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Autor: Bridgewater, Samuel / Pennington, R. Toby / Reynel, Carlos A.

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A preliminary floristic and phytogeographic analysis of the woody flora of seasonally dry forests in northern Peru

SAMUEL BRIDGEWATER, R. TOBY PENNINGTON
CARLOS A. REYNEL, ANICETO DAZA
& TERRENCE D. PENNINGTON

ABSTRACT

BRIDGEWATER, S., R. T. PENNINGTON, C. A. REYNEL, A. DAZA & T. D. PENNINGTON (2003). A preliminary floristic and phytogeographic analysis of the woody flora of seasonally dry forests in northern Peru. *Candollea* 58: 129-148. In English, English and French abstracts.

Inventory data and general woody floristic lists are presented for northern Peruvian seasonally dry tropical forests (SDTFs). These preliminary data record ca. 250 woody species for the SDTFs around Tumbes, the inter-andean valleys and around Tarapoto. High levels of endemism are shown in these SDTFs, with between 13-20% of their tree species recognised as narrow regional endemics. A comparison of disjunct SDTF patches on the Pacific coast, in the Marañon drainage and around Tarapoto reveals only low floristic similarity (ca. 2-10%) between them, suggesting considerable barriers to species movement. Present day barriers are represented by the Eastern and Western Andean Massifs. However, an examination of the disjunct species distribution patterns suggest that either species migration between the Marañon drainage and the Pacific region over the Andes has recently occurred via the Porculla Gap, or these areas were once continuous before the uplift of the Andes. A comparison of Peruvian dry forest plot data with inventories from southern Ecuador and Bolivia indicates that the northern Peruvian Tumbes and Marañon dry forests, and those of southern Ecuador may constitute a distinct phytogeographical unit.

RÉSUMÉ

BRIDGEWATER, S., R. T. PENNINGTON, C. A. REYNEL, A. DAZA & T. D. PENNINGTON (2003). Analyse floristique et phytogéographique préliminaire de la flore ligneuse des forêts saisonnières sèches du nord du Pérou. *Candollea* 58: 129-148. En anglais, résumés anglais et français.

Des inventaires et des listes floristiques des espèces ligneuses sont présentés pour la région des forêts tropicales saisonnières sèches du nord du Pérou (SDTFs). Ces données préliminaires portent sur 250 espèces ligneuses pour les SDTFs aux alentours de Tumbes, dans les vallées interandines et aux alentours de Tarapoto. Des hauts niveaux d'endémisme sont signalés, avec entre 13-20% des espèces ligneuses strictement endémiques de la région. Une comparaison d'aires de SDTF disjointes sur la côte du Pacifique, sur le versant du Marañon et aux alentours de Tarapoto, révèle une faible ressemblance floristique (ca. 2-10%) entre elles, suggérant des barrières importantes au déplacement des espèces. Ces barrières sont aujourd'hui représentées par les Massifs Andins Est et Ouest. Néanmoins, une étude des schémas de distribution disjointe des espèces suggère que, soit que la migration des espèces entre le verssant du Marañon et la région du Pacifique, par dessus les Andes, a eu lieu via l'Abra de Porculla, soit que ces régions ont été autrefois continues avant le soulévement des Andes. Une comparaison des données en provenance de parcelles de forêts sèches péruviennes avec celles d'inventaires faits au Sud de l'Equateur et de la Bolivie indique que les forêts sèches du Nord du Pérou (Tumbes et Marañon) et celles du Sud de l'Equateur pourraient constituer une unité phytogéographique particulière.

KEY-WORDS: Seasonally dry tropical forests – Peru – Phytogeography – Neotropical – Andes.

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Introduction

In recent years there has been an increase in research into South American SDTFs and their neglected floras (e.g. PRADO, 1991; PRADO & GIBBS, 1993; GENTRY, 1995; KESSLER & HELME, 1999; PENNINGTON & al., 2000). The stimulus for this research results from the realisation that as well as this ecosystem being one of the most threatened in the continent (JANZEN, 1988), a study of their floras may elucidate patterns of historical vegetation change (e.g. PRADO & GIBBS, 1993). From species distribution studies, PRADO & GIBBS (1993) suggested that the disjunct SDTF patches that are found today represent fragments of what may have been a larger area of dry forest ranging through the continent during the last glacial maximum – a 'Pleistocene Arc' of dry vegetation.

In this paper we adopt the broad definition of SDTF outlined by PENNINGTON & al. (2000). SDTFs are tree-dominated ecosystems, the vegetation being mostly deciduous during the dry season. In South America they occur on relatively fertile soils where rainfall is less than 1600 mm/year and where there is a strongly defined dry season with at least 5-6 months of the year receiving less than 100 mm (GENTRY, 1995; GRAHAM & DILCHER, 1995). This is in marked contrast to tropical rain forests which occur in wetter climatic regimes, with every month showing more than 100 mm of rainfall (WHITMORE, 1998). They differ from tropical savannas, which may also have a well developed woody component, in that they lack the savanna's usually continuous xeromorphic fire resistant grass layer (MOONEY & al., 1995). In addition, although savannas are found under similar or slightly wetter climatic conditions, they tend to be on poorer soils (SARMIENTO, 1992).

The largest expanses of SDTF in South America (Fig. 1) are found in north-eastern Brazil (the 'caatingas'), in two areas defined by PRADO & GIBBS (1993) as the 'Misiones' and 'Piedmont' nuclei, and on the Caribbean coasts of Colombia and Venezuela. Other smaller and more isolated areas occur in dry valleys in the Andes of Bolivia, Peru, Ecuador, and Colombia, coastal Ecuador and northern Peru, the 'Mato Grosso de Goiás' in Central Brazil and scattered throughout the Brazilian cerrado biome on areas of fertile soils. In Central America, SDTFs are concentrated along the Pacific coast from Guanacaste in northern Costa Rica, to just north of the Tropic of Cancer in the Mexican state of Sonora.

Historically, SDTFs have received relatively little attention from conservationists and ecologists relative to that given to rain forests (JANZEN, 1988; MOONEY & al., 1995), despite the fact that they are far more threatened. Less than 2% of seasonally dry forests on the Pacific coast of Mesoamerica, for example, are still intact (JANZEN, 1988). The primary reason for the massive destruction of this ecosystem is the fertile nature of its soil which is prized for agriculture (RATTER & al., 1978). Its destruction is exacerbated by the large human populations in many Neotropical dry forest life zones (MURPHY & LUGO, 1995). Floristically they are still poorly described, and although a number of authors have made floristic comparisons (e.g. PRADO & GIBBS, 1993; KESSLER & HELME, 1999; SARMIENTO, 1975), much remains to be understood about patterns of floristic diversity between the many disjunct dry forest patches. This lack of botanical research in part reflects their relatively depauperate flora (ca. 30 tree species ≥10 cm/hectare), when compared with the rain forest (ca. 120 species ≥10 cm /hectare).

There is very little floristic information available for the few remaining SDTF areas in Peru. This work seeks to provide detailed floristic data for two inter-Andean SDTFs in northern Peru, and to assess their floristic affinities. The data presented are important in two contexts: (i) Peruvian inter-Andean valleys have been proposed as a historical migration route between SDTFs in southern and northern South America, and therefore their floristic affinities are of particular biogeographic interest; (ii) At present only two significant patches of Peruvian SDTF (Coto de Caza El Angolo and Cerros de Amotape), have any form of protection (neither of which occur in the inter-Andean valleys), and an assessment of whether other SDTF areas also merit conservation is necessary.

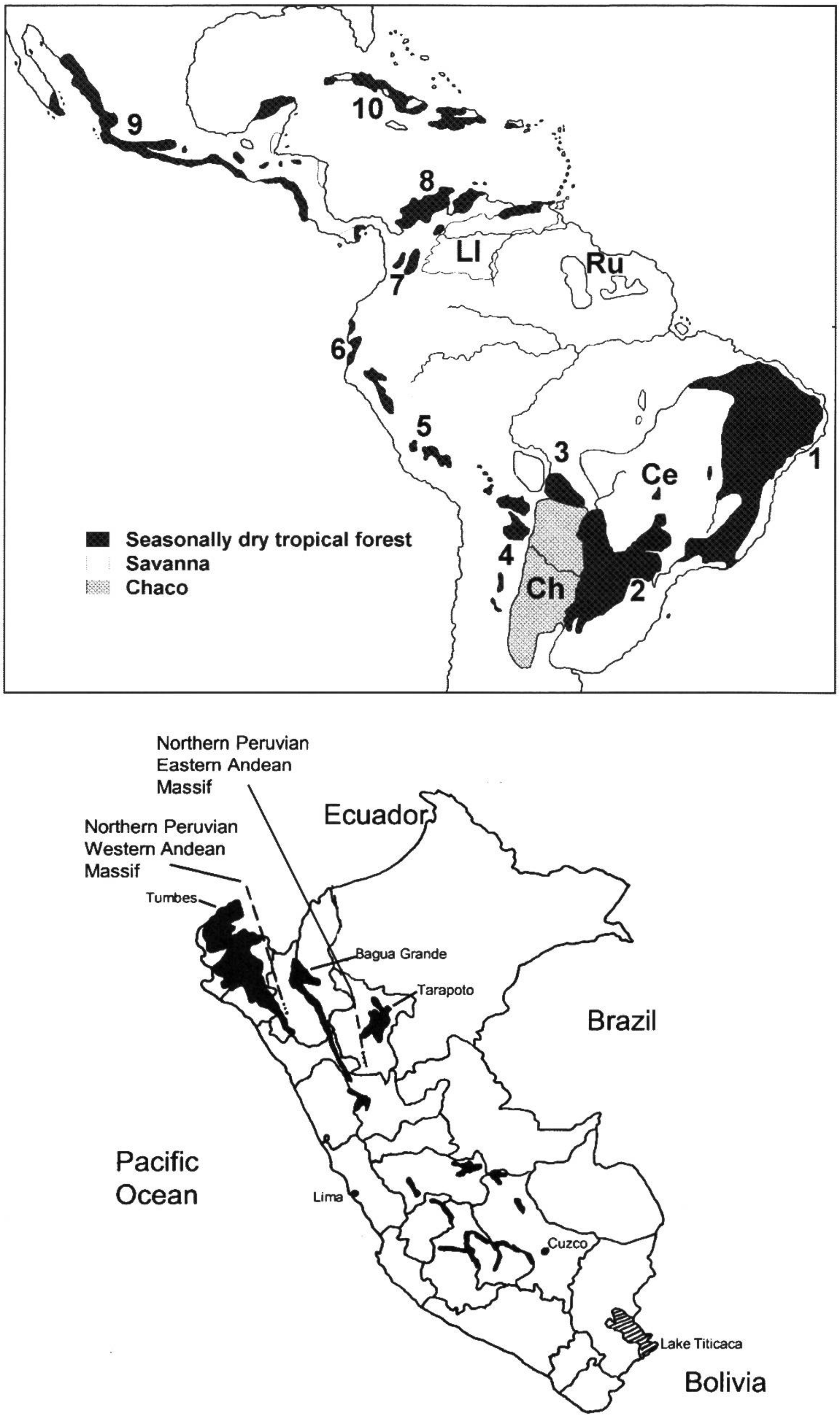


Fig. 1. – The distribution of seasonally dry vegetation in the Neotropics. ***Seasonally dry forests:*** **1,** Caatingas; **2,** Misiones Nucleus; **3,** Bolivian Chiquitano region; **4,** Piedmont Nucleus; **5,** Bolivian and Peruvian InterAndean valleys; **6,** Pacific coastal Ecuador; **7,** Colombian InterAndean valleys; **8,** Cribbean coast of Colombia and Venezuela; **9,** Central America; **10,** Antilles. ***Savannas:*** **Ce,** Cerrado; **Ll,** Llanos; **Ru,** Rupununi; **Ch,** Chaco.

[Reproduced from PENNINGTON & al. (2000). *J. Biogeogr.* 27: 62. Blackwell Publishing.]

Site description and methods

Peru is the third largest South America country, covering almost 1.3 million square kilometers, and floristically can be roughly divided into three zones – the eastern Amazonian region, the mountainous Andean region and the coastal region, a narrow desert strip along the Pacific coast. SDTF patches occur within each of these three primary regions (Fig 1), occurring as a mosaic with other vegetation formations in Tumbes (bordering Ecuador), the inter-Andean valleys of Cajamarca and Amazonas (most significantly the Marañon valley), around Tarapoto and the Rio Huallaga and around Cuzco. In total the extension of these forests areas was originally ca. 44,600 km^2 (Ministerio de Agricultura, 1994), this area including a range of different SDTF types including lowland, montane, and semi-arid dry forest systems. However, the majority of seasonally dry forests have long since been cleared for agriculture, and intact patches only exist in small, discrete and usually heavily disturbed fragments.

Quantitative plot-based surveys were focused on two distinct SDTF areas, lying on either side of the Eastern Andean massif (Fig. 1). The first and most westerly site lies 25 km from Bagua Grande (Dept. of Amazonas) on the road to Chachapoyas (06°31'S, 76°22'W), with the second site east of the Eastern Andean Massif, 25 km from Tarapoto (Dept. of San Martín) on the road to Juanjui (5°51'67"S, 78°13'56"W).

At each area 10 × 50 m plots were marked out, with five plots (0.25 hectare) surveyed at Bagua Grande, and four contiguous plots (0.2 hectare) at Tarapoto. The areas surveyed at each site were constrained by the available area of reasonably undisturbed SDTF, this formation having been decimated in both areas. For each plot, all trees ≥5 cm dbh were identified and their diameter at breast height (dbh) and total height were recorded. In addition general collections were made in the vicinity of each survey to complement the plot species lists. General qualitative species lists (from general observation and collecting) were also compiled on the journey to the survey sites, the most in depth of which were in dry forest fragments on the Pacific slope of the Western Andean Massif between Olmos and Limón (05°55'S, 78°33'W), and on a hill close to Chamayo (05°53'S, 78°46'W). Fieldwork was conducted in two phases: a three week period in March 1998 at Bagua Grande, and a three week period in November 2000 at Bagua Grande and Tarapoto. Collections were made in sets of four. All collections are held at the Universidad Nacional Agraria La Molina (MOL), and duplicate sets of the March 1998 collections have been distributed to Missouri Botanical Garden (MO), the Royal Botanic Gardens, Kew (K), and the Royal Botanic Garden Edinburgh (E).

Results & Discussion

A total of 409 collections were made in the SDTF areas, representing 237 woody taxa. Of these, 171 were identified to species, 48 to genus and 18 to family. Full species lists from the plots and those derived from general collections around the SDTF formations are given in Appendix 1. A total of 26 tree species ≥5 cm dbh were recorded in the seasonally dry forest plot at Bagua Grande and 31 tree species from the plot at Tarapoto. Phytosociological data for both sites is provided in Tables 1, 2, 3 and 4.

Diversity

SDTFs are species-poor compared to tropical rain forests, and their flora, with a few exceptions, can be considered depauperate versions of the latter, with the majority (but not all) of the families and genera shared between them. GENTRY (1995) records that lowland SDTF forest areas typically have between 50 – 70 species (≥2.5 cm dbh) in 0.1 hectare, the average species richness for this class and sample size being 65. This is under half the species richness found in an equivalent area of lowland rain forest. For trees ≥ 10cm dbh, the diversity of lowland SDTF is between 20 and 30 species. Both the dry forest plots of the present survey appear to be of average diversity when compared to other inventoried areas in South America, with 18 species ≥10 cm dbh recorded in 0.25 hectares of forest at Bagua Grande, and 24 species from 0.2 hectares ≥10 cm dbh recorded at Tarapoto.

Table 1. – Phytosociological data for the 0.25 hectare dry forest plot 20km from Bagua Grande on the road to Chachapoyas. Species ordered by IVI

Species	***Family***	***Density***			***Dominance***		***Frequency***		***IVI***
		Ind.	***Aden.***	***Rden.***	***Ado.***	***RelD.***	***Afre.***	***Relfre.***	
Cordia iguaguana I. M. Johnst.	Boraginaceae	111	444	31.62	4.61	23.49	100	6.85	61.97
Hura crepitans L.	Euphorbiaceae	24	96	6.84	4.24	21.64	100	6.85	35.33
Ceiba insignis (Kunth) Gibbs & Semir	Bombacaceae	7	28	1.99	4.62	23.55	80	5.48	31.03
Praecereus euchlorus K. Schum.	Cactaceae	55	220	15.67	0.70	3.58	60	4.11	23.36
Rauhocereus riosariensis Backeb.	Cactaceae	31	124	8.83	0.52	2.64	100	6.85	18.32
Nyctaginaceae (RTP747)	Nyctaginaceae	14	56	3.99	0.86	4.38	80	5.48	13.85
Erythroxylum aff. *deciduum* A. St.-Hil.	Erythroxylaceae	17	68	4.84	0.39	1.97	80	5.48	12.29
Piptadenia viridiflora (Kunth) Benth.	Leguminosae	7	28	1.99	0.62	3.17	60	4.11	9.27
Zanthoxylum sp. (RTP748)	Rutaceae	9	36	2.56	0.23	1.18	80	5.48	9.22
Zanthoxylum rigidum Willd.	Rutaceae	5	20	1.46	0.45	2.28	80	5.48	9.19
Capparis guayaquilensis Kunth	Capparaceae	5	20	1.42	0.16	0.84	80	5.48	7.74
Acacia tortuosa (L.) Willd.	Leguminosae	13	52	3.70	0.23	1.17	40	2.74	7.61
Ruprechtia aperta Pendry	Polygonaceae	7	28	1.99	0.21	1.07	60	4.11	7.17
Capparis petiolaris Kunth	Elaeocarpaceae	6	24	1.71	0.12	0.60	60	4.11	6.42
Celtis loxensis C. C. Berg	Ulmaceae	3	12	0.85	0.25	1.26	60	4.11	6.22
Geoffrea spinosa Jacq.	Leguminosae	3	12	0.8506	0.49	2.51	40	2.74	6.10
Croton sp. (RTP964)	Euphorbiaceae	5	20	1.42	0.07	0.38	60	4.11	5.91
Cyathostegia mathewsii (Jacq.) Benth.	Leguminosae	6	24	1.71	0.10	0.53	40	2.74	4.97
Unknown sp. (RTP966)	Unknown	8	32	2.28	0.12	0.62	20	1.37	4.27
Pithecellobium excelsum (Kunth) Benth.	Leguminosae	4	16	1.14	0.07	0.33	40	2.74	4.21
Acacia polyphylla DC.	Leguminosae	3	12	0.85	0.09	0.45	40	2.74	4.05
Eriotheca ruizii (K. Schum.) A. Robyns	Bombacaceae	2	8	0.57	0.21	1.05	20	1.37	2.99
Salacia sp.	Hippocrateaceae	2	8	0.57	0.13	0.66	20	1.37	2.60
Aspidosperma cf. *parvifolium* A. DC.	Apocynaceae	2	8	0.57	0.10	0.51	20	1.37	2.45
Euphorbiaceae sp.	Euphorbiaceae	1	4	0.28	0.02	0.08	20	1.37	1.73
Bouganvillea sp. (RTP991)	Nyctaginaceae	1	4	0.28	0.01	0.07	20	1.37	1.72
TOTALS		**351**	**1404**	**100**	**19.61**	**100**		**100**	**300**

Ind. = number of individuals recorded in the plot; **Aden.** = absolute density (no. of trees/hectare); **Rden.** = relative density; **Ado.** = absolute dominance (basal area/hectare); **RelD.** = relative dominance; **Afre.** = absolute frequency (%); **Relfre.** = relative frequency; **IVI** = rel. density + rel. dominance + rel. frequency.

Table 2. – Phytosociological data for the 0.4 hectare dry forest plot on Hacienda Sr. Rafael Linares Bensimón, 25km from Tarapoto on the road to Juanjui. Species ordered by IVI.

Species	***Family***	***Density***			***Dominance***		***Frequency***		***IVI***
		Ind.	***Aden.***	***Rden.***	***Ado.***	***RelD.***	***Afre.***	***Relfre.***	
Manilkara bidentata (A. DC.) Chev.	Sapotaceae	33	165	16.84	5.5135	38.36	100	5.06	60.26
Schinopsis peruvianum Engl.	Anacardiaceae	3	15	1.53	2.7293	18.99	75	3.80	24.32
Trichilia ulei C. DC.	Meliaceae	17	85	8.67	0.8191	5.70	100	5.06	19.44
Maytenus cf. *macrocrapa* (Ruiz & Pav.) Briq.	Celastraceae	15	75	7.65	0.3700	2.57	100	5.06	15.29
Maytenus sp. (S2784)	Celastraceae	15	75	7.65	0.2632	1.83	100	5.06	14.55
Rheedia spruceana Engl.	Clusiaceae	8	40	4.08	0.7351	5.12	100	5.06	14.26
Trichilia elegans A. Juss.	Meliaceae	10	50	5.10	0.2871	2.00	100	5.06	12.16
Erythroxylum cf. *ulei* O. E. Schultz	Erythroxylaceae	10	50	5.10	0.1987	1.38	100	5.06	11.55
Euterpe sp.	Palmae	8	40	4.08	0.4116	2.86	75	3.80	10.74
Sorocea sp. (S2799)	Moraceae	7	35	3.57	0.3618	2.52	75	3.80	9.89
Capparis quina J. F. Macbr.	Capparaceae	8	40	4.08	0.2161	1.50	75	3.80	9.38
Simira rubescens (Benth.) Steyerm.	Rubiaceae	5	25	2.55	0.1776	1.24	100	5.06	8.85
Drypetes sp. (S2779)	Euphorbiaceae	5	25	2.55	0.5388	3.57	50	2.53	8.83
Triplaris cf. *peruviana* C. A. Mey.	Polygonaceae	7	35	3.57	0.1139	0.79	75	3.80	8.16
Coccoloba sphaerococca Lindau	Polygonaceae	6	30	3.06	0.1194	0.83	75	3.80	7.69
Capparis sp. (S2787)	Capparaceae	6	30	3.06	0.1681	1.17	50	2.53	6.76
Cereus hexagonus / *C. jamacaru* complex	Cactaceae	4	20	2.04	0.2952	2.05	50	2.53	6.63
Clusia sp. (S2790)	Clusiaceae	3	15	1.53	0.1434	1.00	75	3.80	6.33
Coccoloba scandens Casar.	Polygonaceae	3	15	1.53	0.0954	0.66	75	3.80	5.99
Sideroxylon obtusifolium (Roem. & Schult.) T. D. Penn.	Sapotaceae	3	15	1.53	0.1429	0.99	50	2.53	5.06
Praecereus euchlorus K. Schum.	Cactaceae	4	20	2.04	0.2054	1.43	25	1.27	4.74
Urera elata (Sw.) Griseb.	Urticaceae	3	15	1.53	0.0852	0.59	50	2.53	4.66
Alseis peruvianum Standl.	Rubiaceae	2	10	1.02	0.0805	0.56	50	2.53	4.11
Amyris pinnata Kunth	Rutaceae	2	10	1.02	0.0585	0.41	50	2.53	3.96
Neea sp. (S2798)	Nyctaginaceae	2	10	1.02	0.0334	0.23	50	2.53	3.78
Celtis aff. *pubescens* Humb. & Bonp.	Ulmaceae	2	10	1.02	0.0868	0.60	25	1.27	2.89
Rhamnus sp. (S2752)	Rhamnaceae	1	5	0.51	0.0475	0.33	25	1.27	2.11
Cordia sp. (S2803)	Boraginaceae	1	5	0.51	0.0318	0.22	25	1.27	2.00
Platymiscium pinnatum (Jacq.) Dugand	Leguminosae	1	5	0.51	0.0141	0.10	25	1.27	1.87
Casearia sylvestris Sw.	Flacourtiaceae	1	5	0.51	0.0141	0.10	25	1.27	1.87
Randia sp. (S2795)	Rubiaceae	1	5	0.51	0.0141	0.10	25	1.27	1.87
TOTALS		**196**	**980**	**100**	**14.372**	**100**		**100**	**300**

Ind. = number of individuals recorded in the plot; **Aden.** = absolute density (no. of trees/hectare); **Rden.** = relative density; **Ado.** = absolute dominance (basal area/hectare); **RelD.** = relative dominance; **Afre.** = absolute frequency (%); **Relfre.** = relative frequency; **IVI** = rel. density + rel. dominance + rel. frequency.

Table. 3. – Importance value indices (IVI) for the dry forest families found in the Bauga Grande plot.

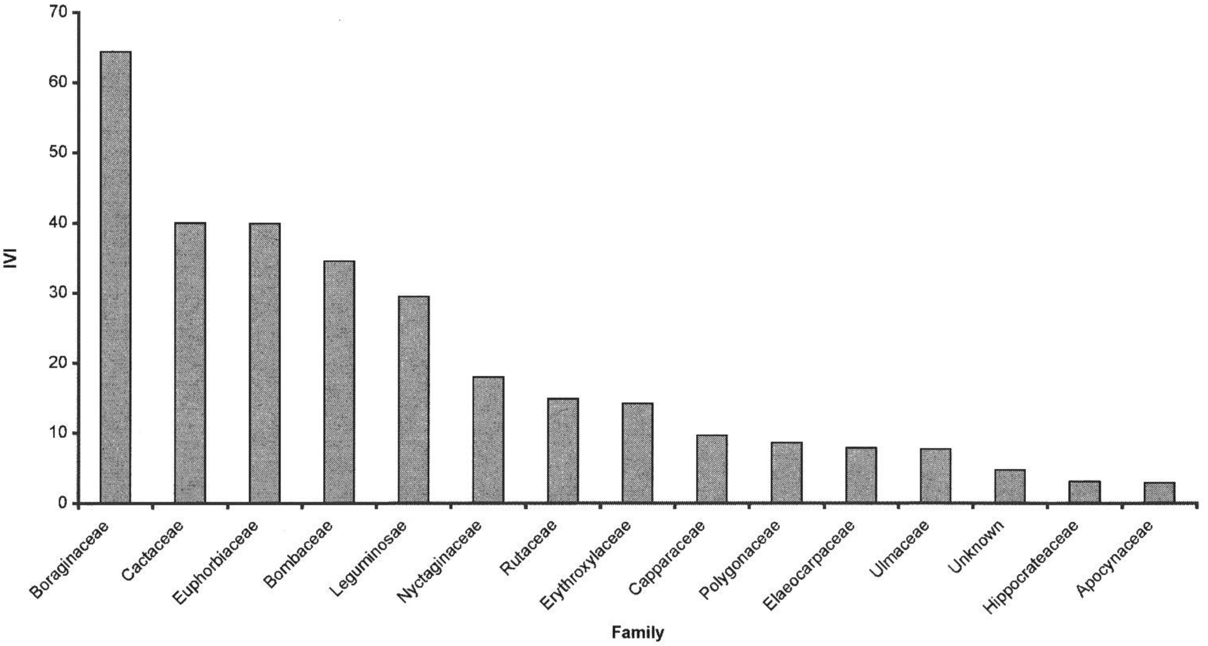
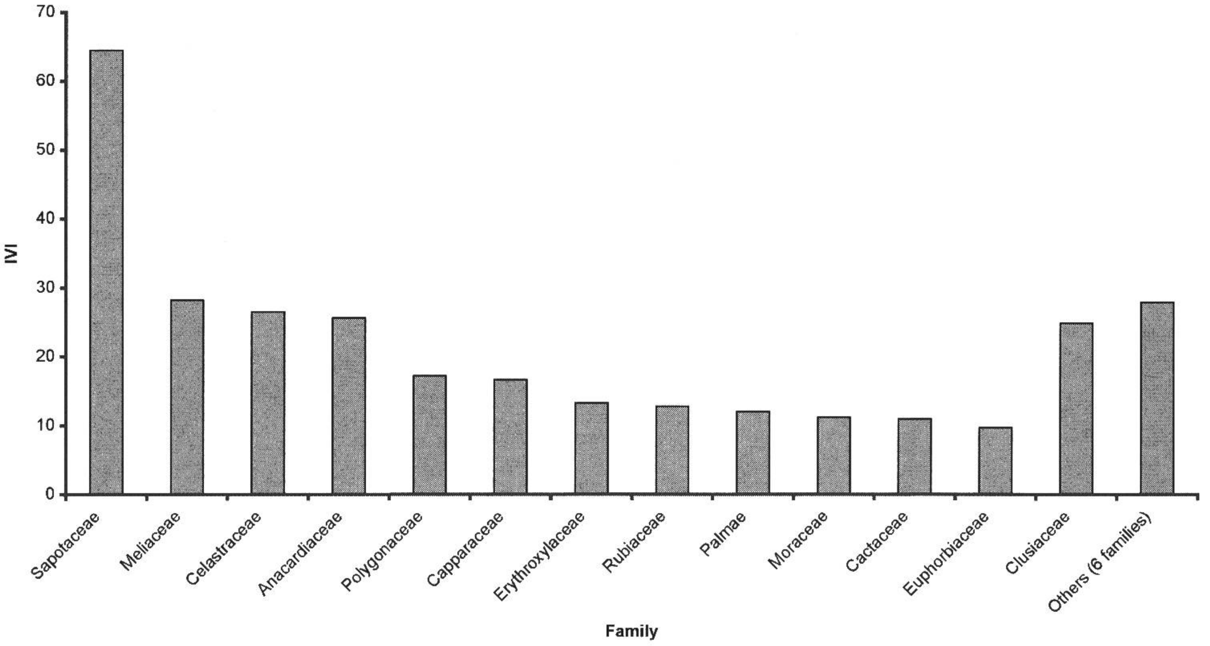


Table. 4. – Importance value indices (IVI) for the dry forest families found in the Tarapoto plot.



The Catalogue of Flowering Plants and Gymnosperms of Peru (BRAKO & ZARUCCHI, 1993) records 17,143 species of flowering plants and gymnosperms as occurring in the country – ca. 6 % of the world total. The plant species diversity of the three departments of northern Peru visited in the present survey is high because of the huge range of topography and climate to be found within them – Cajamarca, Amazonas and San Martín have 2699, 3474 and 3827 species of higher plants respectively (ALVA & al., 1999). In the present survey, general collecting carried out within the SDTFs and closely allied formations recorded a total of 55 species (not including lianas) for Cajamarca, 100 for those of Amazonas (45 of which were recorded inside the 0.25 hectare plot) and 89 species for the SDTF found at Tarapoto (29 of which were inside the plot). Although our rapid surveys concentrated upon woody plants, and certainly do not represent an exhaustive inventory of the woody flora of these areas, these figures strongly indicate that the SDTFs are species poor, and make up a relatively small proportion of the total diversity for the region.

Phytosociology

Structurally, SDTF plots are very variable, typically showing between 310 and 860 trees/hectare (trees ≥10 cm dbh) and a basal area of between 13 and 57 m2/hectare (GENTRY, 1995). Both the forest plots of the current survey fall close to the lower density values recorded for dry forests with 352 and 440 individuals/hectare recorded for Bagua Grande and Tarapoto respectively. Likewise, the basal areas of both sites were relatively low, the Bagua Grande forest plot having a basal area of 14.25 m^2/hectare (≥10 cm dbh) and the Tarapoto plot 12.49 m^2/hectare (≥10 cm dbh). These low levels may reflect disturbance and past removal of important tree species.

Two plant families which tend to dominate South American SDTFs and which are represented by the most species are the *Leguminosae* and the *Bignoniaceae* (GENTRY, 1995). Significantly, however, neither of these two families dominated the study plots. The *Bignoniaceae* was absent from the tree flora of both sites (but would have been important in the liana element), although a species of *Tabebuia* was observed as a seedling at Bagua Grande, and trees of the same genus were commonly observed in the surrounding area. The bigger stems of *Tabebuia* were removed from the Bagua Grande plot by logging, the wood being highly prized locally. One of the authors (A. Daza) remembers *Tabebuia* being common in the region in the 1960s and 1970s, and cut stems were indeed occasionally observed in the area. *Tecoma*, the only other woody genus of this family recorded (as a shrub) was relatively abundant in the general Amazonas and Cajamarca area although was not present in the plots.

The *Leguminosae* was the most speciose family at the Bagua Grande site (6 out of 26 species), although in terms of the Importance Value Index (IVI) the family was not as dominant as one might expect, being ranked fifth after the *Boraginaceae*, *Cactaceae*, *Euphorbiaceae* and *Bombacaceae*. These families were represented by relatively few species (1, 2, 2 and 2 respectively), with the *Euphorbiaceae* and *Bombacaceae* both represented primarily by a few very large trees. Most notable of these were *Hura crepitans* (*Euphorbiaceae*), *Ceiba insignis* and *Eriotheca ruizii* (*Bombacaceae*). *Cordia iguaguana* (*Boraginaceae*), dominated the forest (in terms of IVI) at Bagua Grande.

Surprisingly, within the Tarapoto plot only one legume individual with a dbh ≥5 cm was recorded – *Platymiscium pinnatum*. This is a widespread generalist species occurring from Costa Rica down to Bolivia (KLITGAARD, 1999). At this site the four most important families (in terms of IVI) were the *Sapotaceae* (*Manilkara* and *Sideroxylon*), *Meliaceae* (*Trichilia* spp.), *Celastraceae* (*Maytenus*) and *Anacardiaceae* (*Schinopsis*). The commonest species by far recorded in this plot (accounting for a fifth of the total IVI) was *Manilkara bidentata*, a species widespread across northern S. America, and an ecological generalist occurring in both dry and wet forest habitats. The two next most important species as assessed by IVI were *Schinopsis peruvianum* and *Trichilia ulei*. Both are endemic to the Tarapoto area (MEYER & BARKLEY, 1973; PENNINGTON & al., 1981).

The three families commonly cited as being of greater significance in SDTF than in rain forests – the *Capparaceae*, *Cactaceae* and *Erythoxylaceae*, were all represented in the two dry forest plots surveyed, although by relatively few species in all cases. However, the *Cactaceae*, although only represented by two (totally different) species at each site, were extremely conspicuous components of the vegetation – especially at Bagua Grande where 25% (86) of all individuals with a dbh ≥5cm, belonged to this family.

Two genera which are classically associated with seasonally dry forests – *Capparis* (*Capparaceae*) and *Ruprechtia* (*Polygonaceae*) were present at the sites, with *Capparis petiolaris* recorded in the Bagua Grande plot, and *C. quina* at Tarapoto. One species of *Ruprechtia* (*R. aperta* – a regional endemic) was recorded from Bagua Grande. In the general area around Jaén and Bagua Grande, *Capparis* was extremely common (most frequently observed were *C. guayaquilensis* and *C. scabrida*, the latter being also common in the Loja province of southern Ecuador (G. Lewis, pers. comm.), and together with cacti and *Cordia* (in particular *C. lutea*) were the most conspicuous elements of the thorny dry forest scrub that covered much of the area around the remaining patches of SDTFs.

At the generic level, in addition to *Capparis*, GENTRY (1995) lists the most common South American dry forest genera as *Tabebuia*, *Cordia*, *Casearia*, *Bauhinia*, *Trichilia*, *Erythroxylum*, *Randia*, *Hippocratea*, *Serjania*, *Croton* and *Zanthoxylum*. With the exception of *Hippocratea* and *Serjania* (which were not recorded as present in the plots, although as both are usually found as vines they may have been present but not noted) all of these genera were present in at least at one of the two sites.

At the generic level, both structurally and floristically, despite certain anomalies, both of the study sites can be considered as classic South American SDTF areas, with the majority of the expected families and genera represented. It is at the species level, however, that the real interest of these dry forest fragments is to be found.

Endemism

ALVA & al. (1999) state that the levels of endemism in northern Peru as a whole are extremely high, with more than 715 species and 11 genera recognised as endemic. Taking a close look at the current dry forest plot data, the component flora comprises species belonging to three broad categories: Geographically widespread species with a wide ecological tolerance; widespread species restricted to dry forests; dry forest regional endemics.

Approximately 20% of the flora of the Bagua Grande plot is composed of species endemic to the SDTF of northwestern Peru and southern Ecuador (5 out of 26 species). Of the succulents, the cactus *Rauhocereus riosaniensis* is a narrowly restricted endemic species of northern Peru (TAYLOR, pers. comm., 2001), whereas the other cactus present (*Praecereus euchlorus*) is a widespread classic Peistocene Arc species (*sensu* PRADO & GIBBS, 1993). However, the form found at Bagua Grande (subsp. *jaenensis*) is endemic to northern Peru. The region of the Marañon valley is rich in cactus endemics, which may reflect that it is close to the ancestral area of the *Cactaceae* (N. TAYLOR, pers. comm., 2001). Of the woody element, a further three species are narrow SDTF endemics. *Ruprechtia aperta* (*Polygonaceae*) is restricted to the Marañon drainage basin and Pacific slopes of the Western Andean Massif (PENDRY, pers. comm., 2002), *Cyathostegia mathewsii* (*Leguminosae*) to northern Peru and southern Ecuador (IRELAND, 2001) and *Pithecellobium excelsum* (*Leguminosae*) to semi-deciduous thorn scrub and woodland from SW Ecuador and NW Peru (BARNEBY & GRIMES, 1997). In addition, *Celtis loxensis* (*Ulmaceae*) is endemic to dry forest areas of SW Ecuador and NW Peru (BERG & DAHLBERG, 2001). The remainder appear to be of more widespread distribution. These include *Geoffrea spinosa* (a dry forest Pleistocene Arc species), *Aspidosperma parvifolium* (a generalist found across S. America), *Hura crepitans* (an ecological generalist of northern S. America), *Eriotheca ruizii* (restricted to dry vegetation of the Pacific coast of Ecuador and northern Peru (ROBYNS, 1963)) and *Ceiba insignis*, a polymorphic complex widespread across S. America (GIBBS & al., 1988). *Zanthoxylum rigidum* is a widespread species occurring in both dry and humid forest systems from Paraguay to Colombia, and *Piptadenia viridiflora* is found across S. America.

For the Tarapoto plot, a similar pattern can be seen, with three of the 31 species (ca. 10%) being narrow endemics to the Tarapoto area. Of these, *Schinopsis peruvianum*, *Trichilia ulei* and *Triplaris peruviana* are endemic to the Tarapoto area and the Rio Huallaga (MEYER & BARKLEY, 1973; PENNINGTON & al., 1981; BRANDBYGE, 1986). Outside the plot, other endemic species were found including *Platymiscium gracile*, *Lecointea* cf. *peruviana* and *Inga tenuicalyx*. The remainder of the flora is made up from wide ranging species including *Trichila elegans*, *Manilkara bidentata*, *Platymiscium pinnatum*, *Rheedia spruceana*, *Cereus* sp. (*C. hexagonus/C. jamacaru* complex), *Sideroxylon obtusifolium*, *Casearia sylvestris* and *Praecereus euchlorus*.

Phytogeography

Our data indicate very low floristic similarity between the Bagua Grande and Tarapoto plots. Only one species is shared (*Praecereus euchlorus* – although represented at each site by a different subspecies) and four genera (*Cordia*, *Erythroxylum*, *Capparis* and *Praecereus*). Even with general collecting outside of the plots in both dry forest areas in the Tarapoto and Marañon basin areas (and including inventory data collected by GENTRY (Missouri Botanical Garden Website) in Tarapoto), only four species (*Bauhinia glabra*, *Colubrina* cf. *retusa*, *Platymiscium pinnatum* and *Sideroxylon obtusifolium*) are found to be in common between the dry forest formations of these regions – a similarity of only 2% (out of a total of 198 species recorded for the two areas).

This floristic dissimilarity may reflect strong present-day geographical barriers between the two SDTF sites, represented by the Eastern Andean Massif, which is covered in mesic forest. These particular STDF fragments have not been linked in a single uniform block in recent geological history because the Andean uplift occurred during the Miocene, between 23 and 5 million years BP [before present] (BURNHAM & GRAHAM, 1999).

The SDTF of Tumbes, on the Pacific slope of the Andes, and the Marañon basin are separated from one another by the similarly substantial barrier of the Western Andean Massif. In one area, however, recent migration of SDTF species may have been possible. This is via the Porculla Gap – which represents the lowest pass (only 2000 m) over the entire Andean chain. The SDTF of the Marañon basin and that of Tumbes are separated by only a narrow band of mesic montane vegetation over the Porcuya gap, representing a horizontal distance of 10 km, and an altitudinal barrier of ca. 600 m (personal observations; the main highway to our study sites runs through the Porcuya gap).

A species list (179 species in total) for the dry forest area Coto de Caza El Angolo (TRIGOSO, 1989) which lies south of Tumbes in Peru near the Pacific coast, reveals that 10 species (representing 10% of the flora) are in common with the SDTFs of the Marañon drainage (as compiled through the present study), of which three species (*Eriotheca ruizii*, *Leucaena trichodes* and *Pithecellobium excelsum*) were recorded in the plots as Bagua Grande. This equates to 6.5% of the plot flora in common. This suggests a greater potential for migration, perhaps through the Porculla gap, and is indicated by greater floristic similarity between the STDF of Tumbes and that of the Marañon valley than that found for the comparison of the SDTF of Marañon and Tarapoto. Overall similarity, however, is still low, indicating that the western Andean chain still acts as a considerable barrier. There are two explanations for these shared distribution patterns. Either there has been movement of species across the Western Andean Massif via the Porcuya Gap, or their present disjunction is due to the Andes uplift splitting a former more continuous distribution pattern.

Further data for SDTF on the Pacific side of the Peruvian Andes are available from a floristic survey conducted in six hectares of SDTF in Tumbes (LINARES-PALOMINO, unpubl. data) and from a SDTF site at 800 m altitude along the highway from Olmos towards the Porcuya gap on the Pacific side of the Western Massif, only 30 km from the Marañon basin, where the authors made collections on route to their study sites. There are two species in common (*Eriotheca ruizii* – a broad regional endemic, and *Geoffrea spinosa* – a Pleistocene Arc species) between the Tumbes and Bagua Grande plots, and one species (*Alseis peruvianum*) between the Tumbes and Tarapoto plots. If the floristic comparison is extended to compare these Tumbes plots with species recorded outside of the present study plots through general collecting, a further four species (*Cordia lutea*, *Loxopterigium huasango*, *Bougainvillea peruvianum* and *Acacia macracantha*) are also found in common between the Tumbes plot and the general dry forest area of the Marañon basin bringing the total to four. Of these, *L. huasango* is endemic to SDTF areas of the north of Peru. This species was found for the first time in the Marañon drainage, east of the Andes during this study (J. MITCHELL, pers. comm.), but its distribution in the Marañon basin (i.e. eastern side) appears to be confined to the immediate slopes of the Massif, and is not present further eastwards into the Department of Cajamarca. This indicates lower similarity (ca. 2.5%) between the Marañon area and Pacific sites than demonstrated for the comparison with Coto de Caza Angolo. Limited collections made by the authors on the Olmos highway contain three species in common with those of the Marañon basin – *Celtis loxensis*, *Ruprechtia aperta* and *Loxopterigium huasango* (all regional endemics).

A wider biogeographic question concerns the affinities of the northern Peruvian SDTF with SDTF in Ecuador and Bolivia, adjacent to Peru. El Bosque Petrificado de Puyango is found in the south of Ecuador in the provinces of Loja and El Oro. A survey of 0.2 hectares of this SDTF identified 49 species with a dbh ≥5cm (KLITGAARD & al., 1999). A floristic comparison between this plot and those at Bagua Grande and Tarapoto reveal little similarity – with only one species in common with the Bagua Grande plot (*Eriotheca ruizii*), and none with the Tarapoto plot. However, a more in depth enquiry focusing on the Leguminosae shows clear floristic links between the STDFs of northwestern Peru and southern Ecuador. *Leguminosae* are a good indicator group in this case because it was more thoroughly collected than other families; one of the authors (Toby Pennington) is a legume specialist and his collecting in the Marañon and Tarapoto areas focused solely upon this family. Furthermore, there is a recent checklist for legumes from Southern Ecuador (LEWIS & KLITGAARD, 2002) record 247 native legume species and 24 introduced legume species for southern Ecuador. Of the 44 legume species recorded in the present survey, 21 have also been recorded for southern Ecuador. In addition the SDTFs of southern Ecuador and northwestern Peru share many of the same regional endemics e.g. *Pithecellobium excelsum*, *Cyathostegia mathewsii*, *Celtis loxensis*, *Loxopterygium huasango* and *Eriotheca ruizii.*

A comparison of the SDTF species lists for both the Marañon valley and Tarapoto with the Catalogue of the Vascular Plants of Ecuador (JØRGENSEN & LEÓN-YÁNEZ, 1999) reveals that of the 92 woody species recorded to species level in the Marañon valley, 37 (40%) are also found in Ecuador. Many of the shared species are endemic to northern Peru and Southern Ecuador. Of the 72 woody species found in the SDTFs around Tarapoto, 21 (29%) are found in Ecuador, although the majority of these are widespread, ecologically general species. Unlike the Marañon valley, there are no shared endemics between Tarapoto and southern Ecuador.

KESSLER & HELME (1999) present a floristic survey of the SDTF of the Central Tuichi Valley in Bolivia. General collections made by the authors combined with species lists compiled for the area by others reveal 147 species of tree. Of these, 75 are identified to species level allowing comparisons to be made with our floristic lists. Five species are found to be in common with the present study plots – *Hura crepitans*, *Casearia sylvestris*, *Albizia niopoides*, *Trichilia elegans* and *T. pleeana*, representing a similarity of ca. 3% with the Tarapoto plot, and ca. 1% with the Bagua Grande plot. All of these species are widespread ecological generalists and not confined to SDTFs. From the study of selected indicator groups (*Acanthaceae*, *Araceae*, *Bromeliaceae*, *Cactaceae*, *Palmae* and *Pteridophyta*), KESSLER & HELME estimate that 24% of the flora of the Tuichi Valley to be endemic to Bolivia, with 3% endemic to the valley itself. They record the strongest phytogeographical affinities to be with other lowland SDTF areas within Bolivia, as well as similar forests along the sub-Andean zone to northwestern Argentina and extending to interior southeastern Brazil. They conclude that there are few affinities with the SDTFs of northern S. America, and our data certainly supports this. Strongest floristic links appear to lie between the SDTFs of the Marañon basin and southern Ecuador which we suggest may make up a phytogeographic unit, whilst the affinities of the Tarapoto SDTFs lie elsewhere.

In summary, a comparison of the two present SDTF plots with those of other nearby but disjunct SDTF in Peru (Tumbes), Bolivia (Central Tuichi Valley) and Ecuador (Bosque Petrificado de Puyango), clearly shows that the floristic links between the dry forest patches in Peru and Bolivia, and within Peru itself are relatively weak, with strong internal heterogeneity. At the generic level, SARMIENTO (1975) has analysed the floristic affinities of the dry vegetation formations (in the broadest sense) of South America. He recorded the maximum Sorensen coefficient of similarity of the Central Andean valleys (including the Marañon and Huallaga) as 48% (ca. 34 genera in common), its closest floristically being the Northern Andean valleys of Venezulea and Ecuador. However, the SDTFs of the Central Andes were omitted from the analysis. Certainly there are generic-level similarities between all of the dry forest formations, but in the case of the northern Peruvian Inter-andean SDTFs, few at the species level.

Conclusions

Data derived from SDTF inventory plots and from general collecting indicates that although the woody flora of the northern Peruvian SDTFs is depauperate, it comprises a high percentage of narrow regional endemic species. Disjunct SDTF patches on the Pacific coast, in the Marañon valley and around Tarapoto show remarkably little floristic similarity for the woody flora, suggesting that there has been little recent historical species movement between them. This has important implications for the establishment of conservation areas because protection of each SDTF fragment will be necessary if all species are to be protected. The obvious present-day physical barriers preventing species migration between the SDTF areas are the Eastern and Western Andean Massifs and the mesic montane forest which clothes them. However, the SDTF areas might have been joined in the past before the uplift of the Andes, with the low similarity reflecting subsequent speciation and extinction. An examination of the species distribution patterns suggests that some species migration between the Marañon drainage and the Pacific region may have occurred recently via the Porcuya Gap – the lowest pass over the Andes. Based on the comparison with SDTF plot data from southern Ecuador, there appears to be little floristic similarity between the northern Peruvian dry forests and this region. However, a more detailed analysis of Leguminosae suggests that these areas do belong to a putative phytogeographical unit. The low floristic similarity between the Peruvian (and Ecuadorean) and Bolivian dry forests would indicate that the latter may be more closely related to those of Argentina, Paraguay and Brazil and should not belong to the phytogeographical unit of the northern areas.

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Address of the authors: S. B., R. T. P.: Royal Botanic Garden Edinburgh, 20A Inverleith Row, Edinburgh, EH3 5LR, UK.

C. A. R., A. D.: Facultad de Ciencias Forestales, Universidad Nacional Agraria la Molina, Lima, Peru.

T. D. P.: Herbarium, Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AB, UK.

Appendix 1. – Species list.
The species lists are arranged by family, region, and by Department. The species lists are composed from plot inventories together general collections made from around the plot areas. The majority are woody. Species which occurred in the plots are identifed by 'P'. Species occurring in gallery forest are identified by 'g'. Vouchers were collected by S. Bridgewater (S) & Toby Pennington (RTP).

Species	***A***	***B***		***C***
	Pacific Drainage (Cajamarca)	***Marañon Drainage***		***Tarapoto (San Martín)***
		Cajamarca	***Amazonas***	
Acanthaceae				
Justicia sp. (S972)			P	
Pachystachys puberula Wassh.				X
Tetramerium aff. *peruvianum* (Lindau) T. F. Daniel		X		
Anacardiaceae				
Astronium fraxinifolium Schott				X
Loxopterygium huasango Spruce	X		X	
Schinopsis peruviana Engl.				X
Annonaceae				
Rollinia cf. *mucosa* (Jacq.) Baill.				X
R. ulei Diels				X
Xylopia aromatica (Lam.) Mart.				X
Apocynaceae				
Aspidosperma cf. *parvifolium* A. DC.		X	P	
Geissospermum reticulatum A. H. Gentry			X	
Araceae				
Anthurium bardayanum Engl.				X
Asteraceae				
Baccharis tricuneata (L. f.) Pers.	X			
Onoseris weberbaueri Ferreyra			P	
Bignoniaceae				
Cybistax antisyphilitica (Mart.) Mart.				X
Jacaranda glabra (DC.) Bureau & K. Schum.				X
Tabebuia aurea (Manso) S. Moore				X
T. roseo-alba Ridley				X
Tabebuia sp. (S967)			P	
Tabebuia sp. (S2769)				X
Tabebuia sp. (S2727)			X	
Tecoma rosifolia Kunth			X	
Tecoma sp. (S1042)		X	X	
Bombacaceae				
Ceiba insignis (Kunth) Gibbs & Semir			P	
Eriotheca ruizii (K. Schum.) A. Robyns		X	P	
Pachira aff. *aquatica* Aubl.				X
Boraginaceae				
Cordia alliodora (R. & P.) Oken				x
C. iguaguana I. M. Johnst.			P	
C. lutea Lam.			X	
C. varronifolia I. M. Johnst.		X		
Cordia sp. (S2803)				P
Heliotropium cf. *arborescens* L.				X

Appendix 1 (cont.)

Species	***A***	***B***		***C***
	Pacific Drainage (Cajamarca)	***Marañon Drainage***		***Tarapoto (San Martín)***
		Cajamarca	***Amazonas***	
Boraginaceae (cont.)				
Heliotropium sp. (S2707)		X		
Saccelium lanceolatum Kunth		X	P	
Cactaceae				
Browningia altissima (F. Ritter) F. Buxb.		X		
Ceistocactus sp.		X		
Espostoa sp.		X		
Melocactus bellavistensis Rauh. & Backeb.		X		
Pereskia rorida DC.			X	
Praecereus euchlorus K. Schum.			P	
Rauhocereus riosaniensis Backeb.			P	
Cactaceae sp.			P	
Leguminosae: Caesalpinioideae				
Apuleia leiocarpa (Vog.) Macbride				X
Bauhinia glabra Jacq.			X	X
Bauhinia sp. (RTP785)		X		
Caesalpinia cassioides Willd.		X		
C. glabrata Kunth		X		
C. spinosa Kuntze			X	
Caesalpinia sp. nov. (RTP 955)		X		
Parkinsonia praecox (R. & P.) Hawkins			X	
Senna bacillaris (L. f.) Irwin & Barneby				X
S. huancabambae (Harms) Irwin & Barneby		X		
S. mollissima (Willd.) Irwin & Barneby	X		X	
S. pallida (Vahl) Irwin & Barneby		X	X	
S. pistaciifolia (Kunth) Irwin & Barneby	X			
Capparaceae				
Belencita sp. (S965)			P	
Capparis crotonoides Kunth				X
C. guayaquilensis Kunth		X	P	
C. cf. *heterophylla* DC.	X			
C. petiolaris Kunth			P	
C. quina J. F. Macbr.				X
C. scabrida Kunth		X	X	
Capparis sprucei Eichl.			P	X
Capparis sp. (S1052)	X			
Morisonia oblongifolia Britton				X
Steriphoma cinnabarina Gilg				X
Caricaceae				
Carica candicans A. Gray	X			
Celastraceae				
Maytenus durifolia Briq.	X			
M. macrocarpa (Ruiz & Pav.) Briq.				P
Maytenus cf. *octogna* (L'Hér.) DC.			X	
Maytenus sp. (S963)			P	
Maytenus sp. (S2730)			P	
Maytenus sp. (S2782)				P

Appendix 1 (cont.)

Species	***A***	***B***		***C***
	Pacific Drainage (Cajamarca)	***Marañon Drainage***		***Tarapoto (San Martín)***
		Cajamarca	***Amazonas***	
Clusiaceae				
Clusia sp. (S956)		X		
Clusia sp. (S2790)				P
Rheedia spruceana Engl.				X
Commelinaceae				
Commelinaceae (RTP 981)				X
Connaraceae				
Connarus elsae Forero				X
C. punctatus Planch.				X
Convolvulaceae				
Evolvulus cf. *magnus* Helwig			X	
Ipomoea carnea Jacq.		X		
Crassulaceae				
Crassulaceae sp. (S1047)		X		
Dilleniaceae				
Curatella americana L.				X
Ebenaceae				
Diospyros inconstans Jacq.				X
Elaeocarpaceae				
Sloanea sp. (RTP752)			P	
Erythroxylaceae				
Erythroxylum aff. *deciduum* A. St.-Hil.			P	
E. cf. *ulei* O. E. Schulz				P
Euphorbiaceae				
Croton sp. (S964)			P	
Croton sp. (S952)		X		
Croton sp. (S958)			P	
Croton sp. (S1002)			X	
Drypetes sp. (S2779)				X
Euphorbia sp.			P	
Hura crepitans L.			P	
Maprounea guinanesis Aubl.				X
Phyllanthus acuminatus Vahl		X		
Euphorbiaceae sp. (S998)			X	
Euphorbiaceae sp. (S958)			P	
Euphorbiaceae sp. (S995)			P	
Leguminosae: Faboideae				
Aeschynomene molllicula Kunth		X	X	
Clitoria amazonum Benth.				X
C. juninensis Fantz			X	
Coursetia maraniona Lavin		X		
Cyathostegia matthewsii (Jacq.) Benth.			P	
Dalea carthagenensis var. *brevis* (J. F. Macbr.) Barneby		X	X	
Desmodium cajanifolium (Kunth) DC.				X

Appendix 1 (cont.)

Species	***A***	***B***		***C***
	Pacific Drainage (Cajamarca)	***Marañon Drainage***		***Tarapoto (San Martín)***
		Cajamarca	***Amazonas***	
Leguminosae: Faboideae (cont.)				
D. cf. *incanum* DC.		X		
Erythrina velutina Willd.	X			
Geoffrea spinosa Jacq.		X	P	
Indigofera lespedezioides Kunth				X
I. suffruticosa Mill.		X		
Lecointea cf. *peruviana* J. F. Macbr.				X
Lonchocarpus atropurpureus Benth.		X		
L. confertiflorus Benth.				X
L. hedyosmus Miq.				X
Machaerium isadelphum (E. Meyer) Amshoff				X
Machaerium sp. (RTP 968)				X
Machaerium sp. (RTP 971)				X
Platymiscium gracile Benth.				X
P. pinnatum (Jacq.) Dugand			P	X
Pterocarpus sp. (RTP 983)				X
Stylosanthes sympodialis Taub.		X		
Tephrosia cinerea (L.) Pers.		X		
Flacourtiaceae				
Adenaria floribunda Kunth				X
A. cf. *tumbezensis* J. F. Macbr.		X	X	
Casearia sylvestris Sw.				P
Xylosma sp. (S2755)				X
Flacourtiaceae sp. (S2712)		X		
Gesneriaceae				
Gesneriaceae (S1016)			X	
Hippocrateaceae				
Salacia sp. (RTP752)			P	
Krameriaceae				
Krameria lappacea (Dombey) Burdet & B. B. Simpson		X		
Juglandaceae				
Juglans neotropica Diels			X	
Lythraceae				
Physocalymma scaberrimum Pohl				X
Malphigiaceae				
Bunchosia hookeriana A. Juss.				X
Byrsonima crassifolia (L.) Kunth				X
Stigmaphyllon peruvianum Nied.		X		
Malphigiaceae (S1036)		X		
Malphigiaceae (RTP803)		X		
Malphigiaceae (S2714)		X		
Malvaceae				
Hibiscus brasiliensis L.			X	
Hibiscus sp. (S993)			P	
Pavonia cf. *mollis* Kunth			X	
Tetrasida polyantha Ulbr.			X	

Appendix 1 (cont.)

Species	***A***	***B***		***C***
	Pacific Drainage (Cajamarca)	***Marañon Drainage*** ***Cajamarca***	***Amazonas***	***Tarapoto (San Martín)***
Melastomataceae				
Tibouchina ochypetala (Ruiz & Pav.) Baill.				X
Meliaceae				
Cedrela sp. nov. (RTP 1031)	X			
Cedrela sp. (RTP 786)			Xg	
Schmardea microphylla Müll.	X			
Trichilia elegans A. Juss.				X
T. pallida Sw.			X	
T. pleeana (A. Juss.) C. DC.				X
T. tomentosa Kunth	X			
T. ulei C. DC.			X	
Leguminosae: Mimosoideae				
Acacia aroma Hook. & Arn.		X		
A. farnesiana (L.) Willd.				X
A. macracantha Willd.			X	
A. polyphylla DC.			P	
A. tortuosa (L.) Willd.			P	
A. weberbaueri Harms		X		
Albizia niopoides (Benth.) Burkart			X	
Albizia sp. nov. (aff. *niopoides*)				X
Calliandra mollissima (Willd.) Benth.			X	
Chloroleucon mangense (Jacq.) Britton & Rose		X		X
Cojoba aff. *chazutensis* Standl.			X	
Inga ornata Kunth			X	
I. tenuicalyx T. D. Penn.				X
Leucaena trichodes (Jacq.) Benth.		X	P	
Mimosa pectinatipinna Burkart		X	X	
Piptadenia viridiflora (Kunth) Benth.			P	
Piptadenia sp. (P16838)				X
Pithecellobium excelsum (Kunth) Benth.			P	
Pithecellobium sp. (RTP 945)		X		
Prosopis aff. *juliflora* (Sw.) DC.		X		
Moraceae				
Clarisia racemosa Ruiz & Pav.				X
Ficus trigona L. f.			Xg	
Maclura tinctoria (L.) Steud.		Xg		
Sorocea sp. (S2799)				P
Myrtaceae				
Myrtaceae (S1005)			X	
Myrtaceae (S2820)	X			
Myrtaceae sp (S2791)				X
Nyctaginaceae				
Bougainvillea peruviana Humb. & Bonpl.			X	
B. pachphylla Standl.		X		
Bougainvillea sp. (S991)			P	
Bougainvillea sp. (S950)		X		
Neea cf. *spruceana* Heimerl				X
Nyctaginaceae			P	
Nyctaginaceae (RTP747)			P	

Appendix 1 (cont.)

Species	***A***	***B***		***C***
	Pacific Drainage (Cajamarca)	***Marañon Drainage***		***Tarapoto (San Martín)***
		Cajamarca	***Amazonas***	
Ochnaceae				
Ouratea sp. (S2805)				P
Piperaceae				
Peperomia sp. (S974)			P	
Piper sp. (RTP787)			X	
Phytolacaceae				
Phytolacca weberbaueri H. Walter	X			
Rivinia humilis L.			P	
Polygonaceae				
Coccoloba scandens Casar.				P
C. sphaerococca Lindau				P
Ruprechtia aperta Pendry			P	X
Triplaris peruviana C. A. Mey.				X
T. weigeltiona (Rchb.) Kuntze			Xg	
Portulacaceae				
Talinum triangulare (Jacq.) Willd.		X		
Rhamnaceae				
Colubrina cf. *retusa* (Pittier) R. S. Cowan			P	X
Rhamnus sp. (S2752)				X
Rubiaceae				
Alseis peruvianum Standl.				X
Condaminea corymbosa (Ruiz & Pav.) DC.				X
Randia armata (Sw.) DC.				X
Randia sp. (S2785)				P
Simira *cf.* rubescens *(Benth.) Steyerm.*				P
Rutaceae				
Amyris pinnata Kunth				X
Zanthoxylum culantrillo Kunth			P	
Z. rigidum Willd.			P	
Z. juniperinum Poepp.		X		
Zanthoxylum sp. (RTP748)			P	
Sapindaceae				
Allophylus floribundus (Poepp.) Radl.				X
A. loretensis Mart.				P
Sapindus saponaria L.			X	
Sapotaceae				
Manilkara bidentata (A. DC.) Chev.			Xg	X
Sideroxylon obtusifolium (Roem. & Schult.) T. D. Penn.		X	P	
Solanaceae				
Cestrum auriculatum L'Hér.				X
C. racemosum Ruiz & Pav.	X			
Solanum sp. (S1025)		X		

Appendix 1 (cont.)

Species	***A***	***B***		***C***
	Pacific Drainage (Cajamarca)	***Marañon Drainage***		***Tarapoto (San Martín)***
		Cajamarca	***Amazonas***	
Theophrastaceae				
Clavija myrmeciocarpa Stahl			X g	
Clavija sp. (S2721)			P	
Jacquinia pubescens Kunth		X		
Tiliaceae				
Apeiba tiboubou Aubl.				X
Luehea paniculata Mart.				X
Ulmaceae				
Celtis aff. *pubescens* Humb. & Bonpl.				P
C. loxensis C. C. Berg			P	
C. affinis De Wild.	X			
Guazuma ulmifolia Lam.			P	
Urticaceae				
Boehmeria sp. (S1027)			X	
Pilea sp. (S1006)			X	
Urera elata (Sw.) Griseb.				P
Verbenaceae				
Aloysia virgata (Ruiz & Pav.) Juss.				X
Duranta sp.			P	
Duranta sp. (S2819)	X			
Vochysiaceae				
Vochysia haenkeana Mart.				X
Unknown family				
Unknown (S964)			P	
Unknown (S2767)				X
Unknown (S2757)			X	
Unknown (S966)			P	