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Tree species richness of a South-Western Amazonian forest (Jenaro Herrera, Peru, 73°40'W/4°54'S)

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RÉSUMÉ

SPICHIGER, R., P.-A. LOIZEAU, C. LATOUR & G. BARRIERA (1996). Espèces d'arbres, richesse du sud-ouest de la forêt amazonienne (Jenaro Herrera, Peru, 73°40'W/4°54'S). *Candollea* 51: 559-577. En anglais, résumés français et anglais.

L'article présente les résultats de l'étude de 9 ha d'une réserve forestière d'Amazonie péruvienne, dont 1 ha fait l'objet d'une analyse floristique détaillée. Sur cet ha, les I.V.I. et les F.I.V. (arbres ≥ 10 et 15 cm DBH) ont été calculés. Bien que la forêt de Jenaro Herrera ne contienne que 227 spp./ha (arbres ≥ 10 cm DBH), le rapport nombre d'individus/nombre d'espèces (504/227, soit 2.2) et le nombre d'espèces représentées par un seul individu (55%) indiquent une des plus hautes diversités d'espèce arborées calculées pour des forêts denses humides. Les I.V.I. mettent en évidence la prédominance des taxons suivants: *Leguminosae*, *Sapotacaeae*, *Moraceae*, *Myristicaceae*, *Lauraceae*, *Chrysobalanaceae* et *Lecythidaceae*; *Jessenia bataua*, *Eschweilera coriacea*, *Osteophloeum platyspermum*, *Qualea paraensis.* L'émergence de grands *Qualea*, l'importance des *Vantanea* et des *Sloanea,* ainsi que le pourcentage élevé d'éléments sud-ouest amazoniens distinguent cette forêt des autres forêts néotropicales. L'aire basale faible (23.6 m²/ha) ainsi que la présence d'éléments de forêt secondaire révèlent des perturbations récentes. 10% des arbres des 9 ha de la réserve sont soit de nouvelles espèces pour la science (6.6%), soit des espèces à décrire (3.4%). L'article fournit aussi les résultats d'observations à long terme sur l'écologie, la phénologie et la mortalité des arbres.

ABSTRACT

SPICHIGER, R., P.-A. LOIZEAU, C. LATOUR & G. BARRIERA (1996). Tree species richness of a South-Western Amazonian forest (Jenaro Herrera, Peru, 73°40'W/4°54'S). *Candollea* 51: 559-577. In English, French and English abstracts.

Results of floristic studies of 9 ha Peruvian Amazon forest with a special focus on 1 ha plot are provided. In the 1 ha plot I.V.I. and F.I.V. (trees ≥ 10 and 15 cm DBH) have been calculated. Although the Jenaro Herrera forest contains only 227 spp./ha (trees ≥ 10 cm DBH), the individual/species ratio (504/227 or 2.2) and the number of monoindividual species (55%) indicate one of the highest tree diversity recorded for tropical rainforests. The Importance Value Index (I.V.I.) gives as preponderant following taxa: *Leguminosae*, *Sapotacaeae*, *Moraceae*, *Myristicaceae*, *Lauraceae*, *Chrysobalanaceae* and *Lecythidaceae*; *Jessenia bataua*, *Eschweilera coriacea*, *Osteophloeum platyspermum*, *Qualea paraensis*. The emergence of tall *Qualea*, the importance of *Vantanea* and *Sloanea* and the high rate of South Western Amazonian elements give to this forest its specificity among other Neotropical ones. The low basal area (23,6 m²/ha) as well as the occurrence of elements of secondary forest show that the forest underwent recent perturbation. 10% of the trees growing in the 9 ha reserve are new species for the science (6,6%) or still undescribed ones (3,4%). Long term observations on ecology, phenology and mortality are also provided.

KEY-WORDS: Peruvian Amazon – Tree diversity – Dendroflora.

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Introduction

By analyses of radar images combined with studies of stratigraphical data, RÄSÄNEN & al. (1987) demonstrated that in the basinal forelands of the tectonically active Andes the geological setting causes long-term fluvial disturbance in the Amazon basin. These geodynamic processes, that affect the modern biota of western Amazonia, have occurred with varying intensity during the Tertiary-Quaternary. Mobile river channels cause alterations in inundation conditions which lead either to local forest destruction or, on the contrary, to emergence of new areas, which are colonized successively by plants (KALLIOLA & al., 1991). The vegetation and flora successions have been described by, among others, ENCARNACIÓN (1985) and KALLIOLA & al. (1991). The older, uplifted areas and alluvium beds are occupied by the so-called "Bosques de terraza" according to ENCARNACIÓN (1985), or in other words, the unflooded tierra firme forests. The enormous diversity of the Peruvian Amazon may be explained by the long history of fluvial disturbance and sedimentation which have led to the complex mosaic of fossil and present floodplains.

The diversity between the habitats (beta-diversity) added to that within the habitats (alpha-diversity) makes the Peruvian Amazon one if not the area with the highest biodiversity in the world (GENTRY, 1988).

The Jenaro Herrera Reserve

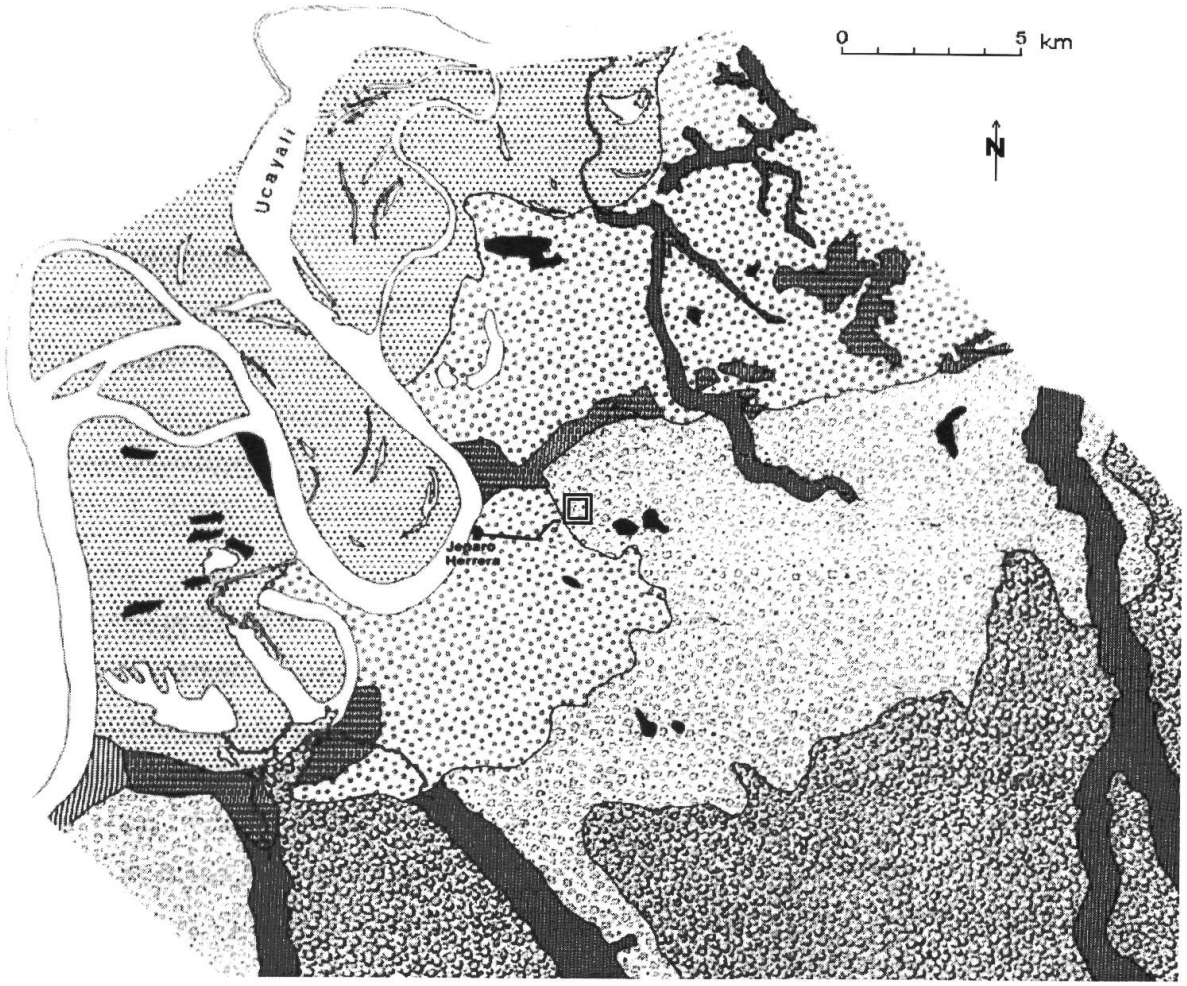
The Jenaro Herrera 9 ha Reserve is an unflooded tierra firme or "bosque de terraza alta" forest (ENCARNACIÓN, 1985). It is situated 200 km upstream Iquitos, on the right side of the Ucayali River (73°40'W/4°54'S) (Fig. 1). The climate is considered as belonging to the West-Amazon subclimate zone characterized by two dry seasons (MARMILLOD, 1982). The mean annual temperature is about 26.5°C, with seasonal variations ranging between 25.4°C (July) and 27°C (November-December). The absolute maxima occur from January to March and from August to October (up to 37.6°C), and the absolute minima in July (down to 11.4°C). The mean annual rainfall is 2521 mm, with a variation between 1700 mm and 4000 mm. Although the annual oscillations are not clearly marked, two drier seasons can be noticed: a long one lasting from July to September, and a short being of about one month's duration and setting in between December and February (SPICHIGER & al., 1989).

The soils are built up from Quaternary alluviums. They are very acid, nutrient-poor, clayey-loamy and belong to the Oxisols class (MARMILLOD, 1982).

A flora work and several papers give an exhaustive account of the dendroflora (SPICHIGER & al. 1989, 1990), and of the phenology of a few chosen woody species (GAUTIER & SPICHIGER, 1986). The flora enumerates 54 families, the legumes being treated as one family, 179 genera and 384 species. Nomenclatural and taxonomic changes are still being made. The present paper aims at completing the former accounts with quantitative (i.e. basal areas, number of trees by ha, alpha-diversity) and qualitative data (viz., origin of the tree species, ecological data), allowing us to compare the Jenaro Herrera forest with other south American ones.

Methods

Material of all trees with a DBH of $\geq$10 cm was collected in the 1 ha plot Nr. 5, situated in the middle of the 9 ha reserve of Jenaro. A map of all trees of plot 5 was drawn. Specimens are deposited in the Jenaro Herrera Herbarium as well as in USM (Lima), G, MO, and other important herbaria. They have been determined thanks to the authors of the "Flora Neotropica" monographs or the "Contribución a la Flora de la Amazonia Peruana" (SPICHIGER & al., 1989,



Seasonally flooded riparian forest

Mauritia-forest

Swamp forest

Gallery forest

Swamp woodland

Transitional seasonally flooded forest

Unflooded terrace forest

Unflooded plateau forest

Fig. 1. – Study area, Jenaro Herrera: 73°40'W/4°54'S (from MARMILLOD, 1982).

1990), and with the help of various specialists. Although names are still being changed by monographers, the inventory may be considered as completed at a level of more than 90%.

Importance Value Index (I.V.I.) and Family Importance Value (F.I.V.) were calculated for specimens with a DBH of ≥ 10 cm and ≥15 cm (CURTIS & McINTOSH, 1951; MORI & al., 1983). These values are the sum of the relative density, the relative dominance, and for the I.V.I. the relative frequency or for the F.I.V. the relative diversity.

Some ecological data were extracted from long term observations in the whole reserve (mortality: 5 years; phenology:10 years). The distribution in space of selected species was calculated with the GREIG-SMITH (1983) dispersion index (see also: ARMESTO & al., 1986).

Results

Forest structure and floristic composition

Only trees with a DBH of ≥ 10 cm were taken into account (Table 1). Thus, 504 individuals were registered in the 1 ha plot Nr. 5. For the whole 9 ha of the Jenaro Herrera Reserve, 4712 trees of ≥ 10 cm DBH were counted, which gives a mean value of ca. 524 trees/ha. These figures are close to the ones recorded for the Neotropical lowland rainforests, i.e. between 423 and 859 trees/ha (GENTRY, 1982; CAMPBELL & al., 1986; MORI & BOOM, 1987; KORNING & al., 1991; SPICHIGER & al., 1992), but are lower than those reported for the Upper Amazonian forests; indeed, 7 out of the 9 surveys that are cited by VALENCIA & al. (1994) contain more than 650 trees of DBH ≥ 10 cm, with a mean value of ca. 673 trees, and a maximum of 842 in Mishana (GENTRY, 1988).

The total basal area (DBH ≥10 cm) is 23.6 m^2/ha in plot Nr. 5. This figure is close to the 25.7 m^2/ha found by VALENCIA & al. (1994) in the Ecuadorian Amazonia, to the 22.2 m^2/ha found by KORNING & al., (1991) in the same area, and to the 21.5 m^2/ha reported by BOOM (1986) for the Bolivian Beni. Nevertheless, in Jenaro Herrera, the total basal area is lower than in other lowland rainforests. MORI & BOOM (1987) mention figures varying from 21.5 to 53.0 m^2/ha, many areas with a higher value than 30 m^2/ha being cited for the Neotropical rainforests.

By taking into account only the trees with a DBH of ≥ 15 cm (Table 2) we also observe that the Jenaro Herrera figures concerning basal area (21.4 m^2/ha) and tree number (306) are low in comparison with those calculated in Manaus by PRANCE (1990) (basal area: 24,7; number of trees: 346).

Osteophloeum platyspermum, *Jessenia bataua*, *Qualea paraensis*, *Buchenavia capitata*, *Eschweilera coriacea* and *Brosimum utile* are the species with the largest basal areas. At the family level, the *Leguminosae*, *Sapotaceae*, *Moraceae*, *Myristicaceae* and *Lecythidaceae* have the highest ones. It is to point out that the basal areas of the three first-mentioned families are also reported to be the highest in the 1 ha survey of Cuyabeno, in the Ecuadorian Amazonia (VALENCIA & al., 1994).

61.6% of the trees measure less than 20 cm ∅ in plot Nr. 5. The major diameters (∅ ≥ 50 cm) and the biggest trees are recorded among *Moraceae* (*Brosimum utile*, *B. potabile, Clarisia racemosa*), *Combretaceae* (*Buchenavia capitata*), *Sapotaceae (Chrysophyllum sanguinolentum*, *Pouteria reticulata*), *Lecythidaceae* (*Eschweilera ovalifolia*), *Proteaceae* (*Euplassa inaequalis*), *Annonaceae* (*Guatteria elata*), *Leguminosae* (*Hymenaea courbaril*, *Parkia multijuga*, *Swartzia polyphylla*), *Lauraceae* (*Mezilaurus synandra*), *Myristicaceae* (*Osteophloeum platyspermum*), *Elaeocarpaceae* (*Sloanea* sp. aff. *eichleri*), *Vochysiaceae* (*Qualea paraensis*) and *Humiriaceae* (*Vantanea paraensis*, *V. parviflora*). The Jenaro forest is characterized by the emergence of tall *Vochysiaceae* representatives.

The following species rank highest in density: *Jessenia bataua* (20 trees), *Eschweilera coriacea* (16), *Sapotaceae* indet. sp. (12), *Qualea paraensis* and *Pourouma ovata* (10 trees), *Micropholis guyanensis*, *Couepia bernardii* and *Eschweilera tessmannii* (9 trees), *Qualea tri-*

chanthera (8 trees), *Osteophloeum platyspermum* and *Ocotea argyrophylla* (7 trees), *Pouteria caimito* and *Diclinanona tessmannii* (6 trees). The commonest species in plot 5 (*Eschweilera coriacea*) has one of the lowest relative densities (3.32%) ever recorded for a predominant tree in a Neotropical rainforest. The most approaching figure is 4.7% (MORI & al., 1983) referring to an undetermined species of *Myrtaceae* from the Cocoa Region of Bahia. The I.V.I. values (Table 1) corroborate the preponderance of *Jessenia bataua* (11.39), *Eschweilera coriacea* (8.47), *Osteophloeum platyspermum* (7.26), *Qualea paraensis* (6.95), *Sapotaceae* indet. (6.09), *Micropholis guyanensis* (5.83) and *Pourouma ovata* (5.21). Anyway, the low figures indicate a weak specific preponderance in plot 5. *Jessenia bataua* and *Eschweilera coriacea* are also recorded from the Ecuadorian Amazon by VALENCIA & al. (1994) as the two commonest trees with a DBH of ≥10cm. The former, a palm, is also reported as the commonest species in a forest of the Colombian Choco (FABER-LANGENDOEN & GENTRY, 1991). In Jenaro, like in many neotropical forests, the frequency of palms is a characteristic aspect of the landscape. Taking into account only trees with a DBH ≥ 15 cm (Table 2), the former species also rank first with the exception of "*Sapotaceae* indet." which is replaced by *Couepia bracteosa*.

At the family level, the following taxa rank highest in density (Table 3): *Sapotaceae* (48 individuals), *Leguminosae* sensu lato (45), *Lecythidaceae* (39), *Chrysobalanaceae* (36), *Lauraceae* (34), *Myristicaceae* (30), *Moraceae* (29), *Arecaceae* (22), *Annonaceae* and *Vochysiaceae* (19), *Burseraceae* (17), *Cecropiaceae* (16), *Elaeocarpaceae* (13). In Cuyabeno, VALENCIA & al. (1994) observed that these families, with the exception of *Elaeocarpaceae* and *Vochysiaceae*, also rank highest in their survey.

The F.I.V. for trees with ≥ 10 cm DBH (Table 3) corroborates the preponderance of *Leguminosae* (29.07), *Sapotaceae* (28.22), *Moraceae* (23.50), *Myristicaceae* (18.84), *Lauraceae* (18.28), *Chrysobalanaceae* (18.05), and *Lecythidaceae* (17.38). According to LOIZEAU (1992), all these families belong to the commonly predominant ones in the tierra firme rainforests. Nevertheless, the highest F.I.V. in Jenaro are among the lowest recorded elsewhere by BALSLEV & al. (1987) (30.7 for *Arecaceae* from Añangu, Amazonian Ecuador) and by CAMPBELL & al. (1986) (75.9 for *Leguminosae* from Rio Xingu, Brazilian Amazon) (Table 5).

In order to compare our results with those of PRANCE (1990) in Manaus, we also calculated the F.I.V. for trees with a DBH of ≥ 15 cm (Tables 4 and 5). Whereas almost the same families emerge as the most important ones in both places, the *Lecythidaceae* are predominant in Manaus (F.I.V. Manaus, 51.72; Jenaro, 18.46), but the *Myristicaceae* are strikingly more important in Jenaro (F.I.V.: Manaus, 3.63; Jenaro 19.41). *Chrysobalanaceae* representatives are also more important in Jenaro (20.47) than in Manaus (13.93), contrarily to the *Burseraceae* (Manaus: 19.22; Jenaro: 13.23). The predominance of *Sapotaceae*, legumes and *Moraceae* is a common feature in the two forests. Unlike Cuyabeno, Jenaro does not share any preponderant species with Manaus-Itacoatiara Highway.

Several circumstances point to the fact that the Jenaro Herrera forest in general and plot 5 in particular suffered perturbations in the past, and is now regenerating. The low basal area (23.6 m^2/ha) is an indicator of a young succession stage (BUDOWSKI, 1963). The presence of pioneers and other elements of secondary forest also argues in favor of past disturbances. The frequency of *Cecropiaceae*, such as *Pourouma* spp. and *Cecropia ficifolia*, heliophilous trees which thrive in gaps and other open areas (BERG & al., 1990), indicates that the forest underwent recent perturbations.

Other taxa are indicators of disturbance: *Melastomataceae*, predominant in the secondary stages (GENTRY & ORTIZ, 1993), and in particular *Miconia* (3 species in plot 5) which is considered as a typical element of the young secondary stages (STUTZ DE ORTEGA, 1988); *Inga* (3 species in plot 5) and *Byrsonima japurensis*, also elements of forest regrowth, as well as *Casearia arborea* (RICHARDS, 1952; STUTZ DE ORTEGA, 1989); pioneers like *Goupia glabra*, *Jacaranda copaia* and other elements which rather occur in gaps and other types of open or disturbed milieu (TRIGOSO, 1990; BRAKO & ZARUCCHI, 1993): *Lacistema aggregatum*, *Ocotea marmellensis*, *Cedrelinga catenaeformis*, *Brosimum parinarioides* var. *amplicoma*, *Quiina peruviana*, *Micropholis venulosa*, *Couepia bracteosa*, *Licania blackii*, *Trichilia septen-*

Species	Basal area	Number of species	Number of occurrences	IVI
Jessenia bataua (C. Martius) Burret subsp. bataua (Arecaceae)	9817.47	20	15	11.39
Eschweilera coriacea (DC.) S. Mori (Lecythidaceae)	6854.16	16	11	8.47
Osteophloeum platyspermum (A. DC.) Warb. (Myristicaceae)	10255.72	7	7	7.26
Qualea paraensis Ducke (Vochysiaceae)	7624.64	10	8	6.95
Sapotaceae indet. 3 (Sapotaceae)	4636.20	12	8	6.09
Micropholis guyanensis (A. DC.) Pierre (Sapotaceae)	5426.31	9	8	5.83
Pourouma ovata Trécul (Cecropiaceae)	4016.52	10	7	5.21
Couepia bernardii Prance (Chrysobalanaceae)	2393.89	9	8	4.54
Buchenavia capitata (M.Vahl) Eichler (Combretaceae)	7138.48	3	3	4.27
Eschweilera tessmannii R. Knuth (Lecythidaceae)	1420.00	9	7	3.91
Qualea trichanthera Warm. (Vochysiaceae)	1922.65	8	6	3.71
Brosimum utile (Kunth) Pittier (Moraceae)	5467.94	3	3	3.56
Couepia bracteosa Benth. (Chrysobalanaceae)	3472.24	5	5	3.55
Mezilaurus synandra (Mez) Kosterm. (Lauraceae)	4274.92	5	3	3.46
Tachigalia polyphylla Poepp. & Endl. (Leguminosae)	3460.46	5	4	3.33
Pouteria reticulata (Engl.) Eyma subsp. reticulata (Sapotaceae)	3306.52	5	4	3.26
Eschweilera ovalifolia (DC.) Niedenzu (Lecythidaceae)	3507.59	4	4	3.15
Iryanthera tricornis Ducke (Myristicaceae)	2299.64	5	5	3.05
Ocotea argyrophylla Ducke (Lauraceae)	787.75	7	6	3.03
Swartzia cuspidata Spruce ex Benth. (Leguminosae)	1926.58	5	5	2.90
Vantanea paraensis Ducke (Humiriaceae)	4841.98	2	2	2.88
Pouteria caimito (Ruiz Lopez & Pavòn) Radlk. (Sapotaceae)	1896.73	6	4	2.86
Pithecellobium sp. 1 (Leguminosae)	4684.90	2	2	2.82
Parkia multijuga Benth. (Leguminosae)	3413.34	3	3	2.69
Brosimum potabile Ducke (Moraceae)	5281.01	1	1	2.65
Diclinanona tessmannii Diels (Annonaceae)	806.60	6	5	2.62
Swartzia polyphylla DC. (Leguminosae)	3158.08	3	3	2.59
Sloanea eichleri Schumann (Elaeocarpaceae)	3070.12	3	3	2.55
Buchenavia oxycarpa (Mart.) Eichl. (Combretaceae)	5026.54	1	1	2.54
Virola elongata (Benth.) Warb. (Myristicaceae)	1050.86	5	5	2.53
Guatteria elata R. E. Fries (Annonaceae)	2968.02	3	3	2.51
Couepia ulei Pilger (Chrysobalanaceae)	1950.14	4	4	2.49
Eschweilera sp. 1 (Lecythidaceae)	1313.18	5	4	2.42
Inga brachyrhachis Harms (Leguminosae)	766.55	5	5	2.41
Hymenaea courbaril L. var. courbaril Lee & Langenheim (Leguminosae)	4185.38	1	1	2.19
Ophiocaryon heterophyllum (Benth.) Urban (Sabiaceae)	639.31	5	4	2.13
Protium sagotianum Marchand (Burseraceae)	2017.69	3	3	2.10
Vantanea parviflora Lam. (Humiriaceae)	3959.19	1	1	2.09
Votomita pubescens Morley (Melastomataceae)	1262.92	4	3	1.98
Trichilia septentrionalis C. DC. (Meliaceae)	691.15	5	3	1.94
Protium hebetatum Daly, sp. nov. ined. (Burseraceae)	1604.57	3	3	1.93
Licania caudata Prance (Chrysobalanaceae)	597.69	4	4	1.92
Lacistema aggregatum (P. Bergius) Rusby (Flacourtiaceae)	578.84	4	4	1.91
Ocotea marmellensis Mez (Lauraceae)	2044.39	3	2	1.90
Licaria latifolia (A. C. Smith) Kosterm. (Lauraceae)	523.07	4	4	1.89
Licania micrantha Miq. (Chrysobalanaceae)	1335.96	3	3	1.81
Macrolobium gracile Spruce ex Benth. var. machadoense Cowan (Leguminosae)	820.74	4	3	1.79
Helicostylis elegans (J. F. Macbr.) C. C. Berg (Moraceae)	2169.27	2	2	1.75
Caryocar glabrum (Aublet) Pers. (Caryocaraceae)	2150.42	2	2	1.74
Virola calophylla Warb. (Myristicaceae)	1076.78	3	3	1.70
...				
Total	**236209.87**	**504**	**459**	**300.00**

Table 1. – Species data for trees ≥ 10 cm DBH in decreasing order of I.V.I. (only the first fifty I.V.I. and the sum of each category are listed).

Species	Basal area	Number of trees	Number of occurrences	IVI
Jessenia bataua (C. Martius) Burret subsp. bataua (Arecaceae)	9817.47	20	15	16.33
Osteophloeum platyspermum (A. DC.) Warb. (Myristicaceae)	10160.69	6	6	8.79
Eschweilera coriacea (DC.) S. Mori (Lecythidaceae)	6128.46	9	7	8.24
Qualea paraensis Ducke (Vochysiaceae)	7283.78	7	6	7.78
Pourouma ovata Trécul (Cecropiaceae)	3921.49	9	7	7.21
Micropholis guyanensis (A. DC.) Pierre (Sapotaceae)	5215.04	7	7	7.16
Couepia bracteosa Benth. (Chrysobalanaceae)	3472.24	5	5	4.99
Mezilaurus synandra (Mez) Kosterm. (Lauraceae)	4274.92	5	3	4.67
Tachigalia polyphylla Poepp. & Endl. (Leguminosae)	3460.46	5	4	4.64
Buchenavia capitata (M.Vahl) Eichler (Combretaceae)	7025.38	2	2	4.63
Brosimum utile (Kunth) Pittier (Moraceae)	5467.94	3	3	4.58
Iryanthera tricornis Ducke (Myristicaceae)	2299.64	5	5	4.45
Sapotaceae indet. 3 (Sapotaceae)	3685.87	4	4	4.42
Eschweilera ovalifolia (DC.) Niedenzu (Lecythidaceae)	3507.59	4	4	4.34
Couepia bernardii Prance (Chrysobalanaceae)	1879.46	5	5	4.25
...				
Total	**213903.01**	**306**	**288**	**300.00**

Table 2. – Species data for trees ≥ 15 cm DBH (only the first fifteen I.V.I. and the sum of each category are listed).

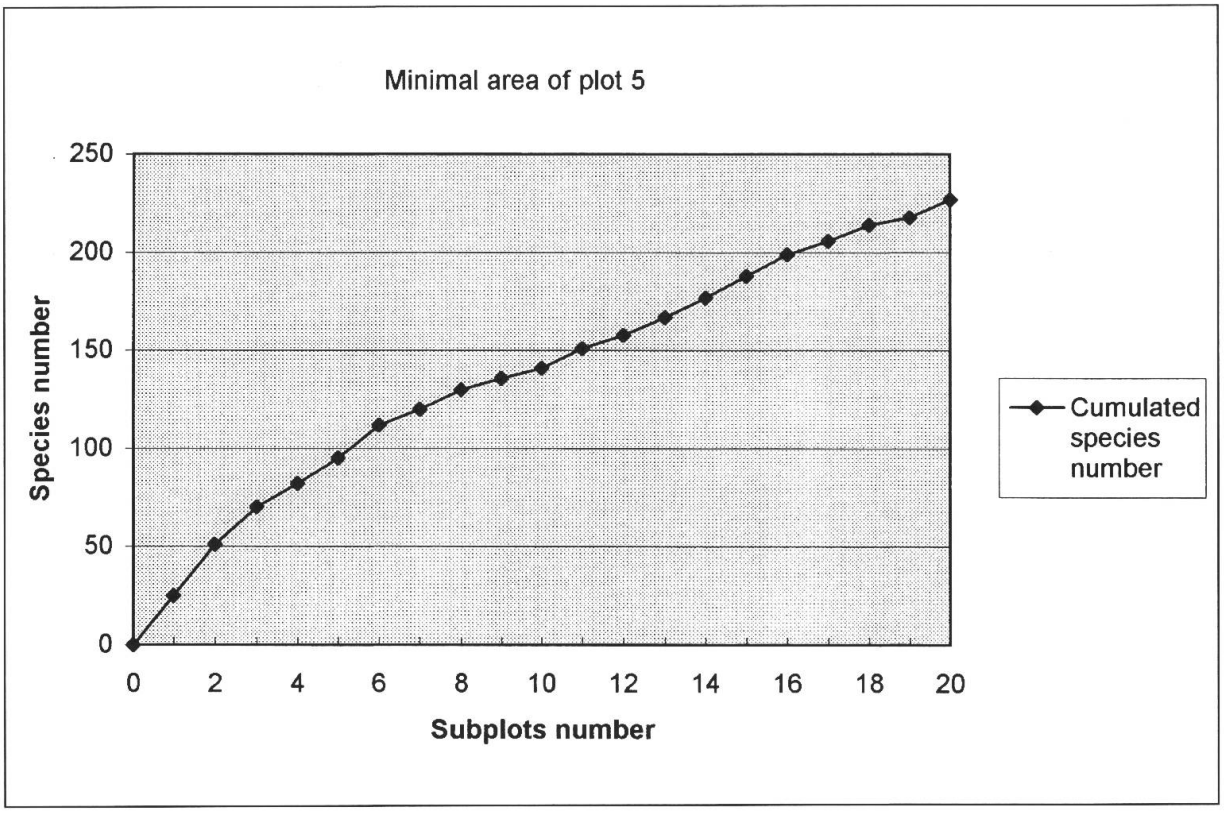


Fig. 2. – Minimal area: area/species curve for the 1 ha plot Nr. 5 (trees ≥ 10 cm DBH).

Family	Basal area	Number of species	Number of trees	FIV
Leguminosae	26771.84	20	45	29.07
Sapotaceae	24382.67	19	48	28.22
Moraceae	21110.70	20	29	23.50
Myristicaceae	17949.47	12	30	18.84
Lauraceae	12681.81	14	34	18.28
Chrysobalanaceae	14313.87	11	36	18.05
Lecythidaceae	14445.03	8	39	17.38
Burseraceae	7521.75	12	17	11.84
Annonaceae	5888.91	10	19	10.67
Arecaceae	9974.55	2	22	9.47
Vochysiaceae	10254.15	3	19	9.43
Humiriaceae	10130.84	6	8	8.52
Cecropiaceae	5932.11	5	16	7.89
Rubiaceae	3414.12	9	12	7.79
Combretaceae	12260.05	3	5	7.50
Elaeocarpaceae	5244.10	6	13	7.44
Melastomataceae	3857.09	6	11	6.46
Meliaceae	1818.20	4	11	4.71
Euphorbiaceae	1171.81	5	5	3.69
Sapindaceae	1376.02	4	6	3.54
Apocynaceae	1255.85	4	6	3.48
Bombacaceae	1735.73	3	7	3.45
Caryocaraceae	3458.89	2	4	3.14
Flacourtiaceae	1223.65	2	6	2.59
Sterculiaceae	2036.54	2	4	2.54
Olacaceae	1434.92	2	5	2.48
Simaroubaceae	1128.62	3	3	2.39
Myrtaceae	497.94	3	4	2.33
Violaceae	595.33	3	3	2.17
Rhizophoraceae	1588.07	2	3	2.15
Bignoniaceae	733.56	2	4	1.99
Quiinaceae	1101.13	2	2	1.74
Sabiaceae	639.31	1	5	1.70
Myrsinaceae	748.48	2	2	1.59
Proteaceae	2123.71	1	1	1.54
Guttiferae	309.45	2	2	1.41
Anisophylleaceae	629.10	1	3	1.30
Nyctaginaceae	482.23	1	3	1.24
Celastraceae	907.92	1	1	1.02
Araliaceae	353.43	1	2	0.99
Malpighiaceae	245.83	1	2	0.94
Fam. indet. 1	706.86	1	1	0.94
Aquifoliaceae	572.55	1	1	0.88
Ochnaceae	530.93	1	1	0.86
Ebenaceae	346.36	1	1	0.79
Opiliaceae	132.73	1	1	0.70
Styracaceae	113.10	1	1	0.69
Rutaceae	78.54	1	1	0.67
Total	**236209.87**	**227**	**504**	**300.00**

Table 3. – Family data for trees ≥ 10 cm DBH in decreasing order of F.I.V.

Family	Basal area	Number of species	Number of trees	FIV
Sapotaceae	22145.07	15	29	29.26
Leguminosae	24776.93	13	26	28.26
Moraceae	20113.24	14	19	24.42
Chrysobalanaceae	12867.17	10	25	20.47
Myristicaceae	16765.10	8	20	19.41
Lecythidaceae	12651.18	8	23	18.46
Lauraceae	10442.65	6	14	13.23
Burseraceae	7102.35	9	13	13.23
Arecaceae	9817.47	1	20	11.75
Annonaceae	5021.05	8	11	10.97
Cecropiaceae	5837.07	5	15	10.78
Vochysiaceae	9434.98	3	12	10.22
Humiriaceae	9939.21	5	6	9.75
Melastomataceae	3743.99	6	10	8.79
Elaeocarpaceae	4687.25	5	8	7.95
...				
Total	**213903.01**	**159**	**306**	**300.00**

Table 4. – Family data for trees ≥ 15 cm DBH (only the first fifteen F.I.V. and the sum of each category are listed).

	Trees ≥ 10 cm DBH				*Tree ≥ 15 cm DBH*	
Families	Jenaro Herrera[1]	Añangu[2] (unflooded)	Rio Iron[3]	Rio Xingu[4] (Jera firme)	Jenaro Herrera[1]	Manaus[5]
Leguminosae	29.07 (1)*	32.67 (1)*	30.1 (4)*	75.91 (1)*	28.26 (2)*	34.28 (2)*
Sapotaceae	28.22 (2)	6.11 (15)	3.5 (18)	8.21 (10)	29.26 (1)	20.41 (4)
Moraceae	23.50 (3)	30.52 (3)	53.3 (1)	15.34 (4)	24.42 (3)	24.46 (3)
Myristicaceae	18.84 (4)	12.40 (6)	41.1 (2)	–	19.41 (5)	3.63 (23)
Lauraceae	18.28 (5)	13.05 (5)	7.2 (11)	–	13.23 (7)	11.01 (8)
Chrysobalanaceae	18.05 (6)	3.24 (20)	8.3 (9)	9.91 (9)	20.47 (4)	13.93 (6)
Lecythidaceae	17.38 (7)	12.15 (7)	1.4 (27)	19.72 (3)	18.46 (6)	51.72 (1)
Burseraceae	11.84 (8)	8.93 (12)	6.8 (12)	–	13.23 (7)	19.22 (5)
Annonaceae	10.67 (9)	5.33 (16)	8.8 (8)	–	10.97 (10)	7.65 (12)
Arecaceae	9.47 (10)	30.73 (2)	35.7 (3)	23.86 (2)	11.75 (9)	1.62 (31)
Vochysiaceae	9.43 (11)	2.86 (22)	13.9 (7)	–	10.22 (12)	12.72 (7)
Humiriaceae	8.52 (12)	–	–	–	9.75 (13)	8.89 (10)

[1]SPICHIGER & al.: this paper(1 ha).
[2]BALSLEV & al., 1987 (1 ha).
[3]BOOM, 1986 (1 ha).
[4]CAMPBELL & al., 1986 (3 ha).
[5]PRANCE, 1990 (1 ha).
*The number (...) indicates the rank of the F.I.V. in the inventory.

Table 5. – The first twelve family importance values (F.I.V.) of Jenaro Herrera compared with those of other inventoies in unflooded forests.

trionalis, *Helicostylis elegans*, *Myrcia fallax*, *Coussarea rudgeoides*, *Ladenbergia magnifolia*, *Remijia peruviana*, *Clarisia racemosa* and *Theobroma subincanum*. The *Myristicaceae*, another important family in the arboretum, could also be considered as an indicator of old secondary forest, although BOOM (1986) observed that the high diversity and frequency of this family is rather related to its West-Amazonian origin. Bernardi (pers. comm.) also noted that the Jenaro Herrera forest looks like a *Myristicaceae* forest!

Tree species diversity

For trees with a DBH of ≥ 10 cm 227 species, 108 genera and 48 families were recorded in the 1 ha plot 5. In comparison with other Upper Amazonian 1 ha surveys, the number of species is relatively low, whereas the number of families is equal to the highest figures cited in the literature (from 46 to 50) (VALENCIA & al., 1994). The highest alpha-diversity of trees in the world is reported by GENTRY (1988), BALSLEV & al. (1987), and VALENCIA & al. (1994) from the Ecuadorian and Peruvian Amazon. They record diversities of 228-307 tree species.

Fig. 2 shows that the area/species curve for the 1 ha plot 5 does not reach a plateau. By counting the tree species (DBH ≥ 10 cm) on the 9 ha of the Reserve, we obtain 384 species, 179 genera and 384 families (SPICHIGER & al., 1989, 1990). These figures have to be considered as a low estimate because several doubtful, unrecorded, or new species are still to be added since Spichiger & al. published their Flora in 1990.

As to species diversity in plot 5 (DBH ≥ 10 cm), the richest families are *Leguminosae* and *Moraceae* (20 spp. each), *Sapotaceae* (19 spp.), *Lauraceae* (14 spp.), *Burseraceae* and *Myristicaceae* (12 spp. each), *Chrysobalanaceae* (11 spp.), *Annonaceae* (10 spp.), *Rubiaceae* (9 spp.), *Lecythidaceae* (8 spp.), *Humiriaceae*, *Melastomataceae*, and *Elaeocarpaceae* (6 spp. each). VALENCIA & al. (1994) observed the same families, with the exception of *Humiriaceae*, *Melastomataceae* and *Elaeocarpaceae*, to rank first in their Ecuadorian 1 ha survey. In Manaus, PRANCE (1990) reports almost the same families as ranking first in number of tree species (DBH ≥ 15cm), with a difference concerning *Myristicaceae* which are more frequent in Jenaro than in Manaus. *Leguminosae* is the most diversified tree family in the Paranean forest (SPICHIGER & al., 1992) as well as in the Amazonian lowland primary forests (GENTRY & ORTIZ, 1993). In the Jenaro plot 5, 14 families (DBH ≥ 10 cm) are monospecific against only 11 in Cuyabeno (VALENCIA & al., 1994). If we take the ≥ 15 cm size class in order to compare with Manaus-Itacoatiara km 30, we count 19 monospecific families in Jenaro against 14 in Manaus. Although the rarity of species is a well-known feature for high diversity forests (GENTRY & TERBORGH, 1990; FABER-LANGENDOEN & GENTRY, 1991), the number of tree species (DBH ≥ 10 cm) represented by a single individual (125 species or 55%) is strikingly high in Jenaro. In the same way the individual/species ratio (504/227 or 2.2) is one of the lowest ever recorded for the Upper Amazonia. Although Jenaro presents a number of species per ha which is lower than what has been counted in other Upper Amazonian surveys, the two former ratios (55% of monoindividual species and ratio individuals/species = 2.2) reflect an exceptional alpha-diversity. Such figures have only been reported by GENTRY (1988) for the Upper Peruvian Yanamono (ratio individuals/species = 2) and by MORI & BOOM (1987) for "La Fumée" Mountain in French Guyana (60.1% monoindividual species). Elsewhere, the records are not so extreme. At the family level, the rarity is also particularly noticeable in Jenaro: a mean value of 10.5 individuals/family. This figure is slightly higher than the one found by GENTRY (1988) in Yanamono, but lower than all the others which vary from 11.9 (CAMPBELL & al., 1986) to 21.6 (BOOM, 1986). The plurispecific genera do not overpass 8 species: *Protium* (8 spp.), *Pouteria* (7), *Licania* (7), *Eschweilera* (6), *Sloanea* (5), and *Ocotea* (5). In Cuyabeno, *Pouteria* is the genus with the highest number of species, whereas *Protium* and *Licania* seem to be the most speciose in "Reserva Ducke" (PRANCE, 1990).

Up to now several new species have been described on the tree material collected in the 9 ha Jenaro Herrera Reserve. They are:

Caryocar harlingii Prance & Encarnación
Couepia bernardii Prance
Cybianthus spichigeri Pipoly
Endlicheria citriodora van der Werff
Erythroxylum vasquezii Plowman
Inga ricardorum Bernardi & Spichiger
Matayba macrocarpa Gereau
Miconia spichigeri Wurd.
Micropholis brochidodroma Penn.
Ocotea alata van der Werff
Oenocarpus balickii F. Kahn
Pleurothyrium acuminatum van der Werff
Pourouma herrerensis C. C. Berg
Pouteria sessilis Penn.
Thyrsodium herrerense Encarnación
Vantanea spichigeri A. Gentry
Votomita pubescens Morley

To the above-mentioned 17 species, we can add the 15 following taxa which are most probably new to science:

Calyptranthes aff. *krugioides* McVaugh
Calyptranthes aff. *ruiziana* O. Berg
Dacryodes aff. *sclerophylla* Cuatrec.
Eschweilera sp.
Eugenia aff. *atroracemosa* McVaugh
Eugenia aff. *lambertiana* DC.
Guatteria aff. *pteropus* Benth.
Myrcia aff. *concava* McVaugh
Naucleopsis aff. *amara* Duke
Protium aff. *sagotianum* Marchand
Simaba aff. *guianensis* Aublet
Sloanea aff. *eichleri* Schumann
Sloanea aff. *guianensis* (Aublet) Benth.
Sloanea aff. *verrucosa* Ducke
Trattinnickia aff. *demerarae* Sandw.

Thus, 17 species out of the 384 cited by SPICHIGER & al. (1989, 1990) in their florula are new-described, which equals 4,4% of the flora. If we add the 15 others which are very probably new, we obtain 32 species, i.e. 8,3%. PRANCE & CAMPBELL (1988) estimate that at least 1% of the specimens collected by the NYBG in each Amazonian survey are species new to science. In fact, in Jenaro, 32 new and potentially new species represent 125 trees, i.e. 10% of the 1259 trees cited in SPICHIGER & al. (1990). Till now, 83 trees, belonging to 17 species, have been described on the basis of the specimens collected in Jenaro, viz. 6.6% trees. These figures are close to those mentioned by GENTRY (1988) for Yanamono.

Ecology

The distribution in space (LATOUR, 1994) of the 50 species represented by a minimum of 3 individuals (22% species of plot 5) shows, that 36 have a non aleatory distribution with individuals spatially grouped; two others also have a non aleatory distribution, but the individuals are uniformly distributed in the whole area; only 12 have a random distribution. These observations corroborate those of other authors (HUBBELL & FORSTER, 1983; ARMESTO & al., 1986) who demonstrated that the grouping of individuals belonging to the same species is a usual pattern in tropical forests.

As to the ecological trends, we observe that *Diclinanona tessmannii* and *Unonopsis floribunda* as well as *Lacistema aggregatum* are restricted to the swampy substrates of plot Nr. 5. *Myristicaceae* are frequently observed in the Reserve on the waterlogged substrates of the downslopes and along the rivulets and swamps.

The oxisols of Jenaro Herrera can be considered as relatively poor since they are very acid, poor in nutrients and very rich in aluminum. According to GENTRY (1988), *Burseraceae*, *Lauraceae* and *Sapotaceae* are strikingly speciose on the poor neotropical lowland substrates. The floristic composition of plot 5 corroborates more or less this assumption although *Moraceae*, a family which is particularly speciose on the richest soils, is also well represented in the Jenaro area. The preponderance of *Melastomataceae* and *Lauraceae* in the whole Western Amazonian area could also be favored by the relative proximity of the Andean piedmont forest (GENTRY, 1988).

Several species which are considered by this author as ecologically rather restricted to the poor substrates are well represented in Jenaro Herrera: *Iryanthera juruensis*, *I. laevis*, *Roucheria punctata*, *Virola sebifera*, *Cedrelinga catenaeformis*, *Cordia toqueve*, *Cordia ucayaliensis*, *Pseudolmedia laevigata*. Nevertheless, some specialists of fertile soils are also present, such as *Euterpe precatoria*, *Pseudolmedia laevis*, *Cordia nodosa*.

It is interesting to note that, on a total of 1967 trees with DBH $\geq$ 10 cm recorded from the whole reserve in 1976, 112 were dead in 1981; this means that 5.7% of the trees disappeared in 5 years, i.e. the annual mortality rate is 1.14%. The annual mortality rate calculated for Jenaro Herrera is lightly lower than the ones cited by KORNING & BALSLEV (1994) for the Ecuadorian Amazonia (1.04-3.01) and by SWAINE & al. (1987) for several tropical lowland forests (mean value of 1.54%).

With regard to phenology, GAUTIER & SPICHIGER (1986) reported that 63% of the tree species, which were followed-up during 10 years, flowered once a year, between June and November, i.e. during the dry season and at the beginning of the rain season (monomodial species). 17% flowered twice a year, i.e. a first time just after the dry season and a second time just after short dry and sunny events during the rain season (bimodial species). 20% did not show any preferential flowering rhythm (arrhythmic species). If we compare the phenology of tree species in Manaus (ARAUJO (1970) and ALENCAR & al. (1979) cited by GAUTIER & SPICHIGER, 1986), the rate is 88% monomodial, 0% bimodial and 6% arrhythmic species (the remaining 6% being monocarpic). The relatively weak seasonal periodicity in Jenaro Herrera would foster the bimodial (17%) and arrythmic (20%) flowering modes. Furthermore, species occurring both in Jenaro and in Manaus (*Virola calophylla*, *V. elongata*, *Caryocar glabrum*, *Mezilaurus synandra*) present a stronger periodicity in Manaus. *Osteophloeum platyspermum*, *Qualea paraensis*, and *Pourouma ovata*, predominant trees in Jenaro, are preferentially monomodial.

As to the mode of dispersion we confirm the observations made by PRANCE (1990) in Manaus: the greatest number of tree species in Jenaro are zoochorous and/or barochorous. Notable exceptions are to be noted among some emergent trees, such as *Qualea paraensis* which has winged seeds.

Origin of the dendroflora

On the basis of the following recent "Flora Neotropica" Monographs, we tried to put in evidence the distribution of some species (57 species), in order to determine the origin of the dendroflora found in Jenaro Herrera:

- *Cecropiaceae* (*Coussapoa*, *Pourouma*) (BERG & al., 1990)
- *Chrysobalanaceae* (PRANCE, 1972, 1989a)
- *Lecythidaceae* part II (MORI & PRANCE, 1990)
- *Meliaceae* (PENNINGTON, 1981)
- *Sapotaceae* (PENNINGTON, 1990)

We classified the distribution types according to the phytochoria proposed by PRANCE (1989b), viz.:

1) South-Western Amazonian elements (phytochorion 10c) 11 spp. = 19.3%:

Couepia bernardii
Chrysophyllum scalare
Eschweilera sp.
Hirtella magnifolia
Licania krukovii
Micropholis brochidodroma
Parinari klugii
Pourouma herrerensis
Pouteria pubescens
Pouteria sessilis
Trichilia stipitata

2) Western Amazonian elements (phytochoria 10a and 10c) 9 spp. = 15.8%:

Eschweilera chartaceifolia
Guarea macrophylla subsp. *pendulispica*
Hirtella rodriguesii
Licania urceolaris
Micropholis madeirensis
Pourouma mollis subsp. *triloba*
Pourouma tomentosa subsp. *tomentosa*
Pouteria lucumifolia
Trichilia poeppigii

So we have for all the Western Amazonia sensu amplo (South Western and Western) 20 spp. = 35,1%.

3) Central and Eastern Amazonian elements (phytochoria 10a, b, c, d) 11 spp. = 19.3%:

Cariniana decandra
Chrysophyllum sanguinolentum subsp. *spurium*
Couepia ulei
Eschweilera bracteosa

Eschweilera ovalifolia
Eschweilera tessmannii
Guarea cinnamomea
Hirtella duckei
Licania emarginata
Pourouma ovata
Pouteria platyphylla

4) Guyano-Amazonian elements (phytochoria 7, 9, 10) 21 spp. = 36.8%:

Carapa guianensis
Couratari multiflora
Coussapoa asperifolia subsp. *magnifolia*
Couepia bracteosa
Couepia obovata
Eschweilera coriacea
Guarea glabra
Guarea silvatica
Hirtella elongata
Licania blackii
Licania caudata
Licania egleri
Licania micrantha
Licania reticulata
Ecclinusa lanceolata
Micropholis guyanensis subsp. *duckeana*
Manilkara bidentata subsp. *surinamensis*
Pourouma bicolor subsp. *bicolor*
Pouteria aubrevillei
Pouteria oblanceolata
Trichilia septentrionalis

5) Widely neotropical elements 5 spp. = 8.8%:

Guarea guidonia
Micropholis guyanensis subsp. *guyanensis*
Pourouma guianensis subsp. *guianensis*
Pouteria caimito
Pouteria reticulata subsp. *reticulata*

Elements belonging the all classes also occur in the Andean and Pacific phytochoria (1, 3 and 4, according to PRANCE, 1989).

The most frequent distribution type is the Guyano Amazonian with 36.6% tree species. The Western Amazonian species represent 35.1%, and the strict South-Western Amazonian ones 19.3%. This means that 19.3% of the tree species belonging to our selected families have their origin in the Peruvian, Bolivian and South-Western Brazilian Amazon.

25% of *Sapotaceae* and 24% of *Chrysobalanaceae* are species or subspecies endemic to the South-Western Amazonian phytochorion. In plot 5 the predominant species are rather widespread Guyano-Amazonian elements (*Osteophloeum platyspermum*, *Eschweilera coriacea*, *Qualea paraensis*, *Micropholis guyanensis*, *Pourouma ovata*). Nevertheless, an apparently endemic species of Jenaro Herrera, viz. *Couepia bernardii*, reaches one of the highest I.V.I. in plot 5 (4.54), and is represented by at least 22 trees in the 9 ha area.

Discussion

Although it is evident that the Jenaro Herrera forest has undergone disturbances in the past, the pioneers and secondary species are now replaced by taxa characteristic of old succession stages and primary forests. This is proved by their rareness, with the exception of *Pourouma ovata, Couepia bracteosa* and *Melastomataceae*. The species belonging to families characteristic of the mature forest stages, such as *Burseraceae*, *Vochysiaceae*, *Lecythidaceae* and *Sapotaceae*, are predominant. These circumstances indicate that Jenaro Herrera is a forest approaching a climactic stage while having still several characteristics of a secondary forest (low basal areas, secondary species).

The relatively high rate of South-Western (19.3%) and Western Amazonian species (35.1%) found in some selected families gives to the Jenaro Herrera forest its specificity among the Neotropical rainforests. After the *Leguminosae*, which are predominant in almost all lowland Neotropical forests (GENTRY, 1988), the second predominant family characterizing Jenaro Herrera is the *Sapotaceae*. Furthermore, this family is especially rich in South-Western Amazonian species and subspecies (25%). Nevertheless, the predominant families in Jenaro are the same as the predominant ones elsewhere in the Amazonian lowland forest (PRANCE, 1990), with the exception of the strikingly predominant *Myristicaceae* and *Chrysobalanaceae* and the relative rareness of *Lecythidaceae* in comparison with Manaus. At the species level, the Jenaro forest is dominated by some widespread panamazonian taxa: *Eschweilera coriacea*, *Osteophloeum platyspermum* and *Qualea paraensis*.

The five families with the highest F.I.V. in Jenaro are the same as those generally ranking first in the other western Amazonian surveys, but the high level of endemics among the *Chrysobalanaceae* (24%) may indicate that the southwestern Amazon is a center of speciation in this family. Furthermore, other families that do not belong to the classical "ten first" are characteristic elements of the forest, viz. *Vochysiaceae* (*Qualea*), *Humiriaceae* (*Vantanea*) and *Elaeocarpaceae* (*Sloanea*).

Thereafter listed the most speciose genera which have been recorded by SPICHIGER & al., (1989, 1990) in the whole 9 ha of the Jenaro Herrera Reserve: *Miconia* and *Protium* (14 spp.), *Virola* (11), *Sloanea* (10), *Inga*, *Licania*, *Ocotea* and *Pouteria* (each 8), *Eugenia* (7), *Eschweilera*, *Guatteria* and *Vantanea* (each 6). The differences in comparison with the 1 ha plot Nr. 5 can be explained by the following factors:

1) the different level of secundarization between the plots which makes that *Inga* and *Miconia* are less frequent in the less disturbed plot 5,

2) the presence of rivulets and swampy lowgrounds that favors, among others, *Virola*.

As to the alpha-diversity, the tree species number/ha (227) is lower in Jenaro than in other Upper-Amazonian surveys (Table 6), but its individual/species rate (2.2) indicates one of the highest tree diversities registered for Upper Amazonia and tropical rainforests worldwide. In Gentry's Yanamono survey, where the tree diversity seems to be the highest in the world (over 300 spp. of ≥10 cm DBH out of approximately 600 trees in a 1 ha plot), the rainfall is very high and regular (3000-4000 mm per annum). The smaller tree species number found in Jenaro may be associated with lower rainfall (mean annual value of 2521 mm), which could corroborate GENTRY'S hypothesis (1988) that there is a correlation between species diversity and rainfall. We do not have enough edaphic data to allow correlations to be made between soil type and tree

Reference	Place	Type of veg.	Area (ha)	Shape (m)	DBH	Trees	Fam.	Gen.	Sp.
Campbell & al. 1986	Río Xingu, Brazil	várzea	0.5	10 x 500	10	220	17	29	40
Balslev & al. 1987	Añangu, Ecuador	area inund.	1	point-centered	10	417	44		149
Black & al. 1950	Belém, Brazil	igapó	1	100 x 100	10	564	28	51	60
Valencia & al. 1994	Cuyabeno, Ecuador	terra firme	1	100 x 100	5		54	187	473
Valencia & al. 1994	Cuyabeno, Ecuador	terra firme	1	100 x 100	10	693	46	138	307
Korning & al. 1991	Añangu, Ecuador	terra firme	1	line transect	10	728	51		239
Balslev & al. 1987	Añangu, Ecuador	terra firme	1	point-centered	10	728	53		228
Spichiger & al. (this paper)	**Jenaro Herrera, Perú**	**terra firme**	**1**	**100 x 100**	**10**	**504**	**48**	**108**	**227**
Korning & al. 1991	Añangu, Ecuador	terra firme	1	100 x 100	10	734	46		153
Boom 1986	Alto Ivon, Bolivie	terra firme	1	10 x 1000	10	649	28	61	94
Black & al. 1950	Belém, Brazil	terra firme	1	100 x 100	10	423	31	65	87
Prance & al. 1976	Manaus, Brazil	terra firme	1	irregul.	15	350	43	115	179
Spichiger & al. (this paper)	**Jenaro Herrera, Perú**	**terra firme**	**1**	**100 x 100**	**15**	**306**	**44**		**139**
Black & al. 1950	Tefé, Brazil	terra firme	1	---	20	230	25	42	79
Rodrigues 1963	Amapá, Brazil	terra firme	1.1	11 x (10 x 100)	15	347	36	63	84
Mori & Boom 1987	Saül, French Guiana	dense forest	1.29	point-centered	10	800	41		295
Rodrigues 1963	Amapá, Brazil	terra firme	1.5	15 x (10 x 100)	15	461	37	70	96
Cain & al. 1956	Belém, Brazil	terra firme	2	20 x (10 x 100)	10	897	39	100	153
Campbell & al. 1986	Río Xingu, Brazil	terra firme	3	10 x 3000	10	1420	39	127	265
Pires & al. 1953	Castanhal, Brazil	terra firme	3.5	irregul.	10	1482	48	130	179
Mori & al. 1983	Una, Bahia, Brazil	dense forest	6.67	point-centered	10	600	42	93	178

Table 6. – Comparative table with some previous papers.

diversity. Nevertheless, the Jenaro Herrera oxisols are not much different from those of other sites with equal or higher tree diversity (GENTRY, 1988; MARMILLOD, 1982). However, the difference between the number of tree species counted in Jenaro Herrera and the ones given for other Upper Amazonian sites could also be partly explained by the higher degree of taxonomic knowledge concerning the flora of the Jenaro Reserve. Better knowledge of the infra-specific variation contributes to a more secure circumscription of a species.

The number of new species for science (probably 10%) invites us to intensify collections in poorly known tropical countries.

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