

Ingrid Roth  
Ana-Maria Giménez

# Argentine Chaco forests

## Dendrology, tree structure, and economic use

2. The humid Chaco



ENCYCLOPEDIA OF PLANT ANATOMY

I. ROTH & A.-M. GIMÉNEZ, ARGENTINE CHACO FORESTS, PART 2



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Dr. David F. CUTLER, Kew, Richmond, England  
Professor Dr. S. FINK, Freiburg (Breisgau)  
Professor Dr. P. OZENDA, Grenoble  
Professor Dr. INGRID ROTH, Freiburg (Breisgau)  
Professor Dr. H. ZIEGLER, München

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ARGENTINE CHACO FORESTS  
DENDROLOGY, TREE STRUCTURE,  
AND ECONOMIC USE  
2. The humid Chaco

by

Professor Dr. INGRID ROTH & Dr. ANA-MARIA GIMÉNEZ  
Freiburg (Breisgau)      Santiago del Estero/Argentina

With 27 figures and 24 tables in the text

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Authors' addresses:

Prof. Dr. INGRID ROTH  
Moosweg 2  
79244 Münstertal  
Germany

Dr. ANA-MARIA GIMÉNEZ  
Ing. Forest.  
Independencia 2573  
4200 Santiago del Estero  
Argentina

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## Preface

The present work is a sequel of the first volume “Argentine Chaco forests: Dendrology, tree structure, and economic uses 1. The semi-arid Chaco”. ROTH & GIMENEZ DE BOLZÓN 1997. Borntraeger Berlin-Stuttgart, and deals with the humid Chaco forest. The circumstances of collaboration were more or less the same. The Department of Dendrology of the National University of Santiago del Estero under the direction of Dr. Ana-Maria Giménez collaborated with Prof. Dr. Ingrid Roth, Emeritus of the Universidad Central de Venezuela in Caracas. The senior author has a 21 year experience of teaching and investigation in Latin America.

The Argentine team was sponsored by the CICYT, UNSE of Argentina—the senior author in Germany had to finance the investigation personally.

A smaller part of the present work is based on earlier publications of Gimenez and her collaborators, but most of it refers to new studies. The Argentine team is responsible for the collection of the material, the identification of species and the preparation of slides, as well as for the chapter dealing with the wood. The bibliography used is mostly of Argentine origin—apart from the valuable publications of HÜECK and KANTER—and is therefore difficult for outsiders to obtain.

The purpose of the present work was to study the humid Chaco forests with their special peculiarities and to find differences in dendrological aspects as well as in bark and wood structure so as to compare them with the other Chaco-forest types. In a further publication (part 3), we will deal with the mountainous Chaco forests and their structural characteristics so that we can make an exhaustive comparison between the 3 types of forest, their dendrological and structural peculiarities, their important species with their requirements and their useful products.

INGRID ROTH, Germany/Venezuela and ANA-MARIA GIMENEZ, Argentina



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## Sites of collection and vegetation

### The eastern Chaco District

This district occupies about half of the Provinces of Chaco and Formosa, as well as the North of Santa Fé and the North-East of Corrientes. The climate is more humid than in other districts, because a declining humidity gradient from the East towards the West can be observed in the eastern Chaco. The annual mean temperature amounts to 19–23° C, with a maximum of 40° C in summer and a minimum of 3° C in winter. Insolation increases towards the West.

The slight inclination of the relief from North-West towards the South-East forces a series of rivers, such as the Pilcomayo and the Bermejo, to flow into the Paraná and the Paraguay.

The soils vary between light and permeable sandy and heavy argillaceous including even inundated substrates. These permeable soils are rich in organic matter and in nutritive substances. Furthermore, the humidity is uniformly distributed, so that optimal conditions are developed for the most productive forests. Extensive swamps develop on top of the argillaceous subsoils, so that a large part of the area is periodically inundated. Due to the lack of inclination of the territory with impermeable soils, lagoons and salty pods arise from the stagnating waters. The dry forests therefore retreat to higher and less humid sites. Between these forests, swamps, humid savannas, palm groves, and humid forests begin to extend. The combination of forests with swamps generates the impression of an open luminous forest (HUECK 1978). Palm groves exist at the margins of areas with impermeable soils. However, on better soils, dicotyledonous trees and shrubs appear.

There is a gradient of vegetation density following the east-west direction; the eastern part called “Quebracho Colorado chaqueño region” is best developed (COZZO 1967).

The vegetation is composed of xerophilous forests mixed with savannas and palm groves. Close to the rivers, there exist marginal forests which contain elements pertaining to the Paraná Province.

The southern limit of the eastern Chaco belongs to a formation called “forestry wedge of Santa Fé”. It corresponds to about the southern limit of the genus *Schinopsis*. This formation is characterized by large forests which alternate with grassland and salty lagoons; it is considered a prolongation of the eastern Chaco forests or what MORELLO & ADAMOLI (1968) define as a subregion of Chaco lagoons, former river beds and gallery forests.

Three different types of forests can be distinguished in this area. At the highest places, the climax forest is developed. On descending grounds, however, the arboreous storey is impoverished and the Quebrachal of colorado-chaqueño establishes. On even lower grounds and frequently on salty soils, the Algarrobales with *Prosopis nigra* gain ground and prevail (LEWIS & PIRE 1981).

## Communities of the eastern Chaco District

Community	Principal species	Secondary species	Preferred sites
Forests of Quebracho colorado-blanco	<i>Schinopsis balansae</i> and <i>Aspidosperma quebracho-blanco</i>	<i>Caesalpinia paraguayensis</i> , <i>Gleditsia amorphoides</i> , <i>Astronium balansae</i> , <i>Ruprechtia laxiflora</i> , <i>Diplokeleba floribunda</i> , <i>Patagonula americana</i> , <i>Pisonia zapallo</i> , <i>Tabebuia heptaphylla</i> , <i>Prosopis kuntzei</i>	Climax community in high and mature soils
Forests of algarrobo and churqui	<i>Prosopis nigra</i> and <i>Acacia caven</i>	<i>Prosopis vinalillo</i> , <i>Parkinsonia aculeata</i> , <i>Schinus longifolia</i> , <i>Celtis tala</i>	Low and inundated soils
Palmar of Caranday with algarrobo	<i>Copernicia alba</i> , <i>Prosopis alba</i>	<i>Prosopis algarroBILLA</i> , <i>Geoffroea decorticans</i> , <i>Celtis tala</i> , <i>Schinus longifolia</i>	Slightly alkaline grounds of the eastern District
Palmar of caranday	<i>Copernicia alba</i>		Frequently on low and alkaline soils
Esparto-grass-fields of <i>Elionurus</i>	<i>Elionurus muticus</i>		Similar soils as those of the climax community, but slightly lower—covering the clearings of the District
Esparto-grass-fields of <i>Paspalum</i>	<i>Paspalum intermedium</i>		covers lower soils than above mentioned species, as well as the ground of washed out river beds and depressions without water
Esparto-grass-fields of paja brava	<i>Panicum prionitis</i> and <i>Paspalum baumannii</i>		On inundated grounds near rivers
<i>Tessaria</i> forests	<i>Tessaria integrifolia</i>		On young islands and sandy banks of the rivers Paraguay, Bermejo and Parana
<i>Salix</i> forests	<i>Salix humboldtiana</i>	<i>Sapium haematospermum</i> , <i>Erythrina crista-galli</i>	On high sandy islands and at the mouth of rivers
Forests of Piri	<i>Cyperus giganteus</i>		In lagoons permanently covered by water
Camalotes (floating plants)	<i>Eichbornia</i> and <i>Reussia</i>		Floating plants at river banks
Swamps	<i>Fuirena robusta</i> and <i>Scirpus cubensis</i> var. <i>paraguayensis</i>	<i>Elodea</i> , <i>Cabomba australis</i> , <i>Potamogeton</i>	Floating islands with soils of mud in which large masses of roots and rhizomes with aerenchyma develop; these enable the plants to float
Submerged plants	<i>Elodea</i> , <i>Cabomba australis</i> , <i>Potamogeton</i>		Lagoons and rivers

In the “cuña boscosa” (forestry wedge), an intense extraction activity of tannins from the Quebracho colorado-chaqueño (*Schinopsis balansae*) led to the disappearance of specimens with a diameter surpassing 40 cm. At the same time, intense catlebreeding affected the shrubby as well as the arboreous storey (PARODI 1934, MEYER 1936, RAGONESE 1941, 1947, TORTORELLI 1956, MORELLO & ADAMOLI 1968 and others).

As far as woodland management is concerned, the eastern Chaco Province is characterized by the existence of 3 arboreous species: *Schinopsis balansae*, *Astronium balansae* and *Tabebuia heptaphylla* (TORTORELLI 1956).

In the eastern Chaco district, keeping of live stock and forest exploitation profoundly modified the composition of plant communities. By felling of the most important tree species or by burning of forest plots to create new arable land for agriculture, the herbaceous layer was destroyed and the invasion of shrubby species was facilitated.

In the table of p. 2, the most important plant species and communities of the eastern Chaco District are mentioned (according to CABRERA 1976).

### Gallery forests of the humid Chaco

Isla del Cerrito, an island in the Chaco Province, Argentina, is one of the sites where samples were taken. It is a very interesting place concerning its various ecosystems. One of the peculiarities found on the Isla del Cerrito is the presence of different forest ecosystems besides Esparto grassland, spots with herbs having distinct flowering times and with a characteristic aquatic flora, while the arboreous species of the forest of Misiones representing the Gallery forests line the humid belt along the river beds.

The hygrophilous forests of the river banks of the Paraná river and its tributaries constitute a dense and complex mass of vegetation arranged in the form of a discontinuous strip. Its width is variable; its profound soils are soft and usually well drained.

The different types of forest are represented by: inundated forests along rivers which are yearly subject to several months of inundation. The species most frequently found are: *Inga urugüensis*, *Cathormion polyanthum*, *Geoffroea striata*, *Erythrina dominguensis*, and *Cecropia adenopus*; furthermore there are spots of grassland with trees which, however, grow at higher altitudes and at greater distances from the rivers behind the forests of inundation; characteristic species of this formation are *Genipa americana*, a species typical of islands, *Nectandra saligna* and *Nectandra falcifolia*; a small treelet, *Crataeva tapia*, likewise occurs frequently.

Small forests appear on the banks with sediments, comprising communities with *Croton urucurana*, which is the most frequent species of the island, besides *Tessaria integrifolia* and *Salix humboldtiana*. *Tessaria integrifolia*, which is the pioneer plant of the middle Paraná, grows on sedimentary islands; it appears where sandy banks develop colonized by not too dense grassland, thus creating the necessary conditions for forest formation. This formation with a maximal height of 8 m, rapidly advances towards the real forest so that *Tessaria* maintains its dominance; this fact is favoured by the rapid propagation of this species which forms suckers.

The forests with *Salix humboldtiana* form almost pure associations in the lower forests of the islands at a level slightly above the *Tessaria* formation which does not

extend beyond the junction of Paranaá and Paraguay so that *Salix* becomes the pioneer of the upper Paranaá; its propagation is favoured by its rapid dissemination by seeds (CARNEVALLI 1994). These hygrophilous forests form an almost pure arboreous storey of 12 m in height.

Other communities are grasslands on river slopes with *Gynereum sagittatum*, on the one hand, and the aquatic vegetation, on the other. The lagoons in the South-West of the island and the only internal water course, the rio Atajito, interchange their floating vegetation during inundations. The large floating beds of *Eichhornia azurea* and *E. crassipes*, as well as *Pistia stratiotes* and aquatic ferns such as *Salvinia* and *Azolla* are the most frequent floating plants; *Victoria regia* appears periodically, while in the marginal areas, banks of *Cyperus giganteus* reed and *Panicum elephantipes* are common.

## Material and methods

As in the first volume, collection of the material in the humid Chaco region and observations in the field were carried out by forestry engineer Dr. Ana-Maria Gimenez and her collaborators. It was attempted to collect material where human influence did not modify the structure of the forest, however, this is a very difficult task, as a large part of the Chaco is already interfered with by man.

Four individuals of each species were studied. As far as possible, wood and bark samples were taken from trees and shrubs at breast height (1.30 m). The structures of young and adult individuals were additionally compared with one another. Twenty unities of sampling were used for the census, studying a surface area of 250 m<sup>2</sup> and clearing the area with transects 10 m wide. All the trees and shrubs were inventorized and the following parameters measured and described:

Stem diameter at breast height (DBH), height of the stem, total tree height, structure and extension of the crown, outer appearance of the tree including outer bark aspect, leaves, flowers and fruits, as far as available. Growth periodicity (leaf fall, flowering and fruiting time) was also observed.

Bark and wood samples were immersed in pure water or in a mixture of alcohol and glycerine (50:50) to soften them. The sections were made with a special wood microtome and cut about 10–30 µm thick. They were stained with astra blue, chrysoidine and acridine red (triple coloration) and mounted with entellan. Transverse as well as radial and tangential longitudinal sections were made through bark and wood. Hand slides were treated with Lugol's solution (iodine in iodide), phloroglucinol and HCl, methylene blue, and Sudan III, for starch, lignine, slime and suberin tests. For the identification of contact and isolation cells, the chemical proofs and the criteria of H.J. BRAUN were applied.

For microscopical studies the light microscope of Leitz "Das Mikroskop", a loan of the Deutsche Forschungsgemeinschaft was at disposal.

Habitus photographs were made in the field. Microscopic photographs, on the other hand, were partly made in Santiago del Estero, and partly in Germany with the Leitz microscope.

The GTZ supported the Institute of Dendrology in Santiago del Estero with a Reichert-Jung microtome, an automatic grinding machine for microtome knives and a picture analyzer.

The most important species of the humid eastern Chaco were selected for investigation. Additionally, other less important species or species of transitional regions were also studied.

However, it must be borne in mind that a complete record could not be made of all species studied, as the material was very difficult to obtain. Distances to cope with are enormous as the sites studied are hundreds of kilometers away from the Institute of Dendrology, and some even more than one thousand kilometers. Furthermore, the sites investigated are not just around the corner, and the access to them is quite difficult: Dense shrubbery and forests, swamps, small rivers and lagoons, hills and so on have to be overcome to reach the sites, not to speak of the insect plagues, the climatic conditions and many other inconveniences. The reader must therefore be lenient, if not all data for all species studied are available.

The following species were considered:

### Species studied

Scientific name	Vernacular name	Family
<i>Acacia aroma</i> Gill.	Tusca	Mimosaceae
<i>Acacia caven</i> Mol.	Churquí	Mimosaceae
<i>Acanthosyris falcata</i> Griseb.	Sacha pera, Saucillo, Sombra de toro hembra	Santalaceae
<i>Allophylus edulis</i> (St. Hil.) Radlkofer	Chal cal	Sapindaceae
<i>Aspidosperma quebracho-blanco</i>	Quebracho blanco	Apocynaceae
<i>Astronium balansae</i> Engl.	Urunday	Anacardiaceae
<i>Bumelia obtusifolia</i> Roem.	Guaraniná, Palo lanza, Palo piedra	Sapotaceae
<i>Caesalpinia paraguariensis</i> Burk.	Guayacán	Caesalpiniaceae
<i>Carica quercifolia</i> (St.Hil.) Solms-Laub.	Higuerón, Papaya silvestre	Caricaceae
<i>Cathormion polyanthum</i> (A. Spreng.) Burk. (syn. <i>Arthrosamanea polyantha</i> , <i>Albizia inundata</i> )	Timbó blanco, Timbó morotí	Mimosaceae
<i>Cecropia adenopus</i> Mart.	Ambay	Moraceae
<i>Celtis tala</i> Gilles ex Planchon	Tala	Ulmaceae
<i>Cercidium australe</i> Johnst.	Brea	Caesalpiniaceae
<i>Chlorophora tinctoria</i> (L.) Caudich. (syn. <i>Morus tinctoria</i> L.)	Mora amarilla	Moraceae
<i>Chorisia speciosa</i> St. Hil.	Samohú	Bombacaceae
<i>Chrysophyllum gonocarpum</i> Engl.	Aguai	Sapotaceae
<i>Chrysophyllum marginatum</i> Radlk.	Vasuriña	Sapotaceae
<i>Croton urucurana</i> Baillon	Sangre de drago	Euphorbiaceae

Scientific name	Vernacular name	Family
<i>Didymopanax morototoni</i> (Aubl.) Decne. et Planch.	Ambay-guazú	Araliaceae
<i>Diplokeleba floribunda</i> N.E. Brown	Palo piedra	Sapindaceae
<i>Enterolobium contortisiliquum</i> (Vell.) Morong	Timbó	Mimosaceae
<i>Erythrina crista-galli</i> L.	Seibo	Papilionaceae
<i>Genipa americana</i> L.	ñandipá	Rubiaceae
<i>Geoffroea decorticans</i> Burk.	Chañar	Papilionaceae
<i>Geoffroea striata</i> (Willd.) Mor.	Manduvira	Papilionaceae
<i>Gleditsia amorphoides</i> Taub.	Espina corona	Caesalpiniaceae
<i>Inga urugüensis</i> Hook. et Am.	Ingai	Mimosaceae
<i>Litbraea molleoides</i> (Vell.)Engl. [syn. <i>L. ternifolia</i> (Gillies) Barkeley]	Molle de beber	Anacardiaceae
<i>Luebea divaricata</i> Mart. et Zucc.	Sota caballo	Tiliaceae
<i>Nectandra saligna</i> Hassler (syn. <i>N. megapotamica</i> (Spreng.) Mez	Laurel negro	Lauraceae
<i>Parkinsonia aculeata</i> L.	Cina-cina	Caesalpiniaceae
<i>Patagonula americana</i> L.	Guayaibí	Boraginaceae
<i>Peltopporum dubium</i> (Spreng.) Taub.	Ibirapitá. Caña	Caesalpiniaceae
<i>Phyllostylon rhamnoides</i> (Pois.) Taub.	Palo amarillo	Ulmaceae
<i>Phytolacca dioica</i> L.	Ombú	Phytolaccaceae
<i>Pisonia zapallo</i> Griseb.	Zapallo caspi	Nyctaginaceae
<i>Pithecellobium scalare</i> Griseb. (syn. <i>Chloroleucon tenuiflorum</i> (Benth.) Barneby & Grimes	Tataná	Mimosaceae
<i>Pouteria salicifolia</i> Radlk. (syn. <i>P. gardneriana</i> )	Aguay-guasú	Sapotaceae
<i>Prosopis alba</i> Griseb.	Algarrobo blanco	Mimosaceae
<i>Prosopis kuntzei</i> Harms	Itín	Mimosaceae
<i>Prosopis nigra</i> (Griseb.) Hieron.	Algarrobo negro	Mimosaceae
<i>Prosopis ruscifolia</i> Griseb.	Vinal	Mimosaceae
<i>Prosopis vinalillo</i> Stuck	Vinalillo	Mimosaceae
<i>Pterogyne nitens</i> Tul. ex Benth.	Viraró, Tipa colorada	Caesalpiniaceae
<i>Ruprechtia laxiflora</i> Meissner	Virarú, Marmelero	Polygonaceae
<i>Ruprechtia triflora</i> Griseb.	Sacha membrillo	Polygonaceae
<i>Salix humboldtiana</i> Will	Sauce criollo	Salicaceae
<i>Sapindus saponaria</i> L.	Palo jabón	Sapindaceae
<i>Sapium haematospermum</i> Müll.Arg.	Lecherón	Euphorbiaceae
<i>Schinopsis balansae</i> Engl.	Quebracho colorado chaqueño	Anacardiaceae
<i>Schinopsis quebracho-colorado</i> (Schlecht.) Barkl. et Meyer (syn. <i>Sch. lorentzii</i> )	Quebracho-colorado santiagoño	Anacardiaceae

Scientific name	Vernacular name	Family
<i>Solanum verbascifolium</i> var. <i>auriculatum</i> (Aiton) O.K. Francisco Alvarez (syn. <i>S. granuloso-leprosum</i> Dunal)	Fumo bravo	Solanaceae
<i>Tabebuia ipé</i> (Mart. ex Schum.) Stand. (syn. <i>T. heptaphylla</i> (Vellozo) Toledo)	Lapacho negro	Bignoniaceae
<i>Tabebuia nodosa</i> Griseb.	Huiñaj, Palo cruz	Bignoniaceae
<i>Tabernaemontana australis</i> Müll. Arg. (syn. <i>Peschiera australis</i> Miers. syn. <i>T. catharinensis</i> A.DC.)	Horquetero, palo vibora, zapirandi	Apocynaceae
<i>Terminalia triflora</i> (Griseb.) Lillo	Lanza amarilla	Combretaceae
<i>Tessaria integrifolia</i> Ruiz et Pavon	Aliso del rio	Compositae
<i>Zizyphus mistol</i> Griseb.	Mistol	Rhamnaceae

### Dendrological description of the most important species in the humid Chaco

The height categories used were the same as in the semi-arid Chaco:

Category 1 = more than 30 m

Category 2 = 20–30 m

Category 3 = 10–20 m

Category 4 = less than 10 m

#### ***Acacia aroma***

Height cat. 4. Shrub or tree (4–7 m). Bole short (2 m), twisted, early ramifying. DBH up to 30 (50) cm. Branches with pairs of conic spines, up to 6 cm long. Crown globular, branches delicate, with lenticels.

Leaves bipinnate with pairs of spiny stipules that are persistent on the branches. 15–30(40) pairs of opposite leaflets of 2<sup>nd</sup> order on each leaflet of first order, about 1–3.5 mm long and 0.5–1 mm broad.

Inflorescences of orange yellowish colour, 1–1.5 cm in diameter, solitary or in fascicles of 2–4; fragrant.

The dark brown legume is constricted between the seeds, it is straight or curved and slightly woody, 5–20 cm long and 1.2 cm broad. Seeds lenticular, 6 mm in diameter, dark brown. The foliage is deciduous.

The tree flowers from September to November and sets fruit from November on. It keeps the fruits on the twigs until July.

The species is found in the eastern and western Chaco as well as in Mesopotamia and in the province del Monte.



***Acacia caven***

with the vernacular names “Churquí”, “Aroma criollo”, “Tusca”, “Espinillo negro” grows in the humid Chaco, the Parque Mesopotámico, as well as in the region of Del Monte and in Mesopotamia, but has otherwise a very ample distribution.

It is a shrub or tree about 2–6 m high with a short stem (up to 1.5 m) and with a diameter of 20 cm (4<sup>th</sup> height category). The branches have lenticels and very young branches are pubescent. The spines which arise in pairs at the base of the leaves and correspond to modified stipules are very characteristic; they are very sharp and 5–30 mm long.

The compound leaves are bipinnate arising in the form of fascicles on alternating brachyblasts. The pinnae of first order which correspond to the rachis are 2–5 cm long and have 15–25 opposed leaflets which are sessile, 1–3 mm long and 0.5–1 mm broad. A gland is found at the insertion of each pair of leaflets on the rachis.

The inflorescences are multiflorous capituliform aggregations of flowers, measuring 1.5 cm in diameter, which arise on pubescent peduncles of 5–18 mm length uniting 2–7 flowers in a fascicle.

The hermaphrodite flowers are sessile, 6–8 mm long. The calyx is tubular with 5 small lobules and pubescent on its outside; the crown is likewise tubular with 5 lobules, and is 2.5–3 mm long; the stamens are numerous and the pubescent ovary is unilocular, pluriovulate and superior.

The halfwoody indehiscent legume is thick, black, circular in transection, lustrous, 4–7 cm long and 1.5–2.5 cm in diameter and has 2 longitudinal sutures, terminating with a mucro.

The numerous seeds are greenish-orange in colour, ellipsoid, 7 mm long and 4 mm broad being embedded in a spongy tissue.

The tree flowers in August and September and has fruits during a large period of the year. The fruits remain on the tree for a long time.

The treelet is considered an invasive species because it propagates easily vegetatively and is dispersed by zoochory.

Fruits and bark contain tannins.

***Acanthosyris falcata***

Known under the vernacular names “Sacha pera”, “Saucillo”, “Sombra de toro hembra”. is a spiny tree with a short bole and an ample well-developed crown. The foliage is evergreen. The tree reaches a height of 10(4–10) m with a diameter of 0.2–0.4 m; it thus belongs to the 4<sup>th</sup> height category. It is common in the dry and humid Chaco, the forest of Tucumán and the Province Yungas.

The leaves are alternate or assembled in fascicles. They are simple. 5–12 cm long and 3–15 mm broad, lanceolate-falcate, with an obtuse apex and an attenuate base, with even margins and a short petiole; the midrib is prominent and the pubescence scarce.

The inflorescences are panicles of 3–5 flowers.

The flowers are hermaphrodite with a bell-shaped perigone, pentamerous, pubescent and with a semi-inferior ovary. They measure 5 mm in height and are yellow-

ish-green; the 5—or more rarely 4—tepals are ovalate. There are 5 stamens (more rarely only 4).

The yellowish globose fruit measures 15 mm in diameter; it is fleshy, sweet and edible and contains a single seed. The kernel is subglobular, dark, and about 10 mm in diameter.

The tree flowers when the young leaves sprout, from the middle of August and throughout September, and fructifies from October to December.

The fleshy fruits are edible, sweet and have a pleasant taste. Dispersal takes place by birds.

### ***Allophylus edulis***

Known under the vernacular name “Chal-cal” or “Cocu” is a small tree of 4–8 m height (height category 4) by a diameter of 0.2 m. Its trunk is short, ramified and torsive. It is characteristic of the eastern humid Chaco, of gallery forests, forests of Misiones and the forests of Tucumán, Jujuy, Salta, Catamarca, Formosa, Corrientes, Entre Ríos, Santa Fé, Buenos Aires; in Tucumán, it only occurs at the lower level of the mountainous forests, up to an altitude of 800–900 m.

The phyllotaxis is alternate. The leaves are trifoliate pinnate with sessile or almost sessile leaflets of elliptic-lanceolate or lanceolate shape. The leaflets have acuminate tips and are constricted at the base. They are 4–7 cm long and 1.5–3 cm broad. The terminal leaflet is larger than the lateral ones. The upper surface of the leaflets is smooth, but on the lower side hairs are found in the axils of the veins. The leaf margins are serrate, the petiole is 2–5 cm long and slightly hairy. The leaf texture is herbaceous. The leaf is thin. Its anatomy has been studied by ROTH (1995). Secretory cells as well as glandular hairs are present. The spongy parenchyma is rich in intercellular spaces indicating a certain adaptation to a moist climate.

The tree is dioecious. The flowers occur in pauciflorous racemes. The male flowers are tetra-merous, with 8 stamens; the female flowers are also tetra-merous and have a superior ovary.

The subglobose to ovoid fruit, an edible drupe, is of reddish colour when mature. Its consistency is fleshy.

The brown seed is subglobose and has a small aril. The fruit has a diameter of 8 mm, the seed diameter is 4 mm.

The tree flowers from August to September (November) and sets fruits from October to January (February).

The thin leaves are probably shed during winter. The tree is considered to be semi-deciduous.

### ***Aspidosperma quebracho-blanco*** (Fig. 1 a in ROTH & GIMÉNEZ DE BOLZÓN 1997)

occurs in the eastern and western Chaco district and in the provinces Del Monte and Mesopotamia. It is characteristically found together with species of *Schinopsis*.

Height cat. 3 (medium-sized to large, 6–20 m (25 m) total height). The strong stem is up to 15 m clear of branches. DBH up to 1 m (1.5 m).

The species appears in 2 different biological forms: an erect form with an ovoid crown and a pendulous form with longer branches. There are also 2 types of bark: a smooth one and one with regular plates; these 2 bark types however, do not coincide with the 2 different biological forms.

The small leaves are simple, leathery, of elliptic-lanceolate shape and bristle-tipped (spiny tip) and may be arranged in trimerous whirls or be opposite.

The ochreous or yellowish flowers are inconspicuous and appear between September and January—with a maximum of flowering in October and November.

The woody capsule is of a grayish green colour and dehisces with 2 valves; it measures 7–11 × 4–6 cm; the numerous suborbicular seeds are surrounded by a membranaceous wing and are therefore dispersed by wind.

The foliage is persistent (leathery leaves!)

The tap-root penetrates deeply into the soil while a shallow root system extends in all directions around the tree.

The tree flowers from September to January and sets fruits from September to December. The fruits mature from March to April.

The species is heliophilous.

The tree regenerates easily, either by seeds or by sprouts from the roots. The sprouting is favoured by wounds or by fire.

### ***Astronium balansae***

is characteristic of the eastern humid Chaco, the Province Paraná, and the forests of Misiones. It is called “Urunday-pichaf” in the Chaco, “Urunday” in Misiones, and “Urunday pardo” in Corrientes. It attains a height of 16–25 m with a diameter of 0.6–0.8 m, and belongs to height category 3(2).

The alternate leaves are imparipinnate compound with 3–7 pairs of opposite leaflets which are obliquely lanceolate and have a very prominent venation on the lower surface; the margins are serrate.

The flowers are unisexual or hermaphrodite; they are small, numerous and occur in panicles.

The 4 mm long fruit has a fleshy consistency and contains very small yellowish-orange coloured seeds.

The tree is deciduous; it pertains to the upper forest stratum and is characteristic of the tree association of the eastern Chaco. The species is mesophilous, semi-heliophilous, of slow growth and has a long life span. It grows in black and argillaceous soils, typical of sites with a slow drainage.

### ***Bumelia obtusifolia* (syn. *Sideroxylon obtusifolium*)**

Known under the vernacular names “Guaraniná”, “Palo lanza” or “Palo piedra” is characteristic of the eastern humid Chaco, the provinces Paraná and Yungas, and the forests of Misiones and Tucumán. It is the largest of the southern species and mainly occurs in northern Argentina. The stem is short and the roundish crown is strongly

ramified; stem and young branches are spiny. The tree reaches a height of 12 m with a diameter of 0.9 m; it belongs to the 3<sup>rd</sup>. height category.

The small leaves are clustered on spur-like branchlets. The simple leaves are pubescent when young, but later on become glabrous; they are oblanceolate or obovate, 20–40 mm long and 7–20 cm broad, obtuse or less frequently emarginate and with a rounded tip and even margin; the base is cuneate and the petiole measures 3–6 mm in length. The leaves have a smell of almonds; Stipules are absent.

The flowers generally occur in fascicles. The hermaphrodite flowers are pentamerous; there are 5 sepals, 5 stamens and 5 staminodes; the crown is white; the staminodes are petaloid, and the ovary is superior.

The ovoid fruit is fleshy and of purple colour, 10 mm long and 7 mm in diameter; it is brilliant, smooth and contains a single seed. The ovoid seed is about 8 mm in diameter, smooth and of a dark-brown colour.

The tree is mesophilous, heliophilous, has a slow growth and a medium lifespan.

It flowers from September to December and fructifies from December to February.

The species grows in very different habitats, it occurs on clay as well as in the high forests of the basin of the Paraná down to the xerophytic regions; its habit changes according to the sites where it grows.

### ***Caesalpinia paraguariensis***

Height cat. 3 (up to 15–20 m). DBH 60–100 cm. The short bole is up to 2–4 m (6 m) high. The crown is extensive, and of globular shape, the foliage is poor. Leaves bipinnate with 3–6 pairs of pinnae and 6–10 pairs of opposite elliptic leaflets of 2<sup>nd</sup> order, 3–7 mm long and 1.5–3 mm broad. The foliage is delicate and rustcoloured at the time of shooting. The tree occurs in the most humid regions of the western Chaco and in the Provinces Yungas and Del Monte.

The flowers are yellowish-orange and appear in racemes. They are rich in honey. The woody, inside somewhat fleshy, indehiscent brownish-violet legume is egg-shaped and of bitter-sweet taste and contains 1–8 seeds. It is 2–6 cm long and 2 cm broad. It ripens from autumn to winter. Dispersal is endozooic.

The species flowers from September to November (December) and the fruits remain on the tree almost until the next flowering period.

The tree grows in the most humid spots of the dry Chaco. It sheds its leaves during the dry winter.

It is found solitary or in small groups. In the mountains it grows up to a height of 1200 m a. s. l.

It is easily grown from seeds. After a short but rapid growth as a young plant it continues to grow slowly. Suckers may come out from injured roots in large quantities. The species is suitable for afforestation as it is a very resistant tree. The fleshy legumes are eaten by livestock and other animals during the dry period. However, this food is of low quality because of its high tannin content (15–25%).

### ***Carica quercifolia***

Known under the vernacular names “Higuerón”, “Papaya silvestre”, grows in the eastern humid Chaco and in the forests of Tucumán, Las Yungas, and in the mountainous Chaco. The tree is dioecious and has a poorly developed crown; the stem is greenish and has lenticels. The stem has a herbaceous character and owes most of its strength to the many thick-walled bast fibers of the bark. The small tree, about 3–7 m in height, has a diameter of 10–30 cm. It belongs to height category 4.

The alternate leaves are glabrous, simple and polymorphous; they are elliptic-lanceolate, lyrate, ovate-oblong, and profoundly or slightly lobulate, glabrous and acuminate. They are 10–30 cm, occasionally 40 cm, long and 6–20 (30) cm broad, have a long petiole of 4–15 cm and stipules. The venation is prominent on the lower leaf side. The leaves are caducous.

The male flowers occur in corymbiform cymes, the female ones in pauciflorous cymes with 3–4 flowers.

The yellowish-green male flowers are 15–27 mm long; they have 5 sepals and 10 stamens; the crown has a cylindric tube; the aborted pistil is subulate.

The yellowish-green female flowers are 15 mm long, have 5 sepals, 5 petals, a superior ovary 8 mm high, with 5 pluriovulate locules and 5 stigmas.

The fruit measures 4–5 × 2–3 cm; it is a fleshy orange coloured berry when mature, pentangular, of ovoid-oblong shape, apiculate, and very juicy. It contains numerous seeds (6×3 mm) which are surrounded by a slimy layer (ROTH & LINDORF 2002).

All parts of the plant have laticifers with a milky content (latex) in which a papain with pepsin-like digestive properties is present.

The tree flowers from October to November and fructifies from January to March.

### ***Cathormion polyanthum* (syn. *Arthrosamanea polyantha* and *Albizia inundata*)**

with the vulgar names “Timbó blanco” and “Timbó moroti” has its natural distribution in the eastern Chaco and the Gallery forests. It is a small tree with an ample globular crown and strong branches; the short torsive stem is sometimes branched. The tree belongs to the 3<sup>rd</sup> and 4<sup>th</sup> height category reaching a maximal height of 13 m with a stem diameter of 0.40 m.

The alternate compound leaves are bipinnate with 1–4 pairs of leaflets, 3–7 cm long, and 4–18 pairs of leaflets of secondary order which are elliptic, subfalcate, have an acute apex, an asymmetric base, and entire margins. The petiole has a gland; stipules are also present.

The white tubular flowers occur in axillary racemes in the form of globular heads.

The slender fruit is a flattened glabrous and linear legume undulated at the margins and divided into segments which—at maturity—separate either completely from one another or only at the level of the endocarp breaking transversely into single-seeded limbs or mericarps. The name of the genus *Arthrosamanea* refers to the articulation of the fruit.

The medium-sized tree with deciduous foliage is characteristic of Gallery forests which are multispecific.

It occurs not only in the humid forests of the Chaco, but also in the higher parts of the swamps which are characterized by the palm “Caranday”.

The delicate tree shows a rapid growth, is hygrophilous and has a short lifespan. The foliage is deciduous.

The leaves resemble those of *Guaiacum*, while the inflorescences resemble those of *Mimosa*, *Samanea* and *Pithecellobium*.

### ***Cecropia adenopus* (syn. *C. pachytachia*)**

Known under the vernacular name “ambay”, grows in the eastern Chaco, District Paraná. The dioecious tree contains latex and has persistent foliage. It is small and has a cylindrical, straight trunk with ring-like leaf scars and stilt roots. The pith of the stem and the branches is hollow and inhabited by ants. The tree is 15 m high by a DBH of 0.4 m, belonging thus to the 3<sup>rd</sup> height category.

The alternating leaves are assembled at the extremities of the large branches. They are large, palmatisect and bicolor. The upper leaf surface is green and very rough, the lower one is whitish-gray and tomentose. The leaf reaches a diameter of 45 cm and has 7–14 leaflets; the petiole is long and thick and is inserted in the center of the peltate leaf; the margins are entire and a median stipule or ochrea is also present.

The inflorescences are small spikes; the male spike has yellow flowers, the female spike grayish flowers; both sexes occur on distinct individuals.

The fruit is woody.

The species is characteristic of secondary forests and also occurs in humid forests of the eastern Chaco, frequently in clearings and on river banks. The hollow branches are inhabited by ants of the genus *Azteca*, a characteristic of the genus *Cecropia*.

The tree flowers and fructifies all the year round.

See also ROTH 1990: (*Cecropia palmatisecta*, *C. peltata*, *C. sciadophylla*) and VELÁSQUEZ 1971.

### ***Celtis tala*, a spiny tree**

Height cat. 4, 3–10(12) m. DBH 10–40, up to 60 cm. Bole twisted. Crown ample, globose. Large branches gnarled and with a zigzag course. The tree occurs in the Provinces Chaco and Del Monte. Leaves simple, of obovate shape and serrate in their upper half. 2.5–5 cm long and 1–3 cm broad, acuminate and with a rounded base, pubescent when young, but glabrous in the adult stage.

Inflorescences cymose with few flowers, about 1 cm long. Male flowers at the base and hermaphrodite (female) flowers at the top of the inflorescence. Flowers inconspicuous and of yellowish-green colour.

The fruit is a drupe, slightly fleshy and sweet, of yellow-orange to scarlet-red colour, ovoid, 6–9 mm long and with a diameter of 4–5 mm. “Stone” (endocarp) hard, rugate on its outside, 4–6 mm long and 3–4 mm in diameter, with a single seed. The fruit is eaten by birds. The root is very resistant.

The tree flowers from September to October and sets fruit from October to March. The foliage is deciduous.