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Diversity and Abundance of Plants with Flowers and Fruits from October 2001 to September 2002 in
Paucarillo Reserve, Northeastern Amazon, Peru
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Table 1. Summary of plants that flowered and produced fruits during the study period.

Family	No. of Genera	No. of Species	No. of Plants	Family	No. of Genera	No. of Species	No. of Plants
1. Annonaceae	9	12	16	31. Linaceae	1	1	1
2. Apocynaceae	2	2	3	32. Loranthaceae	1	1	1
3. Araceae	4	5	9	33. Malpighiaceae	4	5	5
4. Arecaceae	11	19	236	34. Malvaceae	1	2	7
5. Araliaceae	1	1	1	35. Melastomaceae	2	3	12
6. Aristolochiaceae	1	1	2	36. Meliaceae	2	4	5
7. Asteraceae	1	1	1	37. Menispermaceae	3	4	5
8. Bignoniaceae	2	2	2	38. Moraceae	6	14	18
9. Bombacaceae	3	3	8	39. Myristicaceae	4	17	76
10. Boraginaceae	1	2	3	40. Myrsinaceae	1	1	1
11. Burseraceae	2	3	11	41. Myrtaceae	3	5	6
12. Cecropiaceae	3	12	26	42. Nyctaginaceae	1	5	6
13. Celastraceae	3	4	7	43. Ochnaceae	1	1	2
14. Chrysobalanaceae	1	1	1	44. Piperaceae	1	2	3
15. Clusiaceae	3	6	7	45. Polygalaceae	1	1	2
16. Combretaceae	1	1	2	46. Rhamnaceae	1	1	1
17. Connaraceae	3	5	5	47. Rhizophoraceae	1	1	2
18. Convolvulaceae	2	3	17	48. Rubiaceae	11	19	86
19. Cyclanthaceae	1	1	8	49. Sabiaceae	2	3	5
20. Dichapetalaceae	1	2	3	50. Sapindaceae	4	5	12
21. Dilleniaceae	2	4	6	51. Sapotaceae	3	10	21
22. Elaeocarpaceae	1	5	7	52. Simaroubaceae	1	1	1
23. Euphorbiaceae	12	15	42	53. Siparunaceae	1	1	11
24. Fabaceae	10	15	32	54. Solanaceae	2	2	2
25. Flacourtiaceae	4	6	21	55. Sterculiaceae	1	3	3
26. Gesneriaceae	1	1	11	56. Theophrastaceae	1	2	2
27. Heliconiaceae	1	2	3	57. Verbenaceae	2	3	3
28. Icacinaceae	1	1	1	58. Violaceae	3	4	10
29. Lauraceae	3	4	6	59. Vitaceae	1	1	1
30. Lecythidaceae	1	9	40	Total	157	270	847

Climate data from the nearest meteorological station in Pebas (4° S, 73° W) managed by SENAMHI (Servicio Nacional de Meteorología e Hiriología del Perú), 66,88 km northeast from the study site, recorded total precipitation of 3296,9 mm during the one year study period.

Materials and methods

The data presented here is part of a larger study of the birds and forest fruits in this area (Choo, 2005). Two study plots located in terra firme forest were established at the study site. In each plot, four parallel trails 90 m long and 50 m apart were established that served as mist-net lanes for capturing birds as part of another study, and were used for the phenological surveys described here. Each study plot consisted of 8 phenology lanes (each 90 × 10 m) flanking both sides of the net lanes. These phenology lanes covered an area of 7200 m² per study plot. The total area surveyed for 12 months at this site covered an area of 14400 m² or 1,44 ha.

Phenological data were collected from October 2001 to Sep-

tember 2002 and once for the month of December. During surveys, JC walked along net lanes to record the flowering and fruiting activity of all plants (herbs, shrubs, epiphytes, lianas and trees) found within the phenology belts. Two field assistants walked in tandem with her within the phenology belts to detect flowering and fruiting plants in the understory and to help detect flowering and fruiting canopy plants that she may have missed. When flowers or fruits were discovered on the forest floor, attempts were made to locate the source(s). Surveys were conducted visually and if necessary with the aid of binoculars (10×40 and 10×50).

All plants found flowering or fruiting were uniquely numbered with an aluminum tag. Plant habits were recorded as herb, shrub, epiphyte, treelet (subcanopy small trees), liana, tree (large canopy and subcanopy trees). Plants with easily recognized vegetative, floral and fruit characteristics were grouped in the field by JC into morphospecies and a representative voucher for each morphospecies was collected from those plants that subsequently produced fruit. All plant vouchers were deposited in the herbarium of the

Table 2. ...

Family Plants	Genus	Species	N°	
Elaeocarpaceae	<i>Sloanea</i>	<i>terniflora</i> (Moc. & Sessé ex DC.) Standl. 1944	1	
		<i>tuerckheimii</i> Donn. Sm. 1914	1	
Euphorbiaceae	<i>Caryodendron</i>	sp. nov. (aff. <i>macrophylla</i> Benth. ex Turcz 1858)	1	
		<i>grandifolium</i> (Müll. Arg.) Pax 1890	1	
		<i>guianensis</i> Aubl. 1775	3	
	<i>Conceveiba</i>	<i>palanostigma</i> Klotzsch 1843	1	
		sp.	1	
	<i>Drypetes</i>	<i>gentryi</i> Monach. 1948	1	
	<i>Hevea</i>	<i>guianensis</i> Aubl. 1775	1	
	<i>Hyeronima</i>	<i>alchorneoides</i> Allemao 1848	1	
	<i>Mabea</i>	<i>klugii</i> Steyererm 1938	5	
		<i>pulcherrima</i> Müll. Arg. 1872	10	
		<i>standleyi</i> Steyererm. 1938	3	
	<i>Nealchornea</i>	<i>yapurensis</i> Huber 1913	3	
	<i>Pausandra</i>	sp.	2	
	<i>Richeria</i>	<i>grandis</i> Vahl 1796	2	
	<i>Sagotia</i>	<i>racemosa</i> Baill. 1860-61	7	
	<i>Sapium</i>	<i>marmimeri</i> Huber 1902	1	
	Fabaceae	<i>Bauhinia</i>	<i>pterocalyx</i> Ducke 1922	10
		<i>Dalbergia</i>	<i>ecastaphyllum</i> (L.) Taub. 1894	1
		<i>Dialium</i>	<i>guianense</i> (Aubl.) Steud. 1840	1
<i>Dimorphandra</i>		<i>mollis</i> Benth. 1840	1	
		<i>brachyrachis</i> Harms 1907	4	
		cf. <i>cinnamomea</i> Spruce & Benth. 1875	2	
		<i>semialata</i> (Vell.) Mart. 1837	3	
		<i>tomentosa</i> vel sp. aff. Benth. 1875	1	
<i>Mimosa</i>		<i>rufescens</i> Benth. 1875 var <i>rufescens</i>	1	
<i>Parkia</i>		<i>nitida</i> Miq. 1851	2	
		sp.	2	
<i>Swartzia</i>		<i>cardiosperma</i> Spruce ex Benth. 1870	1	
	<i>obscura</i> Huber 1909	1		
	<i>bracteosa</i> (Harms) Zarucchi & Pipoly 1995	1		
Flacourtiaceae	<i>Tachigali</i>	<i>speciosum</i> Ducke 1932	1	
	<i>Vataireopsis</i>	<i>longifolia</i> (Poepp.) Benth. 1861	9	
	<i>Carpotroche</i>	<i>fasciculata</i> Bojer 1837	1	
Casearia		<i>syloestris</i> Sw. 1798	2	
		<i>uleana</i> Sleumer 1980	1	
	<i>Lindackeria</i>	<i>paludosa</i> (Benth.) Gilg 1925	7	
	<i>Tetrathylacium</i>	<i>macrophyllum</i> Poepp. 1843	1	
	<i>Drymonia</i>	<i>semicordata</i> (Poepp.) Wiehler 1973	11	
Gesneriaceae	<i>Heliconia</i>	sp.	1	
	<i>velutina</i> L. Andersson 1985	2		
Icacinaceae	<i>Discophora</i>	<i>guianensis</i> Miers 1852	1	
Lauraceae	<i>Chlorocardium</i>	<i>venenosum</i> (Kosterm. & Pinkley) Rohwer, H.G. Richt. & van der Werff 1991	2	
	<i>Endlicheria</i>	<i>tessmannii</i> D. C. Schmidt 1928	1	
Ocotea		cf. <i>leucoxydon</i> (Sw.) Mez 1889	1	
		cf. <i>longifolia</i> Kunth 1817	2	
Lecythidaceae	<i>Eschweilera</i>	<i>albiflora</i> (DC.) Miers 1874	2	
		<i>coriacea</i> (DC.) S.A. Mori 1990	9	
		<i>gigantea</i> (R. Kunth) J.F. Macbr 1940	2	
		<i>grandiflora</i> (Aubl.) Sandwith 1955	1	
		<i>micrantha</i> (O. Berg) Miers 1874	5	
		<i>ovalifolia</i> (DC.) Nied. 1892	7	
		<i>parviflora</i> (Aubl.) Miers 1874	3	
		<i>ruffifolia</i> S.A. Mori 1990	2	
		sp.	9	
		Linaceae	<i>Hebepetalum</i>	<i>huminiifolium</i> (Planch.) Benth. 1862
Loranthaceae	<i>Psittacanthus</i>	<i>corynocephalus</i> Eichler 1868	1	
Malpighiaceae	<i>Bunchosia</i>	<i>argentea</i> (Jacq.) DC. 1824	1	
	<i>Byrsonima</i>	<i>cowanii</i> W.R. Anderson 1981	1	
	<i>Mascagnia</i>	<i>anisopetala</i> (A. Juss.) Griseb. 1858	1	
		<i>psilophylla</i> (A. Juss.) Griseb. 1858	1	
		<i>includens</i> (Benth.) Cuatrec. 1958	1	
Malvaceae	<i>Mezia</i>	<i>bracteolosa</i> Ducke 1945	1	
	<i>Matisia</i>	<i>ochrocalyx</i> K. Schum. 1886	6	
Melastomaceae	<i>Leandra</i>	<i>caquetana</i> Sprague 1904	3	
		<i>longicoma</i> Cogn. 1886	8	
		<i>biglandulosa</i> Gleason 1932	1	
Meliaceae	<i>Miconia</i>	<i>kunthiana</i> A. Juss. 1830	1	
	<i>Guarea</i>	<i>pterorhachis</i> Harms 1924	1	

Table 2. ...

Family Plants	Genus	Species	N°
	<i>Trichilia</i>	<i>pallida</i> Sw. 1788	1
		<i>poepigii</i> C. DC. 1878	2
Menispermaceae	<i>Abuta</i>	<i>grandifolia</i> (Mart.) Sandwith 1937	1
Menispermaceae	<i>Elephantomene</i>	<i>eburnea</i> Barneby & Krukoff 1974	1
	<i>Odontocarya</i>	<i>tripetala</i> Diels 1936	2
		sp.	1
Moraceae	<i>Brosimum</i>	<i>acutifolium</i> Huber 1910 subsp. <i>oboratum</i>	1
	<i>Ficus</i>	<i>americana</i> Aubl. 1775	3
		cf. <i>hartwegii</i> (Miq.) Miq. 1867	1
		<i>gomelleira</i> Kunth & Bouché 1847	1
		<i>krukovii</i> Standl. 1937	1
		<i>paraensis</i> (Miq.) Miq. 1867	1
		<i>schippii</i> Standl. 1930	2
		<i>trigona</i> L.f. 1781(1782)	1
	<i>Maquira</i>	<i>calophylla</i> (Poepp. & Endl.) C.C. Berg 1969	2
	<i>Naucleopsis</i>	<i>ulei</i> (Warb.) Ducke 1922	1
	<i>Perebea</i>	<i>guianensis</i> Aubl. 1775	1
		<i>mollis</i> (Poepp. & Endl.) Huber 1909 subsp. <i>mollis</i>	1
		<i>xanthochyma</i> H. Karst. 1862	1
Myristicaceae	<i>Pseudolmedia</i>	<i>laevis</i> (Ruiz & Pav.) J.F. Macbr. 1931	1
	<i>Compsonoura</i>	<i>sprucei</i> (A. DC.) Warb. 1897	1
	<i>Iryanthera</i>	<i>crassifolia</i> A.C. Sm. 1937(1938)	3
		<i>elliptica</i> Ducke 1936	2
		<i>juruenensis</i> Warb. 1905	11
		<i>laevis</i> Markgr. 1926	9
		<i>lancifolia</i> Ducke 1936	1
		<i>macrophylla</i> (Benth.) Warb. 1895	1
		<i>paraensis</i> Huber 1909	27
		<i>ulei</i> Warb. 1905	6
		sp.	2
	<i>Otoba</i>	<i>glycycarpa</i> (Ducke) W.A. Rodrigues & T.S. Jaramillo 2000 (2001)	2
	<i>Virola</i>	<i>calophylla</i> (Spruce) Warb. 1897	1
		<i>duckei</i> A.C. Sm. 1937(1938)	1
		<i>elongata</i> (Benth.) Warb. 1897	1
		<i>mollissima</i> (Poepp. ex A. DC.) Warb. 1897	3
		<i>multinervia</i> Ducke 1936	1
		<i>pavonis</i> (A. DC.) A.C. Small. 1938	4
Myrsinaceae	<i>Cybianthus</i>	sp.	1
Myrtaceae	<i>Calyptanthes</i>	<i>densiflora</i> Poepp. ex O. Berg 1854(1855)	1
	<i>Eugenia</i>	<i>egensis</i> DC. 1828	1
		<i>feijoi</i> O. Berg 1857	1
	<i>Myrcia</i>	<i>fallax</i> (Rich.) DC. 1828	1
		<i>obumbrans</i> (O. Berg) McVaugh 1956	2
Nyctaginaceae	<i>Neea</i>	<i>macrophylla</i> Poepp. & Endl. 1838	1
		<i>parviflora</i> Poepp. & Endl. 1838	1
		<i>spruceana</i> Heimerl 1914	2
		<i>verticillata</i> Ruiz & Pav. 1798	1
		<i>virens</i> Poepp. ex Heimerl 1897	1
Ochnaceae	<i>Cespedesia</i>	<i>spathulata</i> (Ruiz & Pav.) Planch. 1846	2
Arecaceae	<i>Astrocaryum</i>	<i>chambira</i> Burret 1934	7
		<i>murumuru</i> Mart. 1824	35
	<i>Attalea</i>	<i>phalerata</i> Mart. ex Spreng. 1816	1
		<i>tessmannii</i> Burret 1929	3
	<i>Bactris</i>	sp.	1
	<i>Chamaedorea</i>	<i>pauciflora</i> Mart. 1823	2
	<i>Euterpe</i>	<i>precatoria</i> Mart. 1842	19
	<i>Geonoma</i>	<i>cuneata</i> H. Wendl. ex Spruce 1869	2
		<i>deversa</i> (Poit.) Kunth 1841	11
		<i>macrostachys</i> Mart. 1823	28
		<i>maxima</i> (Poit.) Kunth 1841 var. <i>chelidonura</i>	12
		<i>poepigiana</i> Mart. 1847	15
		sp.	1
		<i>stricta</i> (Poit.) Kunth 1841	20
	<i>Hyospathe</i>	<i>elegans</i> Mart. 1823	11
	<i>Iriartea</i>	<i>deltoidea</i> Ruiz & Pav. 1798	52
	<i>Iriartella</i>	<i>stenocarpa</i> Burret 1931	1
	<i>Oenocarpus</i>	<i>mapora</i> H. Karst. 1823	1
	<i>Socratea</i>	<i>exorrhiza</i> (Mart.) H. Wendl. 1860	14
Piperaceae	<i>Piper</i>	<i>asterotrichum</i> C. DC. 1753	1
		<i>augustum</i> Rudge 1805	2
Polygalaceae	<i>Moutabea</i>	<i>aculeate</i> (Ruiz & Pav.) Poepp. & Engl. 1838	2
Rhamnaceae	<i>Ampelozizyphus</i>	<i>amazonicus</i> Ducke 1935	1
Rhamnaceae	<i>Carpinus</i>	<i>guianensis</i> A. DC. 1825	2

Table 2. ...

Family Plants	Genus	Species	N°	
Rubiaceae	<i>Alibertia</i>	<i>hispida</i> Ducke 1932	1	
		<i>verrucosa</i> S. Moore 1895	2	
Rubiaceae	<i>Boroja</i>	sp.	1	
		<i>claviflora</i> (K. Schum.) Cuatrec. 1953	1	
		<i>hirsuta</i> (Poepp.) K. Schum. 1889	6	
	<i>Duroia</i>	<i>axillaries</i> Standl. 1930	2	
		<i>multiflora</i> A. Rich. ex DC. 1830	5	
	<i>Geophila</i>	<i>cordifolia</i> Miq. 1850	1	
	<i>Ixora</i>	<i>peruviana</i> (Spruce ex K. Schum.) Standl. 1931	1	
	<i>Notopleura</i>	cf. <i>congesta</i> C.M. Taylor 2001	5	
	<i>Palicourea</i>	<i>subspicata</i> Huber 1906	2	
	<i>Posoqueria</i>	<i>latifolia</i> (Lam.) Roem. & Schult 1819	2	
	<i>Psychotria</i>	<i>boliviana</i> Standl. 1931	1	
		<i>deflexa</i> DC. 1830	8	
	Sabiaceae	<i>Warszewiczia</i>	<i>microbotrys</i> Ruiz ex Standl. 1930	6
			<i>poepigiana</i> Müll Arg. 1881	18
			<i>stenostachya</i> Standl. 1930	2
<i>coccinea</i> (Vahl) Klotzsch 1853			20	
<i>elata</i> Ducke 1922			2	
<i>hebertii</i> Rolfe 1893			1	
<i>vasquezii</i> A.H. Gentry 1986			1	
<i>heterophyllum</i> (Benth.) Urb. 1895			3	
<i>arborescens</i> (Aubl.) Radlk. 1879			1	
cf. <i>anodonta</i> Radlk. 1753			1	
Sapindaceae	<i>Ophiocaryon</i>	<i>pterocarpa</i> Triana & Planch. 1862	7	
		<i>lethalis</i> A. St. -Hil. 1824	2	
		<i>cerasina</i> (Benth.) Radlk. 1878	1	
		<i>amazonicum</i> T.D. Penn. 1990	1	
Sapotaceae	<i>Chrysophyllum</i>	<i>bombycinum</i> T.D. Penn. 1990	1	
		<i>bidentata</i> Williams 1936	1	
		<i>bilocularis</i> (H. Winkl.) Baehni 1942	3	
		<i>caimito</i> (Ruiz & Pav.) Radlk. 1882	1	
		<i>cuspidata</i> (A. DC.) Baehni 1944	2	
		<i>elegans</i> (A. DC.) Baehni 1944	1	
		<i>procera</i> (Mart.) T.D. Penn. 1990	1	
		<i>rostrata</i> (Huber) Baehni 1942	4	
		<i>torta</i> (Mart.) Radlk. 1882	6	
		<i>amara</i> Aubl. 1775	1	
		<i>bifida</i> (Poepp. Endl.) A. DC. 1968	11	
		<i>grandiflora</i> D. Don 1829	1	
		Simaroubaceae	<i>Simarouba</i>	<i>grandiflorum</i> Ruiz & Pav. 1799
<i>apeibophylla</i> Ducke 1945	1			
Siparunaceae	<i>killipiana</i> Standl. ex E.L. Taylor 1989	1		
Solanaceae	<i>Brunfelsia</i>	<i>tessmannii</i> Mildbr. 1927	1	
		<i>elliptica</i> Mez 1905	1	
Sterculiaceae	<i>Clavija</i>	<i>venosa</i> B. Stahl 1990	1	
		<i>elegans</i> Moldenke 1932	1	
Theophrastaceae	<i>Aegiphila</i>	sp.	1	
		<i>blanchetiana</i> Schaner 1847	1	
Verbenaceae	<i>Petrea</i>	<i>sphaerocarpum</i> Triana & Planch. 1862	1	
		<i>cymosa</i> Mart. 1826	2	
		<i>glycyarpa</i> Ruiz & Pav. 1799	2	
Violaceae	<i>Gloeospermum</i>	<i>flavescens</i> (Aubl.) Kuntze 1891	5	
		<i>biformifolia</i> Standl. 1929	1	
Vitaceae	<i>Rinorea</i>	<i>flavescens</i> (Aubl.) Kuntze 1891	5	
		<i>biformifolia</i> Standl. 1929	1	

for identification. This method of identification meant that she was able to identify plants that flowered but failed to produce fruits based on the identity of their fruiting conspecifics.

Angiosperms and a few palms were identified at the Missouri Botanical Garden mostly by RV, with a few plants in Araceae, Menispermaceae and Rubiaceae identified by Thomas Croat, Rosa Ortiz-Gentry and Charlotte Taylor respectively. Most palms were identified at the New York Botanical Garden by Andrew Henderson. Vouchers were deposited in the institutions where they were identified, with duplicate vouchers deposited at AMAZ (Herbario Amazonense - Universidad Nacional de la Amazonia Peruana).

Results and discussion

Floristic description of study site

The canopy in this site is dense, with the majority of trees attaining heights of 15 -- 40 m. The highest emergents consisted of trees and canopy palms approximately 50 m tall. The most diverse plant groups in this site were the Araceae and Rubiaceae, both with 11 genera and 19 species that flowered and/or produced fruits. Palms were the most abundant group of flowering and/or fruiting plants with 156 fruiting palms/ha. The second most abundant group was the Myristicaceae (second most speciose group) from which 50 fruiting plants/ha were

The canopy of this forest is dominated by large canopy palms (*Attalea*, *Astrocaryum*, *Euterpe*, *Socratea* and *Iriarteia*), and tree species from the genus *Eschweilera* (Lecythidaceae). The subcanopy was dominated by the palm *Astrocaryum murumuru* and medium sized trees from the genus *Iryanthera* (Myristicaceae). The understory was dominated by palms in the genus *Geonoma* and shrubs in the genus *Psychotria* (Rubiaceae).

Species richness of flowering and fruiting plants

A summary of the diversity of flowering and fruiting plants in the study site is provided in Table 1, and a list of plants recorded flowering and fruiting in Paucarillo during the one year study period is shown in Table 2. The diversity of flowering and fruiting plants in this site is high, with 270 species from 59 families recorded during the 12 month study period over an area of 1,44 hectares or 188 species/ha.

Proportion of all species that flowered and fruited during the study period

To compare the species richness of flowering and fruiting plants with total plant species richness in our study site, we examined data collected in a nearby site Madre Selva. In Madre Selva (3°37' S, 72°14' W), 19 km east of our study site, 304 species/ha (trees > 10 cm dbh excluding lianas, epiphytes and herbs) were recorded (Davila et al. unpublished data). Madre Selva has a higher diversity of trees > 10 cm dbh than Manu National Park in Peru's Madre de Dios region (174 species/ha) and Yasuni National Park in Ecuador (239 species/ha). To compare our results with the Madre Selva dataset, we excluded 61 species of lianas, epiphytes and herbs from our dataset, which reduced the number of flowering and fruiting tree species to 209 per 1,44 ha or approximately 145 species/ha. Assuming that our study site has the same total tree diversity as Madre Selva, this means that 48% of the total possible species richness (304 species) in this forest was recorded flowering and/or fruiting within our study site. Therefore 52% of plant species in our site were not flowering or fruiting because they were species (1) whose phenological activities were not recorded because they flowered and/or fruited between phenology surveys, (2) represented by non-flowering and non-fruiting immature individuals and / or (3) represented by mature individuals of rare species that did not flower and fruit during our study period due to supra-annual phenological cycles. However, it is also possible that our assumption is not correct and our study site may have lower species richness than Madre Selva.

Proportion of rare species

To compare the proportion of rare species between our site and Madre Selva, we arbitrarily defined rare species as those represented by 1–3 plants within 1–1,44 ha of forest. At Madre Selva, rare species accounted for 63% of all species in one hectare (Davila et al. unpublished data). Whereas, in our site rare species accounted for 57% of flowering and fruiting plants in 1,44 hectares. The high representation of rare species in both sites is consistent with the approximately 50% of species represented by one individual/ha at sites located within other parts of the

Amazon (Faber-Langendoen and Gentry 1991, Valencia et al. 1994, Pitman et al. 2001). For detailed review of the distribution and rarity of Amazonian plants, we refer readers to Pitman et al. (1999 and 2001).

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