near the base, not ribbed	3
4	Flowers red, tubular; capsule filled with hair-like fragments; stems ridged	*Russelia*
4*	Flowers white; capsules without fragments; stems terete to 4-angled	*Scoparia*

Capraria (neotrop. 5, CR 1, GD 1)
Perennial herbs or low shrubs, most species are abundantly pubescent.

C. biflora L.
Erect herb, branched, 1 m tall or less, pubescent; leaves alternate, sessile, lanceolate, serrate, 3-11,5 cm long, 6-20 mm wide; flowers in fascicles of 2-4 in the leaf axils, pedicellate, sepals 5, narrow, subequal, petals 5-lobate, corolla 8-11 mm long, white, stamens 4-5; capsules loculicidally dehiscent 4-6 mm long. From the southern USA to Brazil.
This species is difficult to recognize as a scroph, because of the alternate leaves and the white, radially symmetrical flowers with 5 stamens.

Mazus (paleotrop. 10-15, CR 2, GD 1)
Mostly low herbs with opposite leaves, the upper ones being alternate. The corolla tube is short or elongate, with 4 stamens. The only neotropical species is naturalized from Asia.

M. japonicus (Thunb.) Kuntze
Herb, 10 cm tall or less; leaves mostly basal, petiolate, obovate, crenulate; flowers small, pink or violet, racemose, calyx deeply lobate, 4 mm long. Native to Asia, but naturalized in grassy places in the Neotropics.

Russelia (neotrop. 52, CR 2, GD 1)
Perennial herbs with tubular corolla and with 5 stamens.

R. sarmentosa Jacq., Pl. 98d,e
Herb, erect, up to 2 m tall, glabrous or somewhat pubescent, the branches 4-angulate; leaves opposite or ternate, ovate, 1,5-8 cm long, 1-5 cm wide, dentate or crenate; inflorescences axillary cymes; pedicels 5-8 mm long, corolla 10-15 mm long; capsules 3-4 mm long. From Cuba and Mexico to Colombia.

Schlegelia (neotrop. 12, CR 5, GD 3)
Usually epiphytic vines or scandent shrubs, climbing appressed against tree trunks, with opposite leaves and characteristic small pseudostipules.
The genus was formerly included in the Bignoniaceae and is now treated in some recent publications as its own family, Schlegeliaceae (REVEAL 1995).

S. parviflora (Oerst.) Monach., Pl. 98f
Woody vine leaves simple, obovate to elliptic-obovate, 11,2-19,5 cm long, 4,8-14,7 cm wide; inflorescences axillary, paniculate, ± contracted, to almost fasciculate, few- to many-flowered; calyx cupulate, persistent, flowers 1-1,2 cm long, white or cream, flushed with pink; fruits fleshy berries, 0,9-1,1 cm in diameter, glabrous. From Belize and Guatemala to Venezuela, Peru and Brazil.

Scoparia (neotrop. 20, CR 1, GD 1)
Annual herbs or low shrubs with almost rotate corollas with 4 stamens.

S. dulcis L.
Erect herb, up to 1 m tall, densely branched, nearly glabrous; leaves sessile, ovate or lanceolate, 10-25 mm long and 3-7 mm wide, dentate; flowers 1-2 in axils of upper leaves, pedicellate, very small, sepals 4, corolla white, 5-6 mm in diameter; capsules globose, 3-4 mm in diameter. Abundant in dwellings and in waste grounds throughout the tropics, in the Neotropics, distributed from the southern US to Paraguay and southern Brazil.

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Simaroubaceae

Trees and shrubs, easily recognized by the bitter tasting sap inside the bark, which is often used medicinally. **Leaves** usually alternate, pinnately compound, sometimes simple, entire, stipules lacking; **inflorescences** terminal, axillary or sometimes cauliflorous, racemes spikes or panicles or rarely flowers solitary; **flowers** bisexual or unisexual (then plants mostly dioecious), 3-5(-8)-merous, sepals connate, petals free, stamens same number or twice as many as the petals, epipetal, free, intrastaminal disk usually present, sometimes elongated into a gynophore, ovary superior, 2-5-locular; **fruits** drupes, samaras or berries, sometimes schizocarps, syncarpous or apocarpous, seeds several. Mostly in the tropics worldwide, but several species also in more temperate zones. Pantrop. 13/110, CR 7/14, GD 5/7.

Although the Simaroubaceae were recently split by segregating the Picramniaceae (FERNANDO & QUINN 1995, FERNANDO et al. 1995), the family, is treated here in its broad sense.

The main center of distribution is tropical America, with further distribution centers in Africa (incl. Madagascar) and Asia, Malesia and the Australia-Pacific region (FERNANDO & QUINN 1992).

The wood of *Quassia amara* is used against stomach diseases and as an insecticide (NOOTEBOOM 1962).

Key to the genera (based on CRONQUIST 1944 and PORTER 1973)

1	Leaf petiole and rhachis broadly and conspicuously winged	*Quassia*
1*	Leaf petiole and rhachis inconspicuously winged or unwinged	2
2	Flowers perfect	3
2*	Flowers unisexual	4
3	Leaflets 20-36	*Simaba*
3*	Leaflets usually 5-9, but always less than 20, or leaves simple	*Recchia*

4 Inflorescences widely-branching panicles, stamens or staminodes 10; drupes 1-3 per flower, 1-seeded *Simarouba*

4* Inflorescences simple spike-like racemes, rarely once-branched basally; stamens or staminodes 3-5, or absent; berries 1 per flower, 1-3 seeded *Picramnia*

Picramnia (neotrop. 45, CR 6, GD 2)
Dioecious trees or shrubs with pinnately compound leaves with 6-20 leaflets and characteristic cylindrical pulvinuli. The inflorescence is a long raceme or panicle, bearing numerous flowers.

P. antidesma Sw.
Shrub or small tree, up to 6(-10) m tall; leaflets 8-13, ovate to elliptic, terminal leaflet largest, 7,5-13,5 cm long, 3-6 cm wide, basal leaflets smallest, 3,4-7(-7,5) cm long, 2-5(-6) cm wide, glabrous above, puberulent to glabrate beneath, rhachis 12-23 cm long, puberulent to glabrate; inflorescences terminal to subterminal, racemose or few-branched near base, pendent, with 25-100 glomerules of flowers; sepals and petals 3-4, stramineous to golden-brown, staminodia present in the female flowers; fruits berries, 10-15 mm long, 6-10 mm wide, dark red to black when mature. From southern Mexico to Colombia and Peru.

Quassia (pantrop. 40, CR 1, GD 1)
Trees and shrubs with imparipinnate leaves, usually with pitted glands along the leaf margins and a conspicuously winged rhachis. The fruits are 1-5 sometimes woody, often more or less compressed drupes.

Q. amara L., Pl. 98g-i
Shrub, up to 3 m tall, with very bitter taste; leaves imparipinnate, leaflets usually 5, ovate-oblong, usually sessile, rhachis broadly winged; inflorescences racemose, 10-25 cm long, often branched, calyx bright red, petals bright red outside, whitish inside, fruits of 1-5 drupes, 12-13 mm long, purple-black. From the southern USA to Colombia and Venezuela, sometimes cultivated in the Old World.

Simaba (pantrop. ca. 30, CR 2, GD 1)
Trees or treelets with even pinnate leaves with (1-) 4-40 leaflets. The inflorescences are usually large, terminal or axillary panicles, bearing bisexual flowers.

S. cedron Planch., Pl. 98j
Common name (Costa Rica): cedrón
Small pachycaul treelet, up to 6 m tall, trunk unbranched with a cluster of large leaves at the top; leaves oblong, 1-2 m long, leaflets 20-36, oblong to oblong-lanceolate, glandular tipped, subsessile; inflorescences terminal, paniculate, 1-2 m long, brownish-tomentose; flowers greenish; fruits drupaceous, 5-8 cm long, yellow when mature. From Costa Rica to Bolivia and Brazil.

Simarouba (neotrop. ca. 6, CR 2, GD 1)
Dioecious trees and shrubs, characterized by coriaceous, even or odd pinnate leaves and unisexual, 4-5-merous flowers.

S. amara Aubl.
Common name (Costa Rica): aceituno (HOLDRIDGE et al. 1997).
Tree, up to 35 m tall, dioecious; leaves pinnately compound, with oblong-elliptic leaflets, glabrous; inflorescences terminal panicles, ca. 30 cm long; flowers unisexual, green, 5-merous, male flowers 4-5 mm long, stamens 10, female flowers 3-3,5 mm long, staminodia present; fruits of 3-5 drupes, up to 17 mm long, red-orange to black. In lowland to submontane tropical wet forests, from Guatemala to Brazil.

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Solanaceae

Herbs, shrubs, trees and lianas (often prickly), non-laticiferous and without colored juice, resinous or not-resinous. **Leaves** alternate, opposite or mixed (usually alternate below, but often becoming opposite towards the inflorescence), sometimes modified into spines, simple, or compound, lamina dissected or entire, pinnately veined; **inflorescences** axillary, terminal, or sometimes leaf-opposed; **flowers** small to medium-sized, actinomorphic to very irregular, flowers mostly (4–)5-merous, sepals (4–)5(–7), petals (4–)5(–7), corolla rotate, campanulate, funnel-shaped or tubular, stamens 5, rarely 2 or 4, inserted midway down the corolla or near the base or in the throat of the corolla tube, ovary superior, 2-locular; **fruits** septicidal or loculicidal capsules, berries or drupes. Cosmopol. 94/2950, CR 27/187, GD 9/34.

The flowers of *Solanum* exhibit the character syndrome of oligandric pollen flowers and are buzz-pollinated by several species of bees (KNAPP 1986, BOHS 1994, ENDRESS 1994). The flowers of most species of *Cyphomandra* attract male euglossine bees which collect the perfume substances produced by the anther connectives (SAZIMA & VOGEL 1989, D'ARCY et al. 1990, GRACIE 1993, SAZIMA et al 1993, BOHS 1994). *Cyphomandra hartwegii* is visited by the euglossine bees *Eulaema bombiformis* and *E. meriana* (SAZIMA & VOGEL 1989, SAZIMA et al 1993). Several species of *Cestrum* with red or yellow flowers are pollinated by hummingbirds which feed on the nectar (BENITEZ & D'ARCY 1988, D'ARCY 1999). Other species with whitish flowers were observed or at least assumed to be pollinated by hawkmoths (HABER & FRANKIE 1989). Hawkmoth pollination also occurs in several species of *Datura* and *Nicotiana*, which have long, tubular flowers (KUGLER 1971, GRANT & GRANT 1983a).

The Solanaceae comprise a wide range of commercially important plants, especially in the New World. Tomato, potato, chilies and tobacco are some of the most important cultivated plants worldwide. Plants of minor economic importance include: *Cyphomandra hartwegii* (locally cultivated for its edible fruits that are eaten raw or made into jams or juices), *Solanum quitoense* (locally cultivated for its fleshy fruits), and several species of *Cestrum* (e.g. *C. racemosum*) which are used as garden ornamentals. Several members of Solanaceae play an important role in religious ceremonies because of their hallucinogenic effects. Apart from the well-known *Nicotiana* and *Datura*, certain species of *Cestrum*, *Juannuloa*, *Markea*, and some others, are added to hallucinogenic drinks used in traditional ceremonies (SCHULTES 1979).

Key to the genera (based on GENTRY 1993)

1	Hemiepiphytes or woody epiphytes, mostly climbing	2
2	Corolla campanulate or tubular, 3-4 cm long; leaves coriaceous, clustered at the end of the branchlets	3
3	Flowers campanulate or broadly tubular	*Markea*
3*	Flowers narrowly tubular, with tomentum orange	*Juanulloa*
2*	Corolla with lobes clearly separate; leaves membranaceous, not clustered	*Lycianthes*
1*	Usually soft-wooded trees, mostly small, erect (occasionally large trees in *Solanum*)	4
4	Leaves frequently irregularly, broadly, shallowly toothed, frequently spiny on midrib or main veins below	*Solanum*
4*	Leaves usually broadly asymmetric, ovate and cordate, the juvenile leaves sometimes deeply pinnately lobed and totally different	*Cyphomandra*
4**	Leaves usually more or less oblanceolate or narrowly elliptic; flowers narrowly tubular	*Cestrum*
1**	Terrestrial herbs (sometimes rather coarse and subwoody) and subshrubs, with large or membranaceous leaves; fertile stamens 5	5
5	Fruit with calyx inflated and enveloping the fleshy berry	*Physalis*

5*	Fruit not like this	6
6	Reduced "opposite" leaf very small and round	*Cuatresia*
6*	Reduced "opposite" leaf larger, not round	*Witheringia*

Cestrum (neotrop. 175, CR 22, GD 2)
Shrubs or trees, always without spines and simple and entire leaves. The usually 5-merous yellow, white, orange, or purple flowers are inserted in cymose or paniculate inflorescences. The fruits are always more or less fleshy berries.

Key to the species of *Cestrum*

1	Leaves large, up to 30 cm long, mostly drying black	*C. megalophyllum*
1*	Leaves smaller, up to 15 cm long, rarely drying black	*C. racemosum*

C. megalophyllum Dunal
Shrub or tree, up to 8 m tall; leaves large, up to 30 m long, elliptic to obovate, 12-25(-35) cm long, 3,5-8(-12) cm wide, glabrous; inflorescences axillary, fascicles or short racemes, peduncles up to 1,5 cm long; corolla tubular, ca 15 mm long, greenish-white; fruits elliptical or obovoid, 6-10 mm long, dark violet when mature. In lowland forests, from Guatemala to Venezuela.

C. racemosum Ruiz & Pav.
Tree, up to 20(-25 m) tall, with indumentum of simple hairs; leaves ovate, 11-19(-22) cm long, 2,5-7(-9) cm wide; inflorescences axillary or terminal, clusters of short racemes, peduncles up to 3 cm long; corolla narrowly funnelform, 13-18 mm long, yellowish or greenish; fruits globose, 5-6 mm long, 3-5 mm wide, purple to black. Widespread in tropical America, from southern Mexico to northwestern South America, from Colombia to Bolivia.

Cuatresia (neotrop. 9, CR 2, GD 1)
Very similar to *Witheringia*, but characterized by fewer flowers per node and the reduced "opposite" leaf smaller and round.

Cyphomandra (neotrop. 32, CR 5, GD 1)
Small trees, shrubs or rarely herbs, unarmed and with simple or imparipinnate and sometimes trilobate leaves. The 5-merous flowers are arranged in simple racemes, or the racemes usually scorpioid and forming a cyme. The fruit is often a very large berry.

C. hartwegii (Miers) Walp., Pl. 99a
Common names (Costa Rica): pepinillo, sandillo, zopilote (Bohs 1994)
Small tree, up to 12 m tall, with fetid odor; leaves simple, lobed or unlobed, ovate to elliptic ovate, up to 30(-50) cm long and 20(-40) cm wide; inflorescences (sub-)terminal, branched or unbranched, up to 60 cm long, several-flowered; flowers elongate, calyx somewhat fleshy, corolla greenish, yellowish or brownish; fruits fleshy, ellipsoid, ovoid or globose, 3-9 cm long, yellow or orange, longitudinally striped. In rainforests, usually in disturbed or open areas, from Mexico to northwestern South America to Peru and Bolivia.

Juanulloa (neotrop. 8, CR 1, GD 1)
Usually epiphytic shrubs, unarmed and with thick branches and glabrous or stellate-tomentose indumentum. The rather large flowers have a colored calyx and are inserted solitary or are arranged in cymose inflorescences.

J. mexicana (Schltdl.) Miers., Pl. 99c,d
Hemiepiphytic vine or shrub; leaves elliptic or oblong, up to 20 cm long, densely whitish tomentose; inflorescences (sub-)terminal, corymbose panicles, 8-12 mm long; flowers 5-merous, calyx yellow to orange, corolla tubular, 5-ribbed or pleated, orange; fruits berries, ovoid or conical, 2 cm long. Often in somewhat open areas, from Mexico to Colombia.

Lycianthes (pantrop. 200, CR 13, GD 7)
Usually scandent, unarmed shrubs or herbs with simple, entire and sometimes unequal leaves. The umbelliform inflorescences are commonly sessile in the leaf axils and mostly few flowered. The fruits are always baccate and contain numerous seeds.
The genus was formerly included in *Solanum*, but according to Bitter (1920), it can be distinguished by the shape of the calyx, which forms a

natural and convenient segregate from the latter genus.

L. multiflora Bitter
Scandent or erect shrub, up to 3 m tall, young twigs densely covered with stellate hairs; leaves of a pair unequal, larger leaves ovate-lanceolate to rounded-ovate, mostly 9-13 cm long; inflorescences 9-20-flowered; calyx stellate tomentose, corolla white or whitish; fruits subglobose, 7-10 mm long, white or orange to red. From Honduras and Belize to Panama.

L. sanctaeclarae (Greenm.) D'Arcy
Scandent or erect shrub, densely covered with stellate hairs; leaves of a pair somewhat unequal, ovate to oblong-ovate or obovate, 12-20 cm long; inflorescences axillary, flowers in pairs or solitary; calyx stellate tomendose, corolla olive-green without, reddish-purple within; fruits subglobose, ca. 15 mm long, yellow. From Costa Rica to Panama.

Markea (neotrop. 18, CR 1, GD 1)
Epiphytic or hemiepiphytic climbers, sometimes associated with ants, leaves sometimes glandular-punctate.

M. neurantha Hemsl., Pl. 99b
Large or small epiphytic shrub, rarely terrestrial, glabrous except for the often hirsutulous peduncle, pedicel and calyx; leaves subcoriaceous or membranaceous, elliptic-oblong to obovate-oblong, mostly 10-25 cm long; inflorescences usually greatly elongate, slender, pendent, with few or numerous flowers; petals green, 3,5-7 cm long; fruits ca. 2 cm long. From Costa Rica to Panama.

Physalis (cosmopol. 80, CR 10, GD 2)
Annual or perennial herbs or low shrubs with entire or sinuate-dentate or repand leaves and mostly small flowers, solitary in the leaf axils. The genus is easy to recognize by the calyx which is inflated, enclosing the fruit, leaving only a small opening at the apex.

Solanum (cosmopol. 1700, CR 91, GD 15)
Herbs, shrubs or small trees, sometimes scandent, frequently pubescent with branched hairs and often armed with prickles. The leaves are very heterogeneous, simple and entire or dentate, or often pinnate-lobate or pinnate.

S. jamaicense Mill.
Shrub, up to 3 m tall, densely tomentose with branched hairs; leaves entire, ovate, rhombic or obovate, 4-15 cm long; inflorescences axillary, short racemose; flowers minute, corolla white; fruits fleshy berries, ca. 6 mm in diameter, red. Widespread in tropical America, usually along roadsides, from Florida, Mexico and the Antilles to Ecuador and Peru.

S. lanceifolium Jacq., Pl. 99f
Vine or liana, often in the canopy, stems with short spines, often with stout, stellate-tipped bristles; leaves alternate to subopposite, entire, sinuate-dentate to pinnately lobed, lanceolate to elliptic 3-25 cm long, 2-10 cm wide, sparsely pubescent with stellate hairs on both sides; inflorescences axillary, racemose, to 7 cm long, stellate pubescent, few to several-flowered; flowers mostly small, calyx spiny, corolla purple, densely stellate-tomentose outside, white inside; fruits fleshy berries, ca. 1,3-3 cm in diameter, orange or red. Very common weed along roadsides and pastures, but also in rainforests, from Mexico and the West Indies to Brazil.

S. quitoense Lam., Pl. 99e
Herb or shrub, up to 3 m tall, armed with yellowish spines; leaves sinuate-lobed, broadly ovate, often > 30 cm long; inflorescences fasciculate or subumbellate racemes; flowers rather large, calyx 10 cm long, corolla white, densely tomentose; fruits: fleshy berries, up to 6 cm in diameter, orange. Native to Peru and Ecuador, but cultivated in Central America.

S. sessiliflorum Dunal.
Erect shrub or large herb, up to 2 m tall, usually unarmed, branchlets tomentose with stellate hairs; leaves of a pair unequal, 5-8-lobate on each side, broadly ovate, 15-30 cm long, tomentose beneath; inflorescences axillary, short sub-umbellate racemes with 6-16 flowers; flowers white; fruits globose, 3-9 cm in diameter, tomentose, orange to red. In very wet lowland forests, from Nicaragua to northern South America.

Witheringia (neotrop. 15, CR 11, GD 4)
Understory shrubs, usually with the leaves of one pair unequal. Very similar to *Solanum*, but differenciated by the longitudinally dehiscing anthers and the axillary, fasciculate inflorescences.

W. mortonii Hunz.

Shrub, up to 3,5 m tall; leaves ovate or ovate elliptic, larger leaves 7,5-24,5 cm long, 9,2-10,2 cm wide, smaller leaves 4,8-10,5 cm long, 2,4-5,3 cm wide; inflorescences with 5-17 flowers; flowers 5-merous, corolla yellow; fruits globose berries. Endemic to Costa Rica.

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Sterculiaceae

Mostly trees and shrubs, rarely herbs or lianas, generally with stellate hairs, sometimes with simple hairs or lepidote. **Leaves** alternate, rarely subopposite, often palmately veined, simple and entire to lobate or digitately compound, with usually caducous stipules; **inflorescences** cymose, axillary or terminal, sometimes cauliflorous; **flowers** actinomorphic, rarely zygomorphic, bisexual or unisexual, the plants then monoecious, sepals (3-) 5, more or less connate, sometimes petaloid, petals 5, rarely absent, free, often unguiculate at the base and appendaged at the apex, androgynophore often present, short to elongate, stamens 5 to numerous, free to connate into a tube, often with staminodes alternating with the stamens, ovary superior, 1-5-locular, generally with axile placentation, styles as many as carpels, free to partly connate; **fruits** dry, dehiscing by valves or separating into cocci, or baccate. Throughout the tropics, also subtropical and a few temperate species, most prominent in the Old World. Cosmopol. 67/1500, CR 12/33, GD 7/15.

Several studies were performed to identify the legitimate polliantors of *Theobroma*, especially *T. cacao*. Several small midges (Ceratopogonidae, Cecidomyiidae) as well as stingless bees (Meliponinae) and miner bees (Halictidae) were identified as pollinators of the flowers of *T. cacao* (BILLES 1941; YOUNG

1994; YOUNG et al. 1986, ERICKSON et al. 1987). YOUNG & SEVERSON (1994) assumed that the flowers of ancestral or wild species of *Theobroma* (incl. noncultivated *T. cacao*) attract bees, while those of cultivated *T. cacao* have lost most of its original floral attraction system and are pollinated by midges.

The most important species economically is the cocoa tree (*Theobroma cacao*), which is native to the Amazon Basin, but nowadays cultivated worldwide in the tropics. Additionally, a few related species are of local importance, such as *T. grandiflorum* which is well known in Brazil as cupuaçu. Furthermore, the fermented seeds of the African *Cola nitida* were used as ingredients in various drinks, but are today often substituted by synthetic products. The seeds of *Herrania purpurea* are used by Costa Rican natives to prepare a bitter tasting drink (PITTIER 1908, SCHULTES 1958).

Key to the genera (based on ROBYNS 1964)

1	Seeds winged	*Pterygota*
1*	Seeds not winged	2
2	Petals lacking	*Sterculia*
2*	Petals 5	3
3	Staminodes lacking	*Melochia*
3*	Staminodes 5	4
4	Fruit smooth, rugose or 5- to 10-costate; leaves entire	5
4*	Fruits spinose or muricate; leaves entire or serrate	6
5*	Leaves palmately compound	*Herrania*
5	Leaves simple	*Theobroma*
6	Aculeate scandent shrubs or lianas; capsules densely spinose, separating into 5 cocci, each coccus dehiscent along the ventral suture and along the dorsal upper half	*Byttneria*
6*	Small to tall trees without aculei; capsules tuberculate, indehiscent (the tubercles separating irregularly at maturity to a greater or lesser degree)	*Guazuma*

Byttneria (pantrop. 132, CR 3, GD 2)
Mostly lianas and a few shrubs, pubescent with stellate or simple hairs or a mixture of both. The flowers are arranged in axillary dichasia.

B. aculeata (Jacq.) Jacq.
Climbing shrub, up to 6 m tall, stem and branches with recurved spines, up to 8 mm long, indumentum of simple and minute glandular hairs; leaves ovate-lanceolate, obovate-lanceolate or lanceolate, 8-18 cm long, 3-14 cm wide, entire or irregularly dentate or serrate in the upper half, stipules caducous; inflorescences axillary, cymose; flowers greenish-yellow, rose or dark purple; fruits globose, 4-8 mm in diameter, covered with spines. From southern Mexico to Bolivia and Peru.

Guazuma (neotrop. 4, CR 2, GD 1)
A small genus of usually secondary growth trees, unique in the serrate leaf margins and the numerous flowers in stout axillary panicles.

G. ulmifolia Lam., Pl. 100a
Large shrub or tree, up to 12 m tall, rarely as 20 m tall; leaves short petiolate, unequal at the base, oblong to broadly ovate, 5-15 cm long, serrate, glabrate or densely stellate-tomentose; flowers greenish, yellow or whitish in small axillary cymes; calyx 2-3-parted; petals 5, short unguiculate, cucullate, the apex inflexed and produced into a linear bifid ligule; stamen-tube 5-lobate; staminodes present, 0,8-1 mm long; fruit hard and woody, more or less globose, indehiscent, 2-4 cm long, green, yellowish or blackish, densely covered with short, hard tubercles; the seeds numerous large and hard. In dry or moist thickets or second growth forest. Polymorphous species, widely distributed from Mexico and the West Indies to Paraguay and Bolivia.

Herrania (neotrop. 20, CR 1, GD 1)
Small trees, easy to recognize for its large, digitately compound, 4-9-foliolate leaves. The flowers are always cauli- or ramiflorous and arranged in fasciculate inflorescences.

H. purpurea (Pittier) R.E. Schult., Pl. 100b-d
Shrub or small tree, up to 5,5(-10) m tall; leaves usually 5-digitate, leaflets unequal, obovate-

oblong, 22-35 cm long, 6-13 cm wide, glabrous above, sparsely stellate-villous beneath, petioles 30-45 cm long, densely stellate pubescent, stipules linear, up to 5 cm long, dark purple, caducous; inflorescences 5-8-flowered; flowers purple to maroon, calyx densely stellate pubescent, petals 5, strongly cucullate; fruits elliptic-ovoid, 10-costate, up to 7,5 cm long, up to 4 cm wide, densely covered with stinging stellate hairs, orange, seeds numerous, covered by a sweetish aril. In moist forests, from Nicaragua to northwestern Colombia.

Pterygota (pantrop. 15, CR 1, GD 1)
Large trees, usually of second-growth, usually with large, ovate leaves with truncate or subcordate base. Distinct in fruit by the large winged seeds.

P. excelsa (Standl. & L.O. Williams) Kosterm., Pl. 100e
Tall tree with indumentum of stellate hairs; leaves large, entire, deciduous, almost glabrescent, basally 7-veined; flowers unisexual (plants monoecious), inconspicuous, sepals green, petals lacking; fruits large follicles, seeds with large wings. Endemic to Costa Rica.

Sterculia (pantrop. 150, CR 4, GD 3)
Usually large canopy trees with stellate hairs and simple or palmately lobed, rarely palmately compound leaves. The flowers are bisexual or staminate, the plants then monoecious or dioecious. This genus is unmistakable in lacking petals and in the unique fruit which consists of 5 separate follicles, which are dehiscing along the ventral suture. It is vegetatively distinctive in the terminally clustered leaves of different sizes and with different length of petioles.
One of the three species in our area (*S. allenii*) is still unpublished and a description is lacking. Due to that a key to the remaining two species would be of little use, and is therefore left out.

S. apetala (Jaqc.) H. Karst., Pl. 100f,g
Tree up to 30-40 m tall, the trunk often with prominently developed buttresses; leaves large, deeply 3- to 5- palmately lobed, petiole 8-24 cm long; inflorescences axillary or subterminal, calyx 5-lobate, stamens 15, follicles obovoid, 6 cm long, 4 cm broad, tomentellous outside. Along rivers, in moist or dry thickets or forests. From southern Mexico to northern South America.

S. recordiana Standl., Pl. 100h,i
Tree, 5-25 m tall; leaves crowded at the end of the branchlets, simple, entire to somewhat undulate; inflorescences axillary, calyx deeply (4-) 5-lobate, follicles subglobose, ca. 7 cm in diameter, shortly tomentellous. Costa Rica and Panama.

Theobroma (neotrop. 20, CR 5, GD 5)
Middle-sized evergreen lowland forest trees with the branches in whorls of 3-5, resulting in a more or less candelabra growth form. The leaves are always simple and entire, mostly somewhat silvery stellate pubescent beneath. The flowers are always bisexual, with 5 almost free sepals, and 5 petals which consist of a hood-like lower part and a blade-like upper part, staminodes 5, fertile stamens 5, hidden inside the petal-hoods, gynoeceum 5-carpellate, superior; fruit large, subbaccate or subdrupaceous, indehiscent with a fleshy or hard pericarp, seeds usually arranged in five rows, each surrounded by a thick pulpy tissue.

T. angustifolium Moçiño & Sessé, Pl. 101a,b
Tree up to 26 m tall; leaves thin coriaceous, distichous, subobovate-oblong, elliptic-oblong or oblanceolate, 9-25 cm long, 3-9 cm wide, glabrous above, appressed tomentose with white, stellate hairs beneath, petioles moderately thick, densely subappressed tomentose; inflorescences axillary or extra-axillary, small cymes with 1-3 flowers; petals yellow, staminodes yellow; fruits oblong-ellipsoid or ovoid-ellipsoid, basally 5-costate, irregularly tuberculate-rugose, densely brown tomentose, 10-18 cm long, 6-9 cm wide, seeds embedded in an edible pulp. From southern Mexico to Panama.

T. cacao L., Pl. 101c,d
Small tree, 4-8 m tall, rarely taller; leaves coriaceous or chartaceous, 15-50 cm long, 4-15 cm broad, glabrous or puberulous, petioles characteristically bipulvinate; inflorescences borne on small tubercles, peduncles 1-3 mm long, with few flowers; petals thick membranaceous, pale yellowish to white, staminodes red or purplish, ciliate with simple hairs; fruits subbaccate, more or less elongate, 5-10-costate, seeds covered by a white, sweet pulp.
This common and widely cultivated species is also represented in Costa Rica as the wild growing ssp. *cacao*, commercially known as criollo cacao.

BILLES, D.J. 1941. Pollination of *Theobroma cacao* L. in Trinidad, B.W.I. - Trop. Agric. (Trinidad) 18: 151-156.
BRIZICKY, G.K. 1966. The genera of Sterculiaceae in the southeastern United States. - J. Arnold Arbor. 47: 60-74.
CRISTOBAL, C.L. 1976. Estudio taxonomico del genero *Byttneria* Loefling (Sterculiaceae). - Bonplandia 4: 1-428p.
CUATRECASAS, J. 1964. Cacao and Its Allies: A taxonomic revision of the genus *Theobroma*. - Contr. U.S. Natl. Herb. 35 (6): 379-614.
ERICKSON, B.J., A.M. YOUNG, et al. 1987. Pollination biology of *Theobroma* and *Herrania* (Sterculiaceae): II. Analyses of floral oils. Insect Sci. Appl. 8 (3): 301-310.
GENTRY, A.H. 1976. A new Panamanian *Sterculia*, with taxonomic notes on the genus. - Ann. Missouri Bot. Gard. 63: 370-372.
PITTIER, H. 1908. Plantas Usuales de Costa Rica.
ROBYNS, A. 1964. Family 117. Sterculiaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama, Part VI. - Ann. Missouri Bot. Gard. 51: 69-107.
SCHULTES, R.E. 1958. A synopsis of the genus *Herrania*. - J. Arnold Arbor. 39 (3): 217-295.
TARODA, N. 1984. A revision of the Brazilian species of *Sterculia* L. - Notes Roy. Bot. Gard. Edinburgh 42: 121-149.
YOUNG, A.M. 1994. The chocolate tree. A natural history of cacao. - Washington: Smithsonian Institution Press.
YOUNG, A.M., B.J. ERICKSON, E.H. ERICKSON, JR. & M.A. STRAND. 1986. Pollination biology of *Theobroma* and *Herrania* (Sterculiaceae) I. Floral biology. - Insect Sci. Appl. 8 (2): 151-164.
YOUNG, A.M. & D.W. SEVERSON. 1994. Comparative analysis of steam distilled floral oils of cacao cultivars (*Theobroma cacao* L., Sterculiaceae) and attraction of flying insects: Implications for a *Theobroma* Pollination syndrome. - J. Chem. Ecol. 20 (10): 2687-2703.

Styracaceae

A small family of trees and shrubs, often of higher altitudes and usually characterized by an indumentum of stellate or lepidote hairs, but sometimes glabrous throughout. **Leaves** simple, alternate, entire, serrate or denticulate, stipules lacking; **inflorescences** axillary or terminal, racemose or paniculate; **flowers** with sepals truncate or minutely 4-5-lobate, often pubescent, petals 4-5, basally connate, campanulate or tubular, mostly white, stamens in one whorl, usually twice as many as the petals, rarely as many as the petals, ovary superior to half-inferior, 1-3-5-locular; **fruits** capsules or drupes, sometimes winged, seeds 1-numerous. Pantrop. + subtrop. 11/160, CR 1/4, GD 1/1.

Flowers of *Styrax* are visited by several kinds of insects, but detailed studies are rare. KATO & HIURA (1999) reported that the Japanese species *S. obassia* is mainly pollinated by bumble bees. SUGDEN (1986) identified honeybees and butterflies (*Battus*) as the main pollinators of the North American species *S. officinale,* and it is assumed that the combination of bee and butterfly pollination occurs in several other species of this genus.

Styrax (pantrop. + subtrop. 120, CR 4, GD 1)
The largest genus of the family, characterized by the usually pink to white flowers with basally connate petals and the fruits with a cup-shaped calyx attached to the base.

S. glabratus Schott
Tree, up to 20 m tall; leaves elliptic to oblanceolate, entire, glabrous above, glabrous to sparsely stellate pubescent or lepidote beneath; inflorescences axillary or pseudo-terminal, racemose or rarely paniculate, (1-)2-8-flowered; flowers white to pink; fruits drupes, 13-18 mm long, 7-9 mm wide. Distributed in Costa Rica (Osa Peninsula) and in northern South America to Colombia, Venezuela and Brazil.

D'ARCY, W.G. 1979. Styracaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 66: 165-171.
FRITSCH, P.W. 1997. A revision of *Styrax* (Styracaceae) for Western Texas, Mexico and Mesoamerica. - Ann. Missouri Bot. Gard. 84 (4): 705-761.
GONSOULIN, G.J. 1974. A revision of *Styrax* (Styracaceae) in North America, Central America and the Carribean. - Sida 5: 191-258.
KATO, E. & T. HIURA. 1999. Fruit set in *Styrax obassia* (Styracaceae): the effect of light availability, display size and local floral density. - Amer. J. Bot. 86 (4): 495-501.
SUGDEN, E.A. 1986. Anthecology and pollinator efficacy of *Styrax officinale* subsp. *redivivum* (Styracaceae). - Amer. J. Bot. 73: 919-930.

Symplocaceae

A monogeneric family of trees and shrubs, usually of higher elevations, with rather nondescript entire to serrate leaves. **Leaves** simple, alternate, mostly elliptic and glabrous, stipules lacking; **inflorescences** axillary, racemose, spicate, fasciculate or flowers solitary; **flowers** actinomorphic, bisexual or rarely unisexual, subtended by an involucre of 1-3 bracts, sepals (4-)5(-9), basally united, often ciliate at the margin, petals 3-11 in 1-2 whorls, united at least basally, stamens 5-numerous, filaments connate into a tube at least basally and fused to the corolla, intrastaminal disk present, ovary inferior to half-inferior, 2-5-locular; **fruits** ellipsoid to obovoid drupes, usually blue or black when mature, glabrous or pubescent, sometimes berries. Distributed mainly in tropical, montane regions in America and eastern Asia. Pantrop. + subtrop. 1/250, CR 1/11, GD 1/1.

The fruits of *S. bradei* are dispersed by quetzales.
Some species of *Symplocos* are used for making a yellow dye (D'ARCY 1976).

Symplocos (pantrop. + subtrop. 250, CR 11, GD 1)
With the characters of the family. Leaves usually spirally arranged on the twigs, with serrate margins and reticulate venation (brochidodromous). Flowers axillary, usally whitish or pinkish. Fruits drupaceous.

S. limoncillo Humb. & Bonpl.
Glabrous tree, up to 12 m tall; leaves oblong to oblong-elliptic, entire to serrulate, inflorescences racemose; petals white to pink; fruits oblong, 1,5-2 cm long. In Central America, from Belize and Nicaragua to Panama.

D'ARCY, W.G. 1976. Symplocaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 63: 547-552.
STAHL, B. 1991. Symplocaceae. In: G. HARLING & L. ANDERSSON (eds.): Flora of Ecuador 43: 1-44.

Theaceae

A family of shrubs and trees, with the youngest leaf typically coiled at the twig apex. **Leaves** alternate, simple, often coriaceous, margins entire to serrate, stipules lacking; **inflorescences** axillary, fasciculate, or flowers solitary; **flowers** bisexual, sepals 4-7, free or basally connate, petals mostly 5, free or basally connate, usually large and conspicuous, stamens 5, 10 or often numerous, free or basally connate, ovary mostly superior, 3- or 5-locular; **fruits** loculicidally dehiscent capsules or dry or fleshy berries. Distributed worldwide in the tropics and subtropics, but also extending into temperate regions. Cosmopol. 22/610, CR 6/14, GD 5/9.

BITTRICH et al. (1993) described the pollination of two Amazonian species of *Ternstroemia* (*T. dentata*, *T. laevigata*). They are visited by female bees (e.g. *Euglossa* sp., *Paratetrapedia* spp., *Ptiloglossa* sp., *Xylocopa* sp.), which collect pollen by vibrating the flowers. The authors assumed that this mode of pollination is probably present in other species of this genus.
Thea sinensis (syn. *Camellia sinensis*), the tea plant, which is native to east Asia, is commercially the most important member of the Theaceae. Some species in various genera are used as ornamental plants.

Key to the genera (after ROBYNS 1967)

1	Anthers versatile; fruit capsular	*Gordonia*
1*	Anthers basifixed; fruit indehiscent	2
2	Stamens 5; sepals caducous; flowers large; mangroves	*Pelliciera*
2*	Stamens more than 5; sepals persistent; flowers small	3
3	Leaves densely appressed-sebiceous beneath; anthers glabrous	*Freziera*
3*	Leaves glabrous or glabrate, at least in age	4

4 Ovary inferior — *Symplocócarpon*
4* Ovary superior — *Ternstroemia*

Freziera (neotrop. ca. 42, CR 5, GD 2)
Dioecious trees or rarely shrubs with rather nondescript entire or serrulate leaves. The minute white flowers are solitary or arranged in fascicles in the axils of the leaves.

F. candicans Tul.
Tree, up to 18 m tall; leaves entire to subserrulate, narrowly ovate to elliptic, up to 13 cm long, up to 5,5 cm wide, petioles up to 1,8 cm long, glabrous above, densely appressed pubescent beneath; inflorescences fasciculate; flowers white to yellowish-white; fruits dry berries, globose, up to 7 mm in diameter, dark-brown. From Costa Rica to Colombia and Venezuela.

Pelliciera (neotrop. 1, CR 1, GD 1)
Monotypic genus.

P. rhizophorae Triana & Planch., Pl. 5c, 101e-h
Small to large tree, to 15 m tall; leaves narrowly elliptic, narrowly ovate-elliptic or narrowly obovate-elliptic, to 15 cm long and 5 cm wide, entire; flowers solitary, axillary (apparently terminal), sessile, 5-merous, corolla white or pink; fruits napiform, long beaked, many-sulcate, 7-10 cm long, ca. 8 cm wide. Mangrove plant, from Costa Rica to Colombia.

Ternstroemia (pantrop. 85, CR 4, GD 2)
Trees or shrubs, usually with entire-margined leaves with conspicuous dark gland dots on the surface.

T. multiovulata Gómez-L., Q. Jimenez & N. Zamora, Pl. 101i
Tree, up to 14 m tall; leaves lanceolate, clustered at the twig ends; flowers solitary, sepals white, petals white to pinkish; fruits berries, ovate, 17-21 mm long, 20-24 mm wide, seeds 2. In primary and secondary lowland forests, endemic to Costa Rica.

BITTRICH, V.M., C.E. AMARAL & G.A.R. MELO. 1993. Pollination biology of *Ternstroemia laevigata* and *T. dentata* (Theaceae). - Pl. Syst. Evol. 185 (1-2): 1-6.
GOMEZ, J., J. JIMÉNEZ & N. ZAMORA. 1990. A new Costa Rican species of *Ternstroemia* (Theaceae). - Brenesia 33: 127-129.
KENG, H. 1980. On the unification of *Laplacea* and *Gordonia* (Theaceae). - Gard. Bull. Singapore 33 (2): 303-311.
KOBUSKI, C.E. 1941. Studies in the Theaceae VIII. A synopsis of the genus *Freziera*. - J. Arnold Arbor. 22:457-496.
KOBUSKI, C. 1942. Studies in the Theaceae XIII. Notes on the Mexican and Central American species of *Ternstroemia*. - J. Arnold Arbor. 23: 464-478.
ROBYNS, A. 1967. Theaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 54 (1): 41-56.

Theophrastaceae

A small family of trees and shrubs, sometimes unbranched (*Clavija*) with simple leaves. **Leaves** alternate, often pseudo-verticillately clustered, often coriaceous, stipules lacking; **inflorescences** terminal or lateral, racemose, short to elongate; **flowers** actinomorphic to slightly zygomorphic, bisexual or unisexual, sepals 4-5, free or basally connate, glandular punctate, petals 4-5, connate, white, orange or green, stamens 4-5, opposite the petals, staminodes 4-5, petaloid, fused to the corolla tube, ovary superior, 1-locular; **fruits** berries or drupes, subglobose, oblong to ovoid, indehiscent, yellow to orange, seeds few to numerous, embedded in a soft or gelatinous pulp. Neotrop. 4/90, CR 3/5, GD 1/2.

Some species of *Clavia* are so-called "litter-trappers" (e.g. *Clavija costaricana*). In their crown they collect litter from fallen leaves, which is used by the plant as a source of mineral nutrients (Wanek & WEISSSENHOFER in prep.).

The pollination biology of Theophrastaceae is poorly known. In his investigation of the genus *Theophrasta*, STAHL (1987) states that several species are pollinated by diptera, due to the sapromyiophilous features of the flowers. Eggs of syrphid flies were found on the flowers of *T. americana*. GAGNE et al. (1997) made observations on gall midges, associated with flowers of *Clavija*. The floral biology of other species and genera lacking sapromyiophilous features is still unknown.

The fruits of some *Clavija* species are edible, while some species of *Jacquinia* are used locally as fish poison (D'ARCY 1980).

Clavija (neotrop. 50, CR 2, GD 2)
A dioecious genus, easy to recognize by its habit mostly being unbranched, with the usually large leaves clustered at the stem apex. The leaves are unique in having numerous linear subepidermal sclereids.

Key to the species of *Clavija* (after STAHL 1989)

1 Petioles usually slender, 1,5-12 cm long (1/5-1/2 of total leaf length) and 1-2 mm thick, blades to 25 cm long — *C. biborrana*
1* Petioles 1-4(-7) cm long, (< 1/10 of total leaf length) and 1,5-5(-7) mm thick, blades 25-120 cm long — *C. costaricana*

C. biborrana Öerst.
Shrub or small tree, up to 4 m tall; leaves mostly narrowly obovate to oblanceolate, 7,5-23 cm long, 3,5-9 cm wide, glabrous or almost so on both sides; male inflorescences up to 9 cm long, flowers 4-merous; fruits 2-3,5 cm in diameter, orange. In wet or moist forests, from southern Costa Rica to Panama.

C. costaricana Pittier, Pl. 102a,b
Shrub or small tree, up to 4 m tall; leaves very large, 26-120 cm long, 8-23 cm wide, subcoriaceous to coriaceous, glabrous on both sides; male inflorescences up to 27 cm long, female inflorescences up to 3 cm long; flowers 4-merous; fruits 2-4,5 cm in diameter, yellow to orange. In wet or moist forest, from southern Nicaragua to northwestern Colombia.

D'ARCY, W.G. 1980. Theophrastaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 67: 1047-1055.
GAGNE, R.J., C. OTT & S.S. RENNER. 1997. A new species of gall midge (Diptera: Cecidomyiidae) from Ecuador associated with flowers of *Clavija* (Theophrastaceae). - Proc. Entomol. Soc. Wash. 99 (1): 110-114.
STAHL, B. 1987. The genus *Theophrasta* (Theophrastaceae): foliar structures, floral biology and taxonomy. - Nordic J. Bot. 7 (5): 529-538.
STAHL, B. 1989. A synopsis of Central American Theophrastaceae. - Nordic J. Bot. 9 (1): 15-30.
STAHL, B. 1991. A revision of *Clavija* (Theophrastaceae). - Opera Bot. 107: 3-77.

Thymelaeaceae

A small family consisting of shrubs, trees and a few lianas with nondescript simple, alternate or opposite, entire leaves, soft wood and usually remarkably strong bark. **Inflorescences** axillary or terminal, spicate, racemose, umbellate, or flowers in fascicles or solitary; **flowers** bisexual or unisexual, plants then dioecious, hypanthium tubular to bowl-shaped, sepals 4-6, usually petaloid, connate, petals usually lacking, disk often present, stamens 2-12, ovary superior, 1(-2)-locular; **fruits** nuts or drupes. From temperate to tropical zones worldwide, most abundant in South Africa and Australia. Cosmopol. 53/750, CR 2/6, GD 2/3.

Key to the genera (after WOODSON & SCHERY 1958)

1 Stamens 8, sessile or subsessile; pistillate flowers with staminodes — *Daphnopsis*
1* Stamens 4, widely exserted upon slender filaments winged at the base; pistillate flowers without staminodes — *Schoenobiblus*

Daphnopsis (neotrop. 55, CR 5, GD 2)
Shrubs or small trees with alternate leaves and flowers with 8 stamens.

D. americana (Mill.) J.R. Johnston
Shrub or tree, up to 15 m tall; leaves lanceolate, oblong-elliptic to obovate, 3-21 cm long, 1-8 cm

wide, glabrous to slightly sericeous on both sides; inflorescences umbellate or subracemose; flowers unisexual, tubular; fruits drupes, ovoid, 6-15 mm long, 3-9 mm in diameter. Very widespread, usually in very moist habitats, often along rivers, from Mexico and the Antilles to Colombia and Ecuador.

Schoenobiblus (neotrop. 8, CR 1, GD 1)
Shrubs or small trees with alternate leaves and flowers with 4 stamens.
S. panamensis Standl. & L.O. Williams
Small tree, up to 3 m tall, branches glabrous to glabrate; leaves subsessile, lanceolate, glabrous; inflorescences in the upper leaf axils, paniculate with few umbellate branches; flowers small, pink or white; fruits obovoid, subtended by the persistent calyx. In lowland forests, from Costa Rica and Panama to Ecuador.

Schoenobiblus panamensis

NEVLING, L. I. JR. 1959. A revision of the genus *Daphnopsis*. - Ann. Missouri Bot. Gard. 46 (4): 257-358.
WOODSON, R.E. & R.W. SCHERY. 1958. Thymelaeaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 45: 93-97.

Ticodendraceae

A family consisting of only one genus with one species, first described in 1991 (GOMEZ-LAURITO & GOMEZ 1991). Dioecious or polygamodioecious trees, 7-20 m tall; **leaves** alternate, elliptic-ovate, serrate on the upper part, stipules subulate, encircling the stem, caducous, leaving a scar; male **flowers** in ament-like inflorescences, sometimes crowned by a solitary female flower; stamens numerous, female flowers solitary, ovary inferior, 4-locular; **fruits** drupe-like, asymmetric, to 7 cm long, 4 cm wide, greenish, seed 1. Neotrop. 1/1, CR 1/1, GD 1/1.

Though the first collections of *Ticodendron* date from 1900, its systematic position has been unclear and was always a point of debate. The unusual anatomical and morphological features led to the establishment of a new family in the order Fagales (HAMMEL & BURGER 1991).

The wood is used as firewood (GOMEZ-LAURITO & GOMEZ 1989).

Ticodendron (neotrop. 1, CR 1, GD 1)
Monotypic genus.
T. incognitum Gomez-Laurito & Gomez P.
Common names (Central America): jaúl macho, jaúl nazareno, duraznillo, candelillo morado (GOMEZ-LAURITO & GOMEZ P. 1989).
In wet forested areas between 500 and 2400 m alt., from southern Mexico to Panama.

GOMEZ-LAURITO, J. & L.D. GOMEZ P. 1989. *Ticodendron*: a new tree from Central America. - Ann. Missouri Bot. Gard. 76: 1148-1151.
GOMEZ-LAURITO, J. & L.D. GOMEZ P. 1991. Ticodendraceae: a new family of flowering plants. - Ann. Missouri Bot. Gard. 78: 87-88.
GOVAERTS, R. & D.G. FRODIN. 1998. Ticodendraceae. Pp: 405-407. In: World checklist and bibliography of Fagales (Betulaceae, Corylaceae, Fagaceae and Ticodendraceae).
HAMMEL, B. & W. BURGER. 1991. Neither oak nor alder, but nearly: the history of Ticodendraceae. - Ann. Missouri Bot. Gard. 78: 89-95.

N.N. In prep. Ticodendraceae. Manuál de las plantas de Costa Rica. Missouri Botanical Garden. Instituto Nacional de Biodiversidad. Museo Nacional de Costa Rica.

Tiliaceae

A family consisting mostly of tropical canopy trees, but which is also represented in the subtropics and in temperate regions. In the GD area trees or rarely shrubs, generally with stellate hairs, sometimes with simple hairs or lepidote; **leaves** alternate, simple, entire, serrate to sometimes deeply lobed, more or less 3-veined at the base, petiole usually more or less thickened at the apex, stipules persistent or caducous; **inflorescences** axillary or terminal, rarely opposite the leaves, cymose or flowers solitary, sometimes cauliflorous; **flowers** hermaphrodite, rarely unisexual, then plants monoecious, usually actinomorphic, sepals 4-5, petals 4-5, rarely absent, usually free, androgynophore sometimes present, stamens usually numerous, free or basally connate, ovary usually 2-5-locular, style 1, placentation axile or sometimes parietal; **fruits** capsules, dehiscing by 2-5 valves or indehiscent, rarely fleshy. Subcosmopol. 46/680, CR 11/29, GD 9/12.

This family represents a basal group in Malvales, due to some primitive characters such as numerous stamens and free filaments. BAYER et al. (1998) showed that the Tiliaceae (and other Malvalean families) should be included in Malvaceae (except *Muntingia* and *Discraspidia*: Muntingiaceae).

Key to the genera (based on ROBYNS 1964)

1	Stipules unequal, one filiform, the other large, foliaceous; perianth and androecium subepiginous; sepals provided along the margins with long filiform appendages; ovary subinferior to inferior	*Dicraspidia*
1*	Stipules equal, not foliaceous; perianth and androeceum hypoginous; sepals without appendages or with a small apical appendage only; ovary superior	2
2	Fruit unarmed	3
3	Petals glandular thickened within at the base	4
4*	Petals about half the length of the sepals; fruit composed of 3(-4) samaras	*Goethalsia*
4	Petals longer or somewhat shorter than the sepals; fruit capsules	5
5	Flowers hermaphrodite, calyculate; petals longer than the sepals, white or yellow; capsules ligneous, imperfectly loculicidally 5-valvate	*Luehea*
5*	Flowers unisexual, without calycle; petals somewhat shorter than the sepals, white to violet; capsules coriaceous, compressed contrary to the partition, loculicidally 2-valvate	*Trichospermum*
2*	Fruit armed with spines or bristles	6
6	Flowers hermaphrodite; gynophore absent; anthers with a membranaceous appendage at the top; capsules transversely elliptic, 1,5-4 cm long and 5,5-8 cm broad, densely bristly or spinose	*Apeiba*
6*	Flowers hermaphrodite or pistillate, gynophore present or obsolete; anthers without appendage; fruit capsular, less than 2 cm in diameter	7
7	Tree; flowers 4-5-merous; leaves basally with appendages; fruit laterally compressed and with two rows of long plumose bristles along the margins	*Heliocarpus*
7*	Shrub; flowers 5-merous, leaves without appendages; fruit not compressed, covered on all sides with stiff spines	*Triumfetta*
3*	Petals eglandular; flowers hermaphrodite	8
8	Capsules coriaceous-chartaceous, elongate, silique-like; seeds not arillate	*Corchorus*
8*	Capsules ligneous, more or less globose; seeds arillate	*Mortoniodendron*

Apeiba (neotrop. 10, CR 2, GD 2)
Trees up to 30 m tall, the chartaceous leaves with entire to serrate margins. The flowers are always yellow, with the stamens having a characteristic membranaceous appendage distally. The fruits are unique in being flattened, spiny capsules.

Key to the species of *Apeiba*

1 Leaves more or less rugose and sparsely stellate puberulous above, densely stellate-arachnoid beneath; appendage of the anthers ca. 1 mm long; capsule transversely elliptic, ca. 4 cm long and 7-8 cm broad, covered with long flexible and stout hirsute bristles — *A. tibourbou*

1* Leaves scatteringly and minutely stellate-puberulous to glabrate above, densely and very minutely fimbriate-lepidote beneath; appendage of the anthers ca 4-4,5 mm long; capsule transversely narrow-elliptic, ca 1,5 cm long and 5,5-6,5 cm broad, covered with short to rather long, stout, conic-based spines — *A. membranacea*

A. tibourbou Aubl., Pl. 102d-f
Branchlets densely hirsute; leaves cordate at the base, 5 (-7) palmatinerved; sepals 4-5; petals 4-5, 1,1-1,6 cm long and 0,5-0,8 cm broad. In dry forests and thickets, at savanna edges and along roads throughout tropical Central and South America.

A. membranacea Spruce ex Benth., Pl. 102c
Branchlets shortly stellate-puberulous; leaves rounded to subcordate at the base, 3-palmatinerved, with tufts of brownish hairs in the axils of the secondary veins beneath, sepals 5, petals 5, 1,35-2 cm long, 0,65-1,3 cm wide. Usually on forested hills, from Costa Rica and Panama to western South America, from Colombia to northern Bolivia.

Dicraspidia (neotrop. 1, CR 1, GD 1)
Monotypic genus.

D. donnell-smithii Standl., Pl. 102g-i
Shrub or small tree, 3-10 m tall; branches and petioles whitish tomentose and long-hirsute; leaves 10-20 cm long, margins irregularly dentate, 5-7-palmatinerved, stipules persistent, one of them filiform, the other one large and foliaceous, suborbicular and up to 4,5 cm in diameter; flowers supraaxillary, solitary, large, hermaphrodite, 5-merous, the sepals along the margins with long filiform appendages, petals 3-4 cm long, bright yellow, stamens numerous, free, ovary subinferior to inferior, 10-12-locular; fruit baccate, ca 1 cm long and 1,5-1,8 cm broad, surmounted by the persistent sepals. In second growth and along streams, from Honduras to Costa Rica and Panama.

Heliocarpus (neotrop. 10, CR 3, GD 1)
Trees or shrubs with stellate hairs and usually dentate laves. Most distinct in fruit, consisting of a central body, surrounded by a border of long plumose radiating hairs, suggesting a sun-wheel.

H. appendiculatus, Pl. 103a
Tree, up to 15 m tall, branchlets densely tomentose; leaves broadly ovate or rounded-ovate, crenate-serrulate, with conspicuous foliaceous appendages at the base of the blade, glabrous above, tomentellous beneath; inflorescences much-branched, paniculate; flowers bisexual or males only, 4-5-merous, petals absent in the male flowers, ovary 2-locular; capsules indehiscent, compressed, long stipitate. In moist or wet forests or thickets, from Mexico to Panama.

Luehea seemannii

Luehea (neotrop. 15, CR 3, GD 1)
Trees and shrubs with more or less large white to pink colored, 5-merous flowers. The fruits are woody, ovoid, ligneous, 5-valvate dehiscent capsules with numerous winged seeds.

L. seemannii Triana & Planch., Pl. 103b
Large tree, 15-30 m tall, often strongly buttressed; leaves subcoriaceous, serrate, arachnoid to glabrescent above, brownish arachnoid beneath,

with caducous stipules; inflorescences of axillary or terminal thyrses; flowers ca. 1,3 cm long, calyculate, 5-merous, sepals and petals free, the petals white or yellow, glandular-thickened at the base within, stamens numerous, ovary 5-locular; capsule 2-2,5 cm long and ca. 1 cm in diameter, deeply 5-sulcate and with 5 prominent angles, shortly brownish tomentellous. Common in wet lowland forests along streams, throughout tropical Central America and in Colombia.

Mortoniodendron (neotrop. 5, CR 5, GD 2)
Trees or tall shrubs, distinct in the entire and basally asymmetric leaves; the flowers are white to cream colored, usually 4-5-merous and with numerous stamens that are united basally. The fruit is a more or less rounded, valvately dehiscent capsule with fleshy-arillate seeds.

M. anisophyllum (Standl.) Standl. & Steyerm., Pl. 103c
Tall tree, 12-30 m tall; leaves subcoriaceous, 8-15 cm long, of various shape; flowers 5-merous; capsule more or less globose, ca. 4 cm in diameter, 5-celled with 2-3 seeds in each cell. Known only from Costa Rica and Panama.

Trichospermum (pantrop. 39, CR 2, GD 2)
Trees with stellate hairs. The narrowly oblong leaves are finely dentate. The 2(-3)-valvate capsular fruits are compressed contrary to the partition, containing seeds, which are conspicously ciliate along the margins, resembling the fruits of *Heliocarpus*.

T. grewiifolium (A. Rich.) Kosterm., Pl. 103d
Tree, ca. 20m tall; leaves whitish below; flowers usually white to pink or violet. In lowland forests, sometimes in disturbed areas, from Honduras and Belize to Peru and Brazil.

BAYER, C., M.W. CHASE & M.F. FAY. 1998. Muntingiaceae, a new family of dicotyledons with malvalean affinities. - Taxon 47: 37-42
CUNHA DA SILVA, M.C. 1985. Revisão das espécies do gênero *Luehea* Willd. (Tiliaceae). - Sellowia 37: 5-41.
LAY, K.K. 1949. A revision of the genus *Heliocarpus* L. - Ann. Missouri Bot. Gard. 36: 507-541.
ROBYNS, A. 1964. Tiliaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 51: 1-35.

Tovariaceae

A small family of slender shrubs and subshrubs, closely related to the Capparidaceae, with a strong, unpleasant smell in the vegetative parts. **Leaves** alternate, trifoliolate, stipules present; **inflorescences** terminal, racemose; **flowers** actinomorphic, bisexual, sepals 8, free, petals 8, free, green to yellow, extrastaminal disk present, stamens 8, in one whorl, ovary superior, 5-8-locular; **fruits** leathery berries, seeds numerous. Widespread in the Neotropics. Neotrop. 1/2, CR 1/1, GD 1/1.

Tovaria (neotrop. 2, CR 1, GD 1)
With the characters of the family.
T. pendula Ruiz & Pav.
Shrub or subshrub, up to 2 m tall, glabrous; leaflets narrowly ovate or elliptic; inflorescences 4-5 cm long, flowers green or greenish-white; fruit almost globose, 10-15 mm in diameter, seeds flattened, blackish. Widespread, from Mexico and the West Indies to Bolivia, Peru and Venezuela.

ANDERSSON, L. 1995. Tovariaceae. In: G. HARLING & L. ANDERSSON (eds.): Flora of Ecuador 52.
D'ARCY, W.G. 1979. Capparaceae-Tovarioideae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 66(2): 117-121.
FISEL, K.J. & F. WEBERLING. 1990. Untersuchungen zur Morphologie und Ontogenie der Blüten von *Tovaria pendula* Ruiz et Pavon und *Tovaria diffusa* (Macfad.) Fawcett and Rendle (Tovariaceae). - Bot. Jahrb. Syst. 111 (3): 365-387.

Turneraceae

A small family, mostly herbs and shrubs with a rather distinct and uniform habit. **Leaves** simple, alternate, margin serrate, often with glandular teeth or rarely entire, often with glands at the base of the leaf blade, stipules small or absent; **inflorescences** rarely racemose, cymose or paniculate, mostly flowers

solitary; **flowers** actinomorphic, bisexual, hypanthium tubular, sometimes reduced, sepals 5, petals 5, free, often yellow or orange, inserted in the hypanthium, stamens 5, free, usually inserted in the hypanthium, ovary superior, unilocular; **fruits** capsules, loculicidally or septicidally dehiscing by 3 valves, seeds arillate. Trop. + subtrop. America and Africa 10/100, CR 3/8, GD 1/1.

The pollination biology of Turneraceae is poorly known. The tropical weed, *Turnera ulmifolia*, present in Costa Rica, attracts a wide range of insect visitors, including bees, wasps, butterflies and various kinds of flies, which feed on pollen and nectar (BARRETT 1978).

Key to the genera (after ROBYNS 1967)

1	Trees 7-30(-40) m tall; hypanthium wanting	*Erblichia*
1*	Herbs or shrubs; hypanthium distinct	*Turnera*

Erblichia (neotrop. + Madag. 5, CR 1, GD 1)
A genus, consisting of shrubs and trees with the leaves clustered at the apex of the branches and always having minute stipules.
E. odorata Seem.
Tree, up to 30 m tall; leaves elliptic to oblong-elliptic, crenate, stipules up to 1 mm long; flowers large, sepals up to 6 cm long, greenish, petals up to 8 cm long, bright yellow; fruits ellipsoid, woody, up to 3,3 cm long and 1,7 cm wide, glabrous. From southern Mexico to Panama.

ARBO, M.M. 1979. Revisión del genero *Erblichia* (Turneraceae). - Adansonia ser 2, 18 (4): 459-482.
BARRETT, S.C.H. 1978. Heterostyly in a tropical weed: the reproductive biology of the *Turnera ulmifolia* complex (Turneraceae). - Canad. J. Bot. 56: 1713-1725.
ROBYNS, A. 1967. Turneraceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. Ann. Missouri Bot. Gard. 54 (1): 85-94.
SHORE, J.S. & S.C.H. BARRETT. 1984. The effect of pollination intensity and incompatible pollen on seed set in *Turnera ulmifolia* (Turneraceae). - Canad. J. Bot. 62: 1298-1303.

Ulmaceae

A family of the order Urticales, consisting of trees, shrubs and rarely climbers. It is one of the Laurasian derived taxa, and centered in the northern hemisphere. One of the main features are the asymmetric leaf bases, which are nearly always present, although sometimes only weakly. **Leaves** alternate, rarely opposite, simple, often distichous, usually serrate margined, frequently 3-veined at the base, stipules usually present but early caducous; **flowers** axillary, often in glomerules, sometimes solitary, hermaphrodite or unisexual, (then plants monoecious), inconspicuous, with one whirl of (2-)4-6(-9) free or basally connate tepals, stamens as many or rarely twice as many as the tepals and opposite to them, ovary superior, unilocular or rarely bilocular; **fruits** drupaceous, baccate or dry and flattened, sometimes winged, one-seeded. Distributed mainly in the temperate zone, but extending into the subtropics and tropics. Cosmopol. 16/175, CR 5/8, GD 3/5.

Some temperate members of the family (e.g., *Ulmus* spp.) are of commercial interest for their timber, which is suitable for furniture.

Key to the genera (based on BURGER 1977)

1	Fruit less than 3 mm long with narrow cotyledons; leaves and stems usually covered by grayish pubescence	*Trema*
1*	Fruit more than 5 mm long with broad cotyledons	2
2	Leaves basally 3-veined; stamens equal in number to the tepals; the two styles (style-branches) deeply bifid; spines often present	*Celtis*
2*	Leaves not 3-veined at the base; stamens twice as many as the tepals; the two styles (style-branches) simple; spines absent	*Ampelocera*

Ampelocera (neotrop. 10, CR 1, GD 1)
Usually large trees with alternate, entire to serbade-margined leaves. The inflorescences are always axillary with the flowers solitary or arranged in fascicles. The small flowers are bisexual, 4-5-merous and unique in having twice as many stamens as tepals. The fruit is a small, sometimes more or less fleshy drupe.

A. macrocarpa Forero & A.H. Gentry
Common name (Costa Rica): rescaldo (TODZIA 1989). Tree, up to 30 m tall; leaves oblong to elliptic, strongly oblique, bright metallic blue when young, margin entire, petioles 6-10 mm long; inflorescences 2,5-3,7 cm long, purple, many-flowered; fruits yellow, globose, 1,8-2,2 cm in diameter, usually glabrous. In secondary growth evergreen forest and on limestone, from Honduras to northwestern Colombia.

Trema (pantrop. + subtrop. 10-15, CR 2, GD 2)
A genus of trees and shrubs, widely distributed in the tropics and subtropics, mostly in the Old World, with alternate, basally 3-veined leaves with entire or serrate-margins. The fruit is peculiar in being a small, fleshy, orange-colored drupe, with the two styles persisting.

T. micrantha (L.) Blume
Tree, up to 12(-20) m tall, with the young branches pubescent; leaves usually serrulate, densely pubescent beneath; inflorescences cymose; flowers sessile to subsessile, usually in crowded clusters, unisexual or bisexual, 5-merous; fruits subglobose, ca. 2 mm in diameter. In primary as well as in secondary growth of various, usually more or less open habitats, widely distributed in the subtropics and tropics of the New World, extending from Mexico and the West Indies to southern South America.

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BURGER, W.C. 1977. Ulmaceae. Flora Costaricensis. - Fieldiana Bot. 40: 83-93.
CARAUTA, J.P.P. 1974. Índice das espécies de Ulmaceae do Brazil. - Rodriguésia 27 (39): 99-134.
ELIAS, T. 1970. The genera of the Ulmaceae in the southeastern United States. - J. Arnold Arbor. 51: 18-40.
LASSER, T. 1971. Ulmaceae. Pp.: 9-29. In: T. LASSER (ed.): Flora de Venezuela. Vol III. Primera Parte.
NEVLING, L.I., JR. 1960. Ulmaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 47 (2): 105-113.
TODZIA, C.A. 1989. A revision of *Ampelocera* (Ulmaceae). - Ann. Missouri Bot. Gard. 76: 1087-1102.

Urticaceae

Herbs, shrubs or sometimes small trees, rarely scandent, often having cystoliths or stinging hairs or spines which are filled with an irritating liquid. **Leaves** alternate or opposite, simple or variously lobed, entire or dentate, sometimes anisophyllous (the leaves of adjacent nodes or of one pair sometimes very different in size, e.g. *Pilea* spp.), basally 3-veined, stipules usually present, free or variously connate, lateral or often intrapetiolar, caducous or persistent, the punctiform, linear or elongate cystoliths visible on the upper and/or lower surfaces; **inflorescences** variable, usually pedunculate, racemose, paniculate or spicate usually with fascicles or clusters of flowers; **flowers** actinomorphic or zygomorphic, unisexual (plants then monoecious or dioecious), or rarely bisexual, minute, greenish-white, tepals 3-5, sometimes lacking, free or connate, often with appendages, stamens solitary or 3-5, epitepal, explosively dehiscing, ovary superior, unilocular; **fruits** achenes, usually laterally compressed, sometimes enclosed in the persistent perianth. Cosmopol. 48/1050, CR 9/59, GD 4/8.

The Urticaceae form a natural group within the order Urticales. They are closely related to the Cannabaceae and Moraceae, with which they share several characters, including the presence of stipules, inconspicuous, unisexual flowers, and a perianth of mostly a single, 3-5-merous whorl.
All members of the Urticaceae are anemophilous (FRIIS 1993).

Only a few Urticaceae have developed specialized dispersal modes. The persisting perianth of several genera (e.g., *Urera)* is brightly colored, serving as an attractant for animals which feed on the fruits. In the tribe Lecantheae (e.g., *Pilea*) the achenes are actively ejected by the reflexed staminodes (FRIIS 1993).

Key to the genera (after BURGER 1977)

1	Leaves opposite (the leaves occasionally very unequal in size and apparently alternate)	*Pilea*
1*	Leaves alternate, always solitary at a node, never with a sessile stipule-like opposing leaf	2
2	Some stinging hairs usually present, thin, translucent, straight and narrow, 0,5-3 mm long; inflorescence complex and branched	3
3	Shrubs or trees, perennial, usually unisexual; stigma terminal and erect	*Urera* p.p.
3*	Herbs or subshrubs with succulent stems, annuals, usually bisexual; stigma becoming curved or subterminal	*Laportea*
2*	Stinging hairs absent	4
4	Female flowers without perianth but subtended by bractlets and the pistil with a pulverulent surface; flowers on panicles with long pendulous spicate branches	*Myriocarpa*
4*	Female flowers with perianth segments often becoming fleshy orange and enclosing the fruit; flowers on short-branched panicles	*Urera* p.p.

Laportea (cosmopol. 21, CR 1, GD 1)
Shrubs, perennial or annual herbs, characterized by the alternate leaves with stinging hairs and the axillary, open, paniculate inflorescences.

L. aestuans (L.) Chew
Annual herb, up to 1,5(-2) m tall, glabrescent to densely covered with a mixture of glandular and stinging hairs; leaves ovate to broadly ovate to triangular, serrate-dentate, (2-)3-15(-30) cm long, (1-)2-10(-22) cm wide, stipules paired, 4-10 mm long; inflorescences solitary, 3-20 cm long; flowers unisexual, (sub)sessile, 4-5-merous; fruits asymmetrically ovoid, 1-2 mm long. In wet evergreen forests, from Mexico and the West Indies to Peru and Brazil, as well as in tropical and subtropical Asia and Africa.

Myriocarpa (neotrop. 18, CR 4, GD 1)
Shrubs or small trees, often along streams or in wet areas, distinct in having paniculate or long, slender spicate inflorescences and the female flowers lacking a perianth.

M. longipes Liebm., Pl. 103e
Shrub or small tree, twigs sparsely to densely pubescent; leaves ovate to broadly elliptic, variable in size, serrate, stipules connate and ligulate; male inflorescences whitish, pendent, spicate, 12 cm long, female inflorescences of pendulous spikes, 20-60 cm long; flowers unisexual or bisexual; fruits about 1,5 mm long, 1 mm wide, glabrous or sparsely puberulent. In evergreen forests in Central America, ranging from Mexico to Panama.

Urera (pantrop. 35, CR 7, GD 3)
Herbs, shrubs or small trees, often with heavily stinging hairs and cauliflorous inflorescences.

U. eggersii Hieron., Pl. 103f
Large vine, young stems densely hirsute; leaves elliptic, dentate, without stinging hairs, inflorescences axillary, cymose, up to 5 cm long; flowers unisexual, white to greenish; fruits red to orange. in moist and wet forests, from Mexico to Bolivia.

U. elata (Sw.) Griseb., Pl. 103g,h
Shrub or small tree, 3-8 m tall, stinging hairs present at least in the female inflorescences; leaves very variable in size and shape, entire or slightly serrate, stipules united, 5-14 mm long; male inflorescences glomerules, female inflorescences usually of solitary flowers; flowers unisexual, 1-2 mm long; fruits 1-2 mm long, bright orange, subtended by 2 accrescent perianth parts. From Mexico and the West Indies to South America.

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BURGER, W.C. 1977. Urticaceae. Flora Costaricensis. - Fieldiana Bot. 40: 218-283.
CHEW, W.L. 1969. A monograph of *Laportea*. - Gard. Bull. Singapore 25: 111-177.
FRIIS, I. 1993. Urticaceae. Pp.: 612-630. In: K. KUBITZKI (ed.): The families and genera of vascular plants. Vol II. Magnoliid, Hamamelid and Caryophyllid families. - Berlin: Springer Verlag.
KILLIP, E.P. 1960. Urticaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 47: 179-198.

Verbenaceae

Herbs, shrubs, lianas or trees, with often more or less tetragonal branchlets; **leaves** mostly decussate-opposite, sometimes whorled or alternate, simple or palmately compound, petiolate, sometimes sessile, stipules lacking; **inflorescences** axillary or terminal, mostly pedunculate, racemes or cymes, often composed in panicles, bracts mostly small, sometimes colored and leaflike; **flowers** more or less zygomorphic or sometimes actinomorphic (*Aegiphila*, *Avicennia*), bisexual, sepals connate, calyx tubular-campanulate, mostly 4-5-lobate or -toothed, persistent, often enlarged in fruit (*Petrea*), corolla hypocrateriform-infundibular, the limb 4-5-lobate, sometimes more or less 2-lipped, stamens 4-5 or 2 by abortion (*Cornutia*, *Stachytarpheta*), often didynamous, inserted on the corolla tube, ovary superior; **fruits** drupes or schizocarps, separating into 2-4 nutlets, or 2-valved capsules (*Avicennia*). Temperate or subtropical to tropical. 41/950, CR 21/68, GD 15/27.

The family is closely related to the Lamiaceae.

Key to the genera (based on MOLDENKE 1973)

1	Shrubs or trees in mangrove vegetations, with pencil-like pneumatophores, fruit a 2-valved capsule	*Avicennia*
1*	Herbs, shrubs, trees, or lianas, not especially in mangrove vegetations, fruit a drupe or schizocarp	2
2	Leaves palmately compound	*Vitex*
2*	Leaves simple	3
3	Inflorescences heads, spikes, racemes or panicles composed of racemes	4
4	Flowers sessile or subsessile	5
5	Inflorescences long-spicate, 20-50 cm long, fertile stamens 2	*Stachytarpheta*
5*	Inflorescences heads or short-spicate, 1-10 cm long, fertile stamens 4	6
6	Fruit with fleshy exocarp, berry-like	*Lantana*
6*	Fruit with dry exocarp, schizocarp separating in 2-4 nutlets	7
7	Schizocarp separating in 2 nutlets	*Lippia*
7*	Schizocarp separating in 4 nutlets	*Verbena*
4*	Flowers pedicellate	8
8	Herbs, hairs more or less uncinate, the upper pair of stamens with glandular hairs or a glandular thickening at the top of the filaments, (fruit included in the inflated calyx, fruit ornamented with ridges and spines)	*Priva*
8*	Trees, shrubs or lianas, hairs, if present, not uncinate, stamens without glands at the top	9
9	Fruiting calyx with enlarged lobes, acting like wings	*Petrea*
9*	Fruiting calyx without wings, fruit halfway enclosed by the calyx	*Citharexylum*
3*	Inflorescences thyrses, cymes or panicles composed of cymes	10
10	Flowers essentially actinomorphic; stamens 4-6, equal	11
11	Drupes with 1, 4-loculed pyrene; fruiting-calyx conspicuously inflated	*Tectona*
11*	Drupes normally with 4 or 5, 1-loculed and 1-seeded pyrenes; fruiting-calyx not inflated	12
12	Stigma deeply bifid with long awl-shaped branches; flowers diclinous; fruiting calyx enlarged and indurated; stamens inserted at or above the middle of the corolla tube; ovary mostly glabrous	*Aegiphila*
12*	Stigma depressed-capitate or peltate; flowers mostly polygamous; fruiting calyx usually unchanged and patelliform; stamens inserted at or near the base of the corolla tube; ovary usually more or less pubescent	*Callicarpa*
10*	Flowers more or less zygomorphic, especially the corolla; stamens didynamous	13
13	Drupes with 4 (or less through abortion), 1-loculed pyrenes	*Clerodendrum*
13*	Drupes with 1, 4-loculed pyrene	14
14	Fertile stamens 2, staminodes 2	*Cornutia*
14*	Fertile stamens 4	*Gmelina*

Aegiphila (neotrop. 150, CR 11, GD 7)
A genus of lianas, shrubs and small trees with opposite leaves and small flowers in axillary or terminal inflorescences. The fruits are drupes, containing 1-4 nutlets.

A. anomala Pittier
Small tree, up to 15 m tall, branches roughened-puberulent; leaves opposite, clustered at the end of the branchlets, lanceolate or obovate, 7-24 cm long, 6-7 cm wide, entire or slightly revolute-margined, minutely puberulent on both sides; inflorescences axillary, solitary, cymose, to 3 cm long, few-flowered; flowers very odorous, corolla white, tube 4,5-7 mm long, lobes 5, stamens 5; fruits hard, oblong, ca. 9 mm long, ca. 8 mm wide, conspicuously flattened and umbilicate near the apex, seeds 4. In Costa Rica and Panama.

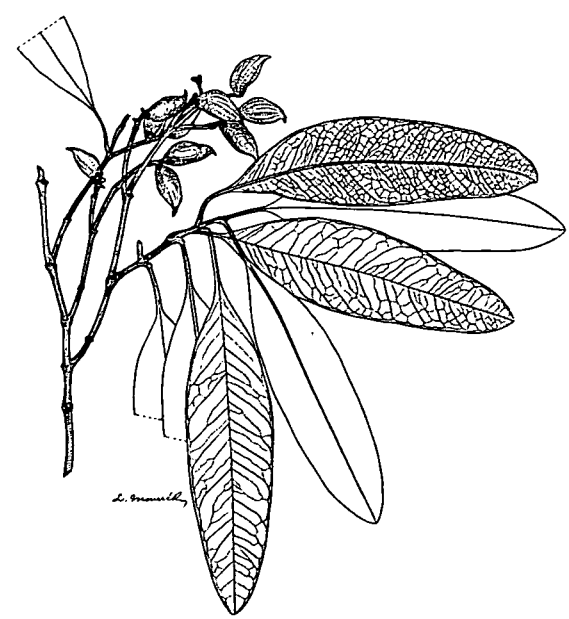
A. cephalophora Standl.
Liana, becoming arborescent, up to 10 m long, stems, petioles, and inflorescence branches bearing dense, long, appressed hairs; leaves elliptic to ovate-elliptic, 10-16 cm long, 5-6,5 cm wide, sparsely appressed-pubescent above, but more densely so on midrib; inflorescences terminal or axillary, cymose, in dense capitate heads; flowers sessile or subsessile, sepals 4, united, ca. 3,5 mm long, enlarging to ca. 5 mm in fruit, corolla 4-lobed, 6-12 mm long, the tube 4-7 mm long, white, stamens 4; fruits globose to ellipsoid, to 9 mm diameter, green, becoming orange at maturity, arranged in dense, more or less globose clusters. In Costa Rica and Panama.

A. costaricensis Moldenke
Shrub or small tree, branches glabrous; leaves lance-oblong to obovate, 7-20 cm long, entire, glabrous; inflorescences axillary cymes, usually 3-flowered; calyx 5 mm long, glabrate, the limb 4-lobate, corolla tube 4 mm long, the 5 lobes 6 mm long; fruits ovoid, 5 mm long. From Mexico to Panama.

A. panamensis Moldenke
Slender shrub or small tree, branches densely puberulent; leaves short-petiolate, thin, oblong-lanceolate to oblong to obovate, 9-17 cm long, entire, rather densely puberulent on both sides, with punctate and disk-shaped glands beneath; inflorescences cymose, dense or lax, 30 cm long or less, the branches densely puberulent; sepals almost 3 mm long, puberulent, truncate, petals pale yellowish, glabrous, the tube 5-7,5 mm long, the 4 lobes 4 mm long; fruits subglobose, 1 cm long, truncate. From southern Mexico to Costa Rica and Panama.

Avicennia (pantrop. 4-7, CR 3, GD 1)
A genus of the mangrove vegetations of the world.

A. germinans (L.) Stearn, Pl. 104a-c
Common name (Costa Rica): palo de sal
Shrub or tree, up to 30 m tall; petioles and inflorescences minutely pubescent or glabrous; leaves narrowly elliptic or elliptic, 5-15 cm long, 1-5 cm wide, entire; inflorescences spicate, 1,5-4 cm long at anthesis; sepals persistent, petals cream with a yellow center, 8-10 mm long; fruits yellow, becoming plum-colored when exposed to the sun, more or less oblique, flattened, ovoid or ellipsoid, 1,5-2 cm long. In Central America and the West Indies to northern South America.



Avicennia germinans

Callicarpa (pantrop. + subtrop. ca. 140, CR 1, GD 1)
This genus is vegetatively characterized by the floccose-stellate indumentum and large membranaceous, serrate leaves.

C. acuminata Kunth, Pl. 104d,e
Shrub, 2-3 m tall, the branches densely stellate-tomentose; leaves ovate-oblong to elliptic, mostly 8-15 cm long, more or less dentate or subentire, glabrate above, densely stellate-tomentose

beneath or sometimes glabrate; inflorescences cymose, small or large, many-flowered, densely stellate-tomentose; petals white; fruits drupes, subglobose, 3-4,5 mm long, glabrous, dark purple or black. From Mexico to Bolivia.

Citharexylum (neotrop. ca. 70, CR 8, GD 4)
Trees and shrubs with drupaceous, fleshy fruits, with the osseous stone, separating into two, 2-seeded nutlets.

C. caudatum L.
Shrub or small tree with terete, glabrous branches; leaves oblong, 7-15 cm long, glabrous, with a pair of black, elongated, sub opposite glands at the base of the lamina above; inflorescences racemose, slender and greatly elongate; petals white, the tube twice as long as the calyx; drupes globose-oblong, black and shining. From Honduras and Belize to Panama.

C. cooperi Standl.
Small tree, the branchlets acutely quadrangular, short-pilose at first with spreading hairs, getting glabrous; leaves ovate to oblong-elliptic, 7-16 cm long, glabrous above or nearly so, densely velutinous-pilose beneath, with a pair of discoid glands at the base of the lamina beneath; inflorescences racemose, 2-5 cm long; fruits globose, 8 mm long. In Costa Rica and Panama.

Clerodendrum (pantrop. ca. 400, CR 6, GD 1)
Shrubs, herbs, or small trees, sometimes scandent, often armed with spines. Leaves opposite, entire or dentate; flowers large or small, in terminal or axillary cymes or panicles.

Cornutia (neotrop. ca. 15, CR 2, GD 2)
Trees and shrubs, usually all parts pubescent or tomentose, or sometimes glandular-punctate. The terminal, paniculate inflorescences bearing small, zygomorphic flowers with blue to purple corolla.

C. pyramidata L., Pl. 104f
Shrub or tree, to 10 m tall, covered with minute globular glands; leaves elliptic, 5-15 cm long 3-7 cm wide, entire; sepals united, calyx campanulate-cupiliform, irregularly 4-dentate, petals blue, violet or pink; fruits globose, 3-4 mm in diameter, pubescent. From southern Mexico to Bolivia and Brazil.

Lantana (neotrop. + Africa 150, CR 6, GD 3)
Shrubs or subshrubs with brightly colored flowers in dense capitate inflorescences.

L. camara L., Pl. 104h
Shrub, 1-2 m tall, armed with small, recurved prickles or unarmed; leaves broadly ovate to oblong-ovate, mostly 3-10 cm long, coarsely crenate-serrate; sepals 4, united, petals 4, united, tubular, yellow or orange, changing to red, stamens 4; drupes round, to 5 mm diameter, black to grayish blue, mesocarp sweet, tasty.
The plant is a troublesome weed in fields and is abundant in many habitats, especially in secondary growth. Widely dispersed in tropical America and introduced into the Old World tropics.

L. trifolia L., Pl. 104g,i
Low shrub; leaves mostly ternate, lanceolate to ovate, margin crenate-serrate; inflorescences spicate, the spikes elongated, at least in fruit, often equaling or exceeding the leaves; petals lilac or purple; fruits subglobose, 2-4 mm in diameter, purple, enclosed by the bracts and the membranaceous calyx. Widely distributed in tropical America, from southern Mexico to Peru.

Lippia (neotrop. + Africa ca. 200, CR 9, GD 1)
Shrubs, trees, or perennial herbs with a salverform, 4-lobate corolla and 4 stamens. The fruit is drupaceous but dry and separates into 2 nutlets.

L. alba (Mill.) N.E. Br. ex Britton & P. Wilson
Aromatic shrub, 1 m tall or less, with slender branches; leaves ovate to oblong, 2-7 cm long, crenate, densely short-pilose; inflorescences capitate, globose or short-oblong, ca. 8 mm wide; petals purple or white, tube 4-5 mm long. Widely distributed in tropical America.

Petrea (neotrop. 30, CR 1, GD 1)
Forest lianas, characterized by the asperous leaves and the showy, blue to violet sepals and petals.

P. volubilis L., Pl. 105a,b
Large, woody vine; leaves short-petiolate, elliptic-oblong to elliptic-oval or obovate-oblong, 5-14 cm long, inflorescences racemose, long-pendent; sepals persistent and accrescent in fruit. Widely distributed in tropical America.

Priva (pantrop. + subtrop. 20, CR 2, GD 1)
Weedy herbs with spicate inflorescences, easy to recognize by their sticky fruits, due to the minute urceolate hairs of the persistent calyx.

P. lappulacea (L.) Pers.
Perennial herb, usually erect, 1 m tall or less, stems rather obtusely angulate and slender; leaves ovate, 6-10 cm long, coarsely crenate; inflorescences many-flowered, usually up to 30 cm long; flowers small, blue. Widely distributed in tropical America.

Stachytarpheta (pantrop. + subtrop. 65, CR 5, GD 1)
Annual or perennial herbs or low shrubs, mostly with opposite leaves and spicate inflorescences or solitary flowers. The fruit is enveloped by the calyx, dry and separates at maturity into 2 nutlets.
S. jamaicensis (L.) Vahl., Pl. 105c,d
Plants stout, herbaceous, 1 m tall or less, the stems glabrous or sparsely and inconspicuously pilose; leaves oblong
to ovate or oval, 3-8 cm long, crenate, glabrous or nearly so; inflorescences spicate, stout, 10-25 cm long, almost glabrous, rhachis much broader than the furrows; petals blue, about 1 cm long, the limb 8 mm broad. Widely distributed in tropical regions of both hemispheres.

Vitex (cosmopol. 250, CR 2, GD 1)
Trees or shrubs with decussate, 3-7 foliate leaves, axillary and/or terminal cymose inflorescences and white, violet or blue flowers.
V. cooperi
Tree up to 26 m tall, usually with buttresses; leaves 3-foliolate, leaflets unequal, the terminal leaflet broadly elliptic, 4,5-22 cm long, 2,5-10,5 cm wide, entire, the lateral leaflets smaller and narrower; inflorescences axillary, solitary, cymose, 3,5-14 cm long, 4-6 cm wide; flowers blue or lavender. Usually along rivers, from Guatemala to Panama.

MOLDENKE, H.N. 1973. Verbenaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 60 (1): 41-148.
RUEDA, R.M. 1993. The genus *Clerodendrum* (Verbenaceae) in Mesoamerica. - Ann. Missouri Bot. Gard. 80 (4): 870-890.
RUEDA, R.M. 1994. Systematics and evolution of the genus *Petrea* (Verbenaceae). - Ann. Missouri Bot. Gard. 81 (4): 610-652.
TOMLINSON, P. B. 1994. The Botany of Mangroves. - Cambridge: Cambridge Univ. Press.

Violaceae

Mostly trees and shrubs but also a few herbs, rather nondescript and vegetatively difficult to recognize sharing similarities with the Flacourtiaceae and Euphorbiaceae. **Leaves** simple, alternate or opposite, entire to serrate, stipules present; **inflorescences** axillary or terminal, spicate, racemose or paniculate or flowers fasciculate or solitary; **flowers** actinomorphic or zygomorphic, bisexual or rarely unisexual, sepals 5, free or basally connate, petals 5, equal to strongly unequal, the anterior one sometimes longer than the others and having a spur, stamens 5, free or connate, in zygomorphic flowers often with dorsal appendages, the connectives often with membranaceous appendages on the top, ovary superior, 1-locular; **fruits** loculicidal capsules, dehiscing by (2-)3(-4) valves, rarely berries or nuts, seeds usually bearing an elaiosome. Best represented in the tropical regions worldwide, with a few genera (but many species) extending into temperate zones. Cosmopol. 20/800, CR 8/29, GD 6/16.

Pollination studies of Violaceae are rare. All genera seem to be adapted to pollination by insects. POWLESLAND (1984) identified several insects, mainly diptera and hymenoptera, as pollinators of three species of *Melicytus* in New Zealand.

Some species of the temperate genus *Viola* are grown as ornamentals. The leaves of the Brazilian species *Rinorea laevigata* are cooked and added to food by local people around Rio de Janeiro (HEKKING 1988).

Key to the genera (after N.N., in prep.)

1 Flowers arranged in long-pedunculate simple cymes, short-pedunculate compound cymes, in panicles or racemes; all petals approximately equal in length, lacking a basal protuberance, the flower ± regularly symmetrical 2

2	Dorsal sterile appendage of stamens absent, replaced by short lacerate ventral appendage, seeds of 2 types, spindle-shaped or disk-shaped	*Fusispermum*
2*	Dorsal sterile appendage of stamens well developed; seeds of one type, ovoid to globose	3
3	Inflorescence a long-pedunculate simple cyme; leaves opposite at summit of branchlets, alternate below summit; one petal twice as broad as the others, emarginate at apex; capsule coarsely muriculate	*Amphirrhox*
3*	Inflorescence a short-pedunculate compound cyme, panicle or raceme; leaves all alternate or opposite; all petals approximately equal in width, rounded at apex; capsule not muriculate	4
4	Inflorescence a panicle or raceme; leaves in most spp. obtuse or concavely tapering at base; sepals in many spp. acute or acuminate; fruit a 3-valved capsule; leaves mostly opposite	*Rinorea*
4*	Inflorescence a compound cyme, leaves broadly rounded at base; sepals broadly rounded; fruit a berry; leaves alternate	*Gloeospermum*
1*	Flowers solitary, in sessile few-flowered glomerules from very short lateral shoots, or in short-pedunculate simple cymes; one petal distinctly longer or shorter than the others, with a basal protuberance or spur, the flowers thus distinctly zygomorphic	5
5	Plant a liana; spur of bottom petal 20 mm or more long, much longer than the blade; capsule globose, 2,5-4 cm long; seeds strongly flattened, with thickened erose marginal wing	*Corynostylis*
5*	Plant a shrub, small tree or rarely a herb; basal protuberance of bottom petal less than 5 mm long, much shorter than the blade; capsule ovoid, to 1,3 cm long	*Hybanthus*

Amphirrhox (neotrop. 6, CR 1, GD 1)
A small genus of glabrous trees and shrubs, with alternate leaves and rather few-flowered axillary or terminal inflorescences with slightly zygomorphic flowers.

A. longifolia (A. St.-Hil.) Spreng., Pl. 105e
Shrub or small tree, up to 10 m tall; leaves narrowly elliptic to narrowly elliptic-subovate, more or less clustered at the ends of the branchlets; inflorescences axillary and terminal, cymose, mostly 3-flowered; petals whitish, 1,5-2 cm long; fruits 3-valved, ellipsoid capsules, up to 2,4 cm long. In lowland wet forests, distributed, from southern Mexico to Colombia, Venezuela, Peru and Brazil.

Fusispermum (neotrop. 2, CR 1, GD 1)
A small genus of small to large trees with alternate leaves, racemose inflorescences, small, actinomorphic flowers and 3-valved fruits.

F. laxiflorum Hekking, Pl. 105f
Small treelet, up to 5 m tall; leaves subentire to serrate, 16-18 cm long, 5-6,5 cm wide, stipules caducous, leaving an annular scar; inflorescences axillary, narrowly thyrsoid to pseudoracemose; petals white, 1,7-1,8 mm long; fruits small, 3-valved capsules, up to 2 mm long, 1,5 mm wide. In lowland wet forests in Costa Rica and Panama.

Rinorea (pantrop. ca. 200, CR 10, GD 9)
Trees and treelets with mostly opposite or rarely alternate, mostly serrate or serrulate leaves, small actinomorphic flowers and 3-valved capsules.

R. crenata S.F. Blake, Pl. 105g
Tree or small treelet, up to 15 m tall; leaves alternate, margin crenate to serrate, stipules soon deciduous; inflorescences axillary, lateral and subterminal, thyrsoid, up to 5(-7) cm long, petals white; capsules symmetric, orbicular to ellipsoid, glabrous. In lowland rain forests, as well as sometimes epiphytic in cloud forests in Costa Rica and Panama.

R. dasyadena A. Robyns
Tree or small treelet, up to 13 m tall; leaves opposite, only the basal leaves alternate, margin subentire, stipules deciduous; inflorescences axillary, lateral and subterminal, (pseudo-)racemose, axis sparsely golden to ferruginous pilosulous; petals whitish, cream to yellowish, occasionally purplish; capsules somewhat asymmetric, ovoid, golden to ferruginous pilosulous. In lowland rain forests and submontane regions, from Costa Rica to Colombia.

R. hummelii Sprague
Tree or small treelet, up to 14 m tall; Leaves apparently opposite, only the basal leaves alternate, glabrous, margin subentire to (sub)serrate to (sub)crenate, stipules deciduous; inflorescences axillary, lateral and subterminal, racemose to thyrsoid, axis golden pilosulous, petals yellowish-white; capsules rather symmetric, ellipsoid, golden-brownish hispidulous. Common in lowland rain forests and submontane regions as well as in disturbed forests, from southern Mexico to Panama.

BLAKE, S.F. 1924. Revision of the American species of *Rinorea*. - Contr. U.S. Natl. Herb. 20: 491-518.
HEKKING, W.H.A. 1984. Studies on neotropical Violaceae: the genus *Fusispermum*. - Proc. Kon. Ned. Akad. Wetensch., Ser. C, Biol. Med. Sci. 87 (2): 121-130.
HEKKING, W.H.A. 1988. Violaceae, part I - *Rinorea* and *Rinoreocarpus*. - Fl. Neotrop. Monogr. 46.
N.N. In prep. Violaceae. Manuál de las plantas de Costa Rica. Missouri Botanical Garden. Instituto Nacional de Biodiversidad. Museo Nacional de Costa Rica.
POWLESLAND, M.H. 1984. Reproductive biology of three species of *Melicytus* (Violaceae) in New Zealand. - New Zealand J. Bot. 22 (1): 81-94.
ROBYNS, A. 1967a. Violaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 54 (1): 65-84.
ROBYNS, A. 1967b. A new species of *Rinorea* (Violaceae) from Panama. - Ann. Missouri Bot. Gard. 54 (2):186-188.

Viscaceae

A family of hemiparasitic shrubs and herbs, closely related to the Loranthaceae, from which they can be distinguished by the absence of a calyculus and the inflorescence, which is divided into several small decussate branches. Plants parasitic on arial stems or on branches of trees and shrubs; stems often articulate at the nodes; **leaves** simple, opposite, coriaceous, glabrous, sometimes reduced to minute scales (*Dendrophthora*), margins entire, stipules lacking, a pair of prophylles sometimes present above the base of the lateral branches; **inflorescences** axillary, rarely terminal, spicate, sometimes dense and catkin-like; **flowers** minute, inconspicuous, usually greenish to whitish, unisexual (plants monoecious or dioecious), arising individually or variously clustered from depressions in the inflorescence, tepals 2-4, calyculus lacking, stamens 3-4, epitepal and adnate to the tepals, ovary inferior, unilocular; **fruits** berries, seed 1, embedded in sticky tissue. Most abundant in tropical areas, but also extending into temperate regions. Cosmopol. 7/385, CR 2/24, GD 1/4.

The Viscaceae are sometimes treated as a subfamily of Loranthaceae, but in accordance with recent taxonomic investigations (BURGER & KUIJT 1983, KUIJT 1986), it is here regarded as a distinct family. Within the family there are root parasitic terrestrial plants as well as shoot parasitic hemiepiphytes and epiphytes. Unlike Loranthaceae, only a few of the Viscacean mistletoes possess so-called epicortical roots, which grow along the host branch and develop haustoria (KUIJT 1969).

The flowers of Viscaceae are mostly pollinated by insects, but there are also several anemophilous species (KUIJT 1969). Flowers of the mistletoe, *Viscum album*, are visited by a large variety of diptera, which feed on the nectar from the female flowers as well as on pollen from the male flowers (KAY 1986). Another well-investigated entomophilous (partly anemophilous) species is the North American *Arceuthobium pusillum* (BAKER et al. 1985).

The fruits of the mistletoes are usually eaten by various unspecialized frugivorous birds. They disperse the seeds by depositing them onto the branch of another host tree. Due to the sticky tissue, the seeds adhere strongly to the host tree and are quite safe from being washed away by the rain (KUIJT 1969). Another dispersal mode is present in some mistletoes where seeds are dispersed by the explosion of the dry fruits. For instance, the bullet-shaped seeds of *Arceuthobium* spp. are shot out up to distances of nearly 15 m and with a velocity of about 24 m/s (KUIJT 1969).

Viscum album in Europe and *Phoradendron serotium* in North America are the traditional Christmas mistletoes and are used as ornamentals during celebrations. The sticky tissue of the fruits of *Viscum album* and some other mistletoes was formerly used as a bird-lime as well as for catching flies (KUIJT 1969).

Phoradendron (neotrop. 190, CR 16, GD 4)
The New World mistletoe, replaced in the Old World by *Viscum*. Hemiepiphytic shrubs, characterized by the spicate inflorescences bearing intervals of flower clusters alternating with bracts, and the small, often reddish flowers arising from small pits in the inflorescence axis.

P. crassifolium
Shrub; a pair of scale leaves present just above the leafy nodes; leaves opposite, ovate to elliptic-oblong to oblanceolate, 6-16 cm long, (2-)4-10 cm wide, entire, apex acute to acuminate, petiole continuous with the lamina; inflorescences axillary, 1-2 per axil, spicate, 1-3 cm long, with 4 vertical ranks of 1-2(-3) flowers; fruits 2-3 mm long, ca. 2,5 mm wide, pale orange-yellow when mature. Endemic to the Pacific side of Costa Rica.

P. robustissimum Eichler
Small shrub, about 1 m tall, commonly grayish or olive green; a pair of scale leaves present just above the leafy nodes; leaves symmetric or asymmetric, lamina usually oblong, 3,5-10(-14) cm long, 2-5(-8,5) cm wide, entire, apex rounded, petiole continuous with the lamina; inflorescences axillary, spicate, unisexual, staminate inflorescence of 1-12 spikes, these up to 11 cm long, pistillate inflorescence of 1-several spikes, these up to 6 cm long; fruits berries, elliptic-ovate, about 4 mm long, 2 mm wide, yellowish-green. In evergreen and deciduous lowland forests, from southern Mexico to Venezuela and in Ecuador.

BAKER, F.A., D.W. FRENCH, H. KULMAN, O.DAVIES & R.C. BRIGHT. 1985. Pollination of the eastern dwarf mistletoe. - Canad. J. For. Res. 15: 708-714
BURGER, W. & J. KUIJT. 1983. Viscaceae. Flora Costaricensis. - Fieldiana Bot. 13, n.s. pp: 59-79.
KAY, Q.O.N. 1986. Dioecy and pollination in *Viscum album*. - Watsonia 16: 232
KUIJT, J. 1969. The biology of parasitic flowering plants. - Univ. California Press.
KUIJT, J. 1986. Viscaceae. In: G. HARLING & L. ANDERSSON (eds.): Flora of Ecuador 24: 11-112.
RIZZINI, C.T. 1982. Loranthaceae. In: T. LASSER (ed.), Flora de Venezuela. Vol IV. Segunda Parte.
RIZZINI, C.T. 1960. Loranthaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 47: 263-290.

Vitaceae

A family of herbs and lianas, mostly climbing and tendrillate, with the tendrils arising opposite of the leaf and frequently bearing suckers, rarely erect treelets. **Leaves** alternate, simple or palmately lobed or compound, often pellucid punctate, stipules present; **inflorescences** usually opposite the leaves, mostly cymose or paniculate; **flowers** actinomorphic, bisexual or unisexual, then plants usually monoecious, small, sepals (3-)4-5(-7), mostly basally connate, petals as many as the sepals, sometimes calyptrate, disk present, annular or lobed, stamens as many as the petals, epipetalous, arising from the disk, ovary superior, 2-(3-6)-locular; **fruits** berries, seeds 1-4(-6), often black or dark purple when mature. Distributed worldwide, mainly in the tropics and subtropics. Pantrop. + subtrop. 14/850, CR 3/19, GD 1/7.

The liana *Vitis vinifera* is one of the most important commercial plants worldwide. The grape has its origin in southeastern Europe and is now cultivated worldwide in subtropical and temperate regions. The fruits are eaten or used for the production of wine. Species of *Cissus* (e.g. *C. alata*), as well as species of *Parthenocissus*, are used as indoor and outdoor ornamentals. Some species of *Cissus* are of importance in popular medicine (LOMBARDI 2000).

The fruits of *Cissus pseudosicyoides* are probably dispersed by birds (CROAT 1973).

Cissus (pantrop + subtrop. ca. 200, CR 15, GD 8)
Usually woody climbing vines with simple or 3-5-foliolate leaves and always cymose inflorescences, bearing 4-merous flowers.

C. alata Jacq.
(syn. *C. rhombifolia* Vahl)
Herbaceous or woody vine, densely pubescent with short and gland-tipped hairs; leaves trifoliolate, leaflets serrate, the terminal leaflet rhombic; inflorescences cymose, congested in pseudoumbels; fruits obovoid, 6-10 mm long. In tropical dry and wet forests, from Mexico to Peru, Bolivia and Venezuela.

C. anisophylla Lombardi
Liana, indumentum of T-shaped trichomes; leaves simple, denticulate, basally cordate to truncate, green; inflorescences umbellate, 8-9,1 cm long; fruits almost globose, ca. 8 mm in diameter, purple. From Costa Rica to Ecuador.

C. biformifolia Standl., Pl. 105h
Liana, indumentum of T-shaped trichomes; leaves simple, elliptic, triangular or cordate, denticulate, (5,6-)7,6-13,8(-23,7) cm long, (0,8-)2,7-7,6(-16,2) cm wide, mature leaves glabrous to sparsely pubescent; inflorescences umbelliform, leaf-opposite, 3,5-4,6 cm long, flowers red; fruits almost globose, ca. 11 mm in diameter, purple. In primary and secondary forests, from Mexico to Panama.

C. fuliginea H.B.K
(syn. *C. pseudosicyoides* Croat)
Herbaceous or basally woody vine, densely and inconspicuously pubescent; leaves simple, denticulate, basally cordate to cuneate, glaucous; inflorescences cymose, terminal or opposite the upper leaves, 1-4 cm long; fruits almost globose, up to 6 mm in diameter, purple. Widespread in lowland areas, from Costa Rica to Colombia, Venezuela and Brazil.

CROAT, T.B. 1973. A new species of *Cissus* (Vitaceae) for Central and South America. - Ann. Missouri Bot. Gard. 60: 564-567.
ELIAS, T.S. 1968. Vitaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 55 (2): 81-92.
LOMBARDI, J.A. 2000. Vitaceae. Gêneros *Ampelocissus*, *Ampelopsis* e *Cissus*. Fl. Neotrop. Monogr. 80.
MORALES, F. In prep. Vitaceae. Manual de las Plantas de Costa Rica. Missouri Botanical Garden. Instituto Nacional de Biodiversidad. Museo Nacional de Costa.

Vochysiaceae

A small family, closely related to the Polygonaceae and Trigoniaceae, with its distribution center in the Amazon Basin. Trees, shrubs, or rarely herbs with small, usually caducous stipules, which are sometimes replaced by a circular gland or rarely with the glands in the stipule axils; **leaves** simple, opposite or whorled, usually entire; **inflorescences** racemes or panicles, terminal or axillary; **flowers** hermaphrodite, zygomorphic, calyx 5-lobate, one of the sepals spurred, petals (0-)1-3(-5), free, often white or yellow, stamen 1, staminodes usually present, ovary superior to inferior, (1-)3-locular; **fruits** three-parted capsules, sometimes winged, often with winged seeds. In savannas and lowland rain forests throughout the Neotropics, except one genus, *Erismadelphus*, which is limited to tropical Africa. Neotrop. + W-Africa 8/210, CR 2/6, GD 2/5.

More advanced genera with zygomorphic flowers, such as *Vochysia* or *Qualea,* are adapted to pollination by various bees (FISCHER & GORDO 1993, OLIVEIRA & GIBBS 1994, OLIVEIRA 1998, SANTOS et al. 1998), while the more primitive genus *Salvertia,* with pentamerous flowers, is pollinated by hawkmoths (OLIVEIRA 1998). In some species of *Vochysia* and *Qualea* hummingbirds or sphingids function as secondary pollinators (OLIVEIRA & GIBBS 1994, OLIVEIRA 1998, SANTOS et al. 1998).

The wood of *Qualea paraensis* is used for roofing and for various other purposes by the local people.

Key to the genera

1	Glands in the axils of the stipules, or instead of the stipules	*Qualea*
1*	Plants without glands	*Vochysia*

Qualea (neotrop. 59, CR 1, GD 1)
Trees and shrubs mainly of savannas and rain forests, unmistakable in flower by having only a single petal as well as in fruit by its unwinged capsule.
Q. paraensis Ducke, Pl. 106a
Common names (Costa Rica): masicaran, areno (Costa Rica)
Large tree; leaves opposite, simple, with numerous parallel secondary veins; circular glands in the stipule axils; flowers with sweet odor; petal 1, white or pink, with red base and yellow center; anther 7-9 mm long, staminodes present. In tierra firme forests, from Nicaragua to Amazonian Brazil and Peru.

Vochysia (neotrop. 100, CR 5, GD 4)
A genus consisting of trees with usually 3 mostly yellow to yellowish petals and opposite to whorled leaves with small deciduous stipules, always without glands. Fruiting individuals can be distinguished from *Qualea* species by the winged capsules containing winged seeds.
V. allenii Standl. & L. O. Williams
Common names (Costa Rica): botarrama, mayo
Medium sized tree, young twigs, leaves and inflorescences sparse ferrugineous pubescent to almost glabrous; leaves opposite, with subparallel secondary veins; inflorescences terminal, many-flowered; flowers with straight spur; capsules 1,5-2 cm long. In hilly rainforests, in Costa Rica and Panama. The glabrous leaves and the straight spur of the flowers distinguish it from *V. ferruginea*.
V. ferruginea Mart., Pl. 106b
Common names (Costa Rica): chancho colorado (STAFLEU 1948), mayo.
Medium-sized tree; leaves, inflorescences and young branches densely ferruginous tomentose; leaves opposite, with subparallel secondary nerves; inflorescences terminal and axillary, many-flowered, flowers with recurved spur, petals 3, staminodes present; capsules1,7-2,5 cm long. In rain forests and savannas, from Nicaragua to the Amazon Basin.
V. megalophylla Stafleu, Pl. 106c,d
Common name (Costa Rica): ira de agua
Medium-sized tree; leaves opposite, glabrous turning yellowish or green-yellow when dry; inflorescences many-flowered, flowers with rather straight spur, petals three, staminodes present; capsules 4-7 cm long. From Costa Rica to Colombia.

FISCHER, E.A. & M. GORDO. 1993. *Qualea cordata*, pollination by the territorial bee *Centris tarsata* in the "campos rupestres", Brazil. - Ci. & Cult. 45 (2): 144-147.
FLORES, E.M. 1993a. Mayo colorado. Red Yemeri. - Arboles Semillas Neotrop. 2 (2): 29-52.
FLORES, E.M. 1993b. Chancho blanco. White Yemeri. - Arboles Semillas Neotrop. 2 (2): 1-27.
OLIVEIRA, P.E. 1998. Reproductive biology, evolution and taxonomy of Vochysiaceae in Central Brazil. Pp.: 381-393. In: S.J. OWENS & P.J. RUDALL (eds.). Reproductive Biology, - Kew: Royal Botanic Gardens, Kew.
OLIVEIRA, P. & P. GIBBS. 1994. Pollination biology and breeding systems of six *Vochysia* species (Vochysiaceae) in Central Brazil. - J. Trop. Ecol. 10 (4): 509-522.
ROBYNS, A. 1967. Vochysiaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 54 (1): 1-7.
SANTOS, M.L., AFONSO, A.P. & P.E. OLIVEIRA. 1997. Biologia floral de *Vochysia cinnamomea* Pohl (Vochysiaceae) em cerrados do Triângulo Mineiro. - Rev. Brasil. Bot. 20: 127-132.
STAFLEU, F.A. 1948. A monograph of the Vochysiaceae I. *Salvertia* & *Vochysia*. - Recueil Trav. Bot. Néerl. 41 (2): 397-540.
STAFLEU, F.A. 1953. A monograph of the Vochysiaceae III. *Qualea*. - Acta Bot. Neerl. 2 (2): 144-217.

Zygophyllaceae

Annual or perennial herbs, shrubs or trees with strong scent and sticky resin, well characterized by the often swollen or articulated nodes at the branches. **Leaves** mostly opposite, rarely alternate, frequently distichous, mostly even-pinnate, sometimes simple to 2-foliolate or 3-7-parted, fleshy to coriaceous, leaflets entire, stipules present, free, usually persisting, sometimes spiny; **inflorescences** racemose or fasciculate or flowers solitary; **flowers** mostly actinomorphic, bisexual, rarely unisexual, plants then dioecious, sepals (4-)5(-6), free, or basally connate, petals as many as the sepals, free or basally connate, disk usually present, often glandular, stamens mostly twice as many as the petals, free, ovary supe-

rior, (2-)5(-12)-locular; fruits capsules, loculicidally or septicidally dehiscent, or a schizocarp, breaking into few to several, sometimes spiny or winged mericarps or nutlets, seeds sometimes arillate. Distributed throughout the world, best represented in dry and arid habitats. Pantrop. + subtrop. 27/285, CR 2/3, GD 1/1.

PORTER (1969b) states that *Kallstroemia* flowers appear to be visited and pollinated by various diptera, hymenoptera and lepidoptera.

Some species of *Kallstroemia* are of local economic importance. *K. maxima* is used for medicinal purposes and is also eaten by humans (PORTER 1969b). *K. pubescens* is reported to be used as a local medicine against kidney stones in Guatemala (PORTER 1969b).

Kallstroemia (neotrop. + subtrop. 17, CR 2, GD 1)
Prostrate to decumbent or ascending weedy herbs, sometimes slightly woody, with paripinnate leaves, consisting of 2-10 pairs of leaflets and the fruits splitting into several mericarps.

K. pubescens (G. Don) Dandy
Annual herb, stems up to 1 m long; leaves with 2-3 pairs of subsessile leaflets, indumentum of appressed hairs, stipules linear, 3-4 mm long; flowers axillary, solitary, petals white to yellow; fruits 5-6 mm in diameter near the base, with 10 longitudinal ridges, surface appressed pilose. On open, sunny sites in lowland formations, from central Mexico and the West Indies to Colombia, Venezuela, Ecuador and Peru.

BURGER, W. 1991. Zygophyllaceae. Flora Costaricensis. - Fieldiana Bot. 28.: 36-41.
PORTER, D.M. 1969a. Zygophyllaceae. In: R.E. WOODSON, R.W. SCHERY et al.: Flora of Panama. - Ann. Missouri Bot. Gard. 56 (1): 1-7.
PORTER, D.M. 1969b. The genus *Kallstroemia* (Zygophyllaceae). - Contr. Gray Herb. 198: 41-153.

Appendix I. Authors of family treatments

Baumgartner, T., G. Zimmermann & N. Zamora: Arecaceae.
Huber, W. & B. Hammel: Burmanniaceae, Clusiaceae, Cyperaceae, Haemodoraceae, Heliconiaceae, Marantaceae.
Huber, W. & N. Zamora: Amaryllidaceae, Poaceae, Pontederiaceae, Smilacaceae.
Kastinger, C. & A. Estrada: Campanulaceae.
Kastinger, C. & J. González: Boraginaceae, Lamiaceae, Oleaceae.
Kastinger, C. & B. Hammel: Convolvulaceae.
Kastinger, C. & F. Morales: Apocynaceae, Asclepiadaceae, Caricaceae, Oxalidaceae.
Kastinger, C. & A. Rodríguez: Begoniaceae.
Kastinger, C. & J. Sanchez: Loganiaceae, Solanaceae.
Kastinger, C. & N. Zamora: Acanthaceae, Asteraceae, Gentianaceae, Verbenaceae, Scrophulariaceae.
Kastinger, C. & G. Zimmermann: Balanophoraceae, Combretaceae, Lentibulariaceae.
Schembera, E., G. Zimmermann & N. Zamora: Fabaceae-Caesalpinioideae, Fabaceae-Faboideae, Fabaceae-Mimosoideae.
Till, W. & F. Morales: Bromeliaceae.
Weber, A. & B. Hammel: Cyclanthaceae.
Weber, A., C. Kastinger & N. Zamora: Gesneriaceae.
Weber, A. & N. Zamora: Orchidaceae.
Will, S., G. Zimmermann & J. Sanchez: Rubiaceae.
Weissenhofer, A. & M. Grayum: Araceae.
Weissenhofer, A. & B. Hammel: Commelinaceae, Costaceae, Dioscoreaceae, Zingiberaceae.
Weissenhofer, A. & A. Rodríguez: Passifloraceae.
Weissenhofer, A. & N. Zamora: Alismataceae.
Zimmermann, G. & A. Estrada: Lythraceae, Melastomataceae, Myrtaceae.
Zimmermann, G. & J. González: Amaranthaceae, Cecropiaceae, Cucurbitaceae, Dilleniaceae, Euphorbiaceae, Hernandiaceae, Lauraceae, Malpighiaceae, Monimiaceae, Papaveraceae, Rhamnaceae, Violaceae.
Zimmermann, G. & Q. Jiménez: Anacardiaceae, Caryocaraceae, Chloranthaceae, Meliaceae, Myristicaceae, Olacaceae, Rutaceae, Simaroubaceae.
Zimmermann, G. & B. Hammel: Cactaceae, Celastraceae, Hippocastanaceae, Icacinaceae, Marcgraviaceae, Triuridaceae.
Zimmermann, G. & F. Morales: Apiaceae, Araliaceae, Aristolochiaceae, Bignoniaceae, Cochlospermaceae, Crassulaceae, Juglandaceae, Lecythidaceae, Loranthaceae, Magnoliaceae, Myrsinaceae, Phytolaccaceae, Polygonaceae, Sabiaceae, Sapindaceae, Proteaceae, Ulmaceae, Viscaceae, Vitaceae.
Zimmermann, G., F. Morales &. N. Zamora: Clethraceae.
Zimmermann, G. & A. Rodríguez: Tiliaceae.
Zimmermann, G. & N. Zamora: Actinidiaceae, Aizoaceae, Annonaceae, Aquifoliaceae, Bixaceae, Bombacaceae, Brunelliaceae, Burseraceae, Cabombaceae, Canellaceae, Cannaceae, Capparidaceae, Caprifoliaceae, Caryophyllaceae, Chrysobalanaceae, Connaraceae, Dichapetalaceae, Ebenaceae, Elaeocarpaceae, Ericaceae, Erythroxylaceae, Fagaceae, Flacourtiaceae, Hippocrateaceae, Humiriaceae, Hydrangeaceae, Hydrocharitaceae, Lemnaceae, Lepidobotryaceae, Limnocharitaceae, Malvaceae, Menispermaceae, Menyanthaceae, Molluginaceae, Moraceae, Musaceae, Nyctaginaceae, Nymphaeaceae, Ochnaceae, Onagraceae, Piperaceae, Podocarpaceae, Podostemaceae, Polygalaceae, Portulacaceae, Quiinaceae, Rafflesiaceae, Rhizophoraceae, Rosaceae, Sapotaceae, Sterculiaceae, Styracaceae, Symplocaceae, Theaceae, Theophrastaceae, Thymelaeaceae, Ticodendraceae, Tovariaceae, Turneraceae, Typhaceae, Urticaceae, Typhaceae.

Appendix II. List of Photo Authors

Aguilar, R.F.: Plate 11d, 13b, 13d, 17c, d, e, 22g, 29d, 34c, 35c, d, f, j, 37a, b, e, f, 38h, j, k, l, 39b, e, i, 40a, b, 41j, 42c, 43d, g, 44e, g, h, 46b, e, g, 48d, 49c, e, 50d, f, i, 51b, c, g, 52c, 53b, g, h, 54c, d, e, f, g, 55b, f, h, i, 56a, f, 57a, b, 58a, b, e, f, 59a, f, 60e, 61d, h, 62b, d, f, g, 63c, d, f, g, 64a, c, d, 65e, g, i, 67d, h, i, 68d, e, f, g, h, 71a, 72c, d, 73c, e, f, g, 74a, b, c, d, f, 75f, 76b, f, h, 77c, 78a, 79f, 80b, f, g, 81h, 82d, 83a, b, d, 84a, c, 84f, 85a, d, 86f, 87c, e, f, h, 90h, 91a, b, 92a, 98a, c, d, g, h, i, 100a, h, i, 103c, g, h, 104c, d, e, f, i, 105e, f, 106b, d.
Baumgartner, T.: 18c.
Grayum, M.: 16c.
Hammel, B.: 13a, c, e, 16e, 17a, 19a, b, 26a.
Huber, W.: 1c, b, 2c, 4a, 6a, b, 6c, 7b, 8a, b, c, d, e, 9d, f, g, 10b, 11c, g, 13f, 14b, c, e, i, 16a, f, 17g, 18c, d, g, h, 19c, e, 20f, 21a, e, 23a, d, 24g, 25f, 26d, 27c, e, 29a, 30d, h, 31c, 32b, h, 33b, c, 34a, 35e, h, 36a, i, 37d, h, 38f, g, i, 39c, d, 40e, h, 41e, 42d, f, g, 43b, c, e, 44f, i, 45g, 47b, g, 48e, f, g, i, 49f, h, 50a, h, 51d, 52b, g, 53a, 55d, 56e, 58c, d, 59c, g, j, 60d, g, 61c, f, g, 62a, c, 63a, e, 64b, e, 65f, 66i, j, 67 g, 69b, g, h, 72f, 73a, 74g, 75b, c, e, 76a, c, e, 77b, d, f, 78g, 79a, b, d, e, 80d, 81a, d, e, i, 82c, f, 83f, g, 84b, d, e, g, 85b, g, 86a, g, 87d, 88b, d, 90g, 91g, i, 92d, 93a, 94f, 95b, 97a, b, d, e, 98j, 99a, f, 100f, g, 101d, e, g, i, 102i, 103f, 104h, 105a, h.
Mayer, V.: 88e, 90c.
Mora, E.: 22b.
Morales, J.F.: 40c.
Prader, W.: 15b, 47f.
Rodriguez, A.: 41a, b, c, d, 51f, 58g, 61e, 71b, 90a, d, 98e, c, 102c, 104g.
Schneider, A.: 67f.
Till, W.: 48a.
Vargas, L.D.:: 91c.
Weber, A.: 1b, 7d, 9a, b, 10d, 11f, 12c, 15a, g, h, 20g, 22d, e, h, 23c, f, g, h, 24a, d, e, f, 25c, d, e, 26e, g, h, i, 27b, 28c, d, e, 29b, e, f, 30a, b, c, 31d, g, 33a, d, e, f, 34d, 35a, b, 36b, c, 37g, 38a, b, c, d, e, 40f, g, i, 41g, h, 42a, 44b, d, 45a, 46a, 46c, d, i, 47a, c, 49b, 50c, 54a, b, j, k, 57e, f, 59b, 64f, 65h , 66f, h, 67a, b, e, 69e, f, 70a, b, d, 71d, e, f, g, h, 72g, 75a, 76d, 77e, h, 78b, c, e, 80i, 81b, g, 82b, 88a, c, 89d, e, g, h, 90f, 92b, e, g, 93e, f, h, i, j, 94g, 95f, j, h, 99b, c, 100c, e, 102b, d, e, g, h.
Weish, P.: 10e, 27f, 31b, 32a, c, i, 70c, f.
Weissenhofer, A.: 1a, 2a, 3a, b, c, 4b, c, 5a, b, c, 7a, c, 9c, e, 10a, c, f, 11a, b, e, h, i, 12a, b, d, e, f, g, h, 13g, h, 14a, d, f, g, h, 15c, d, e, f, 16b, d, 17b, f, h, 18a, b, f, 19d, f, g, h, 20a, b, c, d, e, 21b, c, d, f, 22a, c, f, 23b, e, 24b, c, h, 25a, b, g, 26b, c, f, 27a, d, g, 28a, b, f, g, 29c, 30e, f, g, 31a, e, f, 32d, e, f, g, 34b, 35g, i, 36d, e, f, g, h, 37c, 39a, f, g, h, 40d, j, 41f, i, k, 42b, e, 43a, f, h, i, 44a, c, 45b, c, d, e, f, 46f, h, 47d, e, 48b, c, h, 49a, d, g, 50b, e, g, 51a, e, h, 52a, d, e, f, 53c, d, e, f, h, 55a, c, e, g, 56b, c, d, g, 57c, d, g, h, 59d, e, h, i, k, 60a, b, c, f, 61a, b, 62h, i, 63b, h, 66d, e, g, 67c, 68a, b, c, 69a, c, d, 70e, 71c, 72a, b, e, 73b, d, 74e, 75d, 76g, 77a, g, 78d, f, h, 79c, 80a, c, e, h, 81c, f, 82a, e, g, 83c, e, h, 85c, e, f, 86b, c, d, e, 87a, b, g, 89a, b, c, f, 90b, e, 91f, h, 92i, 93k, 94e, h, 95c, d, e, i, 96c, e, 97f, g, 98b, f, 99d, e, 100b, d, 101a, b, c, f, h, 102a, f, 103a, b, d, e, 104a, 104b, 105b, c, d, g, 106a, c.
Will, S.: 92c, f, h, 93b, c, d, g, 94a, b, c, d, 95a, g, h, 96a, b, d, f, g, h, 97c.
Zamora, N.: 62e, 65a, b, c, d, 66a, b, c, 87i, 91d, e.
Zimmermann, G.: 54i.

Appendix III. Authors of Line Drawings

Instituto Nacional de Biodiversidad, Costa Rica

Aragón, C.: ACANTHACEAE: *Bravaisia integerrima*, ACTINIDIACEAE: *Saurauia yasicae*, ANACARDIACEAE: *Anacardium excelsum*, *A. occidentale*, *Mangifera indica*, ANNONACEAE: *Annona amazonica*, *A. pittieri*, *Cananga odorata*, *Guatteria amplifolia*, *G. chiriquiensis*, *Rollinia pittieri*, APOCYNACEAE: *Aspidosperma megalocarpon*, *Tabernaemontana longipes*, ASTERACEAE: *Tessaria integrifolia*, BIGNONIACEAE: *Amphitecna kennedyi*, *A. latifolia*, *Tabebuia chrysantha*, BIXACEAE: *Bixa orellana*, BOMBACACEAE: *Huberodendron allenii*, BORAGINACEAE: *Bourreria grandicalyx*, *Cordia bicolor*, *C. cymosa*, BURSERACEAE: *Protium ravenii*, CAPPARIDACEAE: *Capparis cynophallophora*, FABACEAE/CAES.: *Copaifera camibar*, *Cynometra retusa*, *Macrolobium hartshornii*, FABACEAE/MIM.: *Calliandra tergemina*, *Cojoba rufescens*, *Inga acrocephala*, *I. bella*, *I. allenii*, *I. cylindrica*, *I. goldmanii*, *I. golfodulcensis*, *I. jimenezii*, *I. litoralis*, *I. pezizifera*, *I. polita*, *I. skutchii*, *Zapoteca portoricensis*, *Zygia cognata*, *Z. englesingii*, *Z. rubiginosa*, *Z. unifoliolata*, FABACEAE/PAP.: *Ormosia paraensis*, *Paramachaerium gruberi*, *Platymiscium curuense*, *Pterocarpus violaceus*, *Swartzia myrtifolia*, LEPIDOBOTRYACEAE: *Ruptiliocarpon caracolito*, SAPINDACEAE: *Talisia allenii*.

Missouri Botanical Garden: WOODSON, SCHERY et al. (1943-1980) Flora of Panama. Ann. Missouri Bot Gard. (var. volumes).

Bazan, R.J.: RUBIACEAE: *Amphidasya ambigua*.
Becker, J.H.: RUBIACEAE: *Posoqueria latifolia*.
Cuddy, H.J.: FABACEAE/PAP.: *Pterocarpus officinalis*, OCHNACEAE: *Ouratea lucens*, GENTIANACEAE: *Voyria tenella*, TILIACEAE: *Luehea seemannii*, EUPHORBIACEAE: *Alchornea costaricensis*.
Klein, J.E.: ACANTHACEAE: *Asystasia gangetica*, *Chaetochlamys panamensis*.
CAMPANULACEAE: *Sphenoclea zeylandica*, CUCURBITACEAE: *Fevillea cordifolia*, *Momordica charantia*, *Psiguria warscewiczii*, *Sicydium tamnifolium*, ICACINACEAE: *Calatola costaricensis*, RUBIACEAE: *Alibertia edulis*, *Boroja patinoi*, *Coccocypselum hirsutum*.
Mourré, L.: HIPPOCASTANACEAE: *Billia colombiana*, BIGNONIACEAE: *Macfadyena unguiscati*, APOCYNACEAE: *Mesechites trifida*, BORAGINACEAE: *Tournefortia glabra*, BURSERACEAE: *Protium panamense*, RHAMNACEAE: *Gouania lupuloides*, VERBENACEAE: *Avicennia germinans*.
Velick, B.: ANNONACEAE: *Cymbopetalum lanugipetalum*, MORACEAE: *Castilla tunu*, MENISPERMACEAE: *Cissampelos tropaeolifolia*, BOMBACACEAE: *Ochroma pyramidale*.
White, R.J.: BIGNONIACEAE: *Martinella obovata*, ASCLEPIADACEAE: *Blepharodon mucronatum*.
Wilson, Y.L.: MALPIGHIACEAE: *Banisteriopsis cornifolia*, RUBIACEAE: *Psychotria uliginosa*, GESNERIACEAE: *Columnea florida*, *Drymonia alloplectoides*, *Kohleria spicata*, ERICACEAE: *Psammisia ramiflora*.
Wise, R.: EBENACEAE: *Diospyros digyna*.
N.N. AIZOACEAE: *Trianthema portulacastrum*, ASTERACEAE: *Emilia fosbergii*, *Neurolaena lobata*, *Vernonia brachiata*, CARICACEAE: *Jacaratia dolichaula*, CECROPIACEAE: *Cecropia obtusifolia*, *C. peltata*, COMBRETACEAE: *Conocarpus erectus*, *Laguncularia racemosa*, FABACEAE/CAES.: *Hymenaea courbaril*, *Prioria copaifera*, FABACEAE/MIM.: *Entada polystachya*, *Inga marginata*, *I. ruiziana*, FLACOURTIACEAE: *Hasseltia floribunda*, GESNERIACEAE: *Gasteranthus delphinioides*, *Paradrymonia decurrens*, HERNANDIACEAE: *Hernandia stenura*,

LECYTHIDACEAE: *Eschweilera pittieri*, LYTHRACEAE: *Lafoensia punicifolia*, MALVACEAE: *Malvaviscus arboreus*, MARCGRAVIACEAE: *Marcgravia schippii*, MORACEAE: *Brosimum alicastrum*, *B. costaricanum*, *B. guianense*, *B. utile*, *Ficus nymphaeifolia*, *Sorocea affinis*, MYRISTICACEAE: *Compsoneura sprucei*, *Virola sebifera*, MYRTACEAE: *Myrciaria floribunda*, POLYGONACEAE: *Polygonum punctatum*, RHIZOPHORACEAE: *Cassipourea elliptica*, RUBIACEAE: *Condaminea corymbosa*, *Warszewiczia coccinea*.

Appendix IV. List of Vascular Plants collected in the Golfo Dulce Region (until oct. 2001)

LYCOPHYTES

LYCOPODIACEAE
Huperzia *bradeorum* (Christ) Holub
dichotoma (Jacq.) Trev.
linifolia (L.) Trevisan
Lycopodiella *cernua* (L.) Pichi-Serm

SELAGINELLACEAE
Selaginella *anceps* C. Presl
arthritica Alston
exaltata (Kunze) Spring
horizontalis (C. Presl) Spring
oaxacana Spring
tarapotensis Baker
viticulosa Klotzsch

SPHENOPHYTES

EQUISETACEAE
Equisetum aff. *giganteum* L.
myriochaetum Schltdl. & Cham.

PTEROPHYTES

ASPLENIACEAE
Asplenium *auritum* Sw.
cuspidatum Lam.
pteropus Kaulf.
salicifolium L.
serratum L.

BLECHNACEAE
Blechnum *flacisquama* A. Rojas
fragile (Liebm.) C.V. Morton & Lellinger
occidentale L.
Salpichlaena *volubilis* (Kaulf.) J. Sm.

CYATHEACEAE
Alsophila *firma* (Baker) D.S. Conant
Cnemidaria *choricarpa* (Maxon) R. M. Tryon
Cyathea *delgadii* Sternb.
multiflora Sm.
pinnula (H.Christ) Domin

DENNSTAEDTIACEAE
Dennstaedtia *dissecta* (Sw.) T. Moore
Lindsaea *lancea* (L.) Beddome
quadrangularis Raddi
Lonchitis *hirsuta* L.
Odontosoria *gymnogrammoides* H. Christ
schlechtendalii (C. Presl) C. Chr.
Saccoloma *domingense* (Spreng.) Prantl
elegans Kaulf.
inaequale (Kunze) Mett.

DRYOPTERIDACEAE
Olfersia *cervina* (L.) Kunze
Polybotrya *alfredii* Brade
caudata Kunze
polybotryoides (Baker) H. Christ

GRAMMITIDACEAE
Ceradenia *jungermannioides* (Klotzsch) L.E. Bishop
kalbreyeri (Baker) L.E. Bishop
knightii (Copel.) L.E. Bishop
Cochlidium *linearifolium* (Desv.) Maxon ex C. Chr.
serrulatum (Sw.) L.E. Bishop
Grammitis *mitchellae* (Baker) F. Seym.
sprucei (Hook.) J. Sm.
Lellingeria *limula* (H.Christ) A.R. Smith y R.C. Moran
Micropolypodium *hyalinum* (Maxon) A. R. Sm.
nanum (Fée) A. R. Sm.
Terpsichore *alfarii* (Donn. Sm.) A. R. Sm.
alsophilicola (H. Christ) A. R. Sm.
staheliana (Posth.) A. R. Sm.

HYMENOPHYLLACEAE
Hymenophyllum *brevifrons* Kunze
polyanthos (Sw.) Sw.
Trichomanes *collariatum* Bosch
crispum L.
curtii Rosenst.
delicatum Bosch
diversifrons (Bory) Mett. ex Sadeb.
ludovicinum Rosenst.
membranaceum L.
osmundoides DC.
pinnatum Hedw.
rigidum Sw.
tuerckheimii H. Christ

LOMARIOPSIDACEAE
Bolbitis *bernoullii* (H. Christ) Ching
nicotianifolia (Sw.) Alston
portoricensis (Spreng.) Hennipman
simplex R. C. Moran
Elaphoglossum *auripilum* H.Christ
christianeae Mickel
foeniculaceum (Hook. & Grev.)
glabellum J. Sm.
grayumii Mickel
hayesii (Mett.) Maxon
heterochroum Mickel
hyalinum H. Christ
killipii Mickel
latifolium (Sw.) J. Sm.
latum (Mickel) Atehortúa ex Mickel
longicrure H. Christ
micropogon Mickel
moralesii A. Rojas & Mickel - ined.
paleaceum (Hook. & Grev.) Sledge
peltatum (Sw.) Urb.
proliferans Maxon & C.V. Morton
Lomariopsis *fendleri* D.C. Eaton
japurensis (Mart.) J. Sm.
recurvata Fee
vestita Fourn.

MARATTIACEAE
Danaea *carillensis* H. Christ
crispa (Endres) Rchb. f.
cuspidata Liebm.
elliptica Sm.
nodosa (L.) Sm.

METAXYACEAE
Metaxya *rostrata* (Kunth) C. Presl

OLEANDRACEAE
Nephrolepis *multiflora* (Roxb.) Jarrett ex C.V. Morton
pectinata (Willd.) Schott
pendula (Raddi) J. Sm.
Oleandra *decurrens* Maxon

PARKERIACEAE
Ceratopteris thalictroides (L.) Brongn.

POLYPODIACEAE
Campyloneurum *costatum* (Kunze) C. Presl
latum T. Moore
occultum (H. Christ) L.D. Gómez
phyllitidis (L.) C. Presl
repens (Aubl.) C. Presl
Dicranoglossum *panamense* (C. Chr.) L.D. Gómez
Microgramma *percussa* (Cav.) Hook. & Grev.
reptans (Cav.) A.R. Sm
Niphidium *crassifolium* (L.) Lellinger
Pecluma *hygrometrica* (Splitg.) M.G. Price
Pleopeltis *astrolepis* (Liebm.) Fourn.
Polypodium *attenuatum* Humb. &

Bonpl. ex Willd.
ciliatum (Willd.) Alston
fallax Schltdl. & Cham.
fasciale Humb. & Bonpl. ex Willd.
fraxinifolium Jacq.
polypodioides (L.) Watt
triseriale Sw.

PTERIDACEAE
***Acrostichum** aureum* L.
***Adiantum** caryotideum* H. Christ
concinnum Willd.
decoratum Maxon & Weath.
latifolium Lam.
lunulatum Burm. f.
obliquum Willd.
pulverulentum L.
seemannii Hook.
tetraphyllum Humb. & Bonpl. ex Willd
villosum L.
***Pityrogramma** calomelanos* (L.) Link
dealbata (C. Presl) R. M. Tryon
***Pteris** altissima* Poir.
biaurita L.
navarrensis H. Christ
pungens Willd.

SALVINIACEAE
***Salvinia** auriculata* Aubl.

SCHIZAEACEAE
***Lygodium** heterodoxum* Kunze
radiatum Prantl
venustum Sw.
***Schizaea** elegans* (Vahl) Sw.

TECTARIACEAE
***Cyclopeltis** semicordata* (Sw.) J. Sm.
***Megalastrum** lunense* (H. Christ) A. R. Sm. & R. C. Moran
subincisum (Willd.) A. R. Sm. & R. C. Moran
***Tectaria** incisa* Cav.
mexicana (Fée) C.V. Morton
nicotianifolia (Baker) C. Chr.
pilosa (Fée) R. C. Moran
plantaginea (Jacq.) Maxon
rivalis (Mett. ex Kuhn) C. Chr.

THELYPTERIDACEAE
***Thelypteris** angustifolia* (Willd.) Proctor
decussata (L.) Proctor
dentata (Forsskal) E. P. St. John
glandulosa (Desv.) Proctor
illicita (H. Chris) C.F.Reed
interrupta (Wild.) K.Lwats
lingulata (C. Chr.) C.V. Morton
nicaraguensis (Fourn.) C.V. Morton
opulenta (Kaulf.) Fosberg
torresiana (Gaudich.) Alston

VITTARIACEAE
***Ananthacorus** angustifolius* (Sw.) Underw. & Maxon
***Anetium** citrifolium* Splitg.
***Antrophyum** cajenense* (Desv.) Spreng.
lanceolatum (L.) Kaulf.
***Vittaria** graminifolia* Kaulf.
lineata (L.) Sm.
stipitata Kunze

WOODSIACEAE
***Diplazium** cristatum* (Desr.) Alston
grandifolium (Sw.) Sw.
seemannii T. Moore
***Hemidictyum** marginatum* (L.) C. Presl

GYMNOSPERMS – CYCADS

ZAMIACEAE
***Zamia** fairchildiana* L.D. Gómez

GYMNOSPERMS – CONIFERS

PODOCARPACEAE
***Podocarpus** guatemalensis* Standl.

ANGIOSPERMS I. MONOCOTYLEDONS

ALISMATACEAE
***Echinodorus** grisebachii* Small
***Sagittaria** lancifolia* L.

AMARYLLIDACEAE
***Crinum** erubescens* Aiton
***Eucharis** bouchei* Woodson & P.H. Allen

ARACEAE
***Anthurium** acutifolium* Engl.
alatipedunculatum Croat & R. Baker
bakeri Hook. f.
brownii Mast.
burgeri Grayum
clavigerum Poepp.
clidemioides Standl.
durandii Engl.
eximium Engl.
flexile Schott
friedrichsthalii Schott
gracile (Rudge) Schott
hacumense Engl.
hoffmannii Schott
interruptum Sodiro
lancifolium Schott
michelii Guillaumin
obtusum (Engl.) Grayum (syn. *A. ochranthum* K. Koch)
oerstedianum Schott
pentaphyllum (Aubl.) G. Don
ramonense Engl. ex K. Krause
ravenii Croat & R.A. Baker
scandens (Aubl.) Engl.
***Dieffenbachia** aurantiaca* Engl.
concinna Croat & Grayum - ined.
killipii Croat & Grayum - ined.
oerstedii Schott
pluricostata Croat & Grayum - ined.
rinconii Croat & Grayum
***Dracontium** pittieri* Engl.
spruceanum (Schott) G. H. Zhu - ined.
***Heteropsis** oblongifolia* Kunth
***Homalomena** allenii* Croat & Grayum - ined.
wendlandii Schott
***Monstera** adansonii* Schott
costaricensis (Engl. & K. Krause) Croat & Grayum
filamentosa Croat & Grayum - ined.
involuta Croat & Grayum - ined.
membranacea Madison
pittieri Engl.
***Philodendron** alliodorum* Croat & Grayum
aurantiifolium Schott
auriculatum Standl. & L.O. Williams
burgeri Grayum - ined.
grandipes K. Krause
inaequilaterum Liebm.
jodavisianum G. S. Bunting
microstictum Standl. & L.O. Williams
popenoei Standl. & Steyerm.
pterotum K. Koch & Augustin
purpureoviride Engl.
rhodoaxis G. S. Bunting
sagittifolium Liebm.
schottii K. Koch
sulcatum K. Krause
tenue K. Koch & Augustin
tripartitum (Jacq.) Schott
wilburii Croat & Grayum - ined.
***Pistia** stratiotes* L.
***Rhodospatha** osaensis* Croat & Grayum - ined.
wendlandii Schott
***Spathiphyllum** phryniifolium* Schott
silvicola R. Baker
wendlandii Schott

Stenospermation angustifolium Hemsl.
marantifolium Hemsl.
Syngonium hastiferum (Standl. & L.O. Williams) Croat
laterinervium Croat
macrophyllum Engl.
oduberi T. Ray
podophyllum Scchott
triphyllum Birdsey ex Croat
Xanthosoma dealbatum Grayum
robustum Schott

ARECACEAE
Acrocomia aculeata Jacq.
Aiphanes hirsuta Burret
Asterogyne martiana (H. Wendl.) H. Wendl. ex Hemsl.
Astrocaryum alatum H. F. Loomis
standleyanum L.H. Bailey
Attalea rostrata Oerst. [syn. *A. butyracea* (Mutis ex L. f.) Wess. Boer]
Bactris baileyana H.E. Moore
glandulosa Oerst.
gasipaes Kunth
hondurensis Standl.
major Jacq.
maraja Mart.
militaris H.E. Moore
Calyptrogyne ghiesbreghtiana (Linden & H. Wendl.) H. Wendl.
Chamaedorea allenii L. H. Bailey
brachyclada H. Wendl.
dammeriana Burret
deckeriana (Klotzsch) Hemsl.
macrospadix Oerst.
matae Hodel
pumila H. Wendl. Ex Dammer
sullivaniorum Hodel & N. W. Uhl
tenella H. Wendl.
tepejilote Liebm.
zamorae Hodel
Cocos nucifera L.
Cryosophila guagara P.H. Allen
Desmoncus costaricensis (Kuntze) Burret
stans Grayum & de Nevers
Elaeis oleifera (Kunth) Cortés
Euterpe precatoria Mart.
Geonoma congesta H. Wendl. ex Spruce
cuneata H. Wendl. ex Spruce
deversa (Poit.) Kunth
gracilis Wendl. ex Spruce *interrupta* (Ruiz & Pav.) Mart.
oxycarpa Mart.
scoparia Grayum & de Nevers
Iriartea deltoidea Ruiz & Pav.
Neonicholsonia watsonii Dammer
Oenocarpus mapora H. Karst.
Pholidostachys pulchra H. Wendl. ex Burret
Prestoea decurrens (H. Wendl. ex Burret) H.E. Moore
Raphia taedigera Mart.
Reinhardtia latisecta (H. Wendl.) Burret
simplex (H. Wendl.) Drude ex Dammer
Socratea exorrhiza (Mart.) H. Wendl.
Synechanthus warscewiczianus H. Wendl.
Welfia regia Mast.

BROMELIACEAE
Aechmea angustifolia Poepp. & Endl.
bracteata (Sw.) Griseb.
dactylina Baker
pubescens Baker
tillandsioides (Mart.) Baker
tonduzii Mez & Pittier
Araeococcus pectinatus L.B. Sm.
Bromelia hemispherica Lam.
Catopsis juncifolia Mez & Wercklé ex Mez
Catopsis morreniana Mez
sessiliflora (Ruiz & Pav.) Mez
werckleana Mez
Chevaliera magdalenae André
Guzmania lingulata (L.) Mez
patula Mez & Wercklé
scherzeriana Mez
zahnii (Hook. f.) Mez
Pitcairnia arcuata (André) André
atrorubens (Beer) Baker
halophila L.B. Sm.
maidifolia (E. Morren) Decne.
megasepala Baker
Tillandsia acostae Mez & Tonduz ex Mez
anceps Lodd.
balbisiana Schult. & Schult. f.
bulbosa Hook.
caput-medusae E. Morren
dexteri H. Luther
excelsa Griseb.
flexuosa Sw.
leiboldiana Schltdl.
monadelpha (E. Morren) Baker
subulifera Mez
usneoides (L.) L.
Vriesea chontalensis (Baker) L.B. Sm.
heliconioides (Kunth) Hook. ex Walp.
Werauhia dodsonii (L.B. Sm.) J.R. Grant
gladioliflora (Linden ex Cogn. & Marchal) J.R. Grant
osaensis F. Morales
sanguinolenta (Linden ex Cogn. & Marchal) J.R. Grant
viridiflora (Regel) J.R. Grant

BURMANNIACEAE
Apteria aphylla (Nutt.) Barnhart
Gymnosiphon breviflorus Gleason
panamensis Jonker
suaveolens (H. Karst.) Urb.
tenellus (Benth.) Urban
Thismia luetzelburgii Goebel & Suess.
panamensis (Standl.) Jonker

CANNACEAE
Canna edulis Ker Gawl.

COMMELINACEAE
Cochliostema odoratissimum Lem.
diffusa Burm. f.
Dichorisandra hexandra (Aubl.) Standl.
Floscopa robusta (Seub.) C. B. Clarke
Tradescantia zanonia (L.) Sw.

COSTACEAE
Costus comosus (Jacq.) Roscoe
glaucus Maas
guanaiensis Rusby
laevis Ruiz & Pav.
lasius Loes.
lima K. Schum.
osae Maas & H. Maas
plicatus Maas
pulverulentus C. Presl
ricus Maas & H. Maas - ined.
scaber Ruiz & Pav.
speciosus (K. D. Koenig) Sm.
stenophyllus Standl. & L.O. Williams
villosissimus Jacq.

CYCLANTHACEAE
Asplundia alata Harling
isabellina Harling
leptospatha Harling
multistaminata Harling
pittieri (Woodson) Harling
sleeperae Grayum & Hammel
utilis (Oerst.) Harling
Carludovica drudei Mast.
rotundifolia H. Wendl. ex Hook. f.
Cyclanthus bipartitus Poit.
Dicranopygium osaënse Hammel - ined.
Evodianthus funifer (Poit.) Lindm.
Ludovia integrifolia (Woodson) Harling
Sphaeradenia acutitepala Harling
Thoracocarpus bissectus (Vell.) Harling

CYPERACEAE
Becquerelia cymosa Brongn.
Calyptrocarya glomerulata (Brongn.) Urb.

Cyperus chorisanthos C. B. Clarke
haspan L.
laxus Lam.
ligularis L.
luzulae (L.) Retz.
papyrus L.
***Diplasia** karatifolia* Rich.
***Eleocharis** elegans* (Kunth) Roem. & Schult.
***Fimbristylis** dichotoma* (L.) Vahl
spadicea (L.) Vahl
***Hypolytrum** longifolium* (Rich.) Nees
***Kyllinga** brevifolia* Rottb.
odorata Vahl
pumila Michx.
***Mapania** assimilis* T. Koyama
***Pycrerus** fugax* (Liebm.) C.D.Adams
***Rhynchospora** polyphylla* Vahl
tuerckheimii C.B. Clarke ex Kuk
watsonii (Britton) Davidse
***Scleria** melaleuca* Rchb. f. ex Schltdl. & Cham.
secans (L.) Urb.
***Torulinium** odoratum* (L.) Hooper

DIOSCOREACEAE
***Dioscorea** liebmannii* Uline
mexicana Scheidw.
polygonoides Humb. & Bonpl. ex Willd.
racemosa (Klotzsch) Uline
remota C.V. Morton
spiculiflora Hemsl.
trifida L.
urophylla Hemsl.

HAEMODORACEAE
***Xiphidium** coeruleum* Aubl.

HELICONIACEAE
***Heliconia** colgantea* R.R. Sm. ex G. S. Daniels & F.G. Stiles
danielsiana W.J. Kress
imbricata (Kuntze) Baker
irrasa R.R. Sm.
latispatha Benth.
longa (Griggs) H.J.P. Winkl.
longiflora R.R. Sm.
marginata (Griggs) Pittier
osaënis Cufod.
pogonantha Cufod.
stilesii W.J. Kress
trichocarpa G.S. Daniels & F. G. Stiles
vaginalis Benth.
wagneriana Petersen

HYDROCHARITACEAE
***Limnobium** stoloniferum* (G.F.W. Mey) Griseb.

LEMNACEAE
***Lemna** aequinoctialis* Welw.

LIMNOCHARITACEAE
***Limnocharis** flava* (L.) Buchenau
laforestii Duchass. ex Griseb.

MARANTACEAE
***Calathea** crotalifera* S. Watson (syn. *C. insignis* Peterson)
donnell-smithii K. Schum.
gymnocarpa H. A. Kenn.
hylaeanthoides H. A. Kenn. - ined.
incompta H. A. Kenn. - ined.
inocephala (Kuntze) H. A. Kenn. & Nicolson
lasiophylla H. A. Kenn.
longiflora H. A. Kenn.
lutea (Aubl.) Schult.
macrosepala K. Schum.
marantifolia Standl.
micans (L. Mathieu) Körn.
nitidifolia H. A. Kenn.
osa H. A. Kenn. - ined.
platystachya Standl. & L.O. Williams
vinosa H. A. Kenn.
***Ctenanthe** dasycarpa* (Donn. Sm.) K. Schum.
villosa H. A. Kenn. - ined.
***Hylaeanthe** hoffmannii* (K. Schum.) A. M. E. Jonker & Jonker
***Ischnosiphon** heleniae* L. Andersson
inflatus L. Andersson
***Maranta** arundinacea* Plum. ex L.
***Pleiostachya** leiostachya* (Donn. Sm.) Hammel
pruinosa (Regel) K. Schum.
***Thalia** geniculata* L.

MUSACEAE
***Musa** textilis* Née
x paradisiaca L.

ORCHIDACEAE
***Aspasia** epidendroides* Lindl.
***Bletia** purpurea* (Lam.) DC.
***Brassavola** nodosa* (L.) Lindl.
***Campylocentrum** micranthum* (Lindl.) Rolfe
***Caularthron** bilamellatum* (Rchb. f.) R.E. Schult.
***Clowesia** warczewitzii* (Lindl.) Dodson
***Coccineorchis** standleyi* (Ames & C. Schweinf.) Garay
Coryanthes sp.
***Cryptarrhena** guatemalensis* Schltr.
lunata R. Br.
***Dichaea** ciliolata* Rolfe
morrisii Fawc. & Rendle
panamensis Lindl.
tuerckheimii Schltr.
***Dimerandra** elegans* (Focke) Siegerist
***Dresslerella** hispida* (L.O. Williams) Luer
Dryadella sp.
***Elleanthus** caricoides* Nash
tillandsioides Barringer
***Encyclia** pygmaea* (Hook. f.) Dressler
***Epidendrum** anceps* Jacq.
baumannianum Schltr.
miserrimum Rchb. f.
nocturnum Jacq.
octomerioides Schltr.
paniculatum Ruiz & Pav.
pseudepidendrum Rchb. f.
sculptum Rchb. f.
***Erythrodes** vaginata* Hook.
***Eulophia** alta* (L.) Fawc. & Rendle
***Galeottia** grandiflora* A. Rich.
***Gongora** tricolor* (Lindl.) Rchb. f.
***Habenaria** monorrhiza* (Sw.) Rchb. f.
***Hexisea** imbricata* (Lindl.) Rchb. f.
***Jacquiniella** equitantifolia* (Ames) Dressler
Lepanthes sp.
***Lockhartia** acuta* (Lindl.) Rchb. f.
amoena Rchb. f.
hercodonta Rchb. f. ex Kraenzl.
micrantha Rchb. f.
pittieri Schltr.
***Macroclinium** alleniorum* Dressler & Papulin
***Masdevallia** calura* Rchb. f.
***Maxillaria** acutifolia* Lindl.
adendrobium (Rchb. f.) Dressler
brachybulbon Schltr.
confusa (Ames & C. Schweinf.) L.O.Williams
crassifolia (Lindl.) Rchb. f.
diuturna (Ames & C. Schweinf-)
longipetiolata Ames & C. Schweinf.
maleolens Schltr.
nasuta Rchb. f.
oreocharis Schltr.
parviflora (Poepp. & Endl.) Garay
porrecta Lindl.
rufescens Lindl.
uncata Lindl.
vittariifolia L.O. Williams
***Monophyllorchis** maculata* Garay
Mormodes
***Notylia** barkeri* Lindl.
***Oncidium** ansiferum* Rchb. f.
baueri Lindl.
pusillum (L.) Rchb. f.
stenobulbom Kraenzl.
***Ornithocephalus** bicornis* Lindl.
***Palmorchis** powellii* (Ames) C. Schweinf. & Correll
***Pleurothallis** grobyi* Bateman ex Lindl.

lewisiae Ames
Polystachya foliosa (Hook.) Rchb. f.
masayensis Rchb. f.
Prescotia cordifolia Rchb. f.
stachyodes (Sw.) Lindl.
Psygmorchis glossomystax (Rchb. f.) Dodson & Dressler
Sarcoglottis sp.
Scaphyglottis behrii (Rchb. f.) Benth. & Hook. ex Hemsl.
boliviensis (Rolfe) B. R. Adams
fusiformis R.E. Schult.
laevilabia Ames
lindeliana (A. Rich. & Galeotti) L.O. Williams
minutiflora Ames & Correll
panamensis B. R. Adams
prolifera (R. Br. ex Lindl.) Cogn.
Schiedeella wercklei (Schltr.) Garay
Sobralia decora Bateman
fragrans Lindl.
labiata Warsz. & Rchb. f
macrophylla Rchb. f.
Stanhopea cirrhata Lindl.
Stelis sp.
Stenorrhynchos bracteosum Ames & Schweinf
Trichocentrum caloceras Rchb. f.
Trichopilia sp.
Trichosalpinx orbicularis (Lindl.) Luer
Trigonidium egertonianum Bateman ex Lindl.
Vanilla inodora Schiede
planifolia Andrews
Warrea costaricensis Schltr.
Wullschlaegelia
aphylla (Sw.) Rchb. f.
calcarata Benth.
Xylobium elongatum (Lindl & Paxton) Hemsl.

POACEAE
Arundinella deppeana Nees
Axonopus compressus (Sw.) P. Beauv.
Coix lacryma-jobi L.
Cryptochloa strictiflora (E. Fourn.) Swallen
Digitaria bicornis (Lam.) Roem. & Schult.
Echinochloa polystachya (Kunth) Hitchc.
Eragrostis pectinacea (Michx.) Steud.
Gynerium sagittatum (Aubl.) P. Beauv.
Homolepis aturensis (Kunth) Chase
Hymenachne amplexicaulis (Rudge) Nees
Hyparrhenia bracteata (Humb. & Bonpl. ex Willd.) Stapf
rufa (Nees) Stapf
Ichnanthus pallens (Sw.) Munro ex Benth.
panicoides P. Beauv.
Isachne arundinacea (Sw.) Griseb.
Ischaemum rugosum Salisb.
timorense Kunth
Lasiacis oaxacensis (Steud.) Hitchc.
procerrima (Hack.) Hitchc.
scabrior Hitchc.
sorghoidea (Desv.) Hitchc. & Chase
standleyi Hitchc.
Muhlenbergia lehmanniana Henrard
Olyra caudata Trin.
ecaudata Döll
latifolia L.
Oplismenus burmannii (Retz.) P. Beauv.
hirtellus (L.) P. Beauv.
Oryza sativa L.
Panicum trichoides Sw.
Paspalum conjugatum Bergius
decumbens Sw.
paniculatum L.
plicatulum Michx.
virgatum L.
Pharus latifolius L.
vittatus Lem.
Rottboellia cochinchinensis (Lour.) Clayton
Setaria parviflora (Poir.) Kerguélen
Streptochaeta sodiroana Hack.
Streptogyna americana C. E. Hubb.
Uniola pittieri Hack.

PONTEDERIACEAE
Eichhornia azurea (Sw.) Kunth
crassipes (Mart.) Solms
Heteranthera limosa (Sw.) Willd.
reniformis Ruiz & Pav.
Pontederia aff. *sagittata* C.Presl

SMILACACEAE
Smilax kunthii Killip & C.V. Morton
domingensis Willd.
mollis Humb. & Bonpl. ex Willd.
panamensis Morong
spissa Killip & C.V. Morton
vanilliodora F.W. Apt

TRIURIDACEAE
Sciaphila picta Miers

TYPHACEAE
Typha domingensis Pers.

ZINGIBERACEAE
Hedychium coronarium J. König
Renealmia cernua (Sw.) J.F. Macbr.
mexicana Klotzsch ex Petersen
pluriplicata Maas

ANGIOSPERMS
II. DICOTYLEDONS

ACANTHACEAE
Aphelandra aurantiaca Lindl.
dolichantha Donn. Sm.
golfodulcensis McDade
lingua-bovis Leonard
Asystasia gangetica (L.) T.Anderson
Blechum costaricense Oerst.
pyramidatum (Lam.) Urb.
Bravaisia integerrima (Spreng.) Standl.
Chaetochlamys panamensis Lindau
Chamaeranthemum tonduzii Lindau
Herpetacanthus panamensis Leonard
Hygrophila costata Nees
Justicia aurantiimutata Hammel & Gómez-Laur.
chamaephyton D. N. Gibson
comata (L.) Lam.
deaurata Hammel & Gómez-Laur.
ephemera Leonard
metallica Lindau
peninsularis Gómez-Laur. & Hammel
refractifolia (Kuntze) Leonard
spicigera Schltdl.
tonduzii Lindau
Mendoncia gracilis Turrill
lindavii Rusby
litoralis Leonard
tonduzii Turrill
Odontonema tubiforme (Bertol.) Kuntze
Pseuderanthemum pittieri Leonard
praecox (Benth.) Leonard
Razisea spicata Oerst.
villosa Gómez-Laur. & Hammel
Ruellia golfodulcensis Durkee
palustris Durkee
tonduzii Lindau
tubiflora Kunth
Thunbergia fragrans Roxb.

ACTINIDIACEAE
Saurauia montana Seem.
yasicae Loes.

AIZOACEAE
Sesuvium portulacastrum (L.) L.
Trianthema portulacastrum L.

AMARANTHACEAE
Alternanthera laguroides (Standl.) Standl.
sessilis (L.) R. Br.
Amaranthus spinosus L.
Chamissoa altissima (Jacq.) Kunth
Cyathula achyranthoides (Kunth) Moq.

prostrata (L.) Blume
Gomphrena *serrata* L.
Iresine *diffusa* Humb. & Bonpl. ex Willd.
Pleuropetalum *pleiogynum* (Kuntze) Standl.

ANACARDIACEAE
Anacardium *excelsum* (Bertero & Balbis ex Kunth) Skeels
occidentale L.
Astronium *graveolens* Jacq.
Mangifera *indica* L.
Mosquitoxylum *jamaicense* Krug & Urb.
Spondias *mombin* L.
purpurea L.
radlkoferi Donn. Sm.
Tapirira *myriantha* Triana & Planch.

ANNONACEAE
Anaxagorea *crassipetala* Hemsl.
dolichocarpa Sprague & Sandwith
Annona *amazonica* R.E. Fr.
glabra L.
muricata L.
pittieri Donn. Sm.
purpurea Moç. & Sessé ex Dunal
Cananga *odorata* (Lam.) Hook. f. & Thomson
Cremastosperma sp. nov.
Cymbopetalum costaricense (Donn.Sm.) Salf.
lanugipetalum Schery
torulosum G.E. Schatz
Desmopsis *heteropetala* R.E. Fr.
maxonii Saff.
microcarpa R.E. Fr.
schippii Standl.
walkeri G.E. Schatz
Duguetia *confusa* Maas
Guatteria *amplifolia* Triana & Planch.
chiriquiensis R.E. Fr.
diospyroides Baill.
dolichopoda Donn. Smith
pudica Mass
recurvisepala R.E. Fr.
sp. nov. 1 + 2
tonduzii Diels
verrucipes R.E. Fries
Klarobelia *stipitata* Chatrou
Malmea *costaricensis* R.E. Fr.
Oxandra *longipetala* R.E. Fr.
venezuelana R.E. Fr.
Rollinia *danforthii* Standl.
mucosa (Jacq.) Baill.
pittieri Saff.
Unonopsis *panamensis* R.E. Fr.
pittieri Saff.
theobromifolia N. Zamora & Poveda
Xylopia *frutescens* Aubl.
macrantha Triana & Planch.
sericophylla Standl. & L.O. Williams

APIACEAE
Eryngium *foetidum* L.

APOCYNACEAE
Allamanda *cathartica* L.
Allomarkgrafia *brenesiana* Woodson
Aspidosperma *megalocarpon* Müll. Arg.
myristicifolium (Markgr.) Woodson
spruceanum Benth. ex Müll. Arg.
Bonafousia *undulata* (Vahl) A. DC.
Forsteronia *acouci* (Aubl.) A. DC.
myriantha Donn. Sm.
Lacmellea *panamensis* (Woodson) Markgr.
Mandevilla *hirsuta* (A. Rich.) K. Schum.
villosa (Miers) Woodson
Mesechites *trifida* (Jacq.) Müll. Arg.
Odontadenia *macrantha* (Roem. & Schult.) Markgr.
puncticulosa L. Richt.
Peltastes *isthmicus* Woodson
Peschiera ***arborea*** (Rose es Donn. Sm.) Markgr.
Plumeria *rubra* L.
Prestonia *concolor* (S.F. Blake) Woodson
hammelii J.F. Morales - ined.
longifolia (Sessé & Moc.) J.F. Morales
mexicana DC.
portobellensis (Beurl.) Woodson
Rauvolfia *aphlebia* (Standl) A.H. Gentry
Rhabdadenia *biflora* (Jacq.) Müll. Arg.
Stemmadenia *donnell-smithii* (Rose) Woodson
paulii Leeuwenb.
Stenosolen *heterophylla* (Vahl) Markgr.
Tabernaemontana *alba* Mill.
arborea (Rose ex Donn. Sm.) Markgr.
amygdalifolia Jacq.
longipes Donn. Sm.

AQUIFOLIACEAE
Ilex *skutchii* Edwin ex W.J. Hahn - ined.

ARALIACEAE
Dendropanax *arboreus* (L.) Decne. & Planch.
caucanus (Harms)Harms.
gonatopodus (Donn. Sm.) A.C. Sm.
ravenii M.J.Cannon & Cannon
sessiliflorus (Standl. & A.C. Sm.) A.C. Sm.
Oreopanax aff. *capitatus* (Jacq.) Decne. & Planch.
Schefflera *brenesii* A.C.Sm.
systyla (Donn. Sm.) Vig.

ARISTOLOCHIACEAE
Aristolochia *leuconeura* Linden
pilosa Kunth
maxima Jacq.
tonduzii O. C. Schmidt

ASCLEPIADACEAE
Asclepias *curassavica* L.
Blepharodon *mucronatum* (Schltdl.) Decne.
Fischeria *blepharopetala* S.F. Blake
panamensis Spellman
Gonolobus *edulis* Hemsl.
Sarcostemma *clausum* (Jacq.) Roem. & Schult.
Tassadia *obovata* Decne.

ASTERACEAE
Acmella *radicans* (Jacq.) R. K. Jansen
Ageratum *houstonianum* Mill.
Baccharis *pedunculata* (Mill.) Cabrera
Bidens *cynapiifolia* Kunth
pilosa L.
reptans (L.) G. Don
Calea *pittieri* B. L. Rob. & Greenm.
urticifolia (Mill.) DC.
prunifolia Kunth
Calyptocarpus *wendlandii* Sch. Bip.
Chromolaena *odorata* (Lam.) R. M. King & H. Rob.
Clibadium *anceps Greenm.*
pittieri Greenm.
surinamense L.
Critonia *morifolia* (Mill.) R. M. King & H. Rob.
Eclipta *prostrata* (L.) L.
Egletes *viscosa* (L.) Less.
Elephantopus *spicatus* Juss. ex Abul.
Emilia *fosbergii* Nicolson
Erechtites *hieracifolia* (L.) Raf. ex DC.
Gongrostylus *costaricensis* (Kuntze) R.M. King & H. Robinson
Hebeclinium *hygrohylaeum* (B.L.Rob.) R.M. King & H. Rob.
Heterocondylus *vitalbae* (DC.) R. M. King & H. Rob.
Melampodium *divaricatum* (Rich.) DC.
Melanthera *aspera* (Jacq.) Small
nivea (L.) Small

Mikania guaco Humb. & Bonpl.
micrantha Kunth
tonduzii B. L. Rob.
quinqueflora L.
Neurolaena lobata (L.) R. Br.
Pectis multiflosculosa (DC.) Sch. Bip.
prostrata Cav,
Porophyllum ruderale (Jacq.) Cass.
Pseudelephantopus spicatus (Juss.) Vahl
Pseudogynoxys cummingii (Benth.) H. Rob. & Cuatrec.
Sclerocarpus divaricatus (Benth.) Hemsl.
Sinclairia polyantha (Klatt) Rydb.
Spiracantha cornifolia Kunth
Synedrella nodiflora (L.) Gaertn.
Tessaria integrifolia Ruiz & Pav.
Thelechitonia trilobata (L.) H. Rob. & Cuatrec.
Tridax procumbens L.
Verbesina turbacensis Kunth
Vernonia brachiata Benth.
cinerea (L.) Less.
patens Knuth.

BALANOPHORACEAE
Helosis cayennensis (Sw.) Spreng.

BEGONIACEAE
Begonia carletonii Standl.
convallariodora C.DC.
corredorana C.DC.
filipes Benth.
hirsuta Aubl.
multinervia Liebm.
parvifolia Poepp. & Endl.

BIGNONIACEAE
Amphilophium paniculatum (L.) Kunth
pannosum (DC.) Bureau & K. Schum.
Amphitecna isthmica (A.H. Gentry) A.H. Gentry
kennedyi (A.H. Gentry) A.H. Gentry
latifolia (Mill.) A.H. Gentry
sessilifolia (Donn. Sm.) L.O. Williams
Anemopaegma chrysoleucum (Kunth) Sandwith
santa-ritense A.H. Gentry
Arrabidaea candicans (Rich.) DC.
chica (Humb. & Bonpl.) Verl.
verrucosa (Standl.) A.H. Gentry
Callichlamys latifolia (Rich.) K. Schum.
Crescentia cujete L.
Jacaranda caucana Pittier
copaia (Aubl.) D. Don
Kigelia africana (Lam.) Benth
Lundia corymbifera (Vahl) Sandwith
Macfadyena uncata (Andrews) Sprague & Sandwith
unguis-cati (L.) A.H. Gentry
Mansoa hymenaea (DC.) A.H. Gentry
kerere (Aubl.) A.H. Gentry
Martinella obovata (Kunth) Bureau & K. Schum.
Mussatia hyacinthina (Standl.) Sandwith
Parabignonia steyermarkii Sandwith
Paragonia pyramidata (Rich.) Bureau
Phryganocydia corymbosa (Vent.) Baillon
phellosperma (Hemsl.) Sandwith
Pithecoctenium crucigerum (L.) A.H. Gentry
Pleonotoma variabilis (Jacq.) Miers
Spathodea campanulata P. Beauv.
Stizophyllum riparium (Kunth) Sandwith
Tabebuia chrysantha (Jacq.) G. Nicholson
guayacan (Seem.) Hemsl.
palustris Hemsl.
rosea (Bertol.) DC.
Tecoma stans (L.) C. Juss. ex Kunth
Tourrettia lappacea (L'Hér.) Willd. ex L.f.

BIXACEAE
Bixa orellana L.
urucurana Willd.

BOMBACACEAE
Bernoullia flammea Oliv.
Bombacopsis sessilis (Benth.) Pittier
Ceiba pentandra (L.) Gaertn.
Huberodendron allenii Standl. & L.O. Williams
Ochroma pyramidale (Cav. ex Lam.) Urb.
Pachira aquatica Aubl.
Pseudobombax septenatum (Jacq.) Dugand
Quararibea asterolepis Pittier
bracteolosa (Ducke) Cuatrec.
obliquifolia (Standl.) Standl.
parvifolia Standl.
platyphylla Pittier & Donn. Sm.
Spirotheca rosea (Seem.) P. E. Gibbs - ined.

BORAGINACEAE
Bourreria grandicalyx J.S. Mill. & Sirot
Cordia alliodora (Ruiz & Pav.)Oken
bicolor A. DC.
collococca L.
cymosa (Donn. Sm.) Standl.
inermis (Mill.) I.M. Johnst.
liesneri J.S. Mill.
linnaei Stearn
lucidula I.M. Johnst.
megalantha S.F. Blake
spinescens L.
Heliotropium indicum L.
Tournefortia angustiflora Ruiz & Pav.
bicolor Sw.
glabra L.
hirsutissima L.
maculata Jacq.

BRUNELLIACEAE
Brunellia hygrotermica Cuatr.

BURSERACEAE
Bursera simaruba (L.) Sarg.
standleyana L.O. Williams & Cuatrec.
Protium aracouchini (Aubl.) Marchand
costaricense (Rose) Engl.
fimbriatum Swart
glabrum (Rose) Engl.
panamense (Rose) I.M. Johnst.
pittieri D. Porter
ravenii D. Porter
schippii Lundell
sp. nov
tenuifolium (Engl.) Engl.
Tetragastris panamensis (Engl.) Kuntze
Trattinickia aspera (Standl.) Swart

CABOMBACEAE
Cabomba furcata Schult. Schult.f.

CACTACEAE
Disocactus biformis (Lindl.) Lindl.
himantocladus (Rol.-Goss.) Kimnach
Epiphyllum grandilobum (F. A.C. Weber) Britton & Rose
phyllanthus (L.) Haw.
Rhipsalis
Weberocereus bradei (Britton & Rose) D. Hunt
imitans (Kimnach & Hutchison) D. Hunt

CAESALPINIACEAE, see FABACEAE-CAESALPINIOIDEAE

CAMPANULACEAE
Centropogon granulosus C. Presl
Hippobroma longiflora (L.) G. Don
Sphenoclea zeylanica Gaertn.

CANELLACEAE
Pleodendron sp. nov

CAPPARIDACEAE
Capparis cynophallophora L.

discolor Donn. Sm.
filipes Donn. Sm.
mollicella Standl.
pittieri Standl.
***Cleome** viscosa* L.
***Crateva** tapia* L.
***Podandrogyne** decipiens* (Triana & Planch.) Woodson

CAPRIFOLIACEAE
***Viburnum** costaricanum* (Oerst.) Hemsl.

CARICACEAE
***Carica** cauliflora* Jacq.
***Jacaratia** dolichaula* (Donn. Sm.) Woodson
spinosa (Aubl.) DC.

CARYOCARACEAE
***Anthodiscus** chocoensis* Prance
***Caryocar** costaricense* Donn. Sm.

CARYOPHYLLACEAE
***Drymaria** cordata* (L.) Willd. ex Schult.
***Stellaria** irazuensis* Donn. Sm.

CECROPIACEAE
***Cecropia** insignis* Liebm.
obtusifolia Bertol.
peltata L.
***Coussapoa** glaberrima* W. C. Burger
macerrima Akkermans & C. C. Berg
parcipeps Standl
parvifolia Standl.
villosa Poepp. & Endl.
***Pourouma** bicolor* Mart.

CELASTRACEAE
***Crossopetalum** gomezii* Lundell
parviflorum (Hemsl.) Lundell [syn. *C. eucymosum* (Loess. & Pittier) Lundell]
***Maytenus** guyanensis* Klotzsch ex Reissek in Mart.
***Perrottetia** sessiliflora* Lundell

CHLORANTHACEAE
***Hedyosmum** brenesii* Standl.
scaberrimum Standl.

CHRYSOBALANACEAE
***Chrysobalanus** icaco* L.
***Couepia** polyandra* (Kunth) Prance
***Hirtella** americana* L.
guatemalensis Standl.
lemsii L.O.Williams & Prance
papillata Prance
racemosa Lam.
triandra Sw.
trichotoma Prance
tubiflora Cuatrec.
***Licania** arborea* Seem.
corniculata Prance
costaricensis Standl. & Steyerm.
diegogomezii Prance
glabriflora Prance
hypoleuca Benth.
kunthiana Hook. f.
operculipetala Standl. & L.O. Williams
platypus (Hemsl.) Fritsch
sparsipilis S.F. Blake
***Maranthes** panamensis* (Standl.) Prance & F. White
***Parinari** parvifolia* Sandwith

CLETHRACEAE
***Clethra** mexicana* A. DC.

CLUSIACEAE
***Calophyllum** brasiliense* Cambess.
longifolium Willd.
***Chrysochlamys** allenii* Maguire
glauca (Oerst. ex Planch. & Triana) Hemsl.
grandifolia (Planch. & Triana) D'Arcy
nicaraguensis Oerst., Planch. & Triana
psychotriifolia Oerst., Planch. & Triana
silvicola Hammel
***Clusia** amazonica* Planch. & Triana
cylindrica Hammel
heterosavia Hammel – ined.
minor L.
osaensis Hammel - ined.
peninsulae Hammel -ined.
rosea Jacq.
stenophylla Standley
valerii Standl.
***Garcinia** macrophylla* Mart.
madruno (Kunth)
magnifolia (Pittier) Hammel sp. nov.
***Havetiopsis** flexilis* Spruce ex Planch. & Tr.
***Marila** laxiflora* Rusby
pluricostata Standl. & L.O. Williams
***Symphonia** globulifera* L. f.
***Tovomita** longifolia* (Rich.) Hochr.
stylosa Hemsl.
weddelliana Planch. & Triana
***Vismia** baccifera* (L) Triana & Planch
macrophylla Kunth

COCHLOSPERMACEAE
***Cochlospermum** vitifolium* (Willd.) Spreng.

COMBRETACEAE
***Buchenavia** costaricensis* Stace
tetraphylla (Aubl.) R.A. Howard
***Combretum** assimile* Eichler
decandrum Jacq.
fruticosum (Loefl.) Stuntz
graciliflorum Stace
laxum Jacq.
***Conocarpus** erectus* L.
***Laguncularia** racemosa* (L.) C.F. Gaertn.
***Terminalia** amazonia* (J.F. Gmel.) Exell
bucidoides Standl. & L.O. Williams
catappa L.
oblonga (Ruiz & Pav.) Steud.

CONNARACEAE
***Cnestidium** rufescens* Planch.
***Connarus** lambertii* (DC.) Sagot
panamensis Griseb.
***Rourea** glabra* Kunth
latifoliolata Standl. & L.O. Williams

CONVOLVULACEAE
***Dicranostyles** ampla* Ducke
***Ipomoea** alba* L.
batatas (L.) Lam.
batatoides Choisy
minutiflora (M. Martens & Galeotti) House
nil (L.) Roth
pes-caprae (L.) R. Br.
quamoclit L.
setifera Poir.
trifida (Kunth) G. Don
***Maripa** nicaraguensis* Hemsl.
***Merremia** discoidesperma* (Donn. Sm.) O'Donell
quinquefolia (L) Hallier f.
umbellata (L.) Hallier f.
***Stictocardia** tiliifolia* (Desr.) H. Hallier f.

CRASSULACEAE
***Kalanchoe** pinnata* (Lam.) Pers.

CUCURBITACEAE
***Cayaponia** racemosa* (Mill.) Cogn.
granatensis Cogn.
***Fevillea** cordifolia* L.
***Gurania** makoyana* (Lem.) Cogn.
spinulosa (Poepp. & Endl.) Cogn.
***Luffa** acutangula* (L.) A.Roem.
cylindrica (L.) A.Roem.
***Melothria** dulcis* Wunderlin
pendula L.
***Momordica** charantia* L.
***Psiguria** bignoniacea* (Poepp. & Endl.) Wunderlin
warscewiczii (Hook. f.) Wunderlin
***Rytidostylis** carthaginensis* (Jacq.)

Kuntze
Sechium pittieri (Cong.) C. Jeffrey
Selysia prunifera (Poepp. & Endl.) Cogn.
Sicydium tamnifolium (Kunth) Cogn.

DICHAPETALACEAE
Dichapetalum acuminatissimum N. Zamora - ined.
axillare Woodson
hammelii Prance
Stephanopodium costaricense Prance

DILLENIACEAE
Davilla kunthii A.St. – Hil
nitida (Vahl) Kubitzki
rugosa Poir.
Doliocarpus dentatus (Aubl.) Standl.
hispidus Standl. & L.O. Williams
major Gmelin
multiflorus Standl.
Pinzona coriacea Mart. & Zucc.
Tetracera hydrophila Triana & Planch.
portobellensis Beurl.
willdenowiana Steud.

EBENACEAE
Diospyros digyna Jacq.
hartmanniana S.Knapp
panamense S. Knapp (syn. *D. whitei* S. Knapp)

ELAEOCARPACEAE
Sloanea ampla Johnst.
brachytepala Ducke
faginea Standl.
guianensis (Aubl.) Benth.
latistipula Damon A.Sm.
laurifolia (Benth.) Benth.
medusula K. Schum. & Pittier
obtusifolia (Moric.) K. Schum.
picapica Standl.
pilosa D. A. Smith
rugosa D. A. Smith - ined.
sulcata D. A. Smith -ined.
zuliaensis Pittier

ERICACEAE
Cavendishia callista Donn. Sm.
osaensis Luteyn & J.F. Morales
Psammisia ramiflora Klotzsch
Satyria panurensis (Benth.) Benth. & Hook.
warszewiczii Klotzsch
Sphyrospermum cordifolium Benth.
ellipticum Sleumer

ERYTHROXYLACEAE
Erythroxylum citrifolium A. St.-Hil.
macrophyllum Cav.

EUPHORBIACEAE
Acalypha arvensis Poepp. & Endl.
diversifolia Jacq.
macrostachya Jacq.
villosa Jacq.
Acidoton nicaraguensis (Hemsl.) G. L. Webster
Adelia triloba (MÜ. ARG)
Alchornea costaricensis Pax & K. Hoffm.
grandis Benth.
latifolia Sw.
Alchorneopsis floribunda (Benth.) Müll. Arg.
Aparisthmium cordatum (Juss.) Bail.
Caperonia palustris (L.) A. St.-Hil.
Chamaesyce dioica (Kunth) Millsp.
hirta (L.) Millsp.
hypericifolia (L.) Millsp.
hyssopifolia (L.) Small
prostrata (Aiton) Small
Cleidion castaneifolium Müll. Arg.
Cnidoscolus tubulosus (Mull. Arg.)I.M.Johnst.
Croton billbergianus Müll. Arg.
brevipes Pax
draco Müll. Arg.
hirtus L'Hér.
schiedeanus Schltdl.
smithianus Croizat
tenuicaudatus Lundell
trinitatis Millsp.
Dalechampia dioscoreifolia Poepp. & Endl.
heteromorpha Pax & K. Hoffm.
osana Armbr.
spathulata (Scheidw.) Baillon
Drypetes brownii Standl.
standleyi G. L. Webster
Euphorbia elata Brandegee
heterophylla L.
Gymnanthes riparia (Schltdl.) Klotzsch
Hippomane mancinella L.
Hura crepitans L.
Hyeronima alchorneoides Allemao
oblonga (Tul.) Müll. Arg.
Jatropha curcas L.
gossypiifolia L.
Mabea excelsa Standl & Steyerm.
klugii Steyerm.
occidentalis Benth.
Manihot brachyloba Müll. Arg.
esculenta Crantz
Margaritaria nobilis L. f.
Omphalea diandra L.
Pausandra trianae (Müll. Arg.) Baill.
Pedilanthus tithymaloides (L.) Poit.
Pera arborea Mutis
Phyllanthus amarus Schumach. & Thonn.
mocinianus Baill
skutchii Standl.
urinaria L.
Plukenetia penninervia Müll. Arg.
stipellata L.J. Gillespie
Richeria obovata (Müll. Arg.) Pax & K. Hoffm.
Sagotia racemosa Baillon
Sapium allenii Huff
Sapium glandulosum (L.) Morong
aurifolium (Rich.) Griseb.
pachystachys Schum. & Pittier
Tragia bailloniana Mull. Arg.
correae Huft

FABACEAE-CAESALPINIOIDEAE
Bauhinia bahiachalensis – N. Zamora - ined.
beguinotii Cufod.
guianensis Aubl. (syn. *B. manca* Standl.)
Caesalpinia bonduc (L.) R. Br.
pulcherrima (L.) Sw.
Cassia grandis L. f.
leiophylla B. Vogel
tora L.
Chamaecrista nictitans (L.) Moench
Copaifera aromatica Dwyer
camibar Poveda, N. Zamora & P. Sánchez
Cynometra bahuinifolia Benth.
hemitomophylla (Donn. Sm.) Britton & Rose
retusa Britton & Rose
Dialium guianense (Aubl.) Sandwith
Hymenaea courbaril L.
Macrolobium costaricense W. C. Burger
hartshornii R. S. Cowan
Mora oleifera (Triana) Ducke
Peltogyne purpurea Pittier
Phyllocarpus riedelli Tul. (syn. *P. septentrionalis* Donn. Sm.)
Prioria copaifera Griseb.
Schizolobium parahyba (Vell.) S.F. Blake
Senna alata (L.) Roxb.
caudata (Standl.) H. S. Irwin & Barneby
(syn. *Cassia caudata* Standl.)
cobanensis (Britton & Rose) H. S. Irwin & Barneby (syn. *Cassia cobanensis* Britton & Rose)
obtusifolia (L.) H. S. Irwin & Barneby
papillosa (Britton & Rose) H. S. Irwin & Barneby
reticulata (Willd.) H. S. Irwin & Barneby
(syn. *Cassia reticulata* Willd.)
spectabilis (DC.) H. S. Irwin & Barneby

(syn. *Cassia spectabilis* DC.)
spinescens (Vogel) H. S. Irwin & Barneby
(syn. *Cassia spinescens* Hoffmanns. ex Vogel)
Tachigali *versicolor* Standl. & L.O. Williams

FABACEAE-FABOIDEAE
Aeschynomene *americana* L.
ciliata Vogel
sensitiva Sw.
villosa Poir.
Alysicarpus *vaginalis* (L.) DC.
Andira *inermis* (W. Wright) Kunth
Calopogonium *caeruleum* (Benth.) Sauv.
mucunoides Desv.
Canavalia *oxyphylla* Standl. & L.O. Williams
rosea (Sw.) DC. [syn. *C. maritima* (Aubl.) Thouars]
Centrosema *plumieri* (Turpin) Benth.
pubescens Benth.
Chaetocalyx *latisiliqua* (Poir.) Benth. ex Hemsl.
Clitoria *javitensis* (Kunth) Benth.
ternatea L.
Dalbergia *brownei* (Jacq.) Urb.
sp.nov.
Desmodium *adscendens* (Sw.) DC.
axillare (Sw.) DC.
barbatum (L.) Benth.
cajanifolium (Kunth.) DC.
distortum (Aubl.) J.F. Macbr.
incanum DC.
nicaraguensis Oerst. ex Benth.& Oerst
scorpiurus (Sw.) Desv.
triflorum (L.) DC.
Dioclea *malacocarpa* Ducke
reflexa Hook. f.
virgata (Rich.) Amshoff
wilsonii Standl.
Diphysa *americana* (Mill.) M.Sousa (syn. *D. robinioides* Benth.)
Dussia *discolor* (Benth.) Amsh. (syn. *D. tessmannii* Harms)
foxii Rudd
macroprophyllata (Donn. Sm.) Harms
mexicana (Standl.) Harms
Erythrina *berteroana* Urb.
cochleata Standl.
costaricensis Micheli
fusca Lour.
gibbosa Cufod.
lanceolata Standl.
Flemingia *strobilifera* (L.) W.T. Aiton
Gliricidia *sepium* (Jacq.) Kunth ex Walp.
Indigofera *hirsuta* L.
trita L. f.
Lecointea *amazonica* Ducke
Lennea *viridiflora* Seem.
Lonchocarpus *ferrugineus* M. Sousa
guatemalensis Benth.
macrophyllus Kunth
pentaphyllus (Poir.) DC.
schiedeana (Schldl.) Harms
Machaerium *cirrhiferum* Pittier
floribundum Benth.
kegelii Meisn.
lunatum (L. f.) Ducke
microphyllum (E.Mey.) Standl
milleflorum Pittier
pittieri J.F. Macbr.
salvadorense (Donn. Sm.) Rudd
seemannii Benth.
Mucuna *holtonii* (Kuntze) Moldenke
mutisiana (Kunth) DC.
Muellera *frutescens* (Aubl.) Standl.
Myroxylon *balsamum* (L.) Harms
Ormosia *coccinea* (Aubl.) Jacks.
macrocalyx Ducke
panamensis Benth.
paraensis Ducke
Oxyrhynchus *trinervius* (Donn. Sm.) Rudd
Pachyrhizus *ferrugineus* (Piper) M. Sorensen
Paramachaerium *gruberi* Brizicky
Phaseolus *lunatus* L.
Platymiscium *curuense* N.Zamora & Klitgaard
Pterocarpus *hayesii* Hemsl.
officinalis Jacq.
rohrii Vahl (syn. *P. violaceus* Vogel)
Pueraria *phaseoloides* (Roxb.) Benth.
Rhynchosia *edulis* Griseb.
erythrinoides Schltdl. & Cham.
minima (L.) DC.
Sesbania *emerus* (Aubl.) Urb.
Swartzia *myrtifolia* Sm.
panamensis Benth.
simplex (Sw.) Spreng.
Teramnus *volubilis* Sw.
Uribea *tamarindoides* Dugand & Romero
Vatairea *lundellii* (Standley) Killip
Vigna *lasiocarpa* (Benth.) Verdc.
vexillata (L.) A. Rich.

FABACEAE-MIMOSOIDEAE
Abarema *adenophora* (Ducke) Barneby & Grimes
barbouriana (Standl.) Barneby & J.W. Grimes
idiopoda (S.F. Blake) Barneby & Grimes
macradenia (Pittier) Barneby & Grimes
Acacia *allenii* D. H. Janzen
tenuifolia (L.) Willd.
Albizia *adinocephala* (Donn. Sm.) Britton & Rose
carbonaria Britton ex Britton & P. Wilson
Balizia *elegans* (Ducke) Barneby & Grimes
Calliandra *bijuga* Rose
grandifolia P.H. Allen
surinamensis Benth.
tergemina (L.) Benth.
Cojoba *arborea* (L.) Britton & Rose
membranacea (Benth.) Britton & Rose
rufescens (Benth.) Britton & Rose
sophorocarpa (Benth.) Britton & Rose
Entada *gigas* (L.) Fawc. & Rendle
polystachya (L.) DC.
Enterolobium *cyclocarpum* (Jacq.) Griseb.
Inga *acrocephala* Steud.
acuminata Benth.
alba (Sw.) Willd.
allenii Jorge León
bella M. Sousa
coruscans Kunth ex Willd.
cylindrica (Vell.) Mart.
densiflora Benth.
edulis Mart.
fagifolia (L.) Willd.
goldmanii Pittier
golfodulcensis N. Zamora
heterophylla Willd.
jimenezii N. Zamora
jinicuil Schltdl. & Cham. ex G. Don
litoralis N. Zamora
marginata Willd.
multijuga Benth.
nobilis Willd.
oerstediana Benth. ex Seem.
paterno Harms
pezizifera Benth.
polita Killip
punctata Willd.
quaternata Poepp.
ruiziana G. Don
sapindoides Willd.
sertulifera DC.
skutchii Standl.
spectabilis (Vahl) Willd.
thibaudiana DC.
umbellifera (Vahl) Steud.
venusta Standl.
vera Willd.
Mimosa *debilis* Humb. & Bonpl. ex Willd.

myriadena (Benth.) Benth.
pigra L.
pudica L.
Newtonia *suaveolens* (Miq.) Brenan
Parkia *pendula* (Willd.) Benth. ex Walp.
Pithecellobium *hymenaeifolium* (Humb.&Bonpl. ex Willd.) Benth.
macradenium Pittier
saman (Jacq.) Benth.(syn. *Samanea saman* Jacq.)
valerioi (Britton & Rose) Standl.
Zapoteca *portoricensis* (Jacq.) H. M. Hern.)
tetragona (Willd.) H. M. Hern.
Zygia *cognata* (Standl.) Record
gigantifoliola (Schery) L. Rico]
rubiginosa L. Rico & Q. Jiménez
stevensonii (Standl.) Killip ex Record
unifoliolata (Benth.) Pittier

FAGACEAE
Quercus *insignis* M. Martens & Galeotti
rapurahuensis Pittier ex Trel.

FLACOURTIACEAE
Carpotroche *platyptera* Pittier
Casearia *arborea* (Rich.) Urb.
arguta Kunth
commersoniana Cambess.
corymbosa Kunth
sylvestris Sw.
tacanensis Lundell
Hasseltia *allenii* Hammel & Grayum - ined.
floribunda Kunth
quinquenervia Standley & L.O. Williams
Lacistema *aggregatum* (Bergius) Rusby
Laetia *procera* (Poepp.) Eichler
thamnia L.
Lindackeria *laurina* C. Presl
Lozania *pittieri* (S.F. Blake) L.B. Sm.
Lunania *mexicana* Brandegee
Mayna *odorata* Aubl.
Pleuranthodendron *lindenii* (Turcz.) Sleumer
Ryania *speciosa* Vahl
Tetrathylacium *macrophyllum* Poepp.
Xylosma *intermedia* (Seem.) Triana & Planch.
oligandra Donn. Sm.

GENTIANACEAE
Irlbachia *alata* (Aubl.) Maas
Schultesia *lisianthoides* (Griseb.) Benth. & Hook. ex Hemsl.
Voyria *corymbosa* Splitg.
kupperi Suess.
pittieri (Standl.) L.O. Williams
tenella Hook.
truncata (Standl.) Standl. & Steyerm.

GESNERIACEAE
Alloplectus *ambonensis* L.E. Skog
Besleria *hirsuta* (Oerst.) Hanst.
laxiflora Benth.
notabilis C.V. Morton
solanoides Kunth
Chrysothemis *friedrichsthaliana* (Hanst.) H.E. Moore
Codonanthe *macradenia* Donn. Sm.
crassifolia (Focke) C.V. Morton
Columnea *angustata* (Wiehler) L.E. Skog
aureonitens Hook.
flaccida Seem.
florida C.V. Morton
nicaraguensis Oerst.
polyantha (Wiehler) L.E. Skog
raymondii C.V. Morton
sanguinolenta (Klotzsch ex Oerst.) Hanst.
segregata B. D. Morley
Diastema *racemiferum* Benth.
Drymonia *alloplectoides* Hanst.
macrantha (Donn. Sm.) D. N. Gibson
macrophylla (Oerst.) H.E. Moore
mortoniana Wiehler
serrulata (Jacq.) Mart.
stenophylla (Donn. Sm.) H.E. Moore
turrialvae Hanst.
Episcia *lilacina* Hanst.
Gasteranthus *delphinioides* (Seem.) Wiehler
reconditus Chavarría & Hammel - ined.
wendlandianus (Hanst.) Wiehler
Kohleria *allenii* Standl. & L.O. Williams
spicata (Kunth) Oerst.
Monopyle *macrocarpa* Benth.
maxonii C.V. Morton
Napeanthus *bracteatus* C.V. Morton
Neomortonia *rosea* Wiehler
Paradrymonia *decurrens* (C.V. Morton) Wiehler
lineata (C.V. Morton) Wiehler
pedunculata L.E. Skog

HERNANDIACEAE
Hernandia *didymantha* Donn. Sm.
stenura Standl.

HIPPOCASTANACEAE
Billia *colombiana* Planch. & Lindl.

HIPPOCRATEACEAE
Anthodon *panamense* A.C. Sm.
Cheiloclinium *cognatum* (Miers) A.C. Sm.
Cuervea *kappleriana* (Miq.) A.C. Sm.
Elachyptera *floribunda* (Benth.) A.C. Sm.
Hippocratea *volubilis* L.
Hylenaea *praecelsa* (Miers) A.C. Sm.
Peritassa *pruinosa* (Seem.) A.C. Sm.
Salacia *cordata* (Miers) Mennega
multiflora (Lam.) DC.
Semialarium *mexicanum* (Miers) Mennega
Tontelea *hondurensis* A.C. Sm.

HUMIRIACEAE
Humiriastrum *diguense* Cuatrec.
Vantanea *barbourii* Standl.

HYDRANGEACEAE
Hydrangea *peruviana* Moric.
preslii Briq.

ICACINACEAE
Calatola *costaricensis* Standl.
Dendrobangia *boliviana* Rusby
Discophora *guianensis* Miers
Oecopetalum *greenmanii* Standl. & Steyerm.

JUGLANDACEAE
Alfaroa *guanacastensis* D. Stone
Oreomunnea *pterocarpa* Oerst.

LAMIACEAE
Hyptis *brevipes* Poit.
capitata Jacq.
mociniana Benth.
obtusiflora C. Presl ex Benth.
pectinata Poit.
suaveolens (L.) Poit.
verticillata Jacq.
vilis Kunth & Bouché
Ocimum *micranthum* Willd.
Salvia *occidentalis* Sw.
Scutellaria *costaricana* H. Wendl.
glabra Leonard

LAURACEAE
Aiouea *costaricensis* (Mez) Kosterm.
obscura van der Werff
Aniba *venezuelana* Mez
Beilschmiedia *alloiophylla* (Rusby) Kosterm.
brenesii (Meisn.) Kosterm.
ovalis (S.F. Blake) C. K. Allen
pendula (Sw.) Hemsl.
Caryodaphnopsis *burgeri* N. Zamora & Poveda
Cinnamomum *neurophyllum* (Mez & Pittier) Kosterm.

triplinerve (Ruiz & Pav.) Koesterm.
sp.nov.
Endlicheria *formosa* A.C. Sm.
Licaria *cufodontisii* Kosterm.
excelsa Kosterm.
misantlae (Brandegee) Kosterm.
pergamentacea W. C. Burger
Nectandra *hihua* (Ruiz & Pav.) Rohwer - ined.
hypoleuca Hammel
latifolia (Kunth) Mez
lineata (Kunth) Rohwer
martinicensis Mez.
membranacea (Sw.) Griseb.
purpurea (Ruiz & Pav.) Mez
reticulata (Ruiz & Pav.) Mez
salicifolia (Kunth) Nees.
umbrosa (Kunth) Mez
Ocotea *atirrensis* Mez & Donn. Sm.
cernua (Nees) Mez
dentata van der Werff
helicterifolia (Meisn.) Hemsl.
insularis (Meisn.) Mez
ira Mez & Pittier
jorge-escobarii C.Nelson
laetevirens Standl. & Steyerm.
leucoxylon (Sw.) Laness.
meziana C. K. Allen
mollifolia Mez & Pittier
multiflora Van der Werff
nicaraguensis Mez
rivularis Standl. & L.O. Williams
rubriflora Mez
sinuata (Mez) Rohwer
skutchii C. K. Allen
tenera Mez & Donn. Sm. ex Mez
valeriana (Standl.) W. C. Burger
veraguensis (Meisn.) Mez
wedeliana C. K. Allen
Persea *americana* Mill.
veraguasensis Seem.
Pleurothyrium *golfodulcensis* W. C. Burger & N. Zamora
immersum van der Werff
pauciflorum van der Werff & Hammel - ined.
trianae (Mez) Rohwer
Rhodostemonodaphne *kunthiana* (Nees) Rohwer
Williamodendron *glaucophyllum* (van der Werff) Kubitzki & H.G. Richt.

LECYTHIDACEAE
Couratari *guianensis* Aubl.
scottmorii Prance
Eschweilera *calyculata* Pittier
integrifolia (Ruiz & Pav. ex Miers) R. Knuth
longirachis S. A. Mori
neei S. A. Mori
pittieri Kunth
Grias *cauliflora* L.
Gustavia *brachycarpa* Pittier
Lecythis *mesophylla* S. A. Mori

LENTIBULARIACEAE
Utricularia *endresii* Rchb. f.
gibba L.

LEPIDOBOTRYACEAE
Ruptiliocarpon *caracolito* Hammel & N. Zamora

LOGANIACEAE
Spigelia *anthelmia* L.
humboldtiana Cham. & Schltdl.
Strychnos *chlorantha* Progel
guianensis (Aubl.) Mart.
panurensis Sprague & Sandwith
peckii B. L. Rob.
tabascana Sprague & Sandwith
toxifera M. R. Schomb. ex Benth.

LORANTHACEAE
Oryctanthus *alveolatus* (Kunth) Kuijt
cordifolius (C. Presl) Urb.
costulatus Rizzini
occidentalis (L.) Eichler
spicatus (Jacq.) Eichler
Phthirusa *pyrifolia* (Kunth) Eichler
Psittacanthus *corynocephalus* Eichl.
costaricensis Kuijt
cucullaris (Lam.) Blume
krameri Kuijt
ramiflorus (DC.) G. Don
rhynchanthus (Benth.) Kuijt
Struthanthus *leptostachyus* (Kunth) G. Don

LYTHRACEAE
Adenaria *floribunda* Kunth
Cuphea *appendiculata* Benth
calophylla Cham. & Schltdl.
carthagenensis (Jacq.) J.F. Macbr.
utriculosa Koehne
Lagerstroemia *speciosa* (L.) Pers.
Lafoensia *punicifolia* DC.

MAGNOLIACEAE
Talauma *gloriensis* Pittier

MALPIGHIACEAE
Banisteriopsis *cornifolia* H.B.K.
Bunchosia *cornifolia* Kunth
dwyeri Cuatrec. & Croat
macrophylla Rose
ursana W. R. Anderson
Byrsonima *crassifolia* (L.) Kunth
crispa A. Juss.
Dicella *aciculifera* W. R. Anderson
Heteropterys *obovata* (Small) Cuatrec. & Croat
panamensis Cuatrec. & Croat
Hiraea *fagifolia* (DC.) A. Juss.
smilacina Standl.
Lophanthera *hammelii* W. R. Anderson
Malpighia *albiflora* (Cuatrec.) Cuatrec.
glabra L.
Spachea *correae* Cuatrec. & Croat
Stigmaphyllon *ellipticum* (Kunth) A. Juss.
lindenianum A. Juss.
puberum (Rich.) A. Juss.
Tetrapterys *donnell-smithii* Small
macrocarpa I.M. C. Johnst.
tinifolia Triana & Planch.

MALVACEAE
Abelmoschus *moschatus* Medik.
Gossypium sp.
Hampea *appendiculata* (Donn. Sm.) Standl.
sp. nov.
Hibiscus *pernambucensis* Arruda
rosa-sinensis L.
Malachra *alceifolia* Jacq.
Malvaviscus *arboreus* Cav.
Pavonia *fruticosa* (Mill.) Fawc. & Rendle
maxonii (Standl.) Standl.
rosea Schltdl.
schiedeana Steud.
Sida *acuta* Burm. f.
rhombifolia L.
urens L.
Urena *lobata* L.
Wissadula *excelsior* (Cav.) C. Presl

MARCGRAVIACEAE
Marcgravia *affinis* Hemsl.
brownei (Triana & Planch.) Krug & Urb.
membranacea Standl.
nepenthoides Seem.
pittieri Gilg
roonii S. Dressler
schippii Standl.
Marcgraviastrum *subsessile* (Benth.) Bedell
Sarcopera *sessiliflora* (Triana & Planch.) Bedell
Souroubea *sympetala* Gilg
vallicola Woodson ex de Roon

MELASTOMATACEAE
Aciotis *caulialata* (Ruiz & Pav. ex E.A. López) Triana [syn. *A. alata* (Beurl.) Almeda, *levyana* Cogn.]
Adelobotrys *adscendens* (Sw.) Triana
Arthrostemma *ciliatum* Pav. ex D. Don

***Bellucia** pentamera* Naudin
***Blakea** gracilis* Hemsl.
itoralis L.O. Williams
subpeltata Cogn.
***Centradenia** paradoxa* (Kraenzl.) Almeda
***Clidemia** capitellata* (Bonpl.) D. Don
crenulata Gleason
densiflora (Standl.) Gleason
dentata D. Don
discolor (Triana) Cogn.
epiphytica (Triana) Cogn.
gracilis Pittier
hammelii Almeda
octona (Bonpl.) L.O. Williams
radicans Cogn.
reitziana Cogn. & Gleason ex Gleason
sericea D. Don
sessiliflora (Naudin) Cogn.
setosa (Triana) Gleason
septuplinervia Cogn.
***Conostegia** bracteata* Triana
cinnamomea (Beurl.) Wurdack
lasiopoda Benth.
micrantha Standl.
montana (Sw.) D. Don ex DC.
setifera Standl.
subcrustulata (Beurl.) Triana
tenuifolia Donn. Sm.
xalapensis (Bonpl.) D. Don.
***Graffenrieda** galeottii* (Naudin) L.O. Williams
***Henriettea** cuneata* (Standl.) L.O. Williams
odorata (Markgr.) Almeda
succosa (Aubl.) DC.
tuberculosa (Donn. Sm.) L.O. Williams
***Leandra** granatensis* Gleason
grandifolia Cogn.
lasiopetala Cogn.
longicoma Cogn.
mexicana (Naudin) Cogn.
***Miconia** affinis* DC.
albicans (Sw.) Triana
ampla Triana
argentea (Sw.) DC.
barbinervis (Benth.) Triana
benthamiana Triana
capitellata (Bonpl.) D. Don
centrodesma Naudin
dissitiflora Almeda
dodecandra (Desr.) Cogn.
doniana Gleason
dorsiloba Gleason
elata DC.
gracilis Triana
hondurensis Donn. Sm.
impetiolaris (Sw.) D. Don
lacera (Bonpl.) Naudin
matthaei Naudin
minutiflora (Bonpl.) DC.
multispicata Naudin
nervosa (Sm.) Triana
oinochrophylla Donn. Sm.
paleacea Cogn.
poeppigii Triana
prasina (Sw.) DC.
punctata (Desr.) D.Don
punctata (Desr.) D.Don
reducens Triana
schlimii Triana
serrulata (DC.) Naudin
shattuckii Standl.
simplex Triana
smaragdina Naudin
theizans (Bonpl.) Cogn.
trinervia (Sw.) D. Don
***Mouriri** colombiana* Morley
cyphocarpa Standl.
gleasoniana Standl. ex Standl. & Steyerm.
myrtifolia Spruce ex Triana
myrtilloides (Sw.) Poir.
osaënsis Morley
***Ossaea** laxivenula* Wurdack
macrophylla (Benth.) Cogn.
micrantha (Sw.) Macfad.
quinquenervia (Mill.) Cogn.
robusta (Triana) Cogn.
***Schwackaea** cupheoides* (Benth.) Cogn. ex Durand
***Tibouchina** longifolia* (Vahl) Baill. ex Cogn.
***Tococa** guianensis* Aubl.
***Topobea** maurofernandeziana* Cogn.
multiflora (D. Don) Triana
praecox Gleason

MELIACEAE
***Carapa** guianensis* Aubl.
***Cedrela** odorata* L.
***Guarea** bullata* Radlk.
glabra Vahl
grandifolia DC.
kunthiana A. Juss.
pterorhachis Harms
***Melia** azedarach* L.
***Trichilia** hirta* L.
martiana C. DC.
pallida Sw.
quadrijuga Kunth
septentrionalis C. DC.
skutchii C.V. Morton & P.H. Allen
tuberculata (Triana & Planch.) C. DC.

MENISPERMACEAE
***Abuta** panamensis* (Standl.) Krukoff & Barnaby
steyermarkii (Standl.) Standl.
***Anomospermum** reticulatum* (Mart.) Eichler
***Cissampelos** tropaeolifolia* DC.
***Curarea** cuatrecasasii* Barneby & Krukoff
***Hyperbaena** leptobotryosa* (Donn. Sm.) Standl.
***Odontocarya** paupera* (Griseb.) Diels
truncata Standl.

MENYANTHACEAE
***Nymphoides** indica* (L.) Kuntze

MIMOSACEAE, see FABACEAE-MIMOSOIDEAE

MOLLUGINACEAE
***Mollugo** verticillata* L.

MONIMIACEAE
***Mollinedia** costaricensis* Donn. Sm.
pinchotiana Perkins
***Siparuna** andina* (Tul.) A. DC *guianensis* Aubl.
pauciflora (Beurl.) A. DC.

MORACEAE
***Batocarpus** costaricensis* Standl. & L.O. Williams
***Brosimum** alicastrum* Sw.
costaricanum Liebm.
guianense (Aubl.) Huber
lactescens (S. Moore) C. C. Berg
utile (Kunth) Oken
***Castilla** tunu* Hemsl.
***Clarisia** biflora* Ruiz & Pav.
racemosa Ruiz & Pav.
***Dorstenia** choconiana* S. Watson
***Ficus** americana* Aubl.
benjamina L.
brevibracteata W.C. Burger
bullenei I.M. Johnst.
caldasiana Dugand
citrifolia Mill.
colubrinae Standl.
costaricana (Liebm.) Miq.
donnell-smithii Standl.
goldmanii Standl.
insipida Willd.
maxima Mill.
nymphaeifolia Mill.
obtusifolia Kunth
osaensis C.C.Berg
paraensis (Miq.) Miq.
pertusa L. f.
tonduzii Standl.
trachelosyce Standl.
trigonata L.
werckleana Rossberg
yoponensis Desv.
zarzalensis Standl.

***Maclura** tinctoria* (L.) G. Don
costaricana (Standl.) C. C. Berg
***Naucleopsis** naga* Pittier
ulei (Warb.) Ducke
***Olmedia** aspera* Ruiz & Pavon
***Perebea** hispidula* Standl.
mollis (Poepp. & Endl.) Huber
***Poulsenia** armata* (Miq.) Standl.
***Pseudolmedia** mollis* Standl.
oxyphyllaria Donn. Sm.
spuria (Sw.) Griseb.
***Sorocea** affinis* Hemsl.
cufodontisii W. C. Burger
pubivena Hemsl.
trophoides W. C. Burger
***Trophis** caucana* (Pittier) C. C. Berg
***Trophis** racemosa* (L.) Urb.

MYRISTICACEAE
***Compsoneura** sprucei* (A. DC.) Warb.
***Otoba** novogranatensis* Moldenke
***Virola** guatemalensis* (Hemsl.) Warb.
koschnyi Warb.
sebifera Aubl.
surinamensis (Rol. ex Rottb.) Warb.

MYRSINACEAE
***Ardisia** compressa* Kunth
dodgei Standl.
dunlapiana P.H. Allen
furfuracella Standl.
nigropunctata Oerst.
opegrapha Oerst.
pittieri Mez
***Cybianthus** schlimii* (Hook. f.) G. Agostini
***Parathesis** acostensis* J.F. Morales
longipedicellata Ricketson
pallida Lundell
***Stylogyne** laevis* (Oerst.) Mez

MYRTACEAE
***Calyptranthes** chytraculia* (L.) Sw.
pallens Griesb.
***Eugenia** acapulcensis* Steud.
glandulosopunctata P. E. Sánchez & Poveda
hypargyrea Standl.
octopleura Krug & Urb.
oerstediana O. Berg
sarapiquensis P. E. Sánchez sp.nov. P. E. Sánchez - ined.
teresae J.F. Morales
***Myrcia** leptoclada* DC.
splendens (Sw.) DC.
***Myrcianthes** fragrans* (Sw.) McVaugh.
***Myrciaria** floribunda* (Willd.) O. Berg
***Plinia** povedae* P. E. Sánchez
salticola McVaugh
***Psidium** friedrichsthalianum* (O. Berg) Nied.
guajava L.
***Syzygium** jambos* (L.) Alston
malaccense (L.) Merr. & L.M. Perry

NYCTAGINACEAE
***Boerhavia** diffusa* L.
***Guapira** costaricana* (Standl.) Woodson
***Neea** amplifolia* Donn. Sm.
elegans P.H. Allen
***Pisonia** aculeata* L.
***Nymphaea** glandulifera* Rodschied (syn. *N. blanda* G. Mey.)

OCHNACEAE
***Cespedesia** macrophylla* Seem.
***Ouratea** lucens* (Kunth) Engl.
osaënsis Whitef.
rinconensis Whitef.
valerii Standl.
***Sauvagesia** erecta* L.

OLACACEAE
***Chaunochiton** kappleri* (Sagot ex Engl.) Ducke
***Heisteria** acuminata* (Humb. & Bonpl.) Engl.
concinna Standl.
cyanocarpa Poepp.
macrophylla Oerst.
scandens Ducke
***Minquartia** guianensis* Aubl.
***Ximenia** americana* L.

OLEACEAE
***Chionanthus** panamensis* (Standl.) Stearn

ONAGRACEAE
Fuchsia
***Ludwigia** hyssopifolia* (G. Don) Exell
latifolia (Benth.) H. Hara
octovalvis (Jacq.) P.H. Raven

OXALIDACEAE
***Averrhoa** bilimbi* L.
carambola L.
***Biophytum** dendroides* (H.B.K.) DC.
***Oxalis** corniculata* L.

PAPAVERACEAE
***Bocconia** frutescens* L.

PASSIFLORACEAE
***Passiflora** ambigua* Hemsl.
arbelaezii Uribe
auriculata Kunth
biflora Lam.
coriacea Juss.
costaricensis Killip
edulis Sims
eueidipabulum S. Knapp & Mallet
foetida L.
lancearia Mast.
lobata (Killip) Hutch. ex J. M. MacDougal
menispermifolia Kunth
pittieri Mast.
quadrangularis L.
talamancensis Killip
vitifolia Kunth

PHYTOLACCACEAE
***Microtea** debilis* Sw.
***Petiveria** alliacea* L.
***Phytolacca** rivinoides* Kunth & Bouché
***Trichostigma** octandrum* (L.) H. Walter

PIPERACEAE
***Peperomia** alata* Ruiz & Pav.
costaricensis C. DC.
distachya (L.) A.Dietr.
glabella (Sw.) A. Dietr.
hispidorhachis Yunck.
lignescens C. DC.
macrostachya (Vahl) A. Dietr.
mameiana C. DC.
obtusifolia (L.) A. Dietr.
pellucida (L.) Kunth
rotundifolia (L.) Kunth
saintpauliella Grayum
serpens (Sw.) Loudon
tenuicaulis C. DC.
tenuifolia C. DC.
trichomanoides Grayum
***Piper** aduncum* L.
aequale Vahl
arboreum Aubl.
augustum Rudge
auritum Kunth
biauritum C. DC.
biseriatum C. DC.
chrysostachyum C. DC.
cenocladum C. DC.
coilostachyum C. DC.
cordulatum C. DC.
corrugatum Kuntze
curtispicum C. DC.
deductum Trel.
dilatatum L. C. Rich.
fimbriulatum C. DC.
friedrichsthalii C. DC.
garagaranum C. DC.
glabrescens (Miq.) C. DC.
guanacostense C. DC.
hispidum Sw.
multiplinervium C. DC.
nigrum L.
nudifolium C. DC.
obliquum Ruiz & Pav.
peltatum L.

phytolaccifolium Opiz
polytrichum C. DC.
pseudofuligineum C. DC.
reticulatum L.
sagittifolium C. DC.
schiedeanum Steud.
silvivagum C. DC.
sinugaudens C. DC.
subsessilifolium C. DC.
terrabanum C. DC.
trigonum C. DC.
urophyllum C. DC.
urostachyum Hemsl.
variegatum (Ruiz & Pavon) Persoon
zacatense C. DC.

PODOSTEMACEAE
Marathrum *tenue* Liebm.
Tristicha

POLYGALACEAE
Moutabea *longifolia* Poepp. & Endl.
Securidaca *diversifolia* Pol.

POLYGONACEAE
Coccoloba *acuminata* Kunth
bejuco P. E. Sánchez & Poveda
guanacastensis W.C. Burger
lehmannii Lindau
padiformis Meisn.
standleyana P.H. Allen
tuerckheimii Donn. Sm.
Polygonum *hydropiperoides* Michx.
punctatum Elliott
Triplaris *melaenodendron* (Bertol.) Standl. & Steyerm.

PORTULACACEAE
Portulaca *oleracea* L.

PROTEACEAE
Panopsis *suaveolens* (Klotzsch & H. Karst.) Pittier
Roupala *montana* Aubl.

QUIINACEAE
Quiina *colonensis* (D'Arcy) D'Arcy
cruegeriana Griseb.
schippii Standl.
(syn. *Q. macrophylla* Tul.)

RAFFLESIACEAE
Apodanthes *casearíae* Poit.

RHAMNACEAE
Colubrina *spinosa* Donn. Sm.
Gouania
colombiana Suess.
lupuloides (L.) Urb.
Rhamnus *oreodendron* L.O.Williams
Ziziphus *chloroxylon* (L.) Oliv.

RHIZOPHORACEAE
Cassipourea *elliptica* (Sw.) Poit.
Rhizophora *mangle* L.
racemosa G. Mey.

ROSACEAE
Prunus *subcorymbosa* Ruiz ex Koehne

RUBIACEAE
Alibertia *edulis* (Rich.) A. Rich.
utleyorum (Dwyer) C. M. Taylor
Alseis *blackiana* Hemsl.
hondurensis Standl.
Amphidasya *ambigua* (Standl.) Standl.
Bathysa *veraguensis* Dwyer
Borojoa *panamensis* Dwyer
patinoi Cuatrec.
Chimarrhis *latifolia* Standl.
parviflora Standl.
Chiococca *alba* (L.) Hitchc.
belizensis Lundell
Chione *sylvicola* (Standl.) W. C. Burger
Chomelia *atlantica* Dwyer
grandicarpa Dwyer
microloba Donn. Sm.
recordii Standl.
venulosa W. C. Burger & C. M. Taylor
Cinchona *pubescens* Vahl
Coccocypselum *hirsutum* Bartling ex DC.
Condaminea *corymbosa* (Ruiz & Pav.) DC.
Cosmibuena *grandiflora* (Ruiz & Pav.) Rusby
Coussarea *curvigemmia* Dwyer
hondensis (Standl.) C. M. Taylor & W. C. Burger
impetiolaris Donn. Sm.
nigrescens C. M. Taylor & Hammel
psychotrioides C. M. Taylor & Hammel
talamancana Standl.
Duroia *costaricensis* Standl.
Faramea *eurycarpa* Standl.
multiflora A. Rich.
occidentalis (L.) A. Rich.
permagnifolia Dwyer
sessifolia P.H. Allen
stenura Standl.
suerrensis (Donn. Sm.) Donn. Sm.
Genipa *americana* L.
Geophila *cordifolia* Miq.
macropoda (Ruiz & Pav.) DC.
repens (L.) I.M. Johnst.
Gonzalagunia *bracteosa* (Donn. Sm.) B. L. Rob.
brenesii Standl.
ovatifolia (Donn. Sm.) B. L. Rob.
panamensis (Cav.) K. Schum.
rudis (Standl.) Standl.
Guettarda *conferta* Benth.
crispiflora Vahl
foliacea Standl.
macrosperma Donn. Sm.
sanblasensis Dwyer
turrialbana N. Zamora & Poveda
Hamelia *axillaris* Sw.
macrantha Little
magnifolia Wernham
patens Jacq.
xerocarpa Kuntze
Hemidiodia *ocimifolia* (Willd.) K. Schum. (syn. *Spermacoce ocymifolia* Willd. ex Roem. & Schult.)
Hillia *loranthoides* Standl.
Hippotis *albiflora* H. Karst.
Hoffmannia *bullata* L.O. Williams
davidsoniae Standl.
hamelioides Standl.
hammelii C. M. Taylor
laxa Standl.
leucocarpa Standl.
liesneriana Standl.
longipetiolata Pol.
pallidiflora Standl.
woodsonii Standl.
Isertia *haenkeana* DC.
laevis (Triana) B. M. Boom.
Ixora *finlaysoniana* Wall. ex G. Don
nicaraguensis Standl.
Ladenbergia *brenesii* Standl.
sericophylla Standl.
Machaonia *martinicensis* Standl.
Macrocnemum *roseum* (Ruiz & Pav.) Wedd.
Malanea *colombiana* Standl.
Manettia *barbata* Oerst.
reclinata L.
Mitracarpus *hirtus* (L.) DC.
Oldenlandia *corymbosa* L.
Osa *pulchra* (D. R. Simpson) Aiello
Palicourea *crocea* (Sw.) Roem. & Schult.
guianensis Aubl.
triphylla DC.
lobata C. M. Taylor
macrophylla Benth.
sprucei Standl.
tinajita Seem.
wendlandii Hook.
Posoqueria *coriacea* M. Martens & Galeotti
latifolia (Rudge) Roem. & Schult.
maxima Standl.
panamensis (Walp. & Duchass) Walp.
Psychotria *acicularis* C. M. Taylor

acuminata Benth.
aggregata Standl.
alfaroana Standl.
aurantibractea C. M. Taylor
borucana (A. R. Molina) C. M. Taylor & W. C. Burger
brachiata Sw.
brachybotrya Müll. Arg.
capitata Ruiz & Pav.
chagrensis Standl.
chiapensis Standl.
chitariana Dwyer & C. W. Ham.
deflexa DC.
elata (Sw.) Hammel.
emetica L. f.
erecta (Aubl.) Standl. & Steyerm.
eurycarpa Standl.
furcata DC.
grandis Sw.
horizontalis Sw.
macrophylla Ruiz & Pav.
marginata Sw.
micrantha Kunth
microbotrys Ruiz ex Standl.
microdon (DC.) Urb.
mortoniana Standl.
officinalis (Aubl.) Raeusch. ex Sandwith
orchidearum Standl.
panamensis Standl.
pilosa Ruiz & Pav.
pittieri Standl.
platypoda DC
poeppigiana Müll. Arg.
polyphlebia Donn. Sm.
racemosa (Aubl.) Willd.
remota Benth.
solitudinum Standl.
suerrensis Donn. Sm.
uliginosa Sw.
valeriana Standl.

Randia *aculeata* L.
altiscandens (Ducke) C. M. Taylor
armata (Sw.) DC.
brenesii Standl.
genipoides Dwyer - ined.
gentryi Dwyer
grandifolia (Donn. Sm.) Standl.

Raritebe *palicoureoides* Wernham
trifoliatum (Dwyer & M. V. Hayden) Dwyer

Richardia *scabra* L.

Rondeletia *bertieroides* Standl.
urophylla Standl. & L.O. Williams

Rudgea *amplexicaulis* Dwyer
cornifolia (Kunth) Standl.
raveniana W. C. Burger

Rustia *costaricensis* (Standl.) Lorence - ined.
occidentalis (Benth.) Hemsl.

Sabicea *panamensis* Wernham
villosa Roem. & Schult.

Simira *maxonii* (Standl.) Steyerm.

Sommera *donnell-smithii* Standl.

Spermacoce *assurgens* Ruiz & Pav.
densiflora (DC.) Liogier - ined.
prostrata Aubl.

Tocoyena *pittieri* (Standl.) Standl.

Warszewiczia *coccinea* (Vahl) Klotzsch

RUTACEAE

Amyris *brenesii* Standl.

Citrus *sinensis* (L.) Osbeck

Conchocarpus *guyanensis* (Pulle) Kallunki & Pirani (syn. *Ticorea unifoliolata* T.S. Elias)

Galipea *dasysperma* Gómez-Laur. & Q. Jiménez

Murraya *paniculata* (L.) Jack

Ravenia *rosea* Standl.

Stauranthus *perforatus* Liebm.

Zanthoxylum *juniperum* Poepp.
ekmanii (Urb.) Allain
kellermanii P. Wilson
panamense P. Wilson

SABIACEAE

Meliosma *allenii* Standl. & L.O. Williams
brenesii Standl.
donnellsmithii Urb.
glabrata (Liebm.) Urb.
grandiflora C.V. Morton ex A.H. Gentry
idiopoda S.F. Blake

SAPINDACEAE

Allophylus *cominia* (L.) Sw.
gentryi Croat
psilospermus Radlk.

Cardiospermum *microcarpum* Kunth

Cupania *glabra* Aw.
livida (Radlk.) Croat
rufescens Triana & Planch.

Dilodendron *costaricense* (Radlk.) A.H. Gentry & Steyerm.

Matayba *ingifolia* Standl.
oppositifolia (A. Rich.) Britton

Paullinia *bracteosa* Radlk.
costata Schltdl. & Cham.
cururu L.
dasystachya Raldk.
faginea (Triana & Planch.) Radlk.
granatensis (Planch. & Linden) Radlk.
grandifolia Benth. ex Radlk.
pinnata L.
pterocarpa Triana & Planch.
rugosa Benth. ex Radlk.
serjaniifolia Triana & Planch.
subnuda Radlk.
trisulca Radlk.

Serjania *circumvallata* Radlk.
racemosa K. Schum.

Talisia *allenii* Croat
nervosa Radlk.

Thinouia *myriantha* Triana & Planch.

Vouarana *anomala* (Steyerm.) P. Acevedo

SAPOTACEAE

Chromolocuma *rubriflora* Jacq. sp. nov

Chrysophyllum *argenteum* Jacq.
brenesii Cronquist
cainito L.
hirsutum Cronquist
aff. *parvulum* Pittier

Elaeoluma *glabrescens* (Mart. & Eichler) Aubrév.

Manilkara *staminodella* Gilly
zapota (L.) Royen

Micropholis *crotonoides* (Pierre) Pierre
melinoniana Pierre
venulosa (Mart. & Eichler ex Miq.) Pierre

Pouteria *amygdalicarpa* (Pittier) T. D. Penn.
bulliformis Q. Jiménez & T. D. Penn.
campechiana (Kunth) Baehni
chiricana (Standl.) Baehni
congestifolia Pilz.
durlandii (Pittier) Baehni
euryphylla (Standl.) Baehni
exofoliata (Pittier) T. D. Penn.
filiformis T. D. Penn.
filipes Eyma
fossicola Cronquist
foveolata T. D. Penn.
glomerata (Miq.) Radlk.
juruana K. Krause
laevigata (Mart.) Radlk.
lecythidicarpa P. E. Sánchez & Poveda
leptopedicellata Pilz
macrocarpa (Mart.) D. Dietr.
reticulata (Engl.) Eyma
subrotata Cronquist
torta (Mart.) Radlk.
triplarifolia P.H. Allen ex T.D.Penn.
viridis (Pittier) Cronquist

Pradosia *atroviolacea* Duke sp. nov.

Sarcaulus *brasiliensis* (A. DC.) Eyma

Sideroxylon *capiri* (A. DC.)

SCROPHULARIACEAE
Capraria biflora L.
Mazus japonicus (Thunb.) Kuntze
Russelia sarmentosa Jacq.
Schlegelia fuscata A.H. Gentry
gamboanum Grayum & Hammel
parviflora (Oerst.) Monach.
Scoparia dulcis L.

SIMAROUBACEAE
Picramnia antidesma Sw.
latifolia Tul.
Quassia amara L.
Recchia simplicifolia T. Wendt & E. J. Lott
Simaba cedron Planch.
polyphylla (Cavalc.) W. W. Thomas
Simarouba amara Aubl.

SOLANACEAE
Cestrum megalophyllum Dunal
racemosum Ruiz & Pav.
Cuatresia exiguiflora (D'Arcy) Hunz.
Cyphomandra hartwegii (Miers) Dunal
Juanulloa mexicana (Schltdl.) Miers
Lycianthes amatitlanensis (J. M. Coult. & Donn. Sm.) Bitter
escuintlensis (J. M. Coult.) D'Arcy
heteroclita (Sendtn.) Bitter
maxonii Standl.
multiflora Bitter
sanctaeclarae (Greenm.) D'Arcy
synanthera (Sendtn.) Bitter
Markea neurantha Hemsl.
Physalis cordata Mill.
minuta Griggs
Solanum americanum Mill.
antillarum O. E. Schulz
aturense Dunal
hirtum Vahl
hispidum Pers.
jamaicense Mill.
lanceifolium Jacq.
mammosum L.
pectinatum Dunal
pensile Ruiz & Pav.
quitoense Lam.
rovirosanum Donn. Sm.
rudepannum Dunal
sessiliflorum Dunal
schlechtendalianum Walp.
torvum Sw.
Witheringia meiantha (Donn. Smith) Hunz.
morii D'Arcy
mortonii Hunz.
solanacea L'Hér.

STERCULIACEAE
Byttneria aculeata (Jacq.) Jacq.
pescapraeifolia Britton
Guazuma ulmifolia Lam.
Herrania purpurea (Pittier) R.E. Schult.
Melochia lupulina Sw.
manducata W. Wright & Sauvalle
Pterygota excelsa (Standl. & L.O. Williams) Kosterm.
Sterculia allenii E. Taylor - ined.
apetala (Jacq.) H. Karst.
recordiana Standl. - ined.
Theobroma angustifolium Moç. & Sessé ex DC.
bicolor Humb. & Bonpl.
cacao L.
mammosum Cuatrec. & Jorge León
simiarum Donn. Sm.

STYRACACEAE
Styrax glabratus Schott

SYMPLOCACEAE
Symplocos limoncillo Humb. & Bonpl.

THEACEAE
Freziera candicans Tul.
grisebachii Krug & Urb.
Gordonia brandegeei H. Keng
fruticosa (Schrad.) H. Keng
Pelliciera rhizophorae Triana & Planch.
Symplococarpon purpusii (Brandegee) Kobuski
Ternstroemia multiovulata Gómez-L., Q. Jiménez & N. Zamora
seemannii Triana & Planch.

THEOPHRASTACEAE
Clavija biborrana Oerst.
costaricana Pittier

THYMELAEACEAE
Daphnopsis americana (Mill.) J. R. Johnst.
costaricensis Barringer & Grayum
Schoenobiblus panamensis Standl. & L.O. Williams

TICODENDRACEAE
Ticodendron incognitum Gómez-Laur. & L.D. Gómez

TILIACEAE
Apeiba membranacea Spruce ex Benth.
tibourbou Aubl.
Corchorus siliquosus L.
Dicraspidia donnell-smithii Standl.
Goethalsia meiantha (Donn. Sm.) Burret
Heliocarpus appendiculatus Turcz.
Luehea seemannii Triana & Planch.
Mortoniodendron anisophyllum (Standl.) Standl. & Steyerm.
guatemalense Standl. & Steyerm.
Muntingia calabura L.
Trichospermum galeottii (Turcz.) Kosterm.
grewiifolium (A. Rich.) Kosterm.
Triumfetta lappula L.

TOVARIACEAE
Tovaria pendula Ruiz & Pav.

TURNERACEAE
Erblichia odorata Seem.
Turnera sp. nov.

ULMACEAE
Ampelocera macrocarpa Forero & A.H. Gentry
Celtis iguanaea (Jacq.) Sarg.
schippii Standl.
Trema integerrima (Beurl.) Standl.
micrantha (L.) Blume

URTICACEAE
Laportea aestuans (L.) Chew
Myriocarpa longipes Liebm.
Pilea gomeziana W. C. Burger
imparifolia Wedd.
pallida Killip
Urera baccifera (L.) Gaudich.
eggersii Hieron.
elata (Sw.) Griseb.

VERBENACEAE
Aegiphila anomala Pittier
cephalophora Standl.
costaricensis Moldenke
deppeana Steud.
elata Sw.
panamensis Moldenke
quararibeana Rueda
Avicennia germinans (L.) L.
Callicarpa acuminata Kunth
Citharexylum caudatum L.
cooperi Standl.
donnell-smithii Greenm.
viride Moldenke
Clerodendrum paniculatum L.
Cornutia grandifolia (Schltdl. & Cham.) Schauer
pyramidata L.
Gmelina arborea Roxb. ex Sm.
Lantana camara L.
trifolia L.
urticifolia Mill.
Lippia alba (Mill) N.E.Br. ex Britton & Wilson
Petrea volubilis L.

Priva *lappulacea* (L.) Pers.
Stachytarpheta *jamaicensis* (L.) Vahl
Tectona *grandis* L. f.
Verbena
Vitex *cooperi* Standl.

VIOLACEAE
Amphirrhox *longifolia* (A. St.-Hil.) Spreng.
Corynostylis *arborea* (L.) S.F. Blake
Fusispermum *laxiflorum* Hekking
Gloeospermum *boreale* C.V. Morton
diversipetalum Standl. & L.O. Williams
Hybanthus *attenuatus* (Humb. & Bonpl.) Schulze-Menz
denticulatus H.E. Ballard, Wetter & N. Zamora
Rinorea *crenata* S.F. Blake
dasyadena A. Robyns
deflexiflora Bartlett
guatemalensis (S. Watson) Bartlett
hummelii Sprague
lindeniana (Tul.) Kuntze
paniculata (Mart.) Kuntze
squamata S.F. Blake
sylvatica (Seem.) Kuntze

VISCACEAE
Phoradendron *chrysocladon* A. Gray
crassifolium (Pohl) Eichler
piperoides (Kunth) Trel.
robustissimum Eichler

VITACEAE
Cissus *anisophylla* Lombardi
biformifolia Standl.
erosa Rich.
microcarpa Vahl
osaensis Lombardi
rhombifolia Vahl (syn. *C. alata* Jacq.)
verticillata (L.) Nicolson & C. E. Jarvis

VOCHYSIACEAE
Qualea *paraensis* Ducke
Vochysia *allenii* Standl. & L.O. Williams
ferruginea Mart.
guatemalensis Donn. Sm.
megalophylla Stafleu

ZYGOPHYLLACEAE
Kallstroemia *pubescens* (G. Don) Dandy

Index to the families and genera (scientific names)

The index includes also the families and genera of pteridophytes, referring to the list of Appendix IV. Capitals: plant families, italics: genera.

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Plates

Plate 1.

a Aerial view of the Esquinas forest (Piedras Blancas N.P.) with the Golfo Dulce

b Coastal forest with characteristic *Schizolobium parahyba* (whitish crowns)

c Playa San Josecito at the Golfo Dulce

Plate 2.

a Aerial view of the Esquinas forest (Piedras Blancas N.P.) with ridges and deep valleys

b Typical forest on slopes near La Gamba (Piedras Blancas N. P.)

c Interior of ridge forest near La Gamba (Piedras Blancas N. P.)

Plate 3.

a Water fall - Río Sardinal (Piedras Blancas N.P.)

b Riverine forest along Río Sardinal (Piedras Blancas N.P.)

c Aquatic vegetation with *Pistia stratiotes* and *Eichhornia crassipes* at Río Sirena (Corcovado N.P.)

Plate 4.

a Río Esquinas, forming part of the natural border of the Piedras Blancas N.P.

b Swamp forest with *Mora oleifera* and *Pterocarpus officinalis*, Río Coto near Golfito

c Interior of swamp forest with buttresses of *Pterocarpus officinalis*, Río Coto near Golfito

Plate 5.

a Mouth of the Río Esquinas with mangrove vegetation

b *Rhizophora racemosa* with stilt roots (Río Coto near Golfito)

c Buttresses of the mangrove species *Pelliciera rhizophorae*, Río Esquinas (Piedras Blancas N.P.)

Plate 6.

a Pasture near La Gamba

b Gap with the invading fern *Dicranopteris pectinata* (Piedras Blancas N.P.)

c The village La Gamba

Plate 7.

a Aerial view of the Esquinas Rainforest Lodge

b The Esquinas Rainforest Lodge

c Part of the field station "Tropenstation La Gamba"

d Biological Station Sirena (Corcovado N.P.)

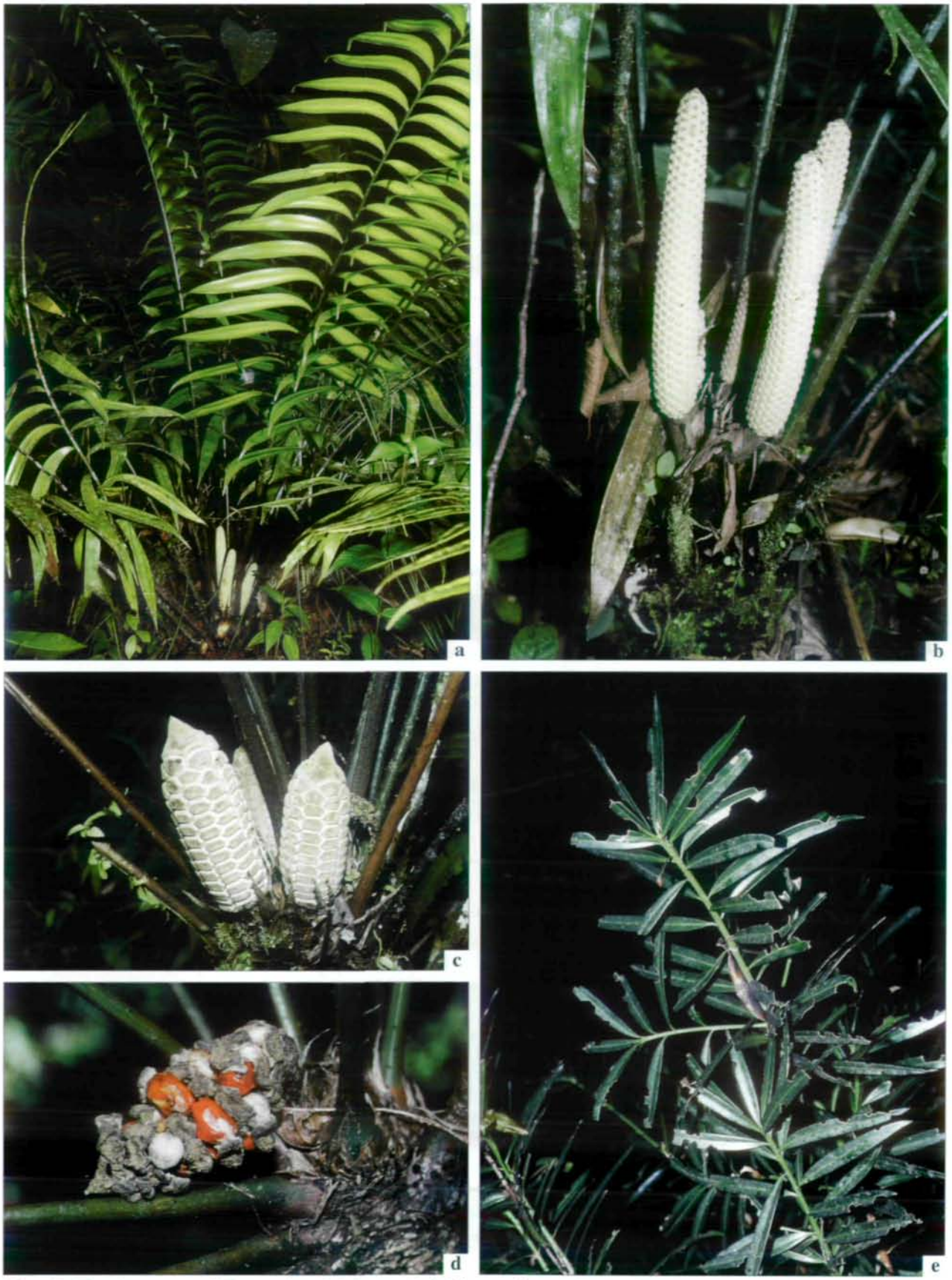

Plate 8. **Zamiaceae**, a-d *Zamia fairchildiana* (a habit - male specimen, b male cones, c,d female cones in unripe and ripe condition); **Podocarpaceae**, e *Podocarpus guatemalensis*, sterile branches

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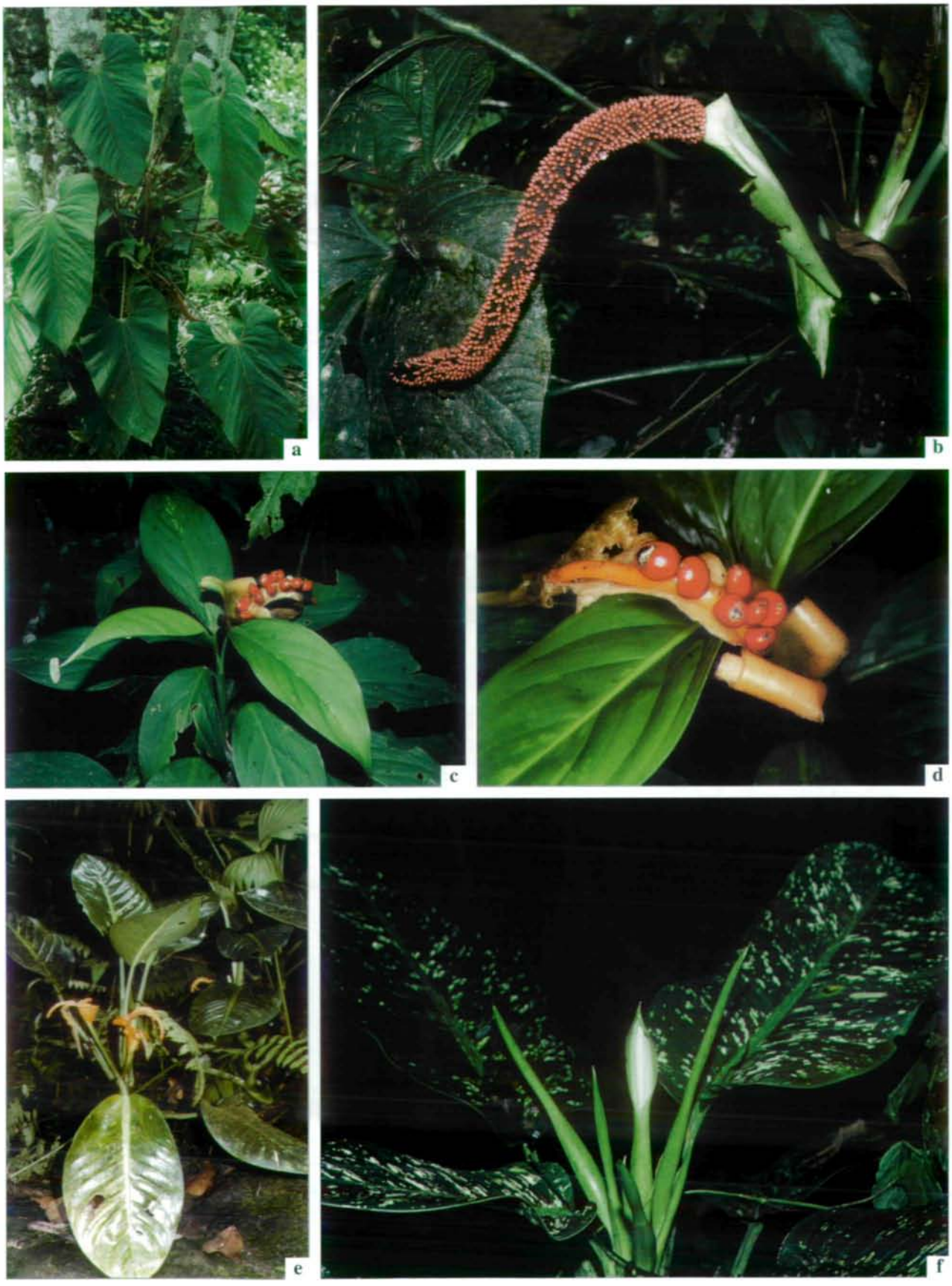

Plate 10. **Araceae**, a,b *Anthurium ravenii*, c,d *Dieffenbachia oerstedii*, e *Dieffenbachia concinna*, f *Dieffenbachia* sp.

Plate 11. **Araceae**, a,b,c *Dracontium pittieri*, d *Heteropsis oblongifolia*, e *Monstera* sp. (transition from juvenile to mature leaves), f *Monstera adansonii*, g *Monstera* sp., h *Philodendron pterotum*, i *Philodendron sagittifolium*

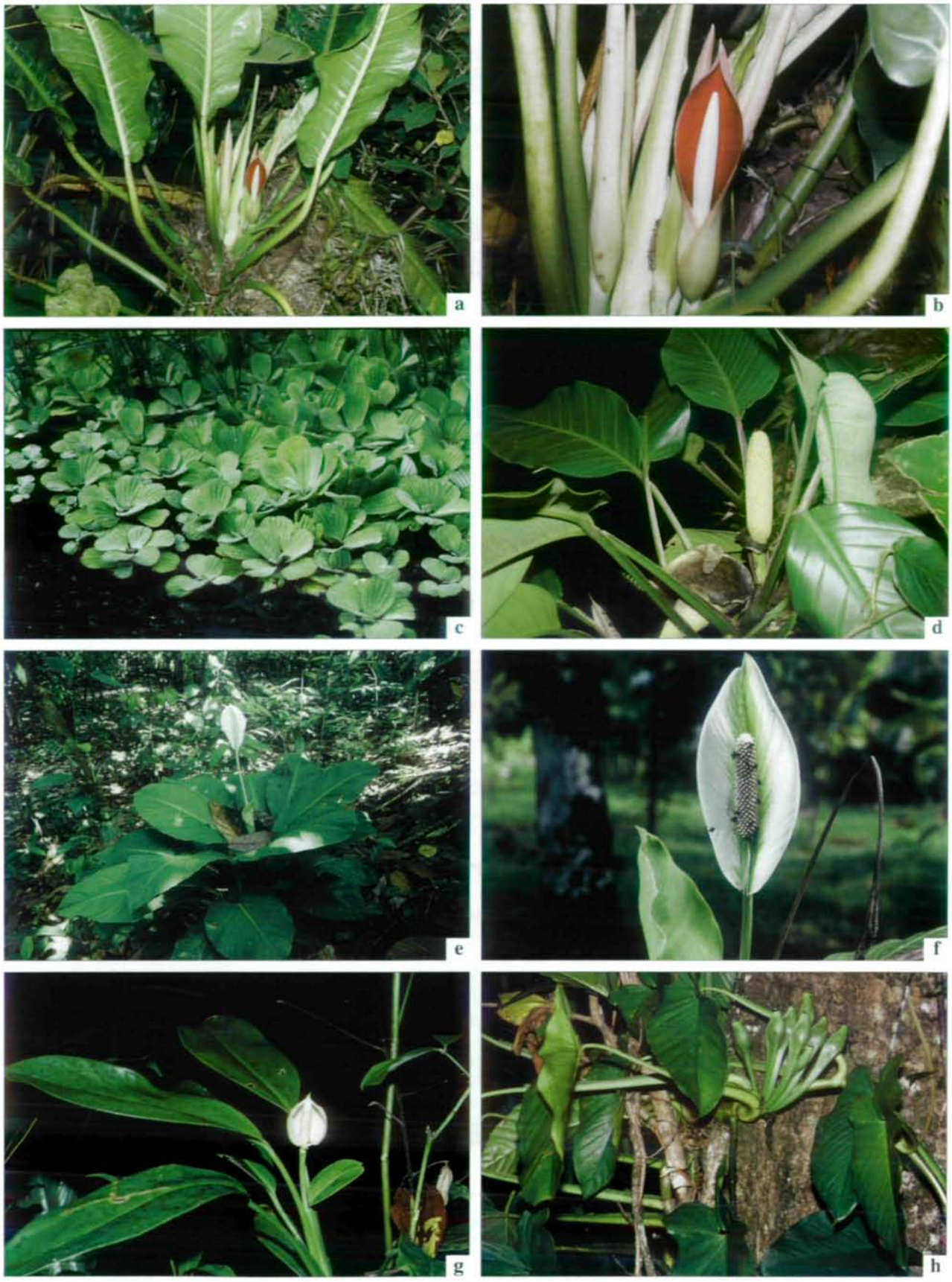

Plate 12. **Araceae**, a,b *Philodendron auriculatum*, c *Pistia stratiotes*, d *Rhodospatha* sp., e,f *Spathiphyllum wendlandii*, g *Stenospermation* cf. *angustifolium*, h *Syngonium hastiferum*

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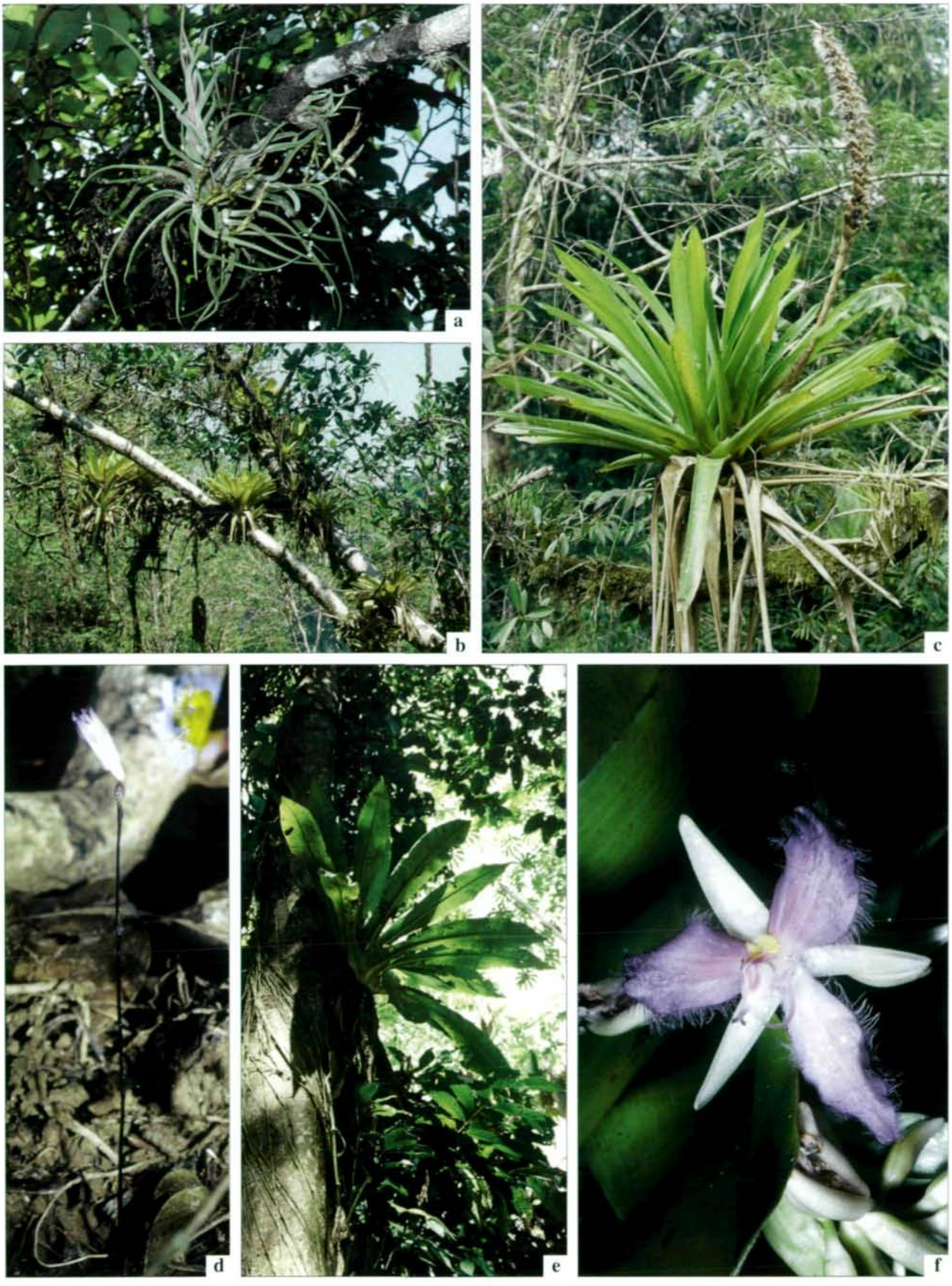

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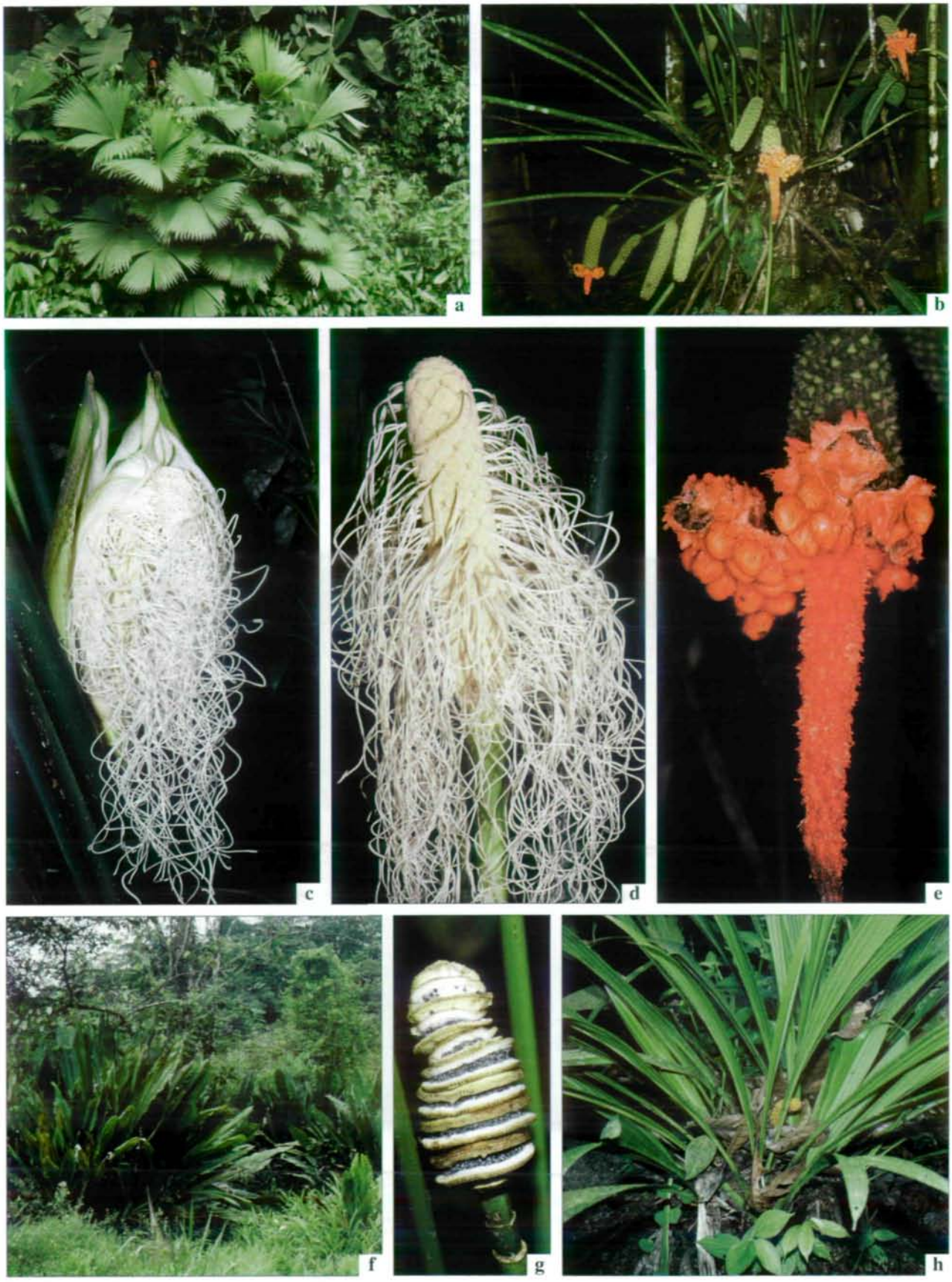
Plate 23. **Costaceae**, a *Costus lima*, b *Costus osae*, c-e *Costus stenophyllus*; **Cyclanthaceae**, f-h *Asplundia pittieri*



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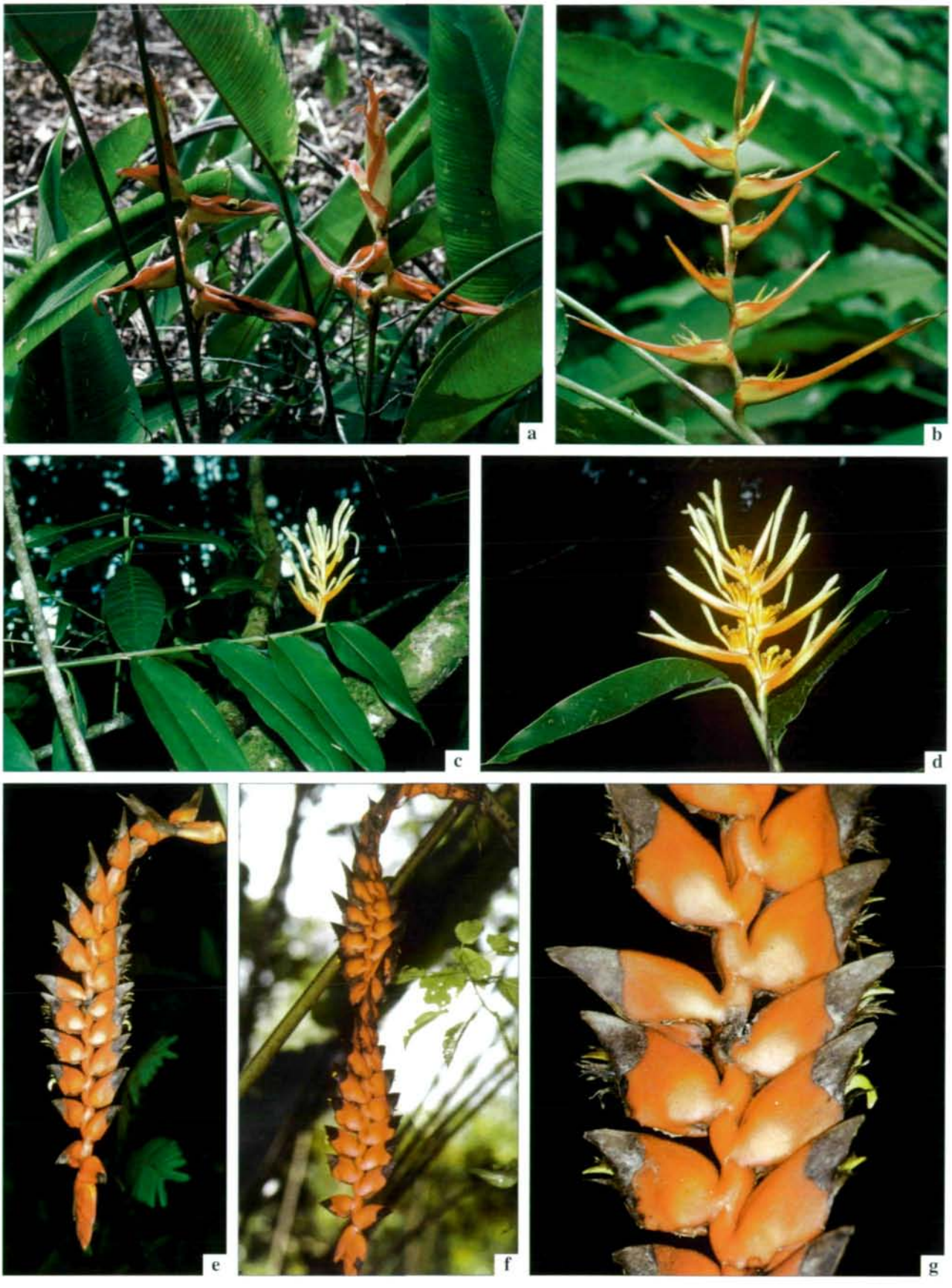

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Plate 29. **Heliconiaceae**, a,b *Heliconia wagneriana*; **Limnocharitaceae**, c,d *Limnocharis flava*; **Marantaceae**, e,f *Calathea crotalifera*

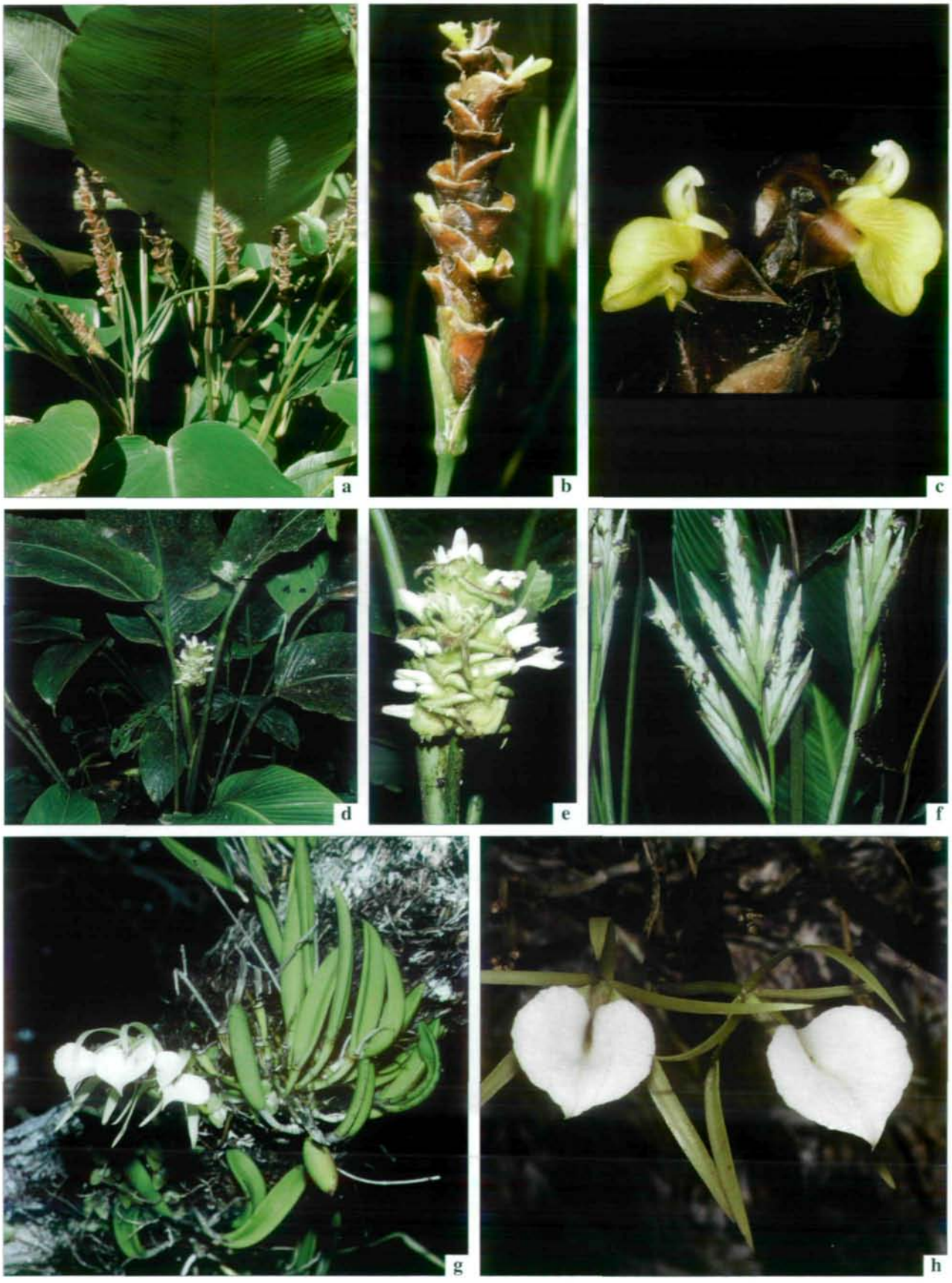

Plate 30. **Marantaceae**, a-c *Calathea lutea*, d,e *Calathea lasiophylla*, f *Pleiostachya pruinosa*; **Orchidaceae**, g,h *Brassavola nodosa*

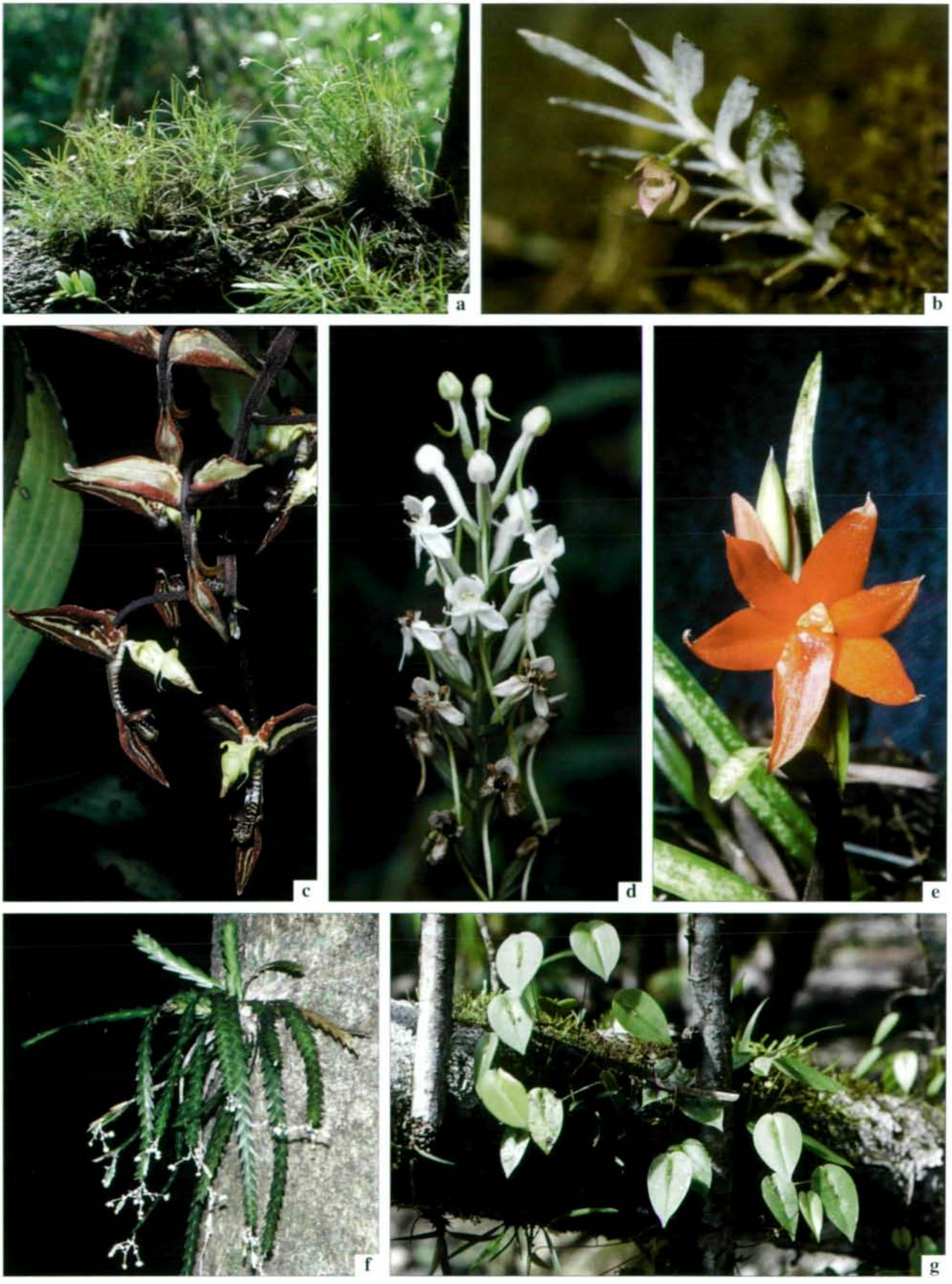

Plate 31. **Orchidaceae**, a *Elleanthus tillandsioides*, b *Dichaea panamensis*, c *Gongora tricolor*, d *Habenaria monorrhiza*, e *Hexisea bidentata*, f *Lockhartia* sp., g *Pleurothallis* sp.

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Plate 33. **Poaceae**, a,b *Gynerium sagittatum*; **Pontederiaceae**, c,d *Eichhornia azurea*, e,f *Eichhornia crassipes*

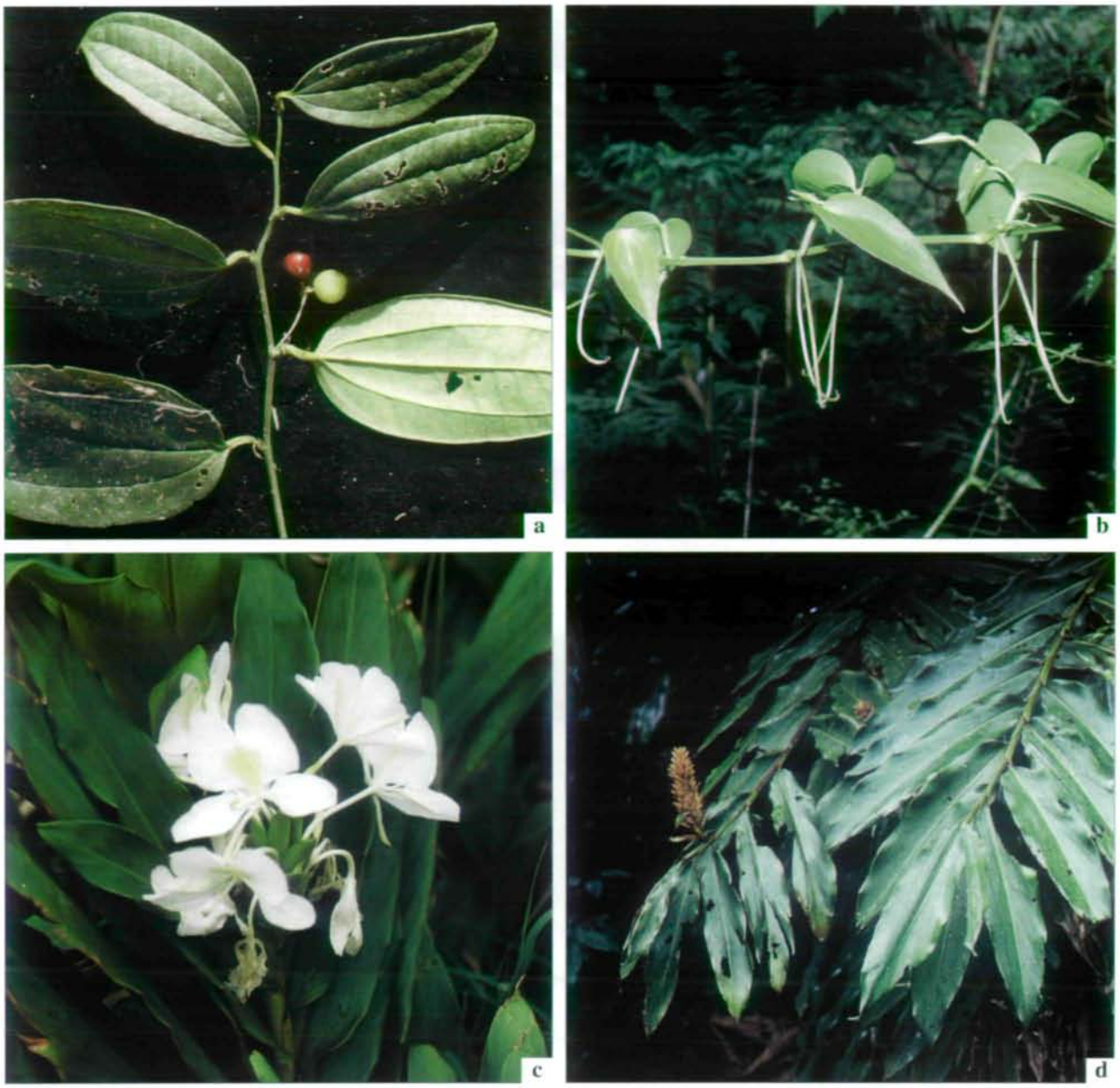


Plate 34. **Smilacaceae**, a *Smilax spissa*, b *Smilax* sp. (note tendrils); **Zingiberaceae**, c *Hedychium coronarium*, d *Renealmia cernua*

Plate 35. **Acanthaceae**, a,b *Aphelandra golfodulcensis*, c,d *Blechum costaricense*, e,f *Bravaisia integerrima*, g,h *Razisea spicata*, i *Thunbergia fragrans*

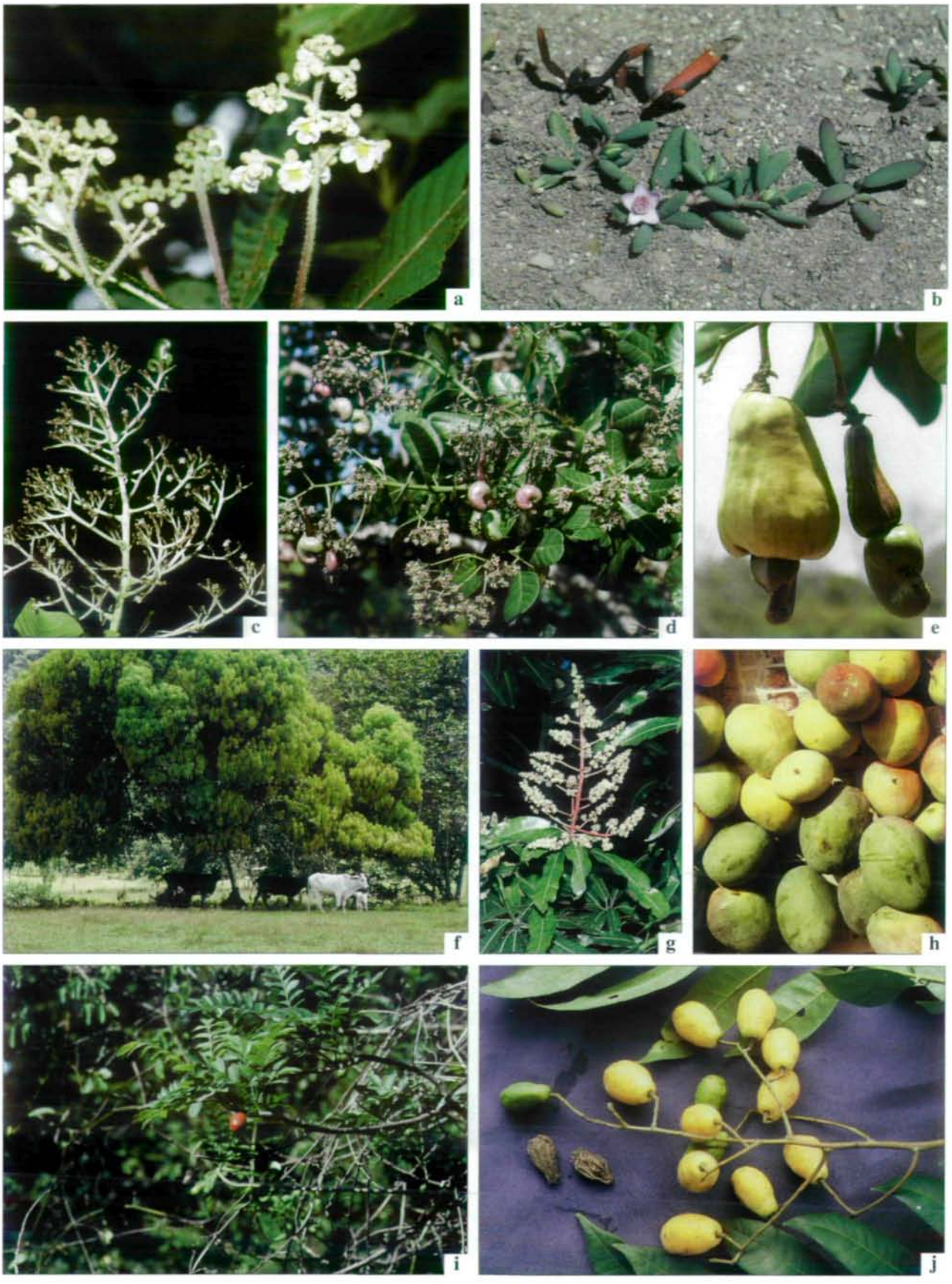


Plate 36. **Actinidiaceae**, a *Saurauia yasicae*; **Aizoaceae**, b *Sesuvium portulacastrum*; **Anacardiaceae**, c *Anacardium excelsum*, d,e *Anacardium occidentale*, f-h *Mangifera indica*, i *Spondias purpurea*, j *Spondias mombin*

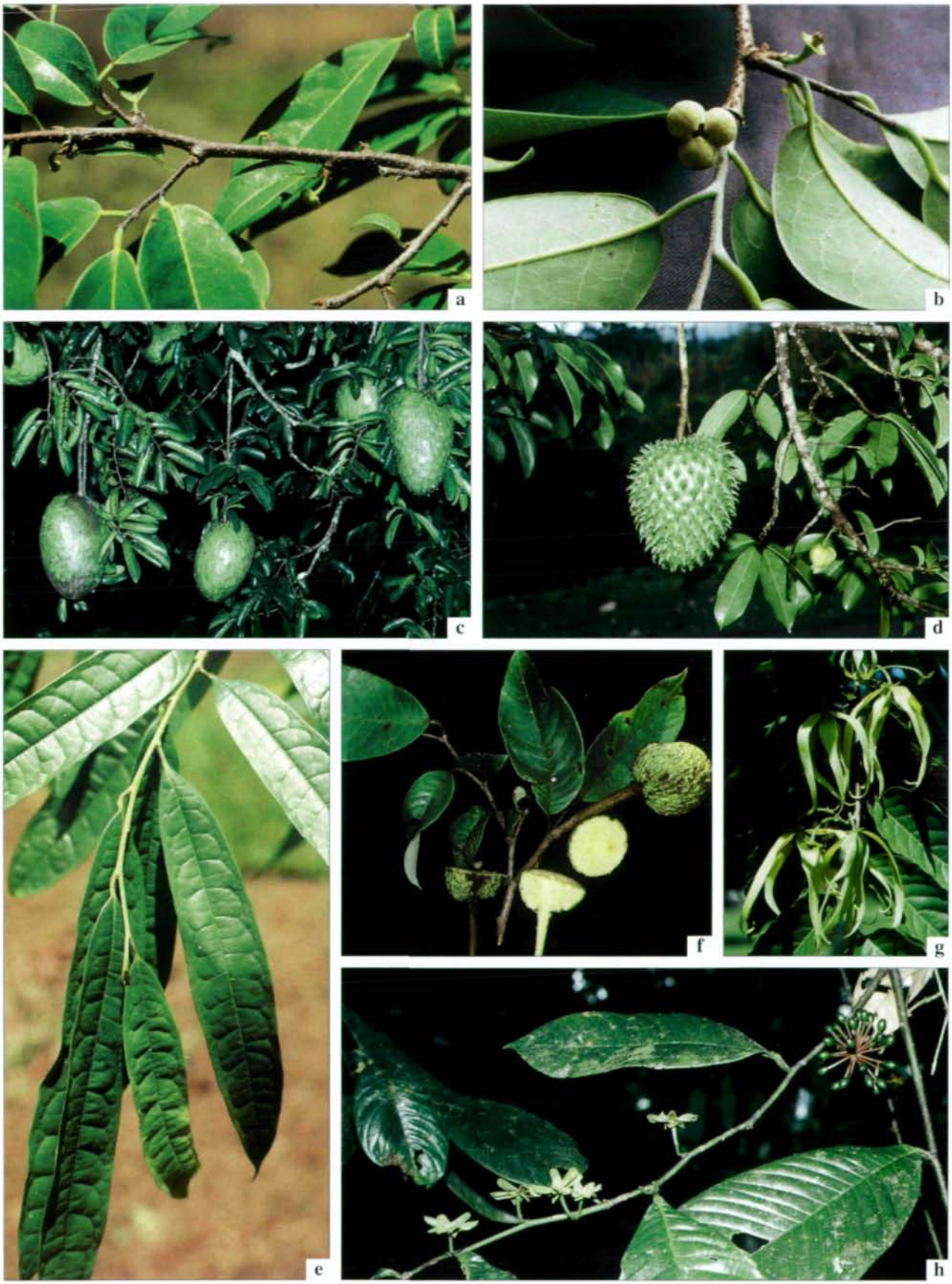


Plate 37. **Annonaceae**, a,b *Annona amazonica*, c,d *Annona muricata*, e,f *Annona pittieri*, g *Cananga odorata*, h *Guatteria amplifolia* (flowers and fruits)

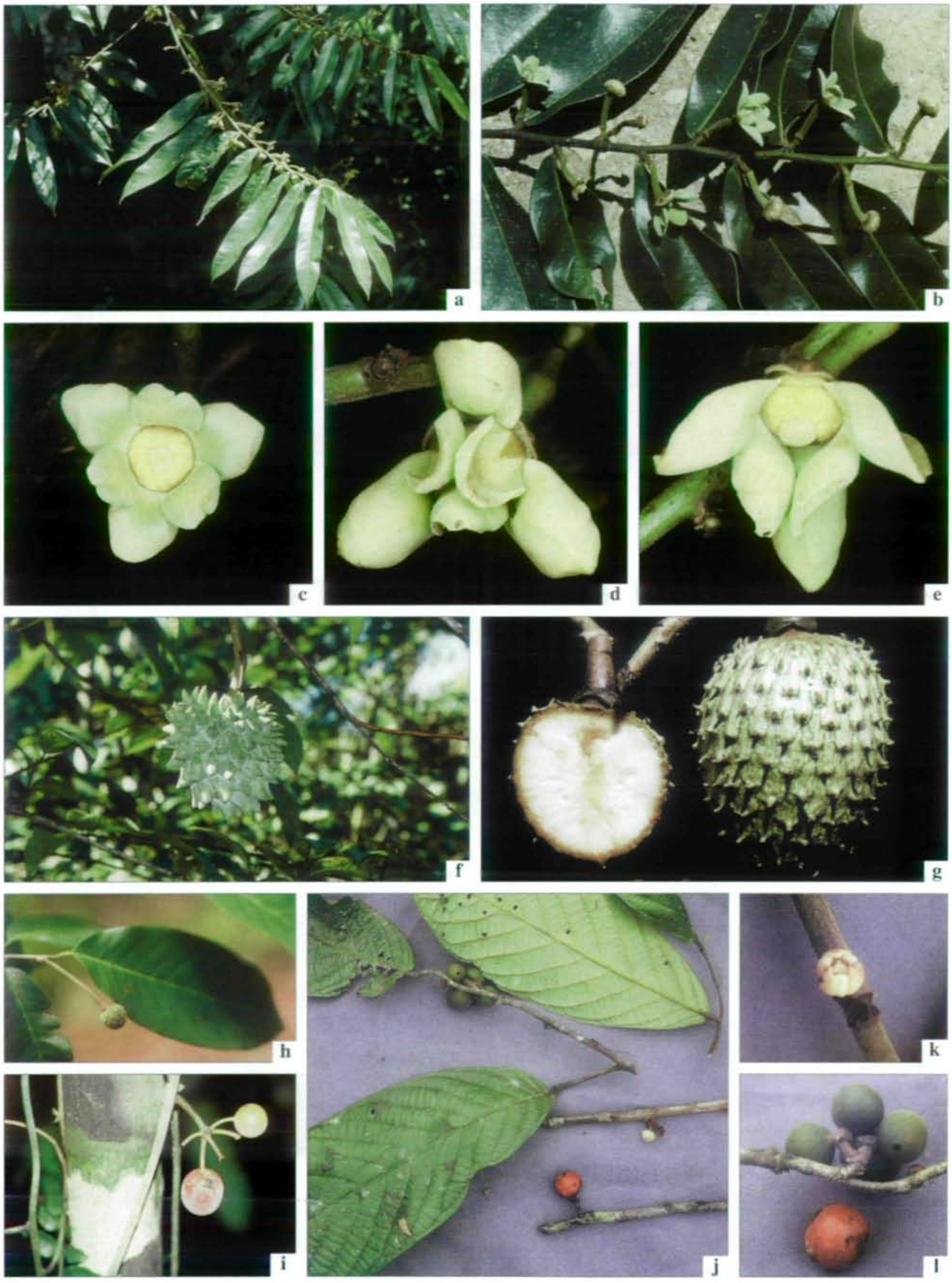


Plate 38. **Annonaceae**, a-e *Guatteria chiriquiensis* (c flower in preanthetic stage, d in anthetic stage, e some petals removed to show stamen and style complex) f,g *Rollinia mucosa*, h *Rollinia pittieri*, i *Unonopsis panamensis*, j-l *Unonopsis theobromifolia*

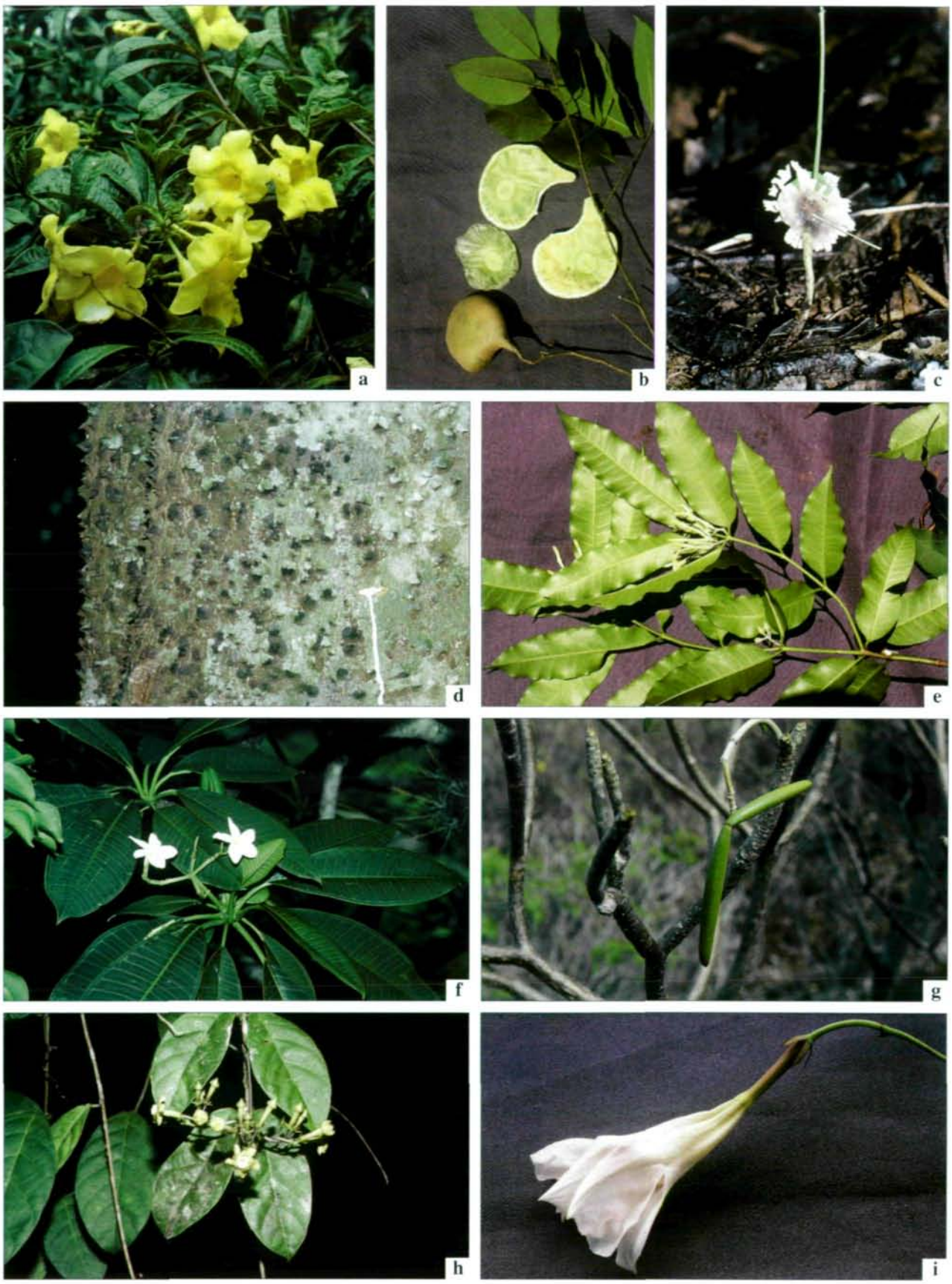


Plate 39. **Apocynaceae**, a *Allamanda cathartica*, b,c *Aspidosperma megalocarpon* (b fruit and seed, c seedling) d,e *Lacmellea panamensis*, f,g *Plumeria rubra*, h *Prestonia portobellensis*, i *Rhabdadenia biflora*

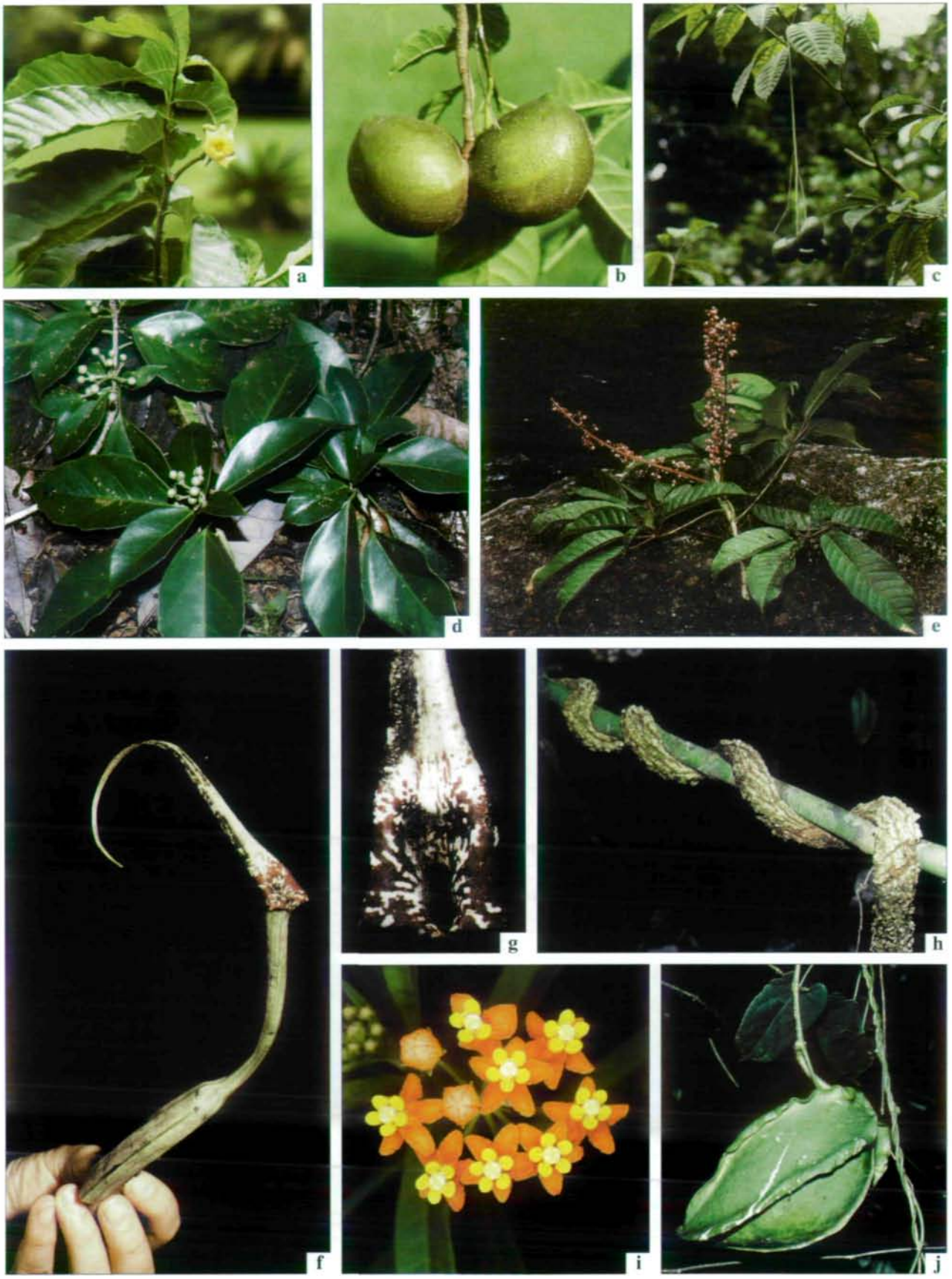


Plate 40. **Apocynaceae**, a,b *Stemmadenia donnell-smithii*, c *Tabernaemontana longipes*; **Araliaceae**, d *Dendropanax arboreus*, e *Schefflera systyla*; **Aristolochiaceae**, f,g *Aristolochia tonduzii*, h *Aristolochia* sp.; **Asclepiadaceae**, i *Asclepias curassavica*, j *Gonolobus edulis*

Plate 41. **Asteraceae**, a *Bidens pilosa*, b *Emilia fosbergii*, c *Heterocondylus vitalbae*, d *Melampodium divaricatum*; **Balanophoraceae**, e *Helosis cayennensis*; **Begoniaceae**, f *Begonia multinervia*; **Bignoniaceae**, g,h *Amphitecna latifolia*, i *Amphitecna kennedyi*, j,k *Jacaranda copaia*

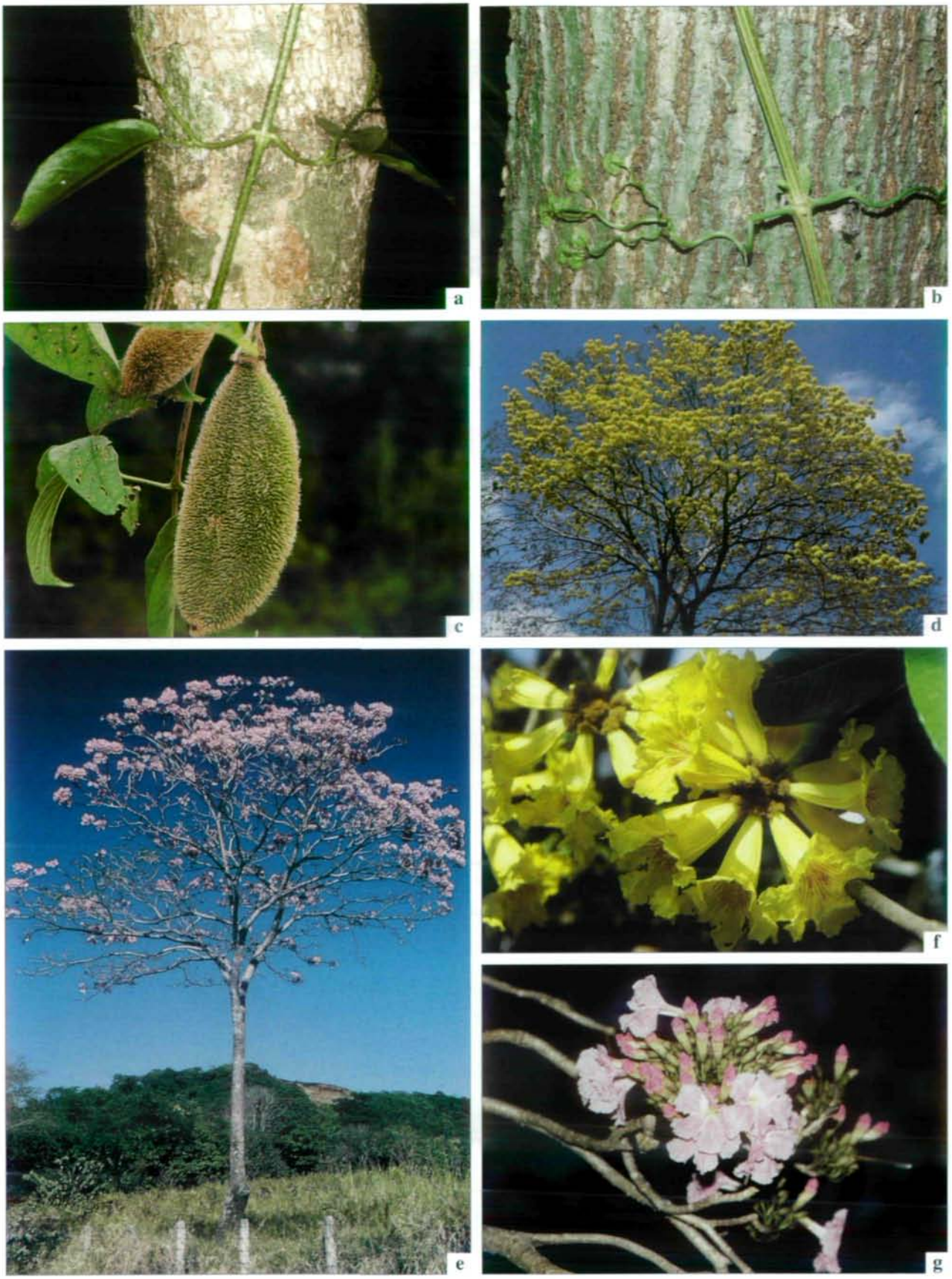


Plate 42. **Bignoniaceae**, a *Macfadyena unguis-cati* (tendrils appressed to the bark of a tree trunk), b *Pleonotoma variabilis*, c *Pithecoctenium crucigerum* (fruits), d,f *Tabebuia chrysantha*, e,g *Tabebuia rosea*

Plate 43. **Bixaceae**, a-c *Bixa orellana*; **Bombacaceae**, d *Bombacopsis sessilis*, e,f *Ceiba pentandra*, g *Huberodendron allenii*, h,i *Ochroma pyramidale*

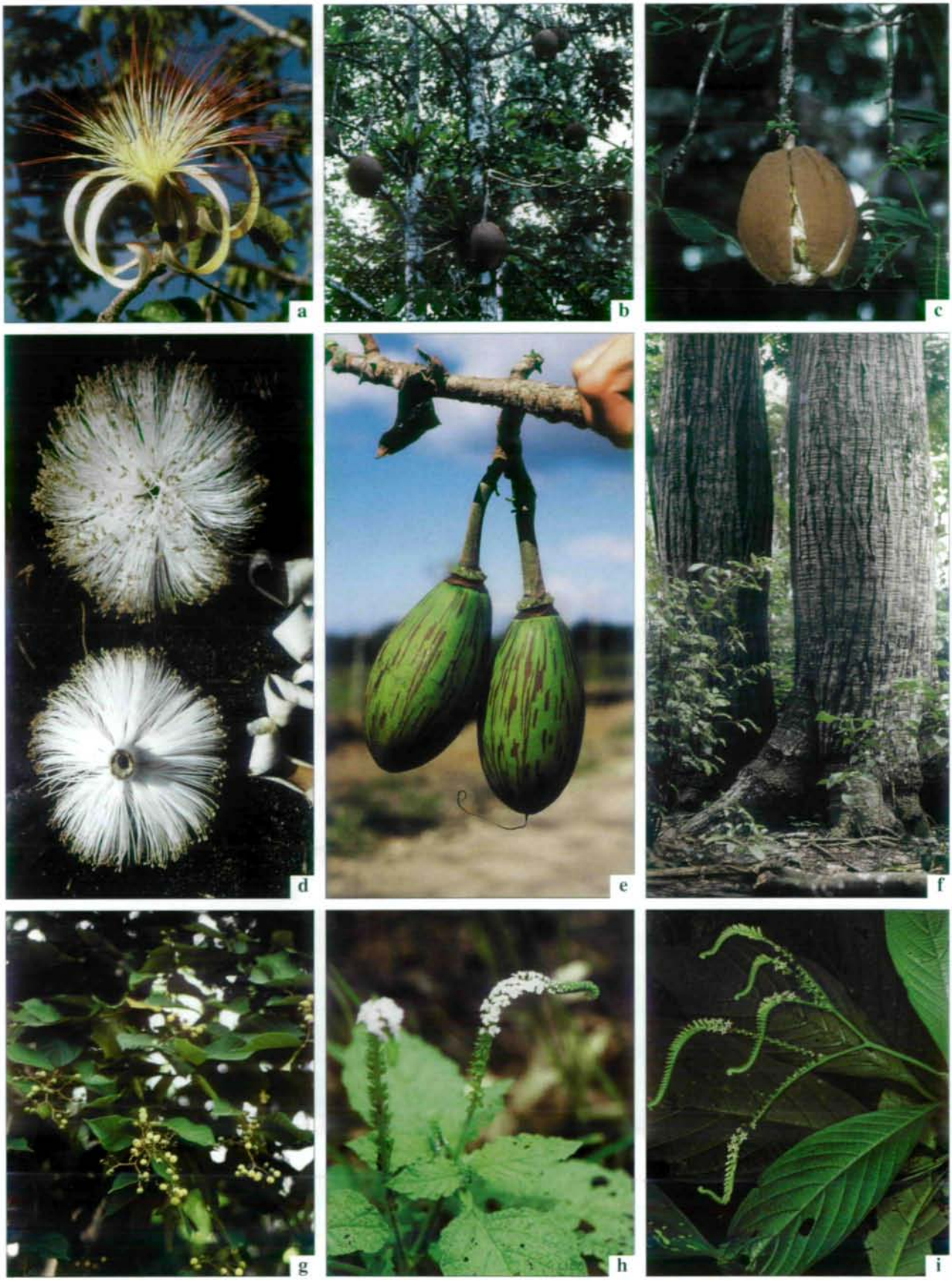


Plate 44. **Bombacaceae**, a-c *Pachira aquatica*, d-f *Pseudobombax septenatum;* **Boraginaceae**, g *Cordia bicolor*, h *Heliotropium indicum*, i *Tournefortia glabra*

Plate 45. **Burseraceae**, a,b *Bursera simaruba*, c *Protium ravenii*, d *Protium* sp. ined., e *Protium* sp. (inflammable resin); **Cactaceae**, f *Epiphyllum phyllanthus*, g *Weberocereus imitans*

Plate 46. **Campanulaceae**, a *Hippobroma longiflora*; **Capparidaceae**, b *Capparis cynophallophora*; **Caricaceae**, c,d *Carica cauliflora*, e-g *Jacaratia spinosa*; **Caryocaraceae**, h,i *Caryocar costaricense* (note inflorescences emerging from the tree crown – flagelliflory)

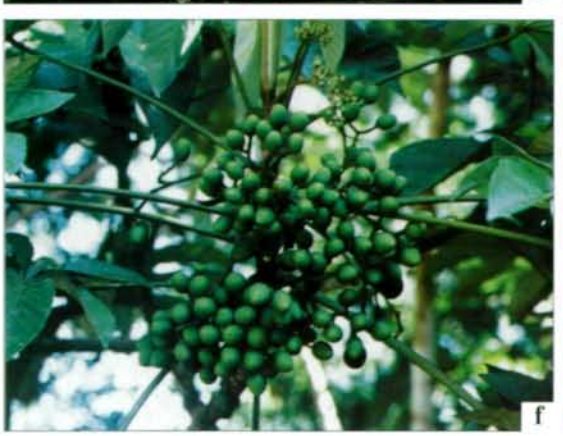


Plate 47. **Cecropiaceae**, a,b *Cecropia insignis*, c,d *Cecropia obtusifolia*, e *Cecropia peltata*, f *Pourouma bicolor*, g *Coussapoa* sp.

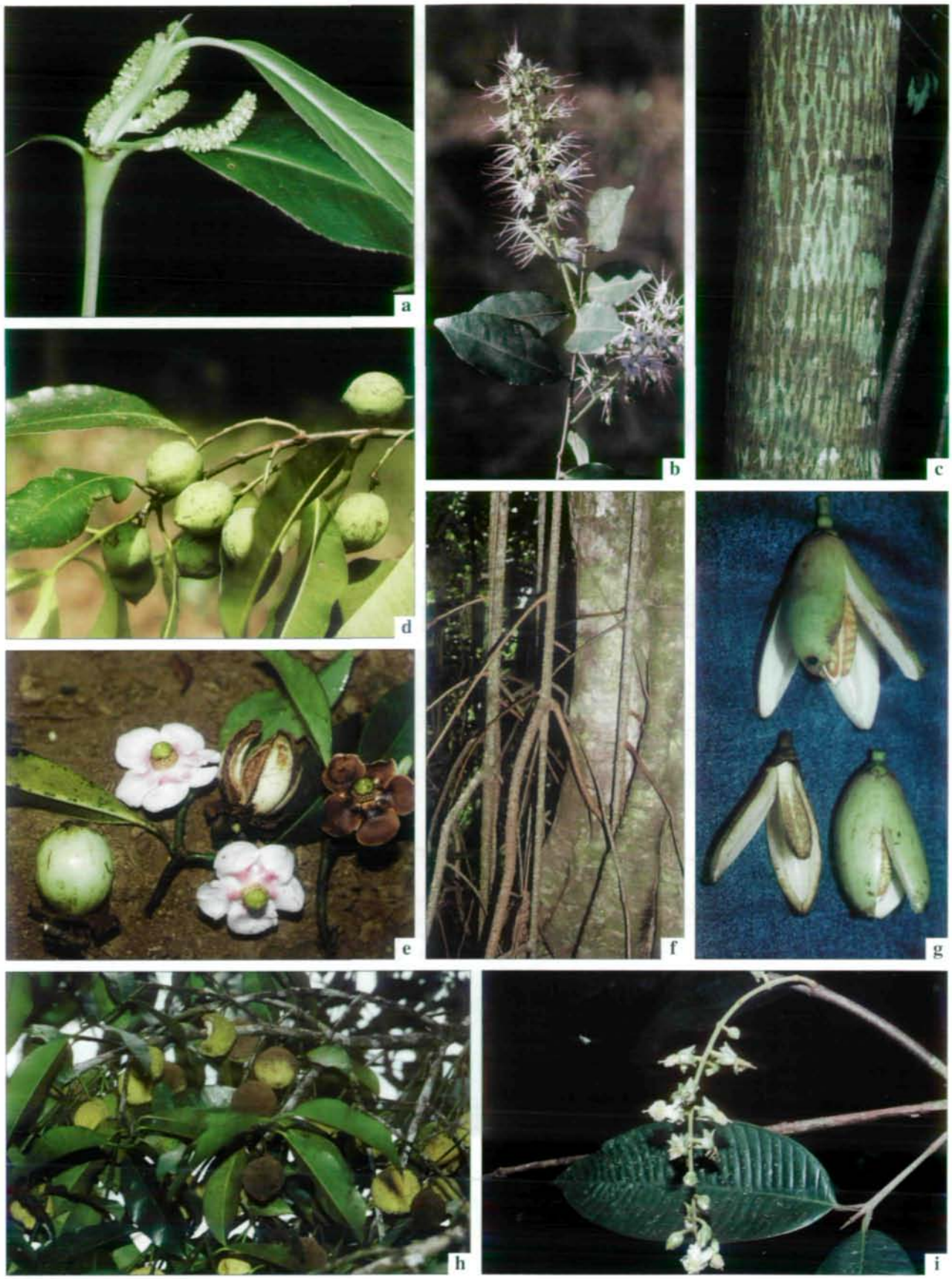


Plate 48. **Chloranthaceae**, a *Hedyosmum scaberrimum*; **Chrysobalanaceae**, b *Hirtella racemosa*; **Clusiaceae**, c *Calophyllum longifolium*, d *Calophyllum brasiliense*, e,f *Clusia valerii*, g *Clusia osaensis*, h *Garcinia madruno*, i *Marila laxiflora*

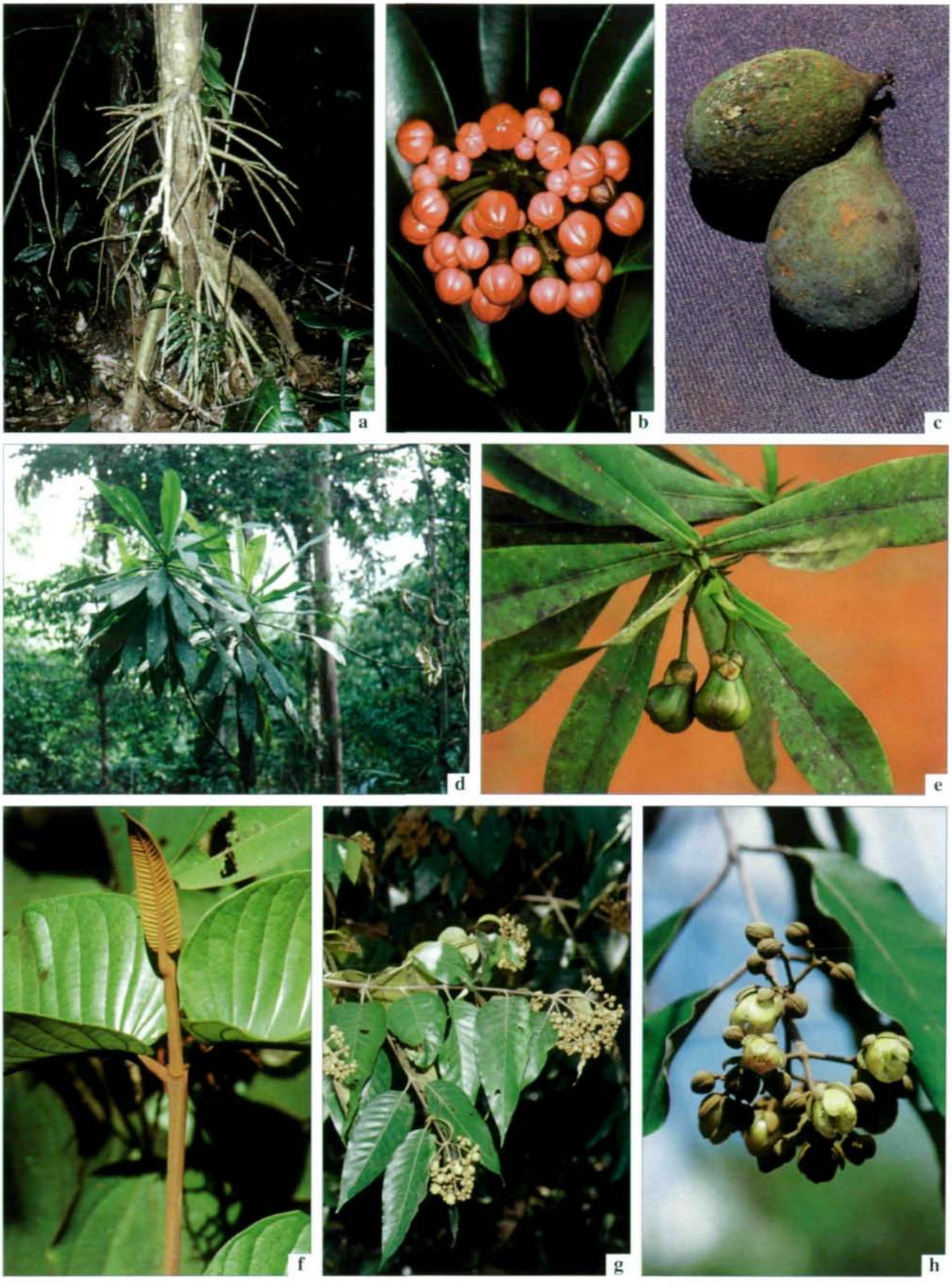


Plate 49. **Clusiaceae**, a-c *Symphonia globulifera* (b flower buds), d,e *Tovomita weddelliana*, f *Vismia macrophylla*, g,h *Vismia baccifera*

Plate 50. **Cochlospermaceae**, a-c *Cochlospermum vitifolium*; **Combretaceae**, d *Conocarpus erectus*, e,f *Laguncularia racemosa*, g,h *Terminalia catappa*, i *Terminalia oblonga*

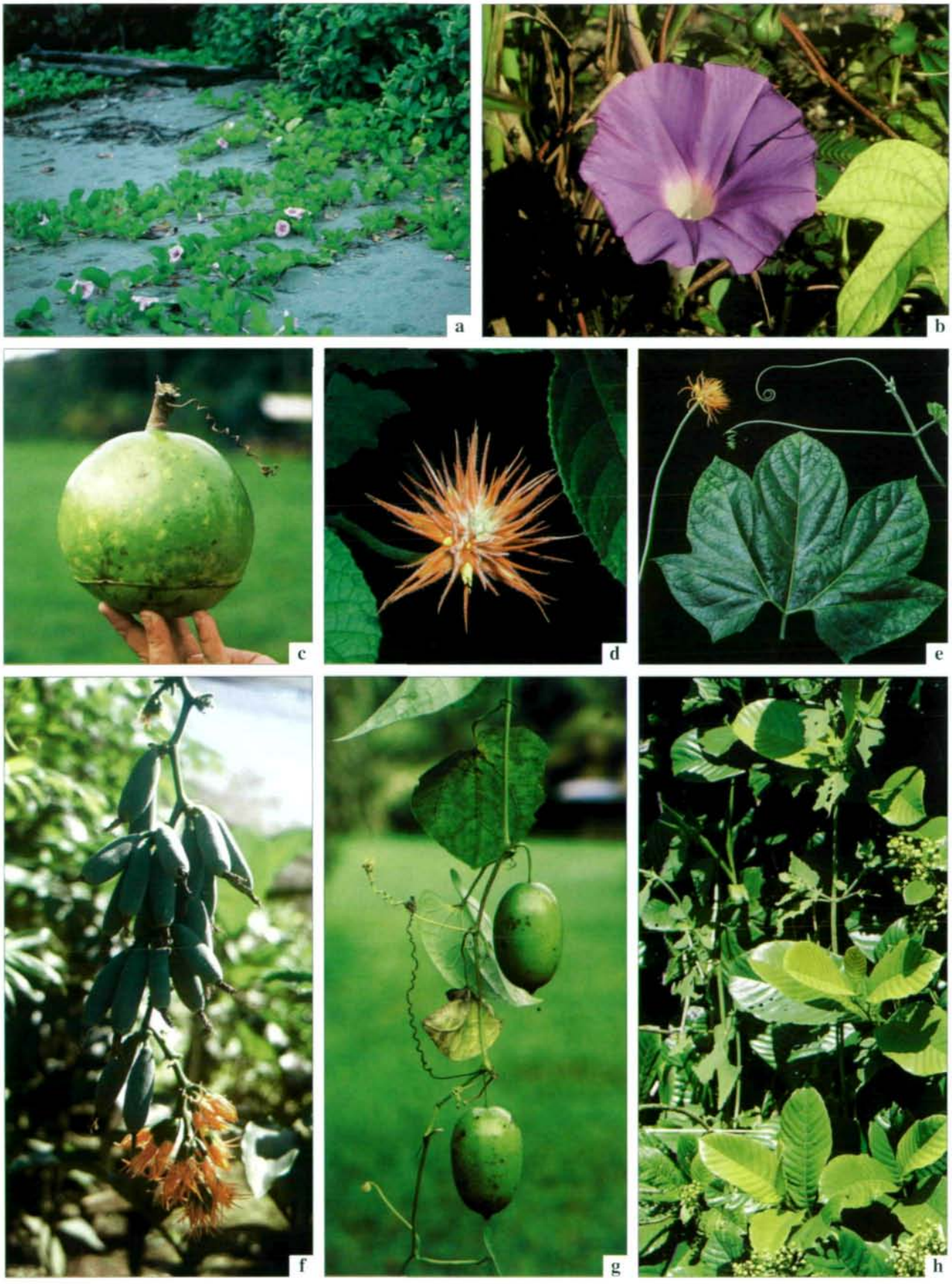


Plate 51. **Convolvulaceae,** a *Ipomoea pes-caprae*, b *Ipomoea nil*; **Cucurbitaceae,** c *Fevillea cordifolia*, d *Gurania* sp., e,f *Gurania makoyana*, g *Melothria dulcis*; **Dilleniaceae,** h *Davilla nitida*

Plate 52. **Dilleniaceae,** a *Doliocarpus multiflorus*, b *Doliocarpus* sp. (note peeling bark); **Ebenaceae,** c *Diospyros digyna*; **Elaeocarpaceae,** d *Sloanea medusula*; **Ericaceae,** e *Cavendishia callista*, f *Cavendishia osaensis*, g *Satyria* cf. *warszewiczii*

Plate 53. **Euphorbiaceae,** a *Acalypha villosa*, b *Dalechampia dioscoreifolia*, c *Euphorbia elata*, d-f *Hura crepitans*, g,h *Hyeronima alchorneoides*

Plate 54. **Euphorbiaceae,** a,b *Mabea klugii* (b close-up, note nectar droplets), c,d *Mabea occidentalis*, e-g *Pausandra trianae* (g note red sap), h *Plukenetia penninervia*, i *Richeria obovata*, j,k *Sapium laurifolium*

Plate 55. **Fabaceae-Caesalpinioideae,** a *Bauhinia bahiachalensis*, b,c *Bauhinia guianensis*, d *Bauhinia* sp., e *Caesalpinia bonduc*, f *Chamaecrista nictitans*, g *Cynometra hemitomophylla*, h *Copaifera camibar*, i *Dialium guianense*

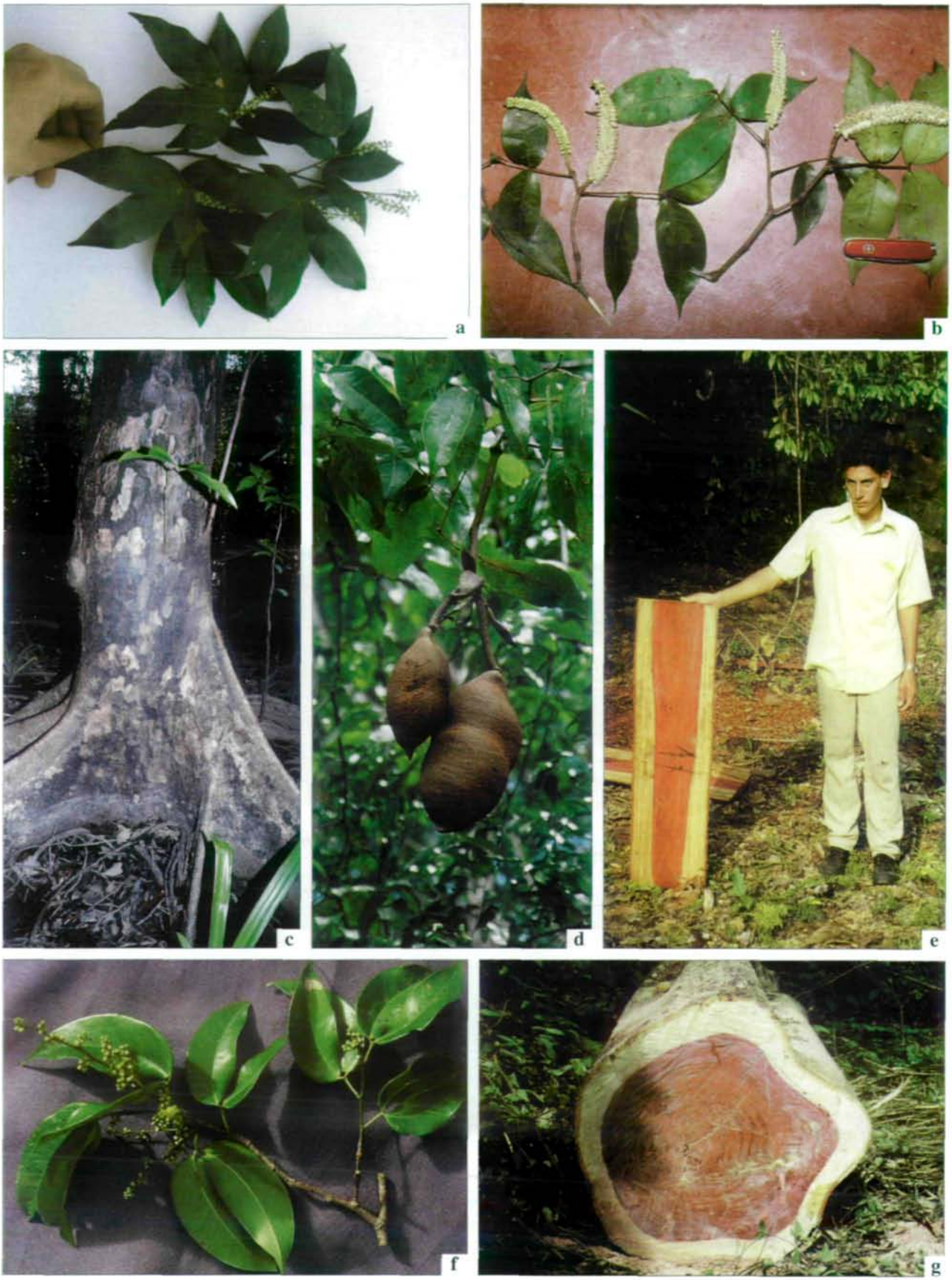


Plate 56. **Fabaceae-Caesalpinioideae,** a *Macrolobium costaricense*, b-d *Mora oleifera,* e-g *Peltogyne purpurea*

Plate 57. **Fabaceae-Caesalpinioideae,** a-d *Schizolobium parahyba* (d open fruit with flat seed), e,f *Senna alata*, g,h *Senna reticulata*

Plate 58. **Fabaceae-Caesalpinioideae,** a-c *Tachigali versicolor* (seeds, fruit lower one with fragmentary valve); **Fabaceae-Faboideae,** d,e *Andira inermis*, f *Canavalia oxyphylla*, g *Centrosema plumieri*

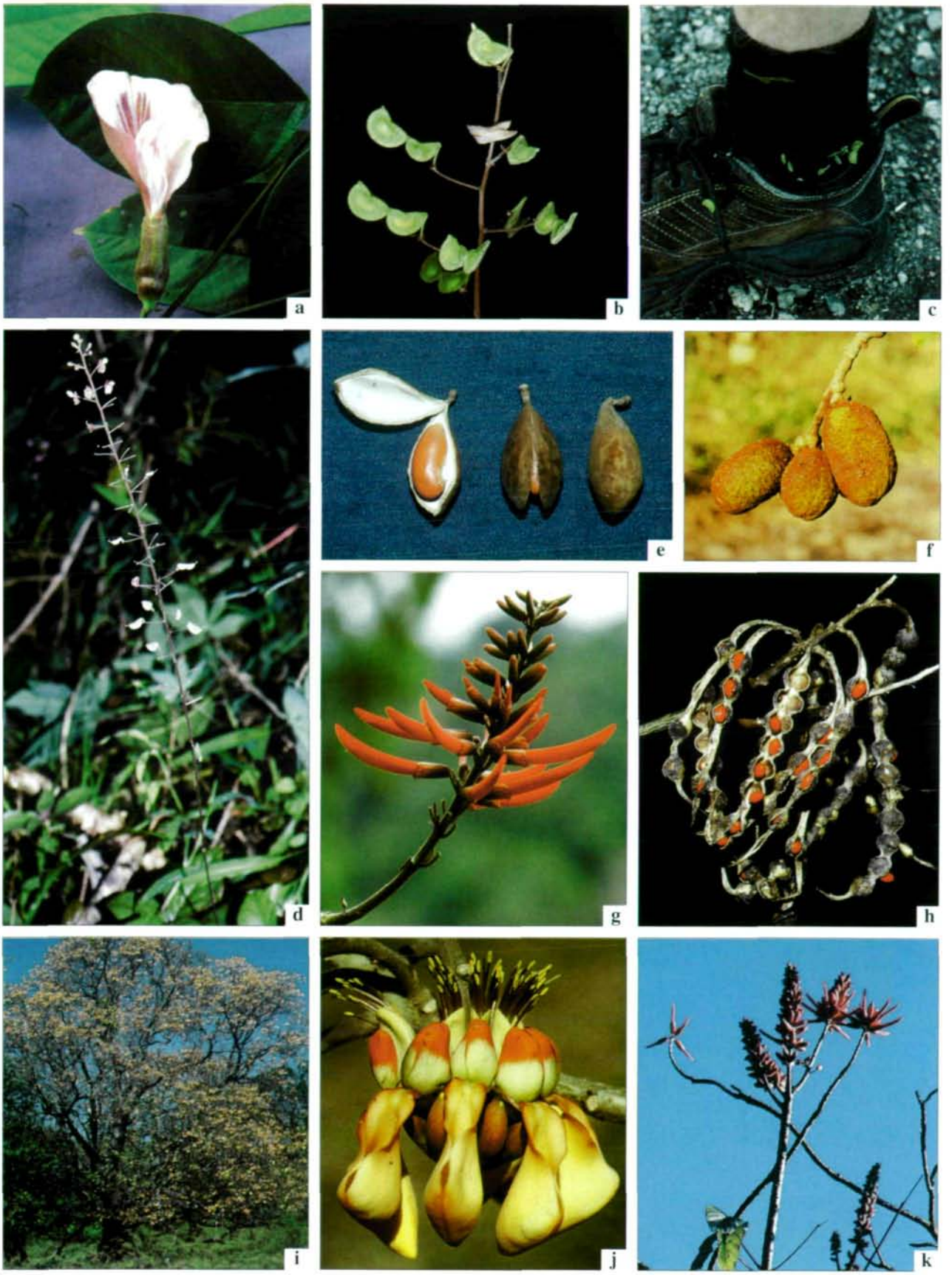


Plate 59. **Fabaceae-Faboideae,** a *Clitoria javitensis*, b-d *Desmodium axillare* (c note mericarps on socks), e *Dussia discolor*, f *Dussia macrophyllata*, g *Erythrina berteroana*, h *Erythrina costaricensis*, i,j *Erythrina fusca*, k *Erythrina lanceolata*

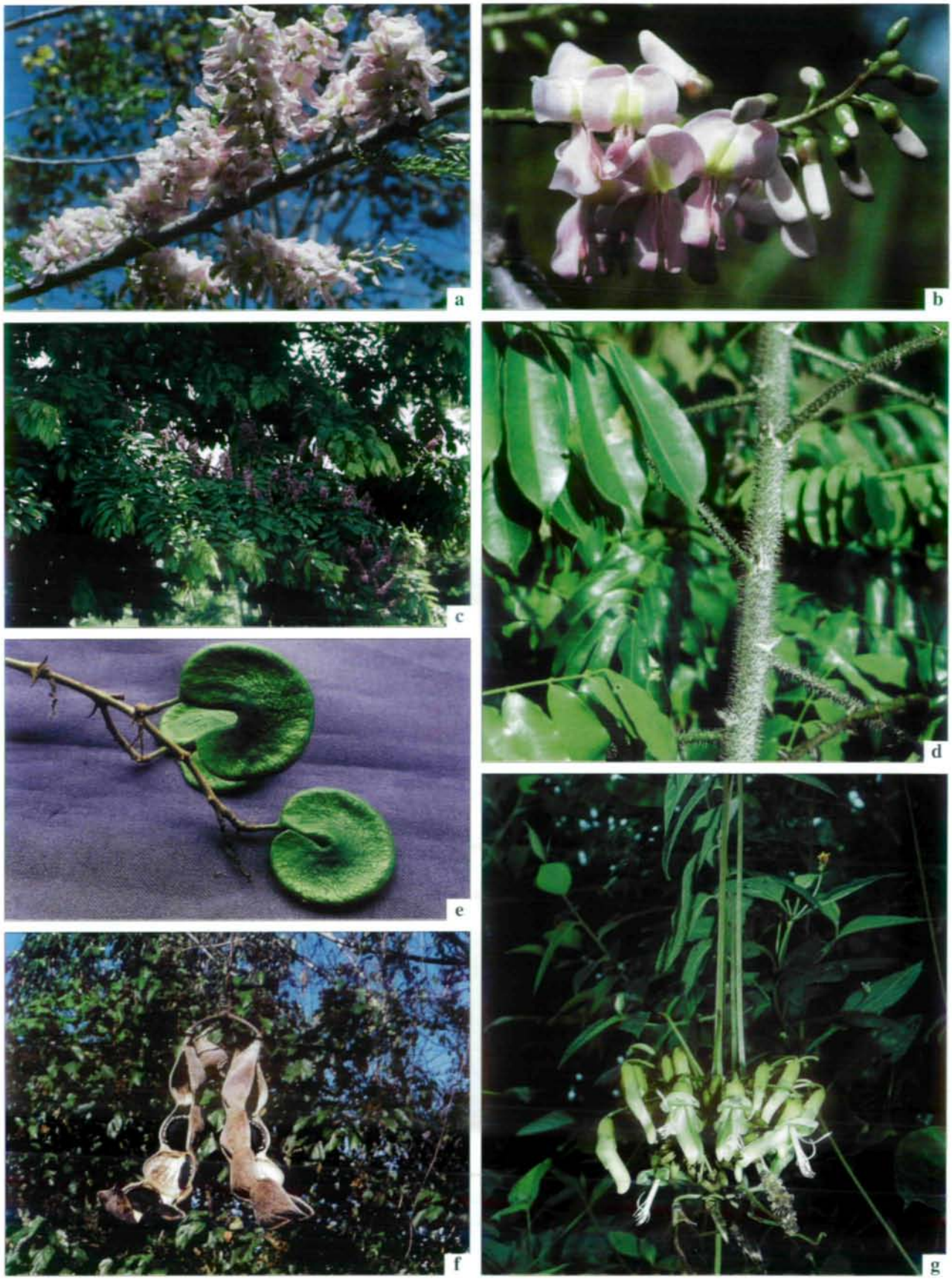


Plate 60. **Fabaceae-Faboideae,** a,b *Gliricidia sepium*, c *Lonchocarpus macrophyllus*, d *Machaerium kegelii*, e *Machaerium lunatum*, f,g *Mucuna holtonii*

Plate 61. **Fabaceae-Faboideae,** a-c *Mucuna mutisiana*, d *Muellera frutescens*, e,f *Ormosia coccinea*, g *Pterocarpus officinalis*, h *Pterocarpus rohrii*

Plate 62. **Fabaceae-Faboideae,** a *Rhynchosia* sp., b *Swartzia panamensis*, c *Swartzia* sp. ined., d *Swartzia myrtifolia*, e *Uribea tamarindoides*; **Fabaceae-Mimosoideae,** f-i *Abarema adenophora*

Plate 63. **Fabaceae-Mimosoideae,** a,b *Acacia allenii*, c *Albizia adinocephala*, d *Balizia elegans*, e *Calliandra grandifolia*, f,g *Cojoba arborea*, h *Cojoba sophorocarpa*

Plate 64. **Fabaceae-Mimosoideae,** a-c *Entada gigas*, d *Entada polystachya*, e,f *Enterolobium cyclocarpum*

Plate 65. **Fabaceae-Mimosoideae,** a *Inga alba* b,c *Inga densiflora*, d *Inga marginata*, e-g *Inga multijuga*, h *Inga oerstediana*, i *Inga pezizifera*

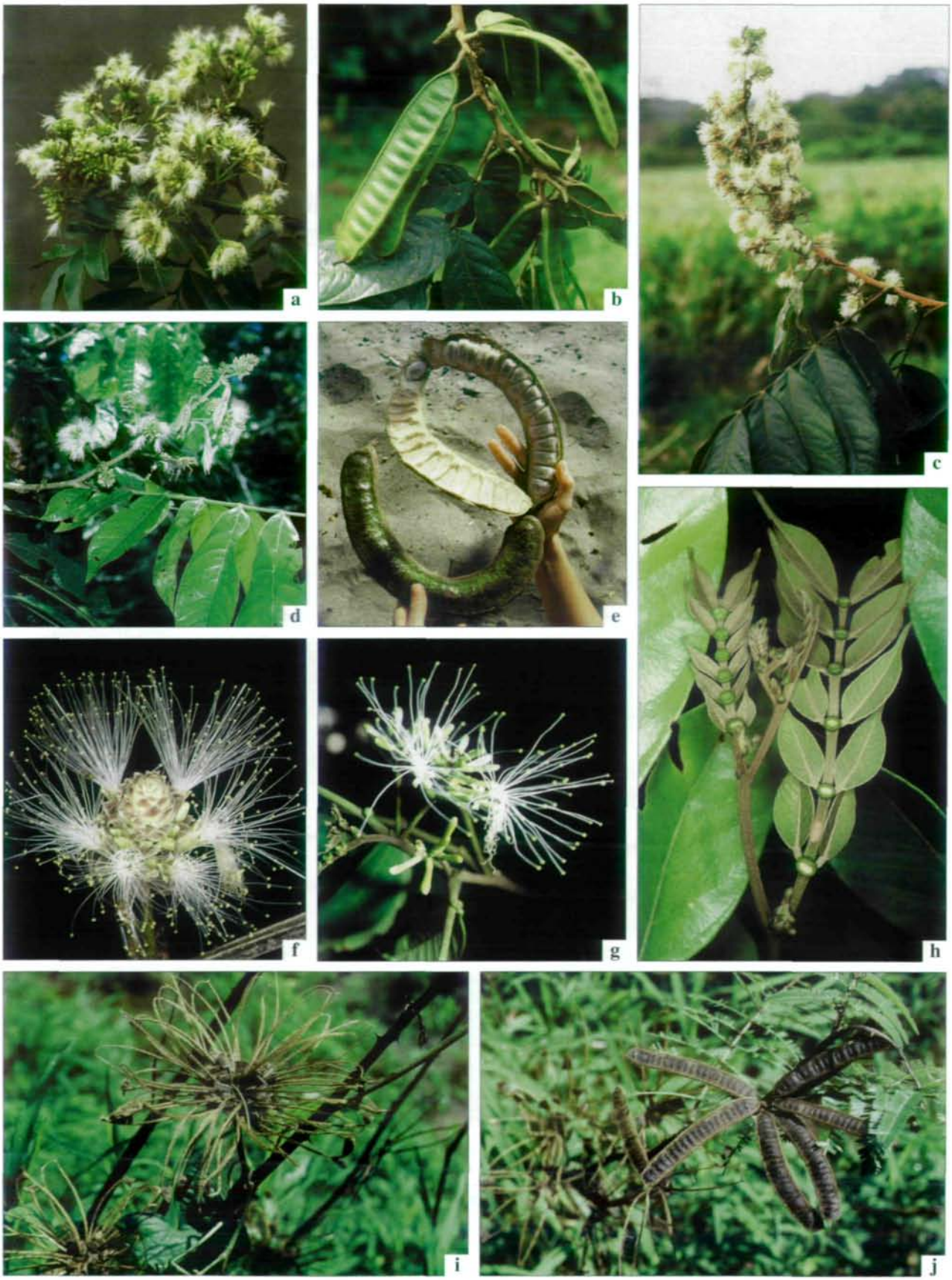


Plate 66. **Fabaceae-Mimosoideae,** a *Inga punctata*, b,c *Inga ruiziana*, d *Inga sapindoides*, e,f *Inga spectabilis*, g,h *Inga thibaudiana* (note nectar glands between leaflet pairs), i,j *Mimosa pigra*

Plate 67. **Fabaceae-Mimosoideae,** a,b *Mimosa pudica* (same twig before and after touching), c-e *Parkia pendula* (c arrows: inflorescences emerging from the tree crown), d inflorescence, e fruit bunch), f-h *Pithecellobium saman*, i *Zygia rubiginosa*

Plate 68. **Flacourtiaceae,** a-c *Carpotroche platyptera*, d,e *Casearia arborea*, f *Hasseltia floribunda*, g,h *Lacistema aggregatum*

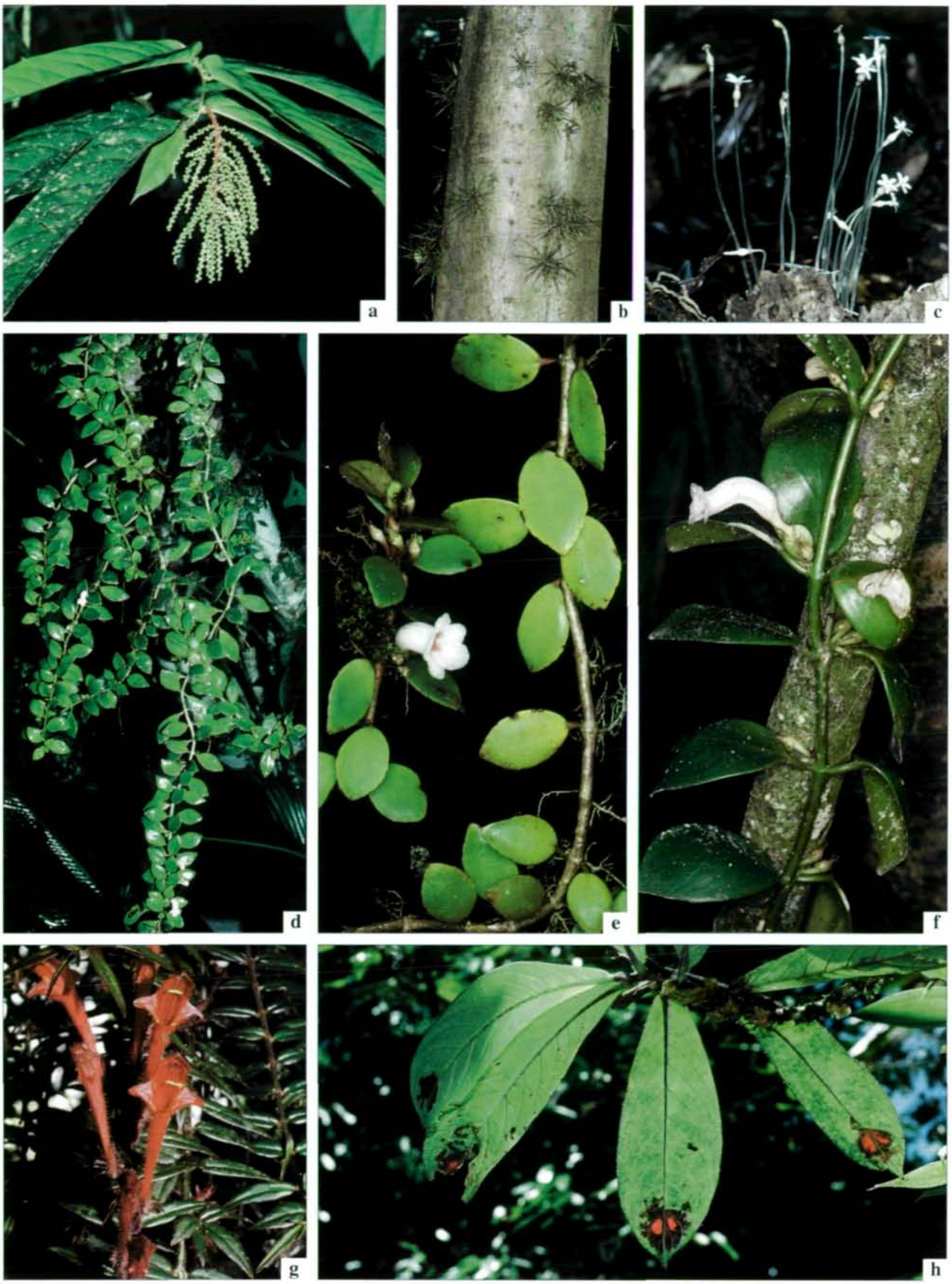


Plate 69. **Flacourtiaceae,** a *Tetrathylacium macrophyllum*, b *Xylosma intermedia*; **Gentianaceae,** c *Voyria tenella*; **Gesneriaceae,** d *Codonanthe crassifolia*, e,f *Codonanthe macradenia*, g *Columnea flaccida*, h *Columnea florida*

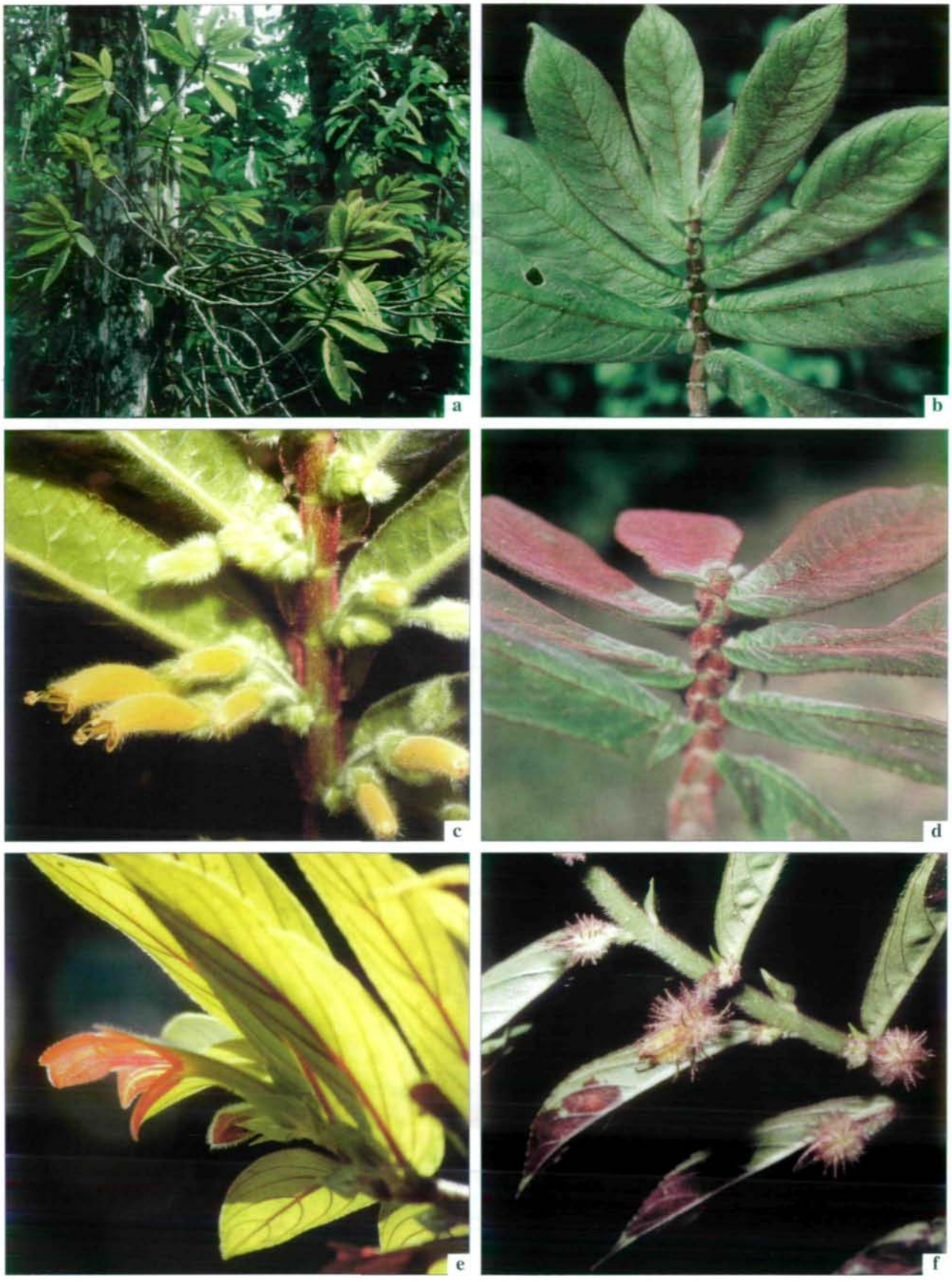


Plate 70. **Gesneriaceae,** a-d *Columnea polyantha* (d note hairy leaf surface turning red when seen from a certain angle), e *Columnea raymondii*, f *Columnea segregata*

Plate 71. **Gesneriaceae,** a *Drymonia alloplectoides*, b *Drymonia macrantha*, c *Drymonia serrulata*, d *Episcia lilacina*, e,f *Gasteranthus delphinioides*, g *Kohleria allenii*, h *Kohleria spicata*

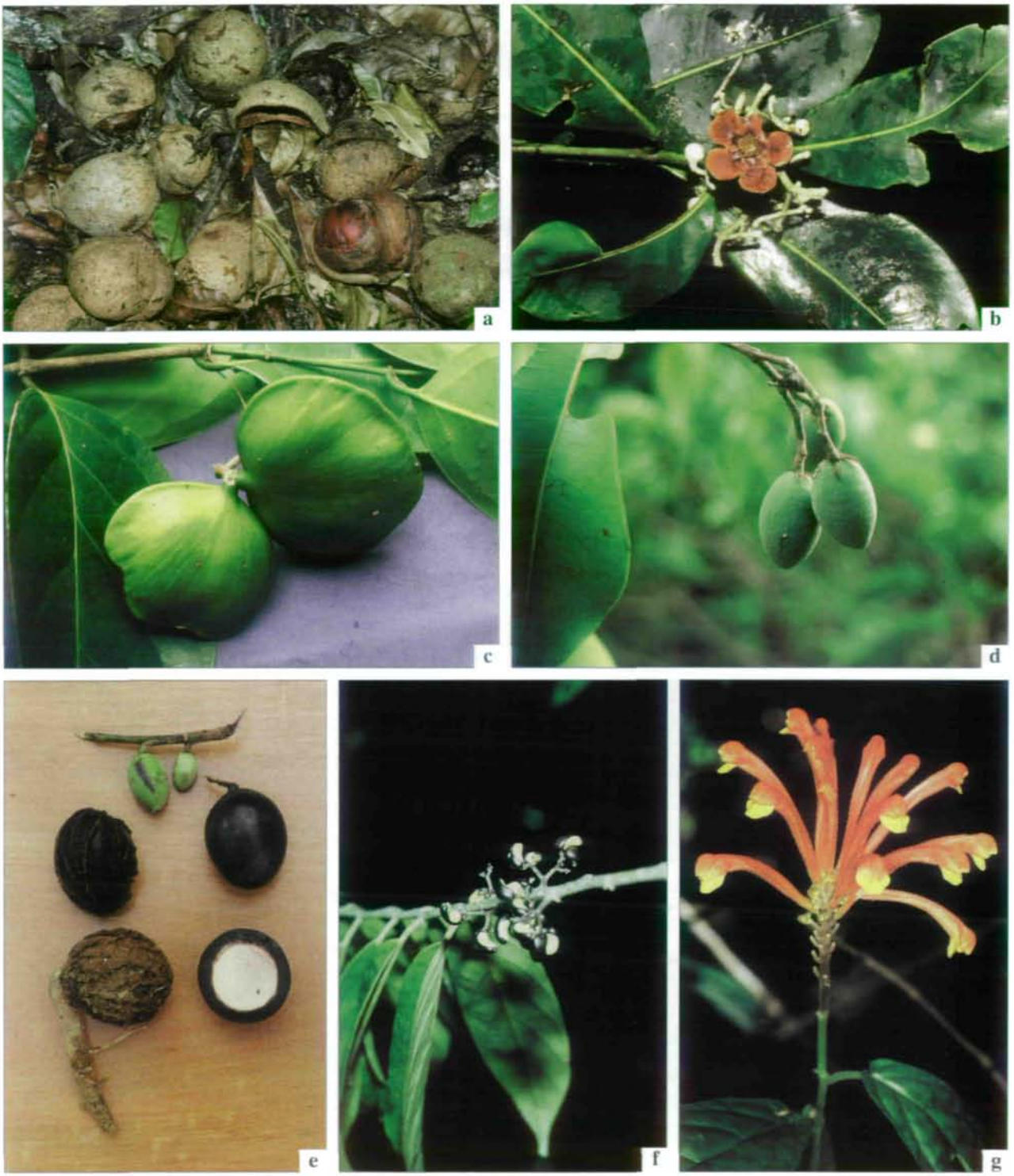


Plate 72. **Hippocastanaceae,** a *Billia colombiana*; **Hippocrateaceae,** b,c *Cuervea kappleriana*; **Humiriaceae,** d *Humiriastrum diguense*; **Icacinaceae,** e *Calatola costaricensis*, f *Discophora guianensis*; **Lamiaceae,** g *Scutellaria costaricana*

Plate 73. **Lauraceae,** a *Aiouea obscura*, b *Cinnamomum neurophyllum*, c *Nectandra umbrosa*, d *Ocotea nicaraguensis*, e *Ocotea leucoxylon*, f,g *Pleurothyrium golfodulcensis*

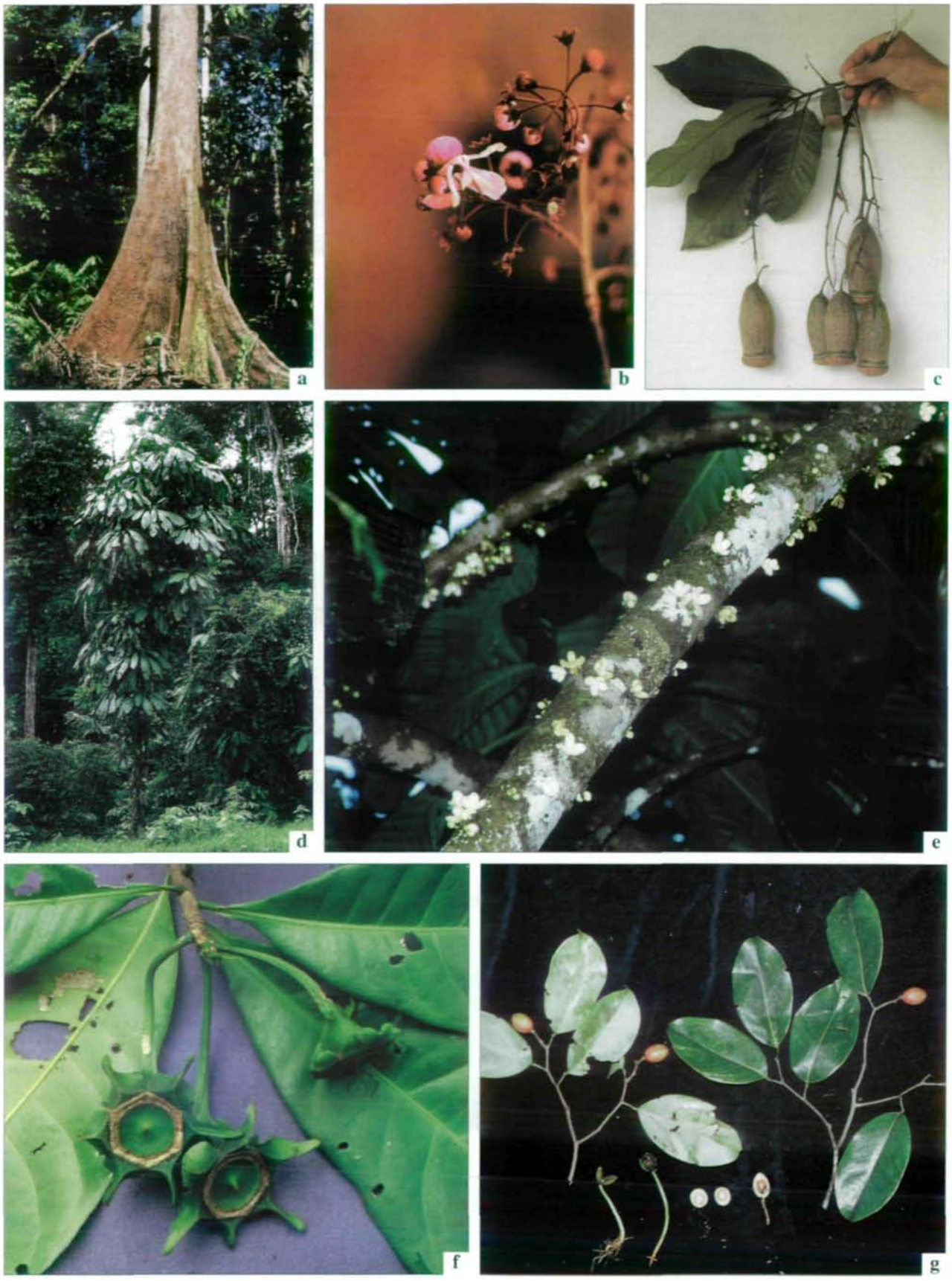


Plate 74. **Lecythidaceae,** a-c *Couratari guianensis*, d,e *Grias cauliflora*, f *Gustavia brachycarpa*; **Lepidobotryaceae,** g *Ruptiliocarpon caracolito*

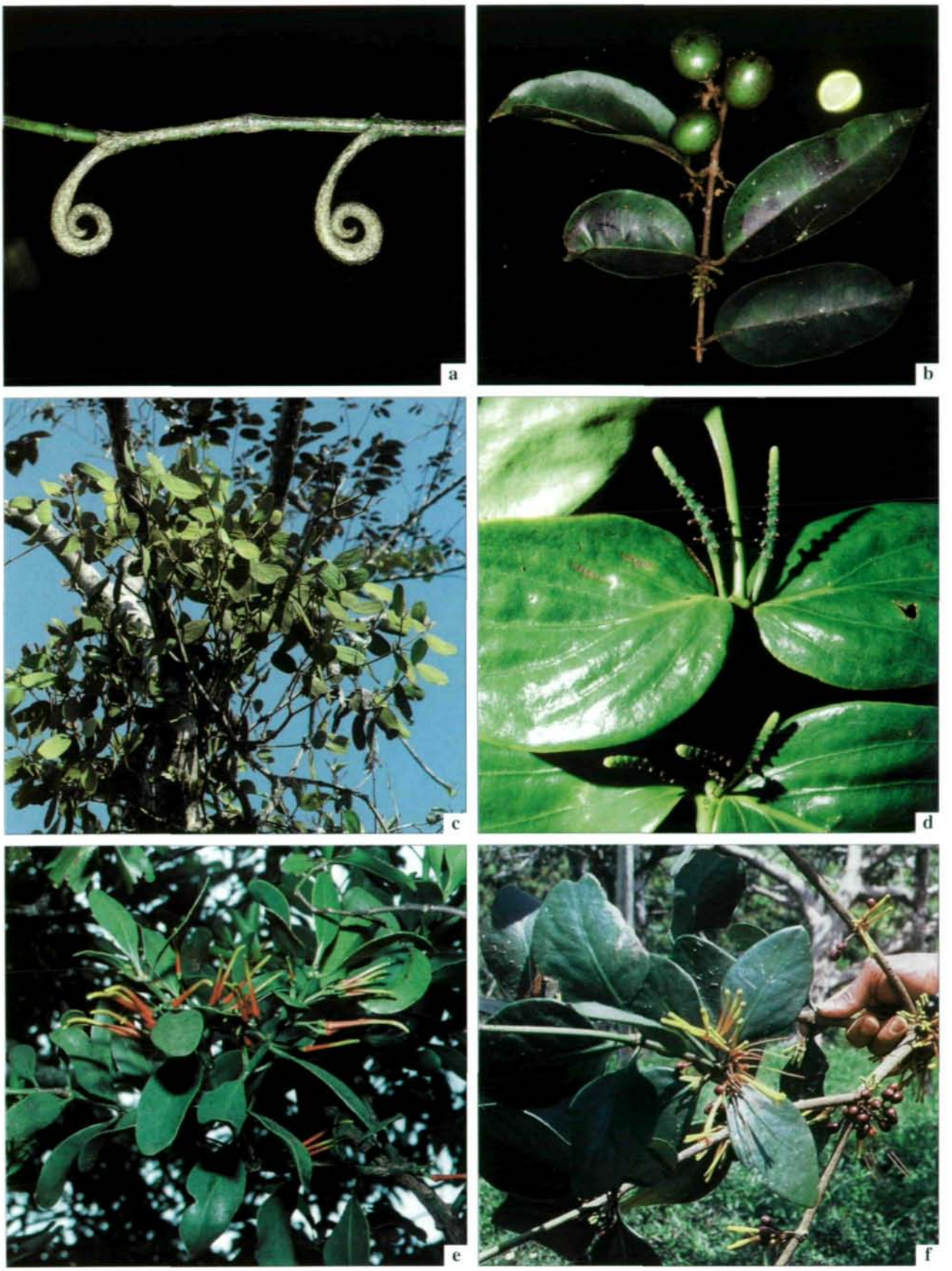


Plate 75. **Loganiaceae,** a *Strychnos* sp. (woody, hooked tendrils), b *Strychnos* cf. *chlorantha*; **Loranthaceae,** c *Oryctanthus occidentalis*, d *Oryctanthus cordifolius*, e,f *Psittacanthus rhynchanthus*

Plate 76. **Malpighiaceae,** a *Bunchosia macrophylla*, b-e *Bunchosia cornifolia* (c,d flower from above and below, note oil glands between petals), f *Heteropteris panamensis*, g *Spachea correae*; **Malvaceae,** h,i *Malvaviscus arboreus*

Plate 77. **Marcgraviaceae,** a-c *Marcgravia pittieri*, d *Marcgravia schippii*, e *Marcgravia* sp. (juvenile), f,g *Sarcopera sessiliflora*

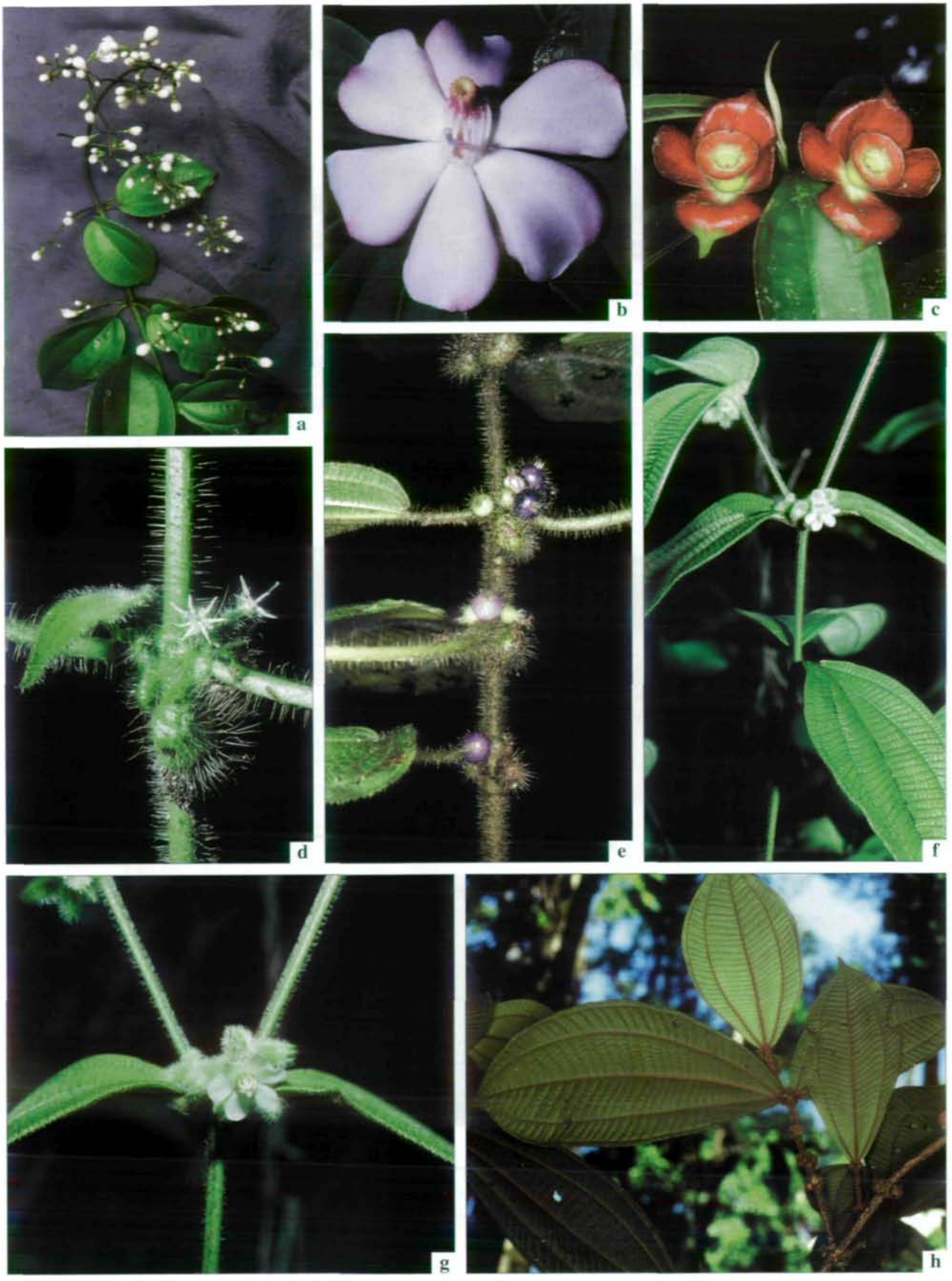


Plate 78. **Melastomataceae,** a *Adelobotrys adscendens*, b *Blakea gracilis*, c *Blakea litoralis*, d,e *Clidemia crenulata*, f,g *Clidemia dentata*, h *Clidemia densiflora*

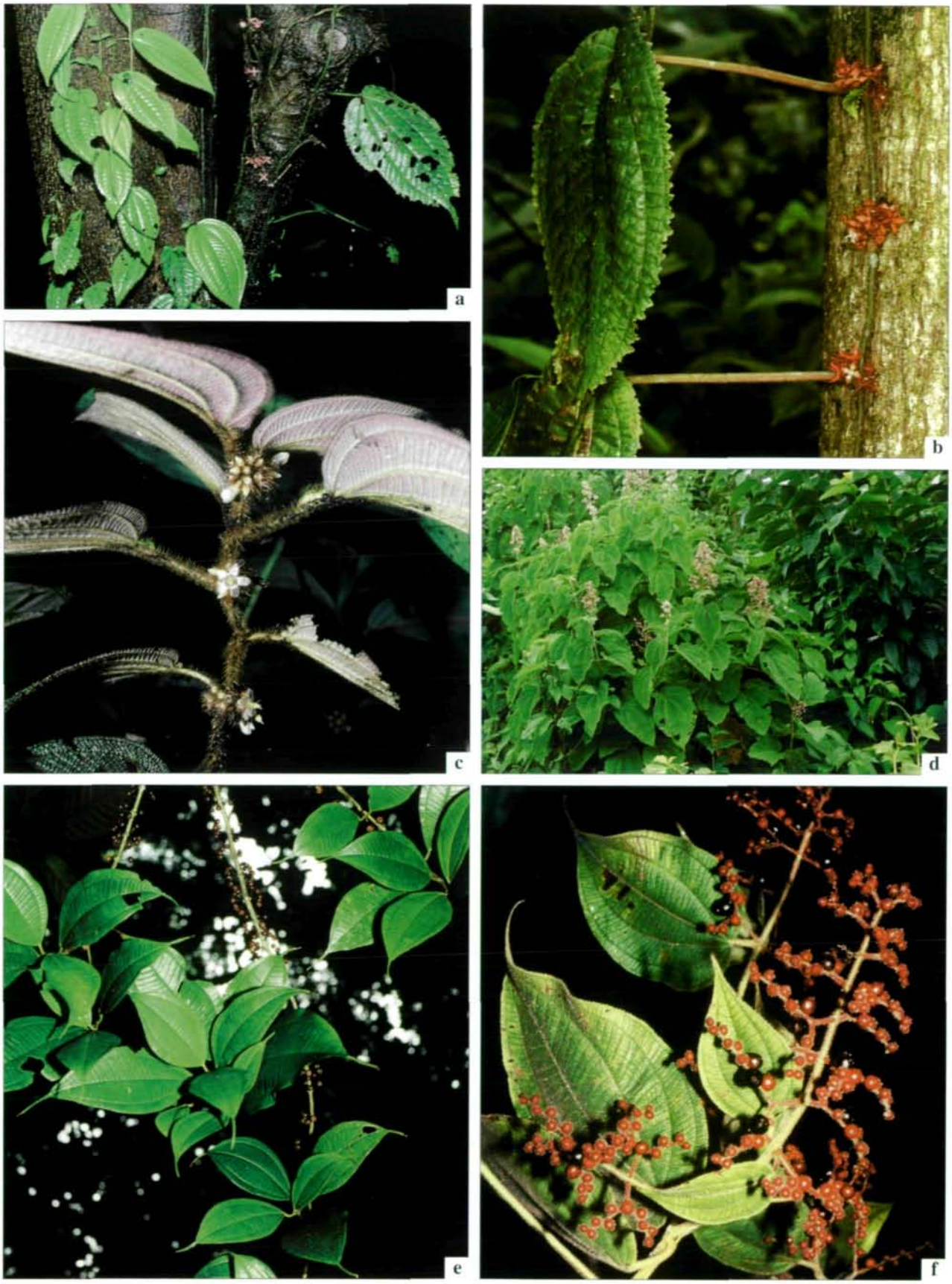


Plate 79. **Melastomataceae,** a,b *Clidemia epiphytica*, c *Clidemia setosa*, d *Conostegia subcrustulata*, e *Henriettea odorata*, f *Leandra mexicana*

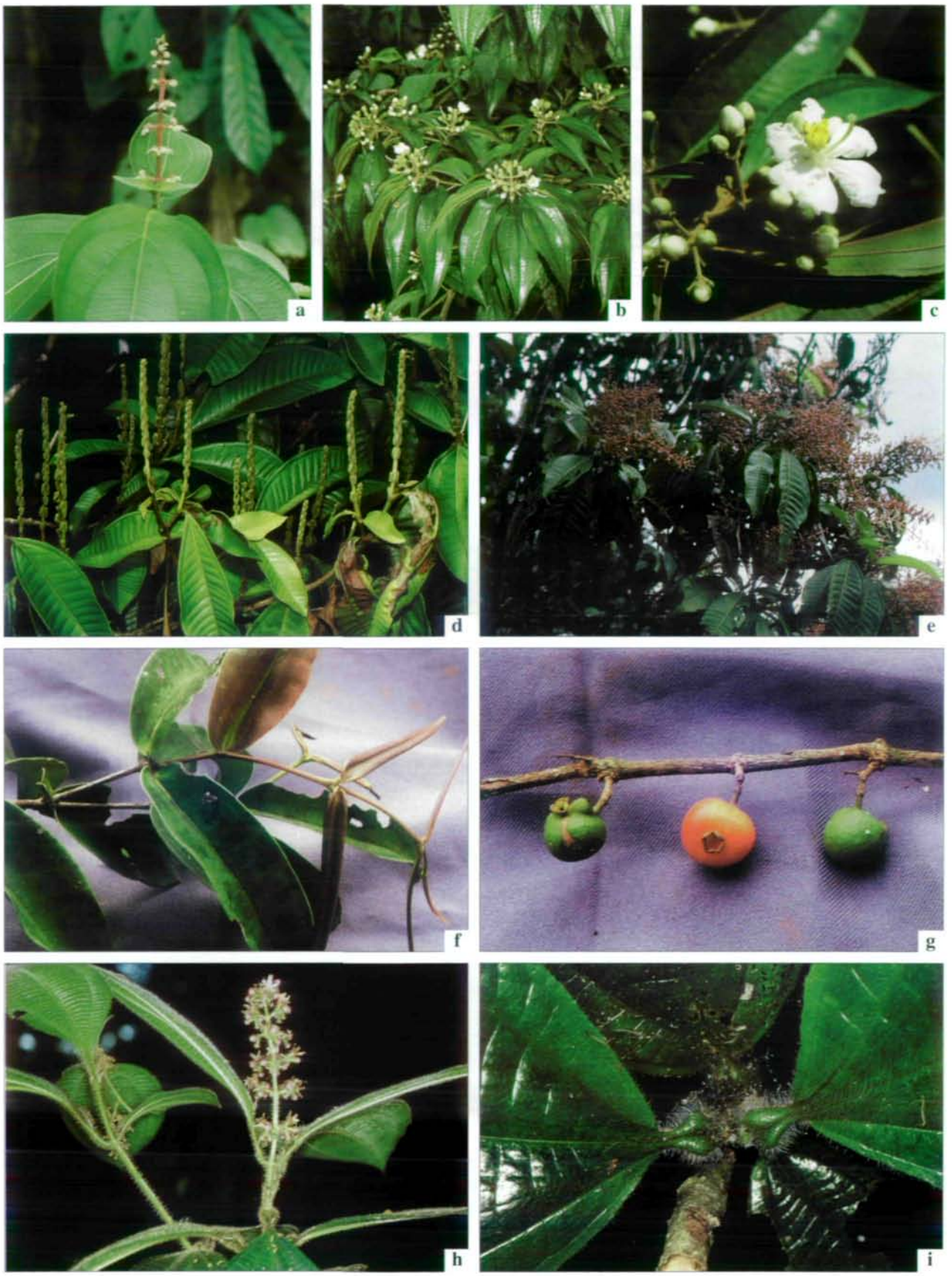


Plate 80. **Melastomataceae,** a *Miconia nervosa*, b,c *Miconia schlimii*, d,e *Miconia trinervia*, f,g *Mouriri gleasoniana*, h,i *Tococa guianensis*

Plate 81. **Melastomataceae,** a,b *Topobea maurofernandeziana*; **Meliaceae,** c-e *Carapa guianensis*, f,g *Cedrela odorata*, h *Trichilia septentrionalis*; **Menispermaceae,** i *Cissampelos tropaeolifolia*

Plate 82. **Monimiaceae,** a-c *Siparuna thecaphora*; **Moraceae,** d *Brosimum costaricanum*, e *Brosimum lactescens*, f,g *Brosimum utile* (f note white sap)

Plate 83. **Moraceae,** a-c *Castilla tunu*, d *Clarisia biflora*, e,f *Dorstenia choconiana* (note variation in leaf shape), g *Ficus* sp., h *Ficus* sp.

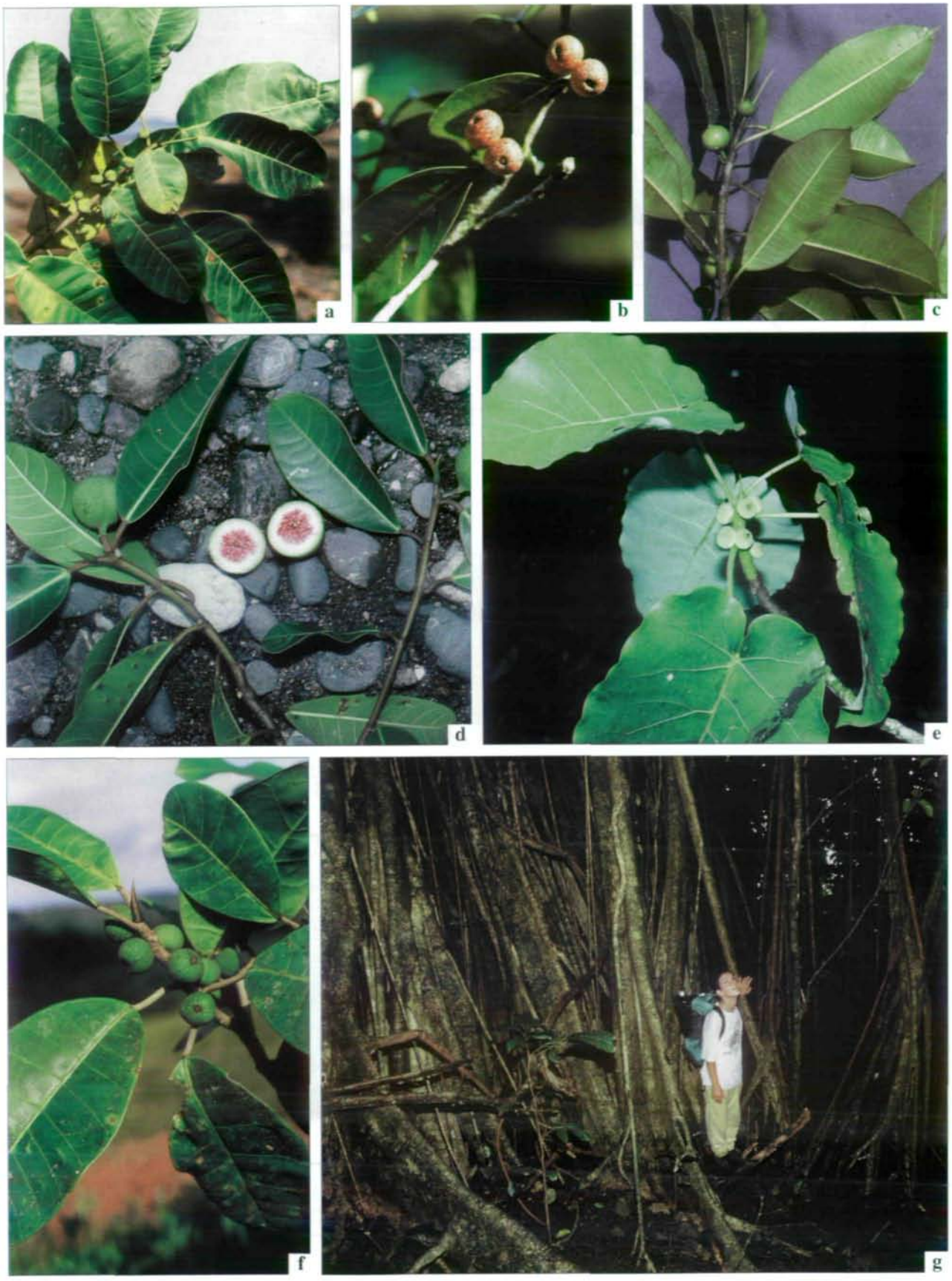


Plate 84. **Moraceae,** a *Ficus citrifolia*, b *Ficus costaricana*, c *Ficus insipida*, d *Ficus maxima*, e *Ficus nymphaeifolia*, f *Ficus tonduzii*, g *Ficus zarzalensis*

Plate 85. **Moraceae,** a *Naucleopsis ulei*, b *Perebea hispidula*; **Myristicaceae,** c *Compsoneura sprucei*, d *Otoba novogranatensis*, e *Virola koschnyi*, f,g *Virola sebifera*

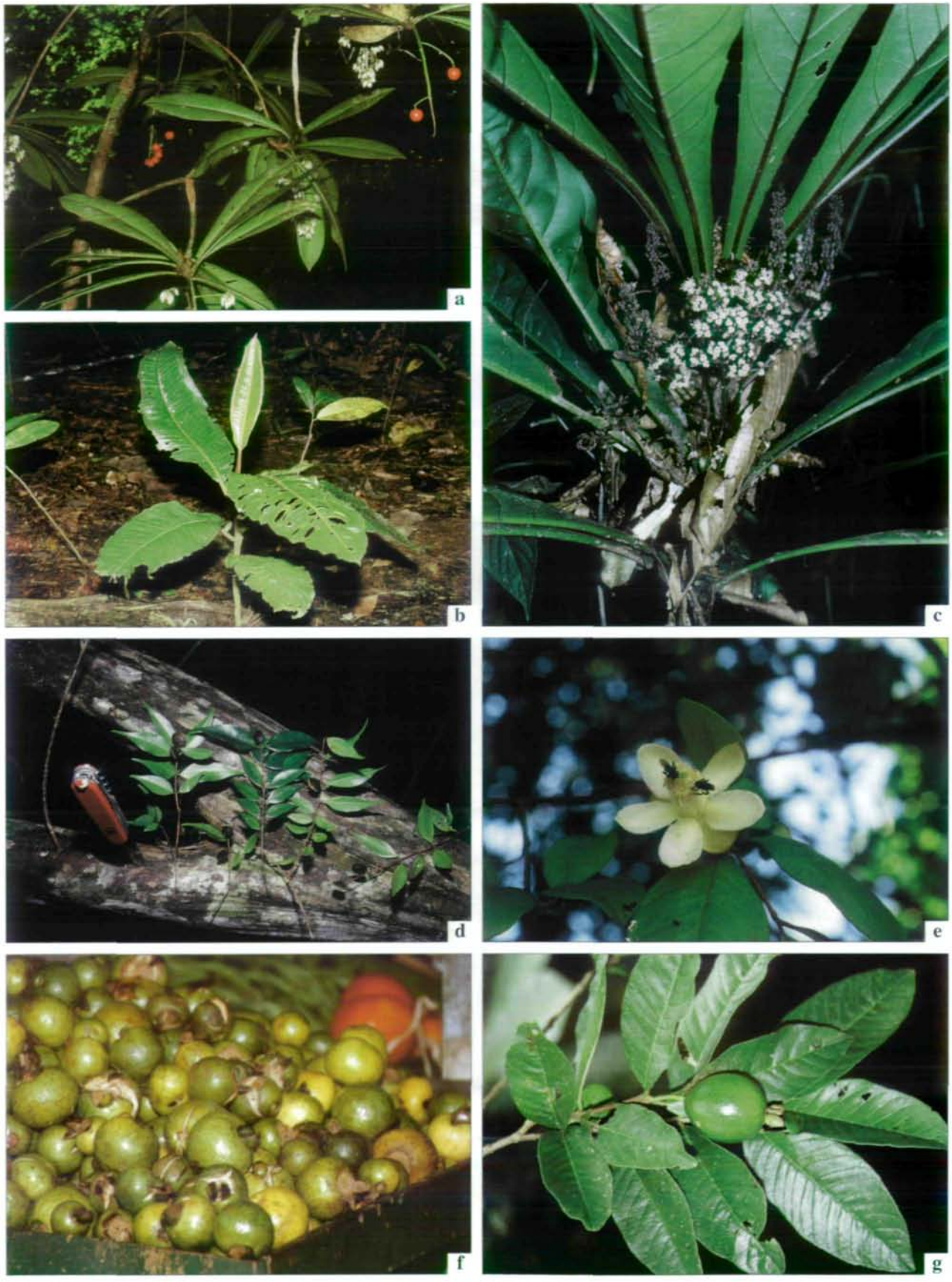


Plate 86. **Myrsinaceae,** a *Ardisia pittieri,* b *Parathesis* sp., c *Cybianthus schlimii*; **Myrtaceae,** d *Myrciaria floribunda*, e,f *Psidium friedrichsthalianum*, g *Psidium guajava*

Plate 87. **Myrtaceae,** a,b *Syzygium malaccense*; **Nyctaginaceae,** c *Neea amplifolia*; **Ochnaceae,** d *Ouratea lucens*; **Olacaceae,** e,f *Chaunochiton kappleri*, g *Heisteria acuminata*, h,i *Minquartia guianensis*

Plate 88. **Oxalidaceae,** a,b *Averrhoa carambola*, c *Biophytum* cf. *dendroides*; **Papaveraceae,** d,e *Bocconia frutescens* (e note fruit with exposed arillate seed)

Plate 89. **Passifloraceae,** a-c *Passiflora quadrangularis*, d,e *Passiflora vitifolia*; **Phytolaccaceae,** f *Phytolacca rivinoides*; **Piperaceae,** g *Peperomia* cf. *rotundifolia*, h *Peperomia saintpauliella*

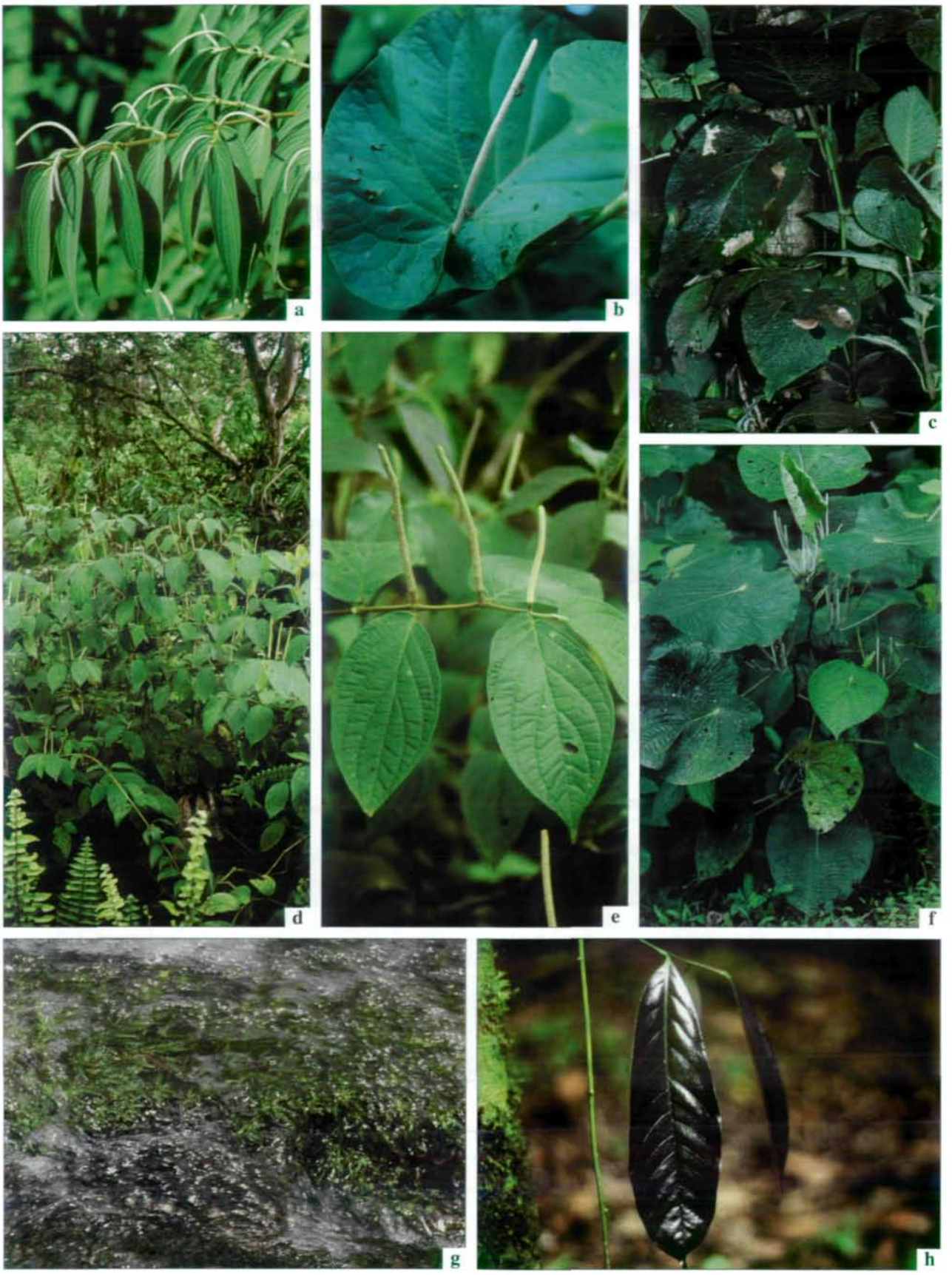


Plate 90. **Piperaceae**, a *Piper aduncum*, b *Piper auritum*, c *Piper fimbriulatum*, d,e *Piper hispidum*, f *Piper peltatum*; **Podostemaceae**, g *Marathrum* sp.; **Polygalaceae**, h *Moutabea* sp.

Plate 91. **Polygonaceae,** a,b *Coccoloba standleyana* (b leaf ochrea), c *Polygonum punctatum*; **Rafflesiaceae,** d,e *Apodanthes casearíae*; **Rhamnaceae**, f *Gouania lupuloides*; **Rhizophoraceae,** g,h *Rhizophora mangle*, i *Rhizophora racemosa*

Plate 92. **Rubiaceae,** a *Alibertia edulis*, b *Amphidasya ambigua*, c *Boroja patinoi*, d *Chiococca alba*, e-g *Coccocypselum herbaceum* s.l., h *Duroia costaricensis*, i *Faramea sessifolia*

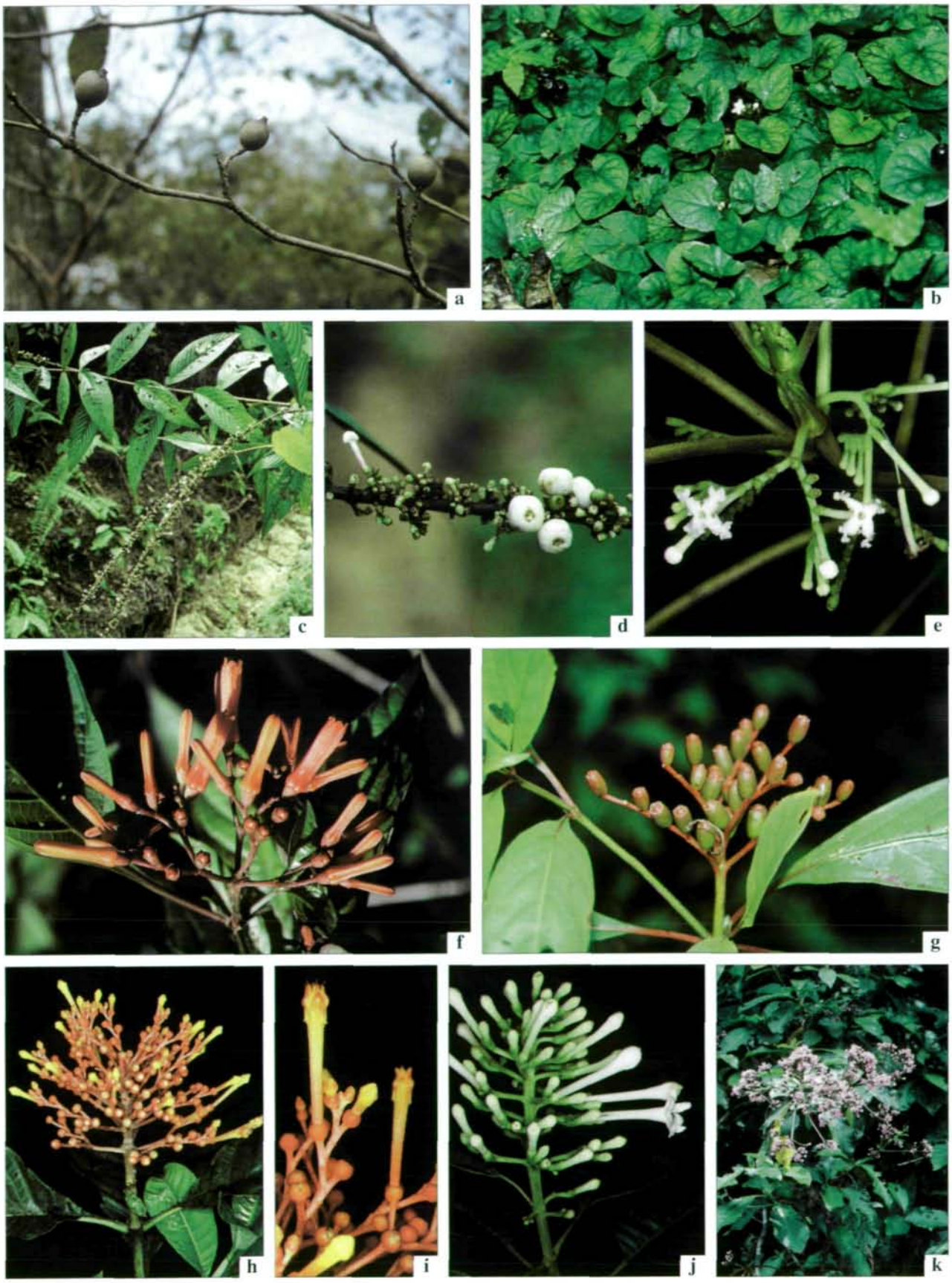


Plate 93. **Rubiaceae,** a *Genipa americana*, b *Geophila macropoda*, c,d *Gonzalagunia brenesii*, e *Guettarda crispiflora*, f,g *Hamelia patens*, h,i *Isertia haenkeana*, j *Isertia laevis*, k *Macrocnemum* sp.

Plate 94. **Rubiaceae,** a,b *Palicourea guianensis*, c *Pentagonia tinajita*, d,e *Pentagonia wendlandii*, f-h *Posoqueria latifolia*

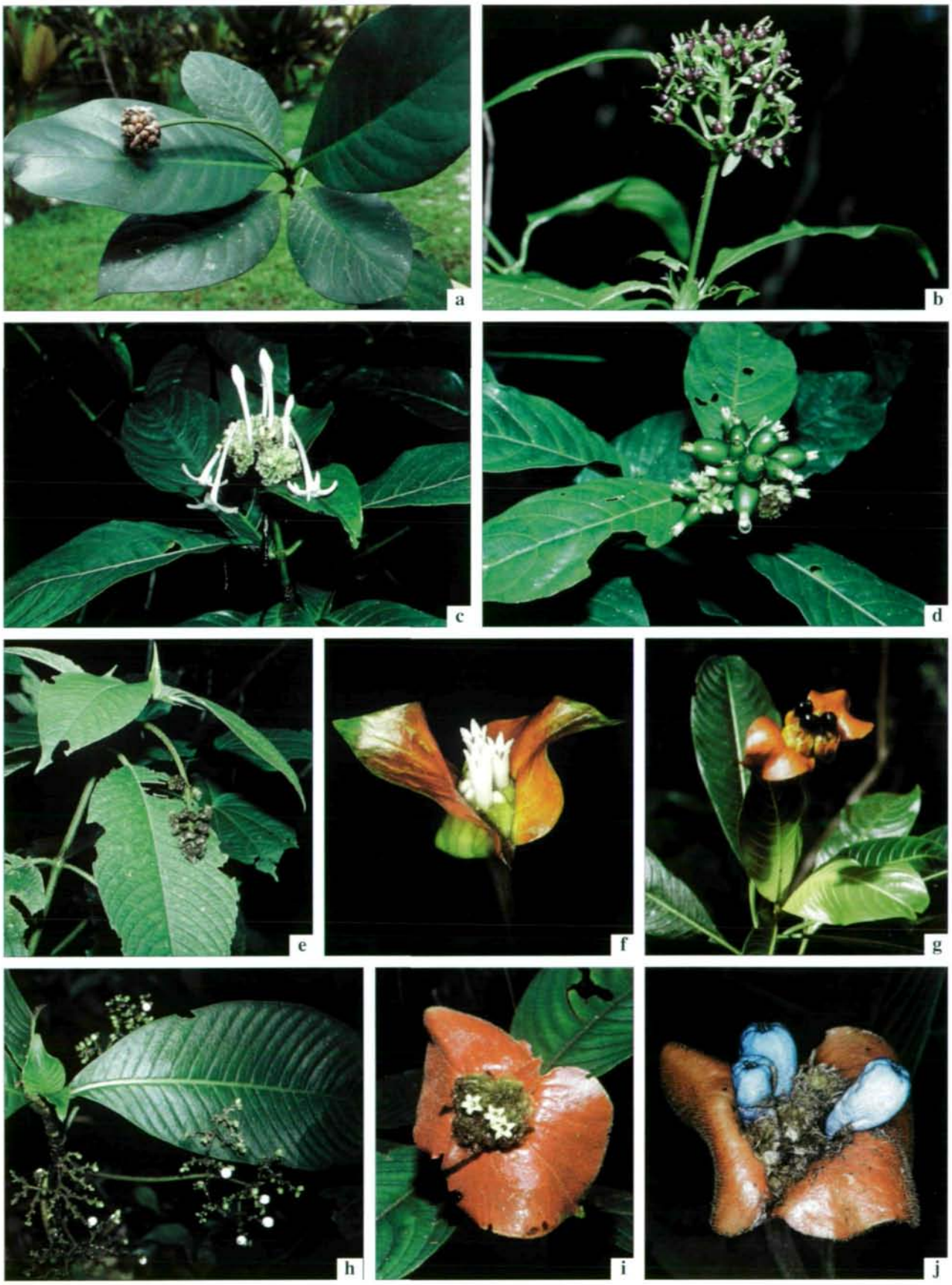


Plate 95. **Rubiaceae,** a *Psychotria borucana*, b *Psychotria capitata*, c,d *Psychotria chiapensis*, e *Psychotria pillosa*, f,g *Psychotria elata*, h *Psychotria macrophylla*, i,j *Psychotria poeppigiana*

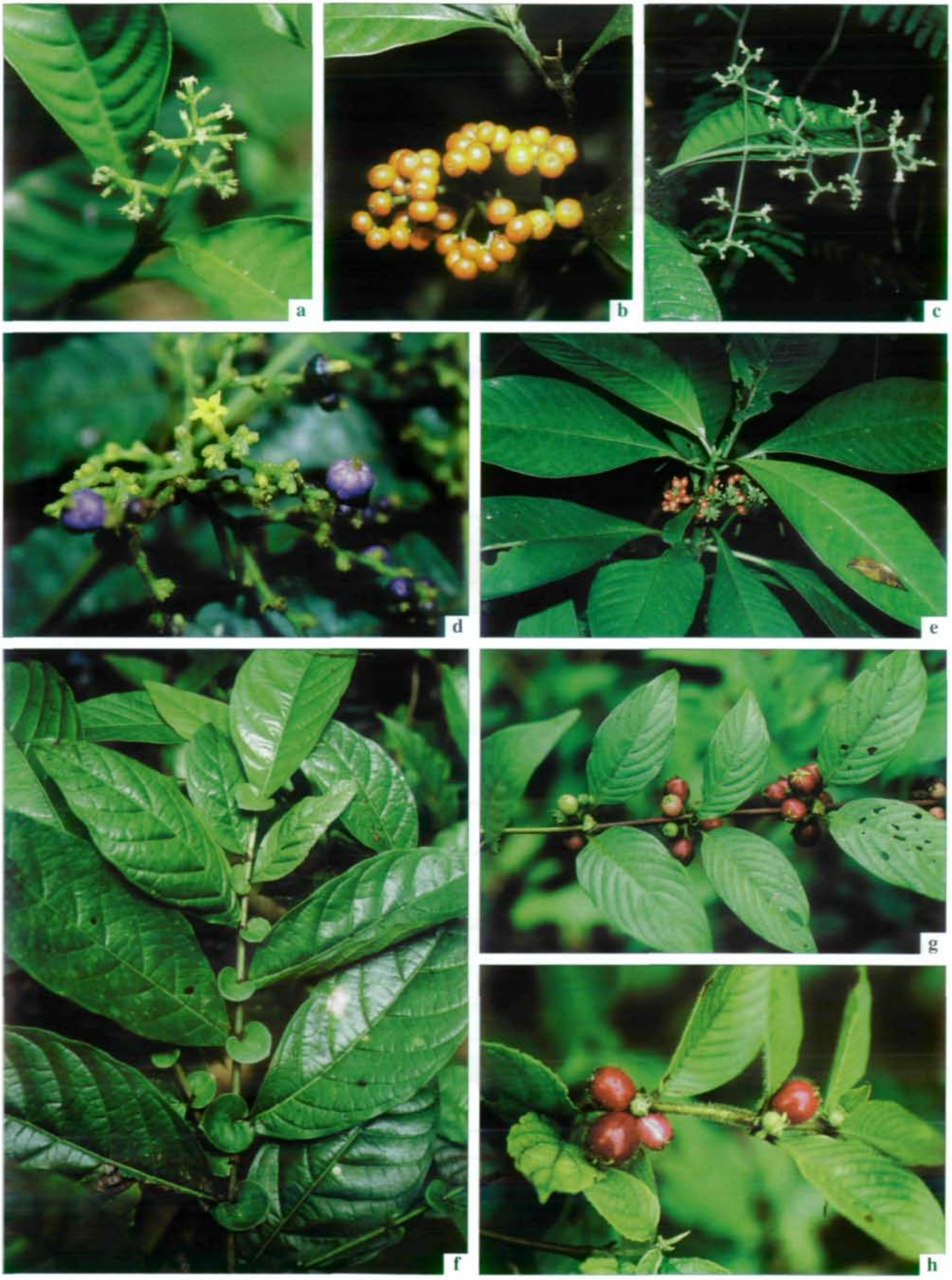


Plate 96. **Rubiaceae,** a,b *Psychotria racemosa*, c,d *Psychotria solitudinum*, e *Psychotria uliginosa*, f *Randia gentryi*, g *Sabicea panamensis*, h *Sabicea villosa*

Plate 97. **Rubiaceae,** a,b *Simira maxonii*, c,d *Warszewiczia coccinea*; **Rutaceae,** e *Conchocarpus guyanensis*, f *Zanthoxylum ekmanii*; **Sapindaceae,** g *Cupania rufescens*, h *Paullinia* sp. (note exposed seeds with white aril)

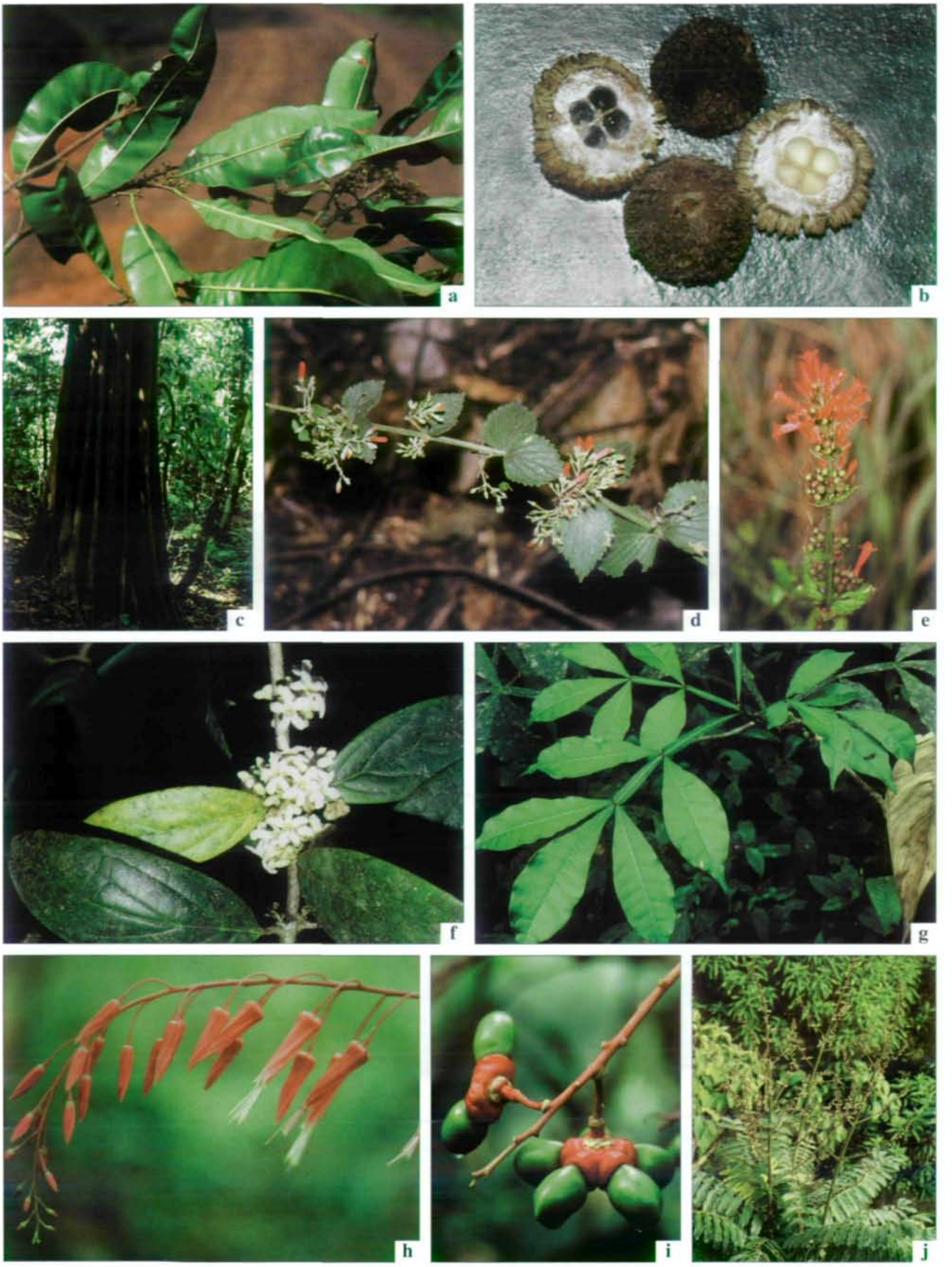


Plate 98. **Sapotaceae,** a *Micropholis melinoniana*, b,c *Pouteria torta*; **Scrophulariaceae,** d,e *Russelia sarmentosa*, f *Schlegelia parviflora*; **Simaroubaceae,** g-i *Quassia amara*, j *Simaba cedron*

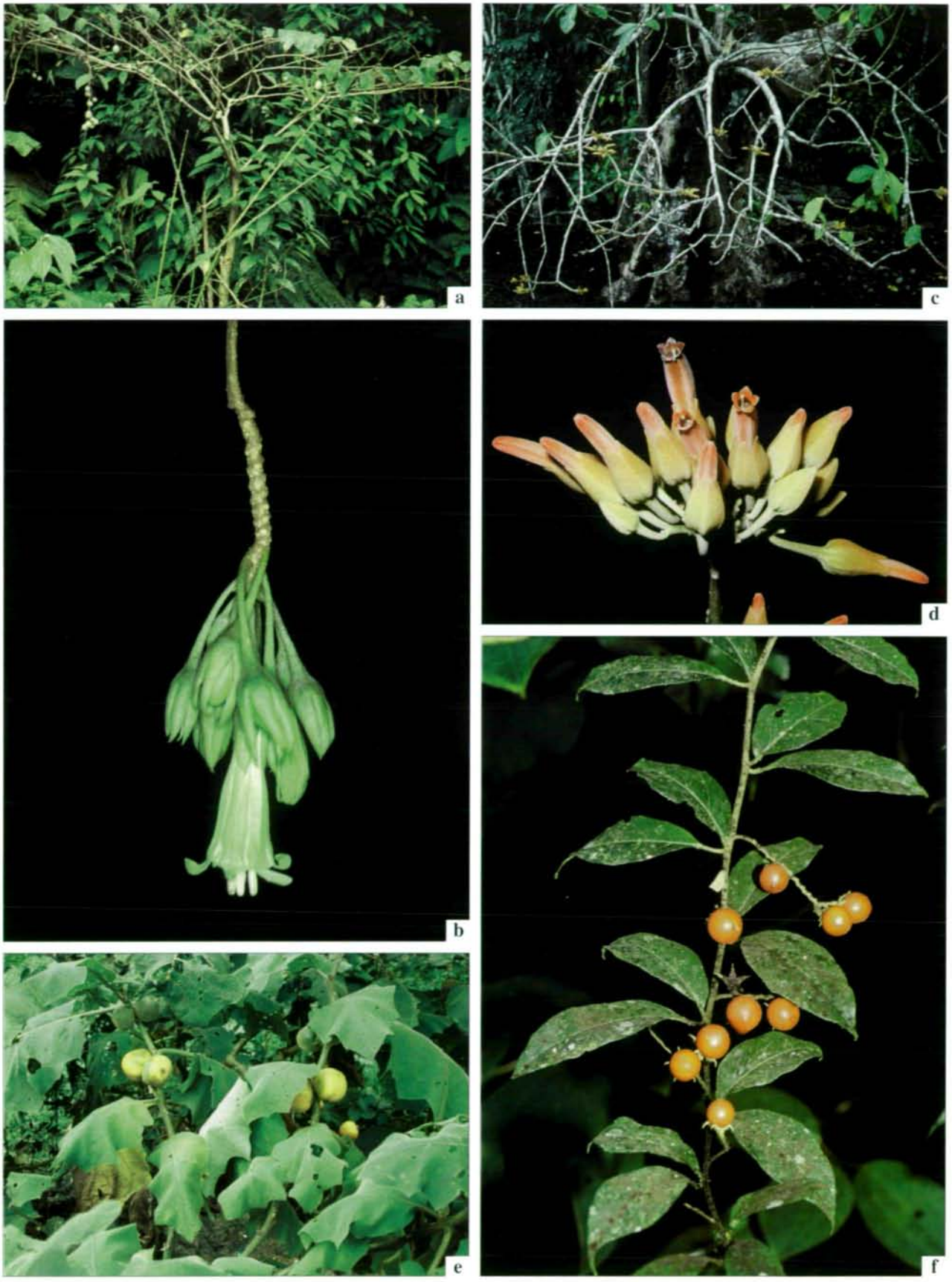


Plate 99. **Solanaceae,** a *Cyphomandra hartwegii*, b *Markea neurantha*, c,d *Juanulloa mexicana*, e *Solanum sessiliflorum*, f *Solanum lanceifolium*

Plate 100. **Sterculiaceae,** a *Guazuma ulmifolia*, b-d *Herrania purpurea*, e *Pterygota excelsa*, f,g *Sterculia apetala*, h,i *Sterculia recordiana*

Plate 101. **Sterculiaceae,** a,b *Theobroma angustifolium*, c,d *Theobroma cacao*; **Theaceae,** e-h *Pelliciera rhizophorae*, i *Ternstroemia multiovulata*

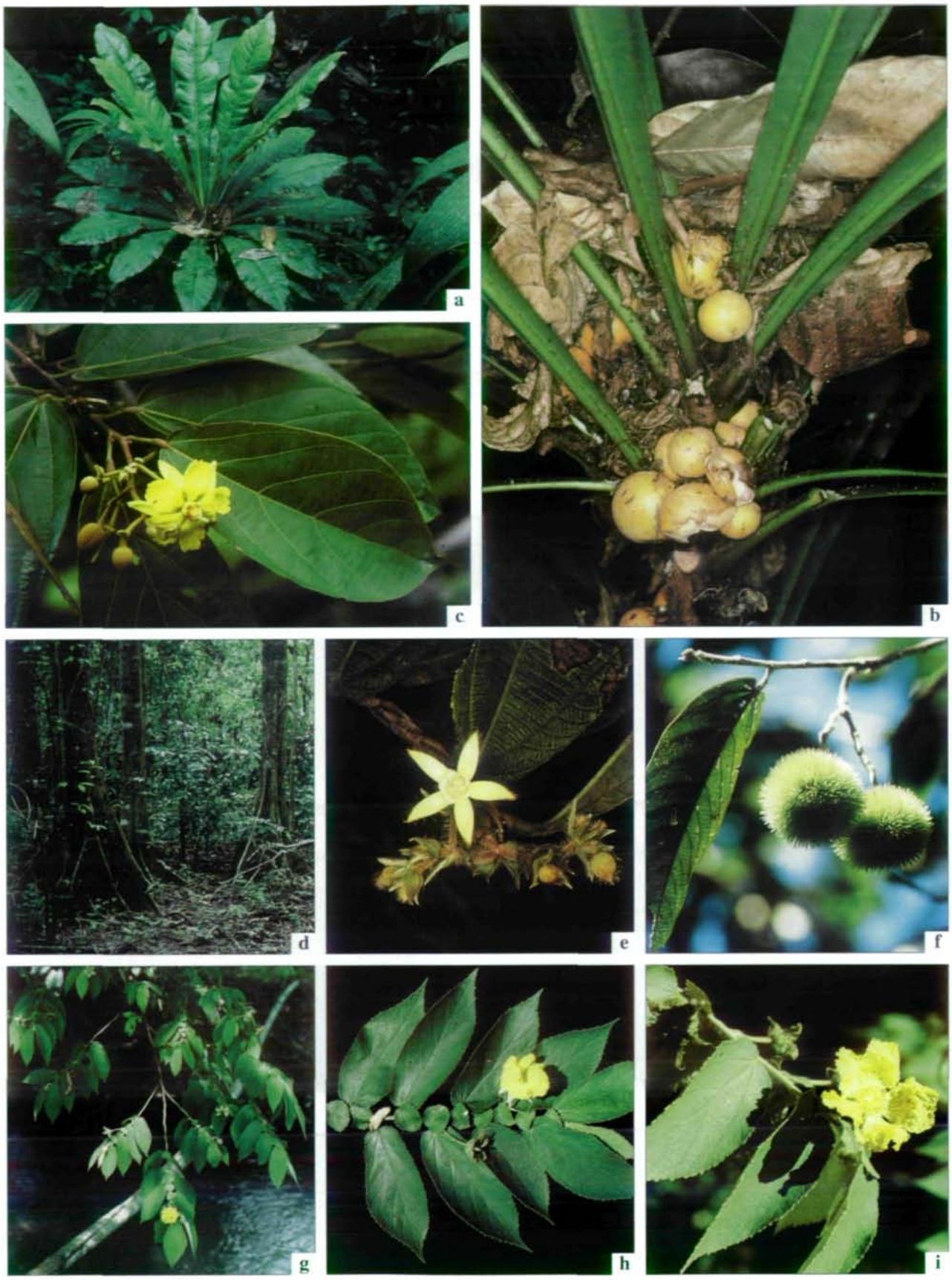


Plate 102. **Theophrastaceae,** a,b *Clavija costaricana*; **Tiliaceae,** c *Apeiba membranacea*, d-f *Apeiba tibourbou* (d note buttresses), g-i *Dicraspidia donnell-smithii*

Plate 103. **Tiliaceae,** a *Heliocarpus appendiculatus,* b *Luehea seemannii*, c *Mortoniodendron anisophyllum*, d *Trichospermum grewiifolium*; **Urticaceae,** e *Myriocarpa longipes*, f *Urera eggersii*, g,h *Urera elata*

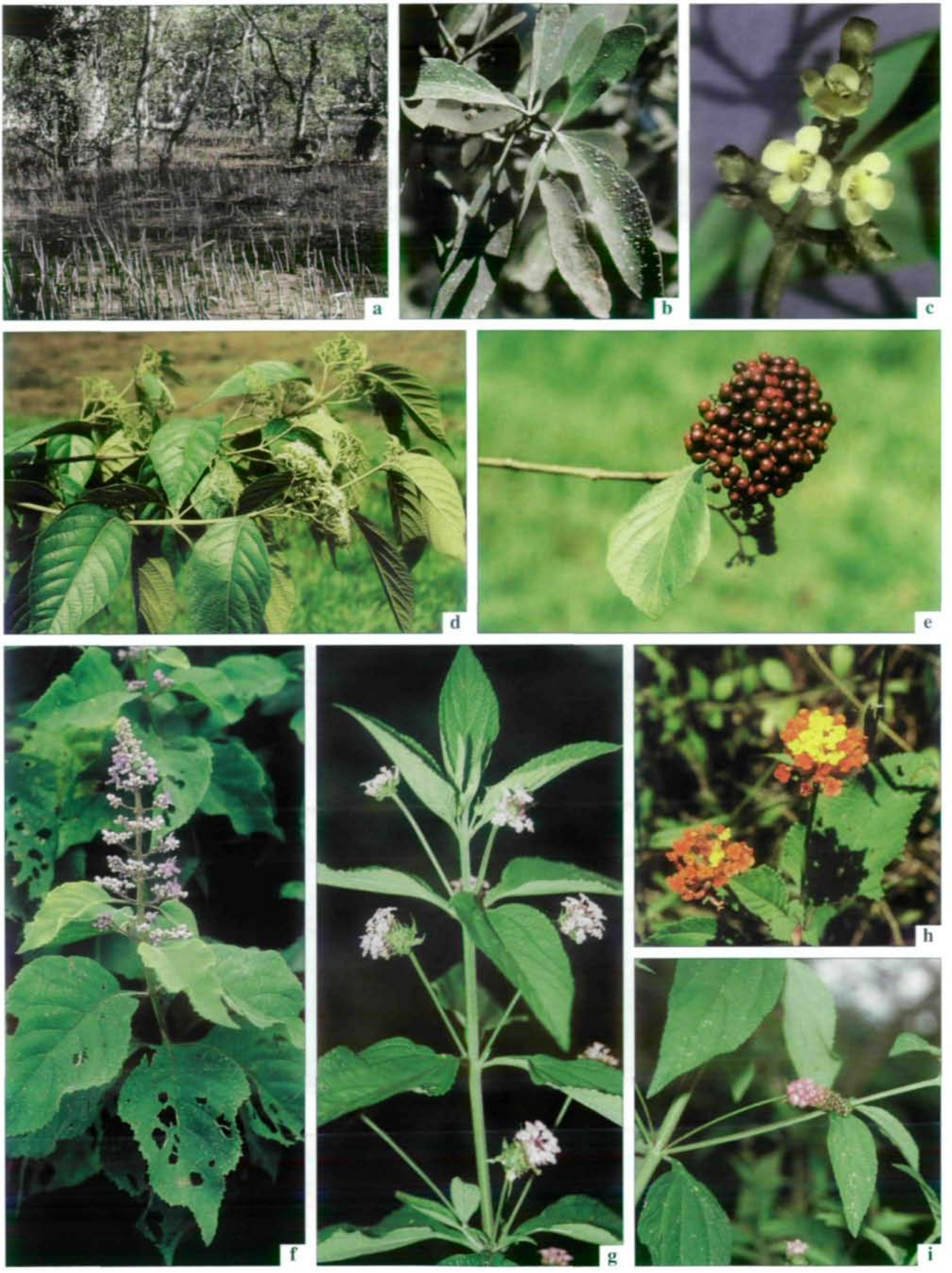


Plate 104. **Verbenaceae,** a-c *Avicennia germinans* (a note pneumatophores, b leaves with excretions of salt), d,e *Callicarpa acuminata*, f *Cornutia pyramidata*, g,i *Lantana trifolia,* h *Lantana camara*

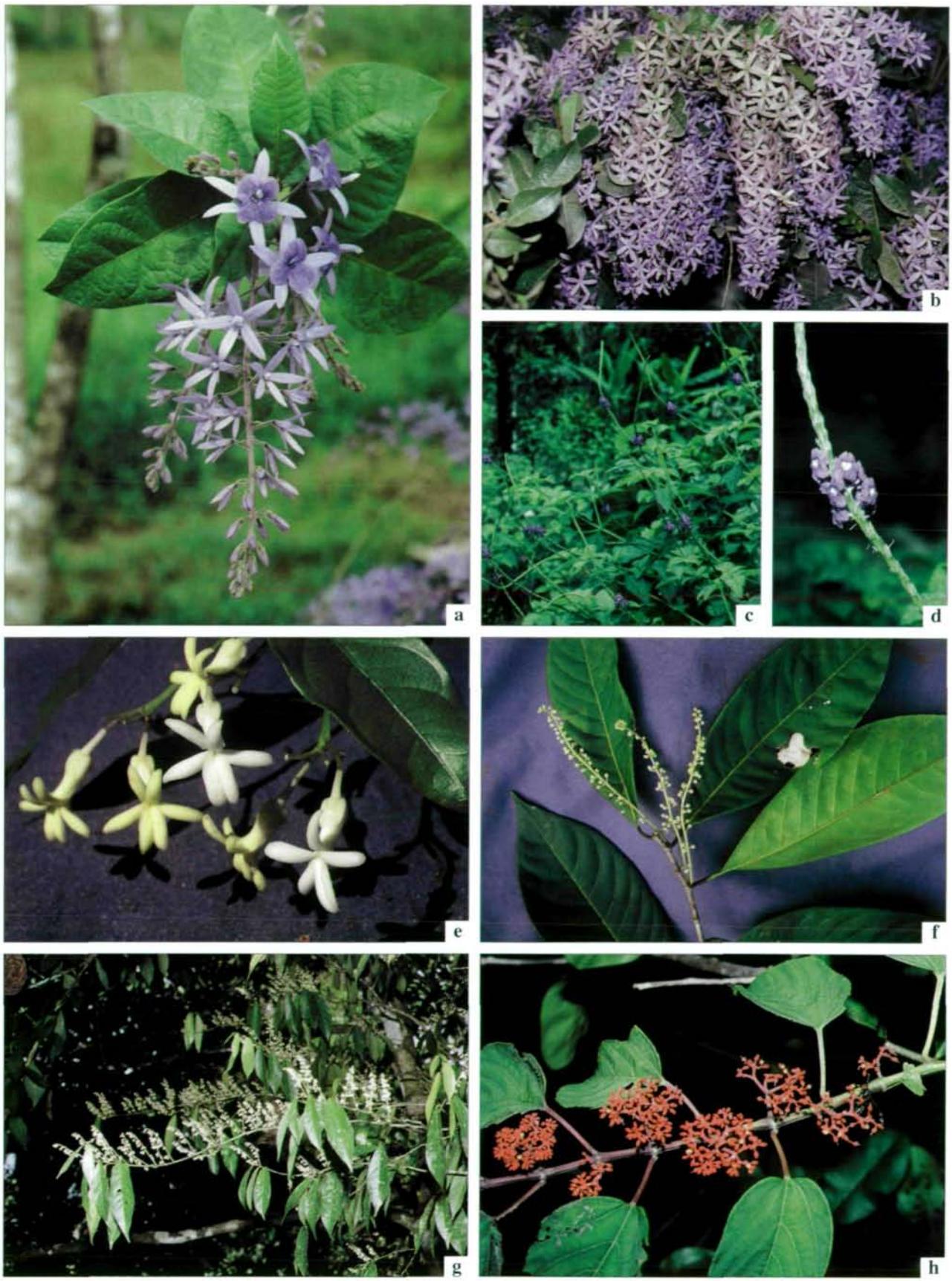
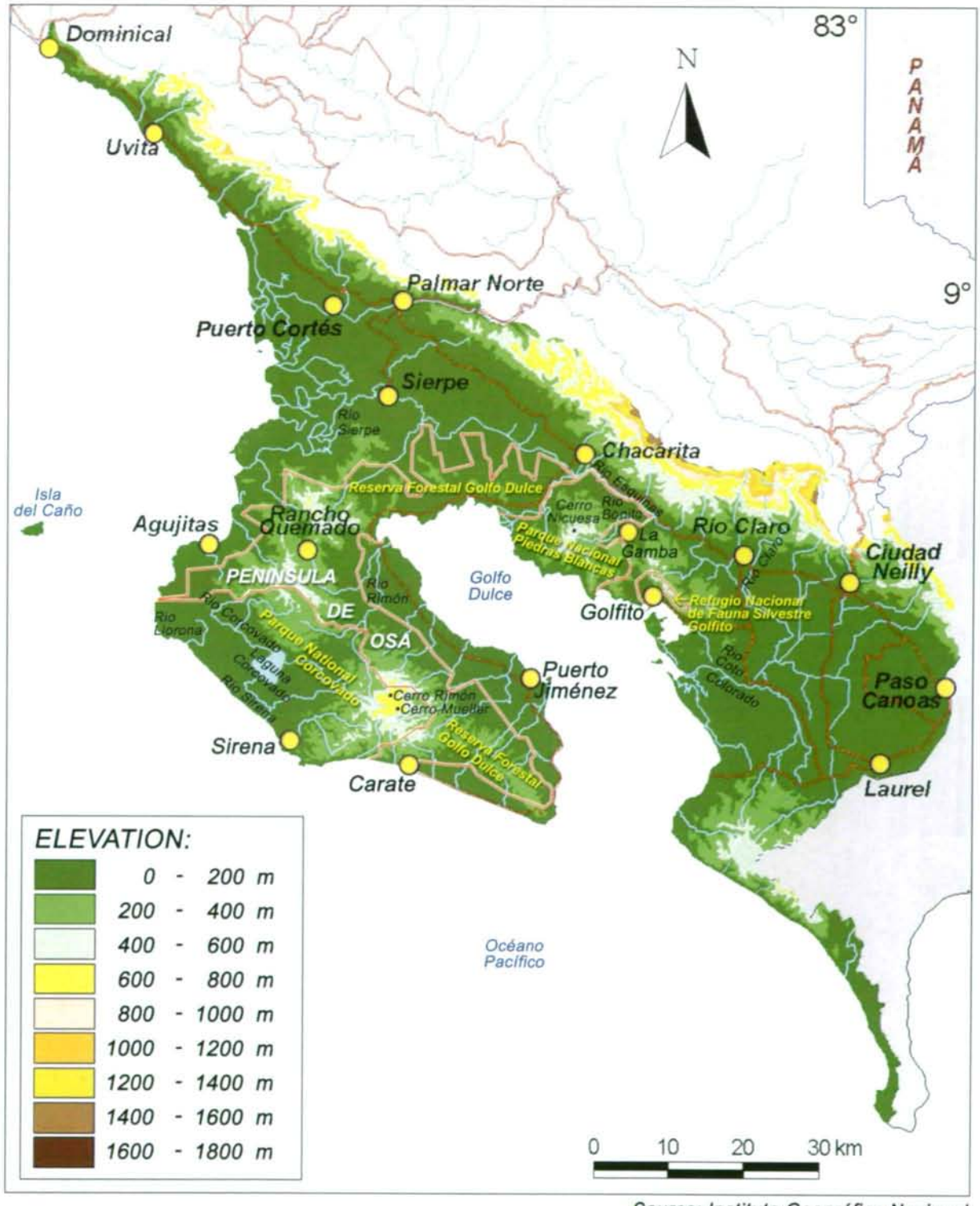
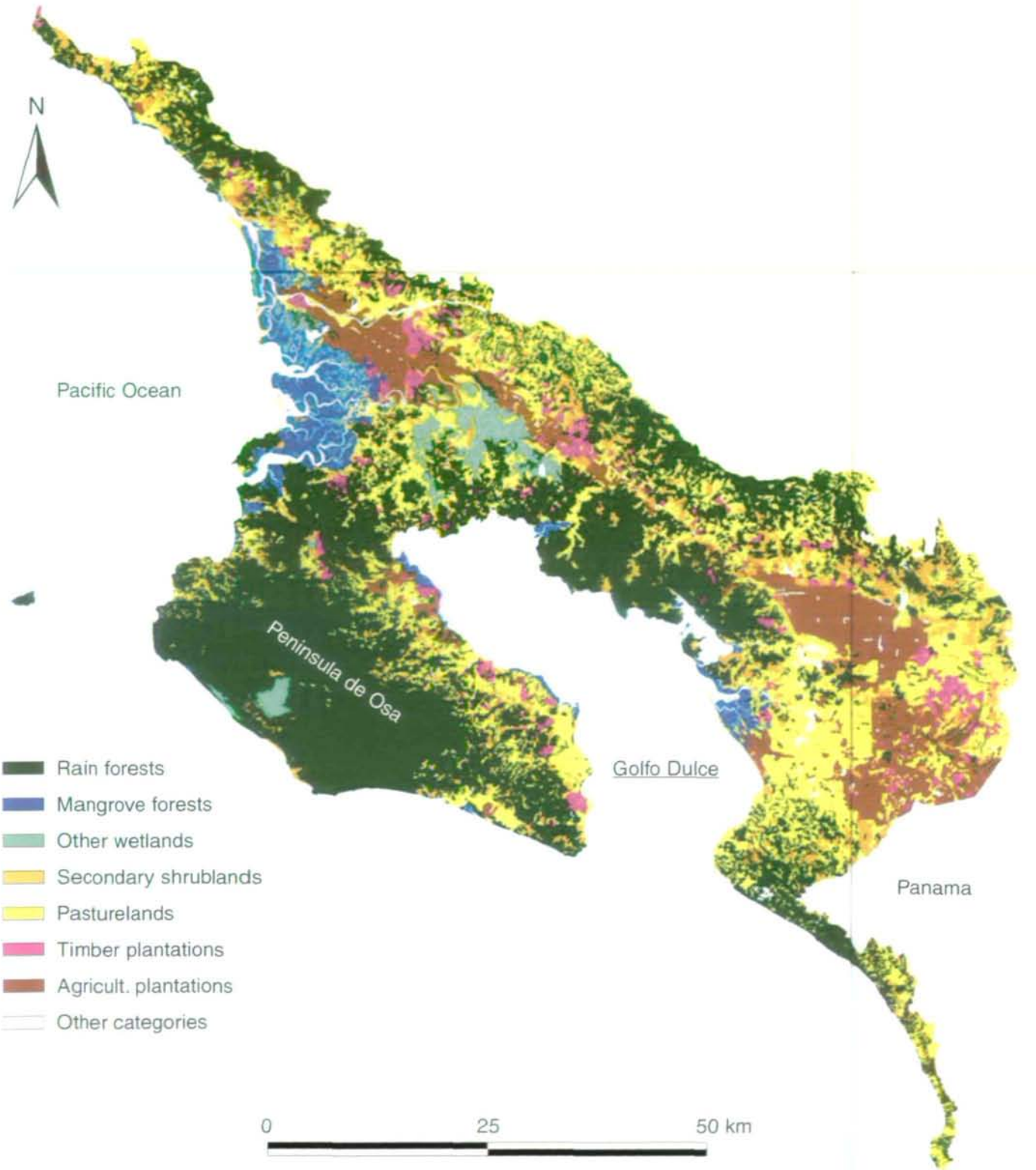


Plate 105. **Verbenaceae,** a,b *Petrea volubilis*, c,d *Stachytarpheta jamaicensis*; **Violaceae,** e *Amphirrhox longifolia*, f *Fusispermum laxiflorum*, g *Rinorea crenata*; **Vitaceae,** h *Cissus biformifolia*

Plate 106. **Vochysiaceae,** a *Qualea paraensis*, b *Vochysia ferruginea*, **c**,d *Vochysia megalophylla*



Source: Instituto Geográfico Nacional



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