

Structure, physiognomy and floristic composition of a *Schinopsis balansae* (Anacardiaceae) forest in the Southern Chaco, Argentina

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Abstract. Amazonia and the Gran Chaco are the largest phytogeographic units of tropical and subtropical South America. The Santa Fe Forest Wedge is the southernmost portion of the Eastern Chaco, where the *Schinopsis balansae* forest (Quebrachal) is the most widespread and characteristic community. A detailed analysis of the floristic composition, physiognomy and vegetation structure was carried out in 32 10 x 10 m contiguous plots sampled along two transects in one of these forests near Vera, Province of Santa Fe, Argentina. All woody individuals higher than 0.6 m present in the plots were recorded, identified and their height and crown diameter measured. With these data, cartographic diagrams and vegetation profiles were drawn. Woody species were classified according to leaf size, leaf texture, presence of spines and phenology. This quebrachal is an open forest with very complex structure and heterogeneous floristic composition. Most woody species of this forest are deciduous, with small leaves and frequently with spiny structures. It has two higher tree layers of *S. balansae* and *Acacia praecox*, and a lower tree layer of *Achatocarpus praecox* with younger individuals of the higher strata species and some large shrubs. There is as well a 2 m high shrub layer. The tree canopy is discontinuous, with gaps that can be rather large, where the soil is covered by a dense grass layer. This forest is much like other *S. balansae* forests of the Santa Fe Forest Wedge, but quite different from most other forest areas of the Gran Chaco.

Key words: Argentina, Chaco, floristic composition, forests, physiognomy, stratification, vegetation structure.

The Chaco (15° to 35°S) is a very large alluvial plain that covers about 1 000 000 km² of Eastern Bolivia, Western Paraguay, Northern Argentina and a very small part of Southern Brasil. The Paraguay and the Paraná rivers run along the east boundary and pre-Andean mountains on the west. Climate is seasonal tropical-subtropical, mean annual temperature varies from 18°C in the S to 26°C in the N with an absolute maximum of 48°C and there are frosts in winter. Rainfalls occur mainly during summer (from September to April) and then, there is a strong winter drought of variable length. Annual precipitation ranges from 1 300 mm in the east to less than 500 mm in the west, though it increases when approaching the mountains (Burgos 1970, Spichiger and Ramella 1989).

The Eastern Chaco is wet and the Western Chaco is rather dry (Ragonese and Castiglioni 1970, Cabrera and Willink 1980, Ramella and Spichiger 1989, Spichiger *et al.* 1991). The Pilcomayo river separates the Northern Chaco

from the Austral Chaco that Cabrera (1971) divides in four districts, the Eastern characterized by the presence of *Schinopsis balansae* Engl. the Western by *Schinopsis quebracho-colorado* (Schlecht.) Barkley et Meyer, the Serrano district by *Schinopsis haenkeana* Engl. and the Savanna district which is in the Submeridional Lowlands (Gollan and Lachaga 1939) and is characterized by the *Spartina argentinensis* Parodi grasslands and the almost absence of trees (Lewis *et al.* 1990). The southernmost segment of the Eastern Chaco is the Santa Fe Forest Wedge ("Cuña boscosa"), placed between the Submeridional Lowlands and the Paraná river from parallel 28°00'S to 30°30'S.

The Santa Fe Forest Wedge vegetation is a mosaic of forests, savanna grasslands and hygrophylous communities ordered along moisture and salinity gradients correlated with topographic elevation (Lewis and Pire 1981). The *S. balansae* forests ("Quebrachales") are on halo-hydromorphic soils (Espino *et al.* 1983,

Mussetti and Alconchel 1986), in the middle of the elevation gradient between *Prosopis nigra* (Gris.) Hier. var. *ragonesei* Burk. forests ("Algarrobales") and the mixed dense forests ("Bosques chaqueños") (Lewis and Pire 1981). The Quebrachales were heavily lumbered in the first half of this century for tannin and later on, until present times, for fuel extraction and charcoal production.

Plant communities can be floristically or physiognomically analysed. An association is a community with defined floristic composition and a formation is defined on the physiognomy and structure of the component plants (Mueller-Dombois and Ellenberg 1974). Key structural properties include the height of trees, whether they tend to have their crowns in layers or not, their spatial distribution and canopy architecture and the presence of different kinds of climbers and epiphytes. Physiognomic properties include whether or not the forest is evergreen, tree crown shape, morphology of the leaves (size, shape, thickness, margin), presence of spines, etc. (Whitmore 1990).

The floristic composition, horizontal and vertical structure and the physiognomy of several communities of different areas of the Chaco have been analysed at different scales by Ragonese and Covas (1940), Ragonese and Castiglioni (1970), Sarmiento (1972), Sejzer (1973), Lewis and Pire (1981), Gräffe *et al.* (1991), Lewis (1991), Spichiger *et al.* (1991), Prado (1993a,b), as well as many other authors. However there is not a detailed analysis at a fine scale of a *S. balansae* forest ("Quebrachal") of the Santa Fe Forest Wedge with special reference to its horizontal and vertical structure, physiognomy and floristic composition. Therefore, the object of this paper is to analyse these aspects in a stand of Quebrachal near Vera (Santa Fe, Argentina), previous to a long term study of its dynamics.

MATERIAL AND METHODS

The study area: It is located in the experimental center of the Provincial Ministry of Agriculture at Las Gamas, near Vera (29°28'S - 60°12'W), Province of Santa Fe. Although this stand is not completely mature, not even in a steady state, it is partially recovered and cattle grazing, mild wood

extraction and sporadic fires are the main disturbances.

Data collection and analysis: On March 1989, 22 contiguous 10 x 10 m plots were sampled along a transect and another ten plots of the same size were sampled along a second discontinuous transect parallel to the first one. All individuals were counted and mapped on a grid of quadrats, their crown diameters were measured and the height of some individuals was measured with a clinometer. With these data cartographic diagrams and vegetation profiles (Davis and Richards 1933, Richards 1952) were drawn (Fig 2 and 3). The general cover of woody species of each plot was measured from the cartographic diagrams with a leaf-area meter. Woody species were classified in five classes according to their growth form and maximum height: 1) trees taller than 10 m. 2) trees from 8 to 10 m. 3) trees smaller than 8 m. 4) shrubs taller than 2 m. and 5) shrubs smaller than 2 m high. Voucher specimens were collected and deposited in the University of Rosario Herbarium (UNR).

Leaf size of all woody species present in the stand was determined measuring 20 leaves (leaflets in the case of compound leaves) taken randomly from one mature individual. Leaf sizes were grouped into Raunkiaer (1934) leaf size classes (microphyllous = 2.25-20.25 cm², nanophyllous = 2.25-0.25 cm², leptophyllous = less than 0.25cm²). Leaves were classified as well in four texture classes: filmy, membranous, coriaceous or succulent (Dansereau 1957). Species were considered evergreen when mature individuals have green leaves the whole year around. Different degrees of deciduousness were not distinguished. The presence of spines, including any thorny structure either on foliage, branches or trunk was recorded (Sarmiento 1972).

RESULTS

Eighteen tree and 14 shrub species were found in the stand. However, some were so rare that they were not recorded in the sampled plots (*Caesalpinia paraguariensis* (D. Parodi) Burk. *Jodina rhombifolia* Hook. et Arn. *Patagonula americana* L. *Ruprechtia laxiflora* Meissner and *Banara umbraticola* Arechav.). Although some species, like *S. balansae*, lose their leaves only

for a short period, most species are deciduous, with small leaves and often with spiny structures. There were neither tree species with succulent leaves, nor shrub species with coriaceous leaves. There was only one shrub species (*Senna pendula* var. *paludicola* (Willd.) Irwin et Barneby) with compound leaves (Table 1). Of all individuals recorded (N=459) 84.7% were deciduous, with single (61.7%), microphyllous (54.9%) membranous leaves (52.3%), and with spiny structures (79.3%) (Table 2). Similar results were obtained when crown cover was analysed (Table 2).

Acacia praecox Gris. and *S. balansae* were the most abundant tree species, and *Celtis pallida* Torrey the most abundant shrub. These two tree species also have the highest cover, while the cover of most other species is minimal. Shrub cover (9%) is not very high, unless *Achatocarpus praecox* Gris. (10% cover), which is considered a small tree in this paper, were considered a shrub. *Acacia praecox* is also one of the relatively most frequent tree species, but some other species with a comparatively high relative frequency, like *Geoffroea decorticans* (Hook. et Arn.) Burk. cover very little ground surface (Table 1).

The *S. balansae* forests are open forests, with open spaces. The general cover of woody species is 63% and there is a 35% overlap in cover of woody individuals. Plot cover is not uniform, as there are some places with a dense canopy, like in plots 8, 11, 12, 13 and 26 where woody species cover is 90% or more, and others with low cover like in plots 3 and 25, where the general cover of woody species is less than 20%, or less than 4% in plot 24 (Fig. 1). Some plots, like 16 and 21, have no trees rooted inside the plots, but they have a relative high tree cover, which is the result of tree crowns of neighbouring areas.

Individuals of woody species are clumped. Therefore tree canopy is very dense at some places, but discontinuous, so all along the transects there are gaps of different sizes (Fig. 2). In large gaps there is a dense understory of grasses, while the more shadowy parts of the forest are invaded by spiny bromeliads (*Aechmea distichantha* Lemaire and *Bromelia serra* Gris.).

There are two upper tree strata, which are not always easy to segregate from each other. The stratum higher than 10 m has *S. balansae* as

the dominant species, accompanied by *Sideroxylon obtusifolium* (Roem. et Schult.) Pennington and *Aspidosperma quebrachoblanco* Schlecht. The other stratum about 9 m high has *Acacia praecox* as the dominant species, accompanied by *Prosopis* sp. (*P. alba* Gris. *P. nigra* (Gris.) Hieron. and their hybrids) and other species including young individuals of the highest stratum species. Both strata do not form a continuous canopy, and leave gaps that sometimes can be rather large. Below the upper tree strata there is a layer of *Achatocarpus praecox* and *C. pallida* and young individuals of all of the higher tree layers. Below them, there is a very discontinuous and grouped shrub layer, about 2 m high, forming thickets where it is present (Fig. 3).

DISCUSSION

The general cover of woody vegetation is not 100% and the degree of overlapping is not very high, meaning that in some places one or more tree strata are absent. The two higher tree strata do not always overlap, in fact, as shown in Fig. 3, in many places they are segregated from each other, but when they overlap their limits are diffuse. The shrub layer is discontinuous, forming very dense clumps in certain places, while it is absent in many others.

As a result of the uneven distribution of strata and individuals, the structure of this forest is very complex. The complex structure, the clumped distribution of individuals and the uneven distribution of species hypothetically is the result of environmental heterogeneity. Though dynamics and successional processes may also change the structural characteristics of this forest. Soil surface is very irregular, so there are places that often flood while others are well drained (pers. obs.). Most woody species grow on the drier soils, while *G. decorticans* and sometimes *Prosopis* sp. grow on more wet soils. On flooded soils there is only herbaceous vegetation, mostly grasses and sedges (pers. obs.). As a result of edaphic heterogeneity, the clumped distribution of trees together with their different leaf architecture, probably creates a heterogeneous light environment, so there would be many kinds of biotopes.

Nevertheless, the environmental heterogeneity of this forest is in need of further research.

Although all woody species of this forest have small leaves or leaflets, the larger tree species as well as the smaller ones have relatively wide leaves, while the intermediate, like *Acacia praecox* and *Prosopis* sp. are leptophyllous (bipinnate leaves with tiny leaflets). Shrubs of this forest almost always have relatively large leaves. The leaf size spectrum of this forest is similar to that shown by Sarmiento (1972) who found that 32%, 56% and 12% of the eastern Chaco woody species were mesophyllous, microphyllous and nanophyllous plus leptophyllous, respectively. It must be borne in mind that the Forest Wedge is the southernmost portion of the eastern Chaco, thus, as a possible consequence of the temperature gradient Sarmiento's (1972) data have more species and also more species with larger leaf sizes. Moreover, at the south of the Forest Wedge is the Peristepic Thornforest where prickly Mimosoideae (leptophyllous) are dominant (Lewis and Collantes 1973). When leaf size is weighted by abundance or crown cover, the percentage of leptophyllous trees increases in the southern Chaco. Therefore, in the Eastern Chaco towards the south decrease the number of species, as well as individuals, with large leaves. Leaf size spectra of the humid Chaco given by Sejzer (1973) and Eskuche (1986) also show a larger average size of leaves than in the Forest Wedge, while the dry Chaco has a smaller average size of leaves (Sejzer 1973).

Although 61% of all tree species have spines, almost 90% of the trees are spiny. In the case of shrubs only about 36% of the species are spiny, but 56% of the individuals have spines. Generally, spines are woody structures, but *A. quebracho-blanco* and *J. rhombifolia* have non-woody spines on the tips of leaves. *S. balansae* has thorns only during the juvenile stage.

This forest is similar to other *S. balansae* forests of the Santa Fe Forest Wedge (Lewis and Pire 1981). In other *S. balansae* forests Ragonese and Covas (1940) did not record some species observed in this forest (*Zizyphus mistol* Gris, *Grabowskia duplicata* Arnott, *Acacia caven* (Mol.) Mol, *Lycium cuneatum* Dammer, *Celtis iguanea* (Jacquin) Sargent, *J. rhombifolia* and *Sapium haematospermum* Müll. Arg.) but

they recorded several others, such as *Scutia buxifolia* Reisseck, *Eugenia uniflora* L. *Prosopis vinalillo* Stuck. *Schaefferia* sp. *Capparis tweediana* Eichler, *Allophylus edulis* (St. Hil.) Radlk. and *Berberis ruscifolia* Lamarck, which were not observed in this forest. They also recorded *C. paraguayensis*, *P. americana*, *R. laxiflora* and *B. umbraticola* which were observed but not recorded in the plots in this forest because they were very rare. However, they recorded most of these species farther north, reflecting that species richness increases northwards (Lewis 1991). Ragonese and Covas (1940) did not differentiate the Quebrachal from mixed dense forests as we do (Lewis and Pire 1981, Lewis *et al.* 1994).

The Quebrachal of the Santa Fe Forest Wedge differs from the Quebrachal of the Argentinian western Chaco where the dominant species are *S. quebracho-colorado* and *A. quebracho-blanco* (Adámoli *et al.* 1972, Adámoli *et al.* 1990, Sennhauser 1991). In the dry Paraguayan Chaco, Spichiger and Ramella (1989) and Ramella and Spichiger (1989) also mention a "Quebrachal" with some of the same species (*A. quebracho-blanco*, *Capparis retusa* Gris, *Z. mistol*), but *S. quebracho-colorado* and *A. quebracho-blanco* are the dominants and *S. balansae* is absent. In the humid Paraguayan Chaco Spichiger *et al.* (1991) mention a xeromesophytic forest of *S. balansae* and *Astronium balansae* Engl. but they also did not differentiate the *S. balansae* "Quebrachal" from the mixed dense forest (Lewis *et al.* 1994).

According to Prado (1993b) in the eastern Chaco there are four different kinds of true chaquenian forests, (*S. balansae* "Quebrachal", *Prosopis* sp. "Algarrobal", palm forests of *Copernicia alba* Morong, and *Stetsonia coryne* (Salm. Dyck) Br. et Rose "Cardonal") and an Austro-Brazilian Transitional Forest with species of chaquenian and amazonian lineage. The two major woody communities of the eastern Chaco have been repeatedly mistaken for a single one (Prado 1993a), the Quebrachal of *S. balansae* and the Austro-Brasilian Transitional Forest or mixed dense forests (Lewis and Pire 1981, Prado 1991, Lewis *et al.* 1994), although Morello and Adámoli (1974) reported differences between them. The *S. balansae* forest is characteristic of the Santa Fe Forest Wedge and is probably mainly confined to this area. The ecological optimum for *S.*

balansae is in this part of the Chaco (Morello and Adámoli 1974) as witnessed by the location of the most important tannin industries.

It must be borne in mind that this forest, like all the forests of the Chaco, has been heavily disturbed in the past, and probably now there is not a single stand that is in a steady state or near climax stage. Therefore, after this analysis was completed, one of the transects has been closed with a fence to prevent cattle grazing. In this way some aspects of the dynamics and further evolution of this forest can be studied.

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RESUMEN

Amazonia y el Gran Chaco son las unidades fitogeográficas más grandes de Sud América tropical y subtropical. La porción más austral del Chaco oriental es la Cuña Boscosa de Santa Fe, donde la comunidad característica y más difundida es el bosque de *Schinopsis balansae* (Quebrachal). En uno de estos bosques cerca de Vera, Provincia de Santa Fe, República Argentina, se establecieron 32 parcelas contiguas de 10 x 10 m a lo largo de 2 transectas paralelas y en las mismas se hizo un detallado análisis florístico, fisonómico y estructural de la vegetación. Todos los individuos leñosos de más de 0,60 m de altura fueron identificados y se les midió la altura y el diámetro de sus copas. Con estos datos se construyeron perfiles de vegetación y mapas cartográficos con la ubicación de los individuos. Las especies leñosas fueron clasificadas de acuerdo al tamaño, y textura de sus hojas, presencia de espinas y fenología. Este quebrachal es un bosque abierto de estructura muy compleja y composición florística heterogénea. La mayoría de las especies leñosas de este bosque son deciduas, con hojas pequeñas y frecuentemente con estructuras espinosas. Tiene dos estratos arbóreos altos de *S. balansae* y *Acacia praecox*. y uno arbóreo bajo de *Achatocarpus praecox* con individuos juveniles de las especies de los estratos superiores. Existe asimismo un estrato arbustivo de 2 m de altura. El dosel arbóreo es discontinuo y tiene aberturas que pueden ser bastante grandes, donde el suelo está cubierto por un

denso estrato gramíneo. Este bosque es similar a otros bosques de *S. balansae* de la Cuña Boscosa de Santa Fe, pero muy diferente de la mayoría de los bosques de otras áreas del Gran Chaco.

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TABLE 1
 Characteristics and relative importance of the Schinopsis balansae forest's woody species near Vera, Santa Fe (Argentina).

Code	Species	Family	Class ^a	Function ^b	Leaf type ^c	Leaf size ^d	Leaf texture ^e	Spines ^f	Relative frequency ^g	Abund. Indiv/ha	Crown cover (%)
Aq	<i>Aspidosperma quebracho-blanco</i> Schlecht.	Apocynaceae	1	E	S	N	X	Y	37.50	38	2.37
Bu	<i>Sideroxylon obtusifolium</i> (Roem. et Schult.) Pennington	Sapotaceae	1	D	S	N	Z	N	18.75	25	4.17
Gu	<i>Caesalpinia paraguayensis</i> (D. Parodi) Burkart	Fabaceae	1	D	C	L	F	N	+	0	0.01
Pa	<i>Patagonula americana</i> L.	Boraginaceae	1	D	S	M	F	N	+	0	0.00
Sb	<i>Schinopsis balansae</i> Engl.	Anacardiaceae	1	D	S	M	F	Y	43.75	141	16.67
Ap	<i>Acacia praecox</i> Griseb.	Fabaceae	2	D	C	L	F	Y	56.25	350	23.38
Gd	<i>Geoffroea decoricans</i> (Hook. et Arn.) Burkart	Fabaceae	2	D	C	N	F	Y	43.75	84	3.73
Pr	<i>Prosopis</i> sp.	Fabaceae	2	D	C	L	F	Y	56.25	100	11.57
Rl	<i>Raprechtia laxiflora</i> Meisn.	Polygonaceae	2	D	S	M	Z	N	+	0	0.00
Zy	<i>Zizyphus mistol</i> Griseb.	Rhamnaceae	2	D	M	M	Z	Y	25.00	34	1.33
Aa	<i>Acacia aroma</i> Gill. ex Hook. et Arn.	Fabaceae	3	D	C	L	F	Y	+	0	0.00
Ac	<i>Acacia caven</i> (Mol.) Mol.	Fabaceae	3	D	C	L	F	Y	9.38	16	0.71
Af	<i>Acanthosyrus falcata</i> (Mart. et Eichler) Griseb.	Santalaceae	3	D	S	M	Z	Y	6.25	6	0.17
Ec	<i>Myrcianthes cisplatensis</i> (Camb.) Berg.	Myrtaceae	3	E	S	M	Z	N	34.38	72	1.18
Jr	<i>Jodina rhombifolia</i> Hook. et Arn.	Santalaceae	3	E	S	M	X	Y	+	0	0.00
La	<i>Tabebuia nodosa</i> (Griseb.) Griseb.	Bignoniaceae	3	D	S	M	Z	N	3.13	3	0.10
Sh	<i>Sapium haematospermum</i> Müll. Arg.	Euphorbiaceae	3	D	S	M	Z	N	+	0	0.03
Tn	<i>Achatocarpus praecox</i> Griseb.	Achatocarpaceae	3	D	S	M	Z	Y	50.00	122	9.19
Ca	<i>Coccoloba argentinensis</i> Speg.	Polygonaceae	4	D	S	M	Z	N	18.75	19	1.12
Ci	<i>Celtis iguanea</i> (Jacquin) Sargent	Ulmaceae	4	D	S	M	F	Y	12.50	16	0.17
Cp	<i>Banara umbraticola</i> Arechav.	Flacourtiaceae	4	D	S	M	F	N	+	0	0.00
Cr	<i>Capparis retusa</i> Griseb.	Capparidaceae	4	D	S	M	Z	N	50.00	88	1.19
Cs	<i>Celtis pallida</i> Torrey	Ulmaceae	4	D	S	M	Z	Y	56.25	153	2.58
Mv	<i>Maytenus vitis-idaea</i> Griseb.	Celastraceae	4	E	S	M	Z	N	43.75	81	2.13
Sp	<i>Schinus fasciculatus</i> (Griseb.) Johnston.	Anacardiaceae	4	E	S	N	Z	Y	15.63	25	1.44
Al	<i>Aloystia gratisima</i> (Gill. et Hook.) Tronc.	Verbenaceae	5	D	C	N	F	N	3.13	3	0.03
Cb	<i>Senna pendula</i> var. <i>paludicola</i> (Willd.) Irwin et Barneby	Fabaceae	5	D	C	M	Z	N	+	0	0.01
Cc	<i>Erythroxylum microphyllum</i> St. Hil.	Erythroxylaceae	5	D	S	L	Z	N	6.25	6	0.07
Gw	<i>Grabowskia duplicata</i> Arnott	Solanaceae	5	D	S	M	Z	Y	9.38	50	0.38
Ht	<i>Holmbergia tweedii</i> (Moq.) Speg.	Chenopodiaceae	5	E	S	M	K	N	+	0	0.01
Va	<i>Lycium cuneatum</i> Dammer	Solanaceae	5	E	S	M	Z	Y	3.13	3	0.03
Ti	<i>Tessaria dodoneaefolia</i> (Hook. et Arn.) Cabr.	Astereae	5	E	S	M	Z	N	+	0	0.00

a) Class: 1: trees taller than 10 m, 2: trees from 8 to 10 m, 3: trees smaller than 8 m, 4: shrubs taller than 2 m and 5: shrubs smaller than 2 m. b) Function: E: Evergreen, D: Deciduous. c) Leaf type: S: Simple, C: Compound. d) Leaf size: L: Leptophyllous, N: Nanophyllous, M: Microphyllous. e) Leaf texture: F: Filmy, K: Succulent, X: Coriaceous, Z: Membranous. f) Spines: Y: yes, N: no. g) Relative frequency: + denotes that these species were not recorded in plots either because there are no individuals at all or that shrub individuals are less than 0.6 m high and tree ones less than 1.6 m high.

TABLE 2

Leaf characteristics of a Schinopsis balansae forest near Vera (Sta. Fe) in percentage of species, individuals, and cover.

	Species			Trees	Individuals		Cover		
	Trees	Shrubs	Total		Shrubs	Total	Trees	Shrubs	Total
Leaf size									
Microphyllous	55.56	78.57	65.63	38.17	92.25	54.90	38.41	83.20	43.30
Nanophyllous	16.67	14.29	15.63	14.83	6.34	12.20	13.78	16.05	14.03
Leptophyllous	27.78	7.14	18.75	47.00	1.41	32.90	47.81	0.74	42.66
Leaf texture									
Filmy	38.89	21.43	31.25	55.52	3.52	39.43	52.82	2.01	47.26
Membranous	50.00	64.29	56.25	40.69	78.17	52.29	44.00	74.68	47.36
Coriaceous	11.11	0.00	6.25	3.79	0.00	2.61	3.18	0.00	2.83
Succulent	0.00	14.29	6.25	0.00	18.31	5.66	0.00	23.30	2.55
Leaf type: compound	33.33	7.14	21.88	55.52	0.00	38.34	52.82	0.09	47.05
Spines	61.11	35.71	50.00	89.91	55.63	79.30	92.65	50.25	88.02
Deciduousness	83.33	57.14	71.87	88.90	75.45	84.73	95.24	60.48	91.44
Total (100%)	18	14	32	317	142	459	2387.1	293.0	2680.1

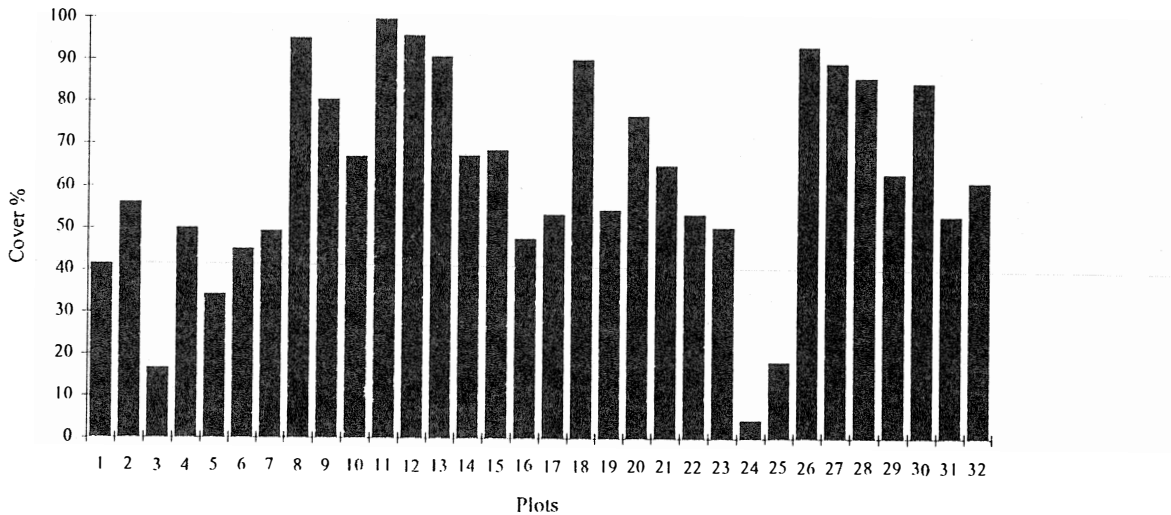
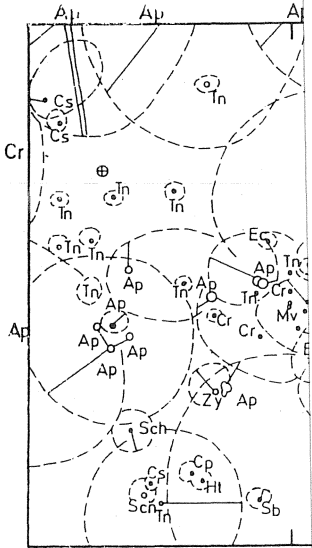


Fig. 1. General cover of tree layers on different plots.

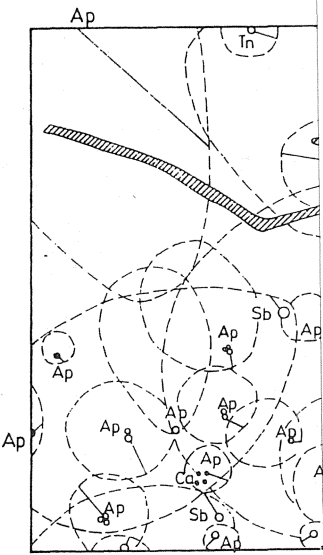
Fig. 2. Cartographic diagrams of woody vegetation of plots 6 to 9 (above) and plots 10 to 12 (below). Al: *Aloisia gratissima*, Ap: *Acacia praecox*, Aq: *Aspidosperma quebracho-blanco*, Bo: *Sideroxylon obtusifolium*, Ca: *Coccoloba argentinensis*, Cb: *Senna pendula* var. *paludicola*, Ci: *Celtis iguanea*, Cr: *Capparis retusa*, Cs: *Celtis pallida*, Ec: *Myrcianthes cisplatensis*, Gd: *Geoffroea decorticans*, Gw: *Grabowskia duplicata*, Ht: *Holmbergia tweedii*, Mv: *Maytenus vitis-idaea*, Pr: *Prosopis* sp., Sb: *Schinopsis balansae*, Sp: *Schinus fasciculatus*, Tn: *Achatocarpus praecox*, Va: *Lycium cuneatum*, Zy: *Zizyphus mistol*.

Fig. 3. Profile of the vegetation of the same plots as in Fig. 2. Species symbols also as in Fig. 2.

Plot 9



East 5m



East 5m

