

Supplementary Materials for

Hyperdominance in the Amazonian Tree Flora

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Other Supplementary Material for this manuscript includes the following:

available at www.sciencemag.org/content/342/6156/1243092/suppl/DC1

Appendices S1 to S4

Supplementary Text

Short description of our data

The 1170 tree plots used for compositional analyses were distributed between regions and forest types as shown in Figure 1 and Table S1. The proportion of tree plots in the ATDN dataset that sample each forest type is roughly equivalent to the proportion of the greater Amazon that these forest types cover. Várzea and igapó together cover 10% of Amazonia (1, 2) and account for 19% of our plots. Podzols and Arenosols cover 4.6% of Amazonia (1) and account for 6% of our plots. Swamps account for 1.8% of our plots, and peatlands are believed to account for approximately 1.7% of the study area (3).

Main floristic results

We found a total of 4962 valid species, 810 genera, and 131 families in the 1170 tree plots used for compositional analyses. Fabaceae, not surprisingly, is the most abundant family, with almost 100,000 individual trees and 119 genera, followed by Arecaceae (52,507; 25), Lecythidaceae (46,322; 10), Sapotaceae (40,429; 17), Malvaceae (29,424; 36), Burseraceae (28,762; 7), Chrysobalanaceae (28,597; 7), Moraceae (28,069; 19), Euphorbiaceae (25,955; 42), and Annonaceae (22,378; 27). Fabaceae are also the most species-rich family, with 795 species, followed by Lauraceae (311), Annonaceae (289), Rubiaceae (278), Sapotaceae (207), Chrysobalanaceae (195), Myrtaceae (176), Malvaceae (168), Melastomataceae (168), and Euphorbiaceae (143). Note that Fabaceae has more than twice as many species as the second most diverse family. The genera with the largest numbers of individuals were *Eschweilera* (31,495), *Protium* (26,131), *Pouteria* (21,852), *Licania* (21,321), *Euterpe* (14,802), *Inga* (14,791), *Eperua* (10,951), *Virola* (10,283), *Astrocaryum* (8973), and *Lecythis* (8505). The most species-rich genus was *Inga* with 134 species, followed by *Pouteria* (117), *Licania* (105), *Ocotea* (93), *Miconia* (92), *Guatteria* (85), *Eugenia* (76), *Protium* (69), *Swartzia* (67), *Ficus* (59), and *Eschweilera* (52).

Finding a fit for the Rank Abundance Distribution (RAD)

We applied a two-step approach to find the best possible RAD for the full Amazonian tree community. The first step was estimating Amazon-wide population sizes of the 4962 species occurring in our dataset. The second step was extrapolating the right tail of the resulting RAD to estimate the number and population sizes of unsampled species (i.e., species that occur in the Amazon but do not occur in our dataset). This second step required a consideration of the various different strategies developed over several decades to estimate the total number of species in a community from a sample (53).

To estimate species richness, statisticians can now choose from a vast array of possible estimators and distribution models, developed under a theoretical sampling framework (53-57). This is a daunting challenge (56), “*considering the contributions of rare species and the role of undetected species for a fixed sampling effort*” (57). Very sensitive to sample coverage (58), these methods are mostly designed for local or regional-scale extrapolations. The underlying distributions are based on some statistical properties of community samples, mostly the information carried by the number of rare species, first used by Good (59), singletons alone or

with other lower abundance taxa, the coverage concept (59, 60) and newly discovered properties (55, 61).

Community ecologists have long argued over whether the log-series (62), the log-normal (63), or alternative methods give the best fit for RAD curves. Because extrapolating the total number of tree species in the Amazon from a very small subsample of the region is a perilous exercise, we applied at least 11 different extrapolation methods to our data, before concluding that the log-series was the best. Eighteen estimates from software packages SPECIES (64), and CatchAll (54) are shown in Table S2.

Sixteen of these 18 methods can be immediately rejected, since they predict the total number of Amazonian tree species to fall in the range 4015-6412. This is a demonstrably severe underestimation of the true species richness, since previous estimates of tree species richness in Amazonia and the Neotropics (10^6 km^2) based on floras and expert opinion were around 12,500 and 22,500 respectively (1, 65), consistent with our estimate of ca. 16,000 for Amazonia. A new estimator recently implemented in CatchAll(WLRM_UnTransf) (54, 61) gave an estimated total richness above 11,000, closer to that calculated with our log-series extrapolation (16,000), but was not selected by the program as the best estimator. The ACE1_Max Tau estimator gave a result greatly exceeding the expected richness and its Tau was much higher (9048) than its recommended value (Tau < 10).

The failure of these models to fit our data is not surprising. Brose et al. (58) noted that sampling-theoretical methods of estimation require high sampling intensity to avoid what Wang et al. (55) call the “severe under-estimation observed from popular nonparametric estimators due to the interplay of inadequate sampling effort, large heterogeneity and skewness”. We believe that these estimators performed poorly because their assumptions are not met by our system. Mostly, they measure the expected number of species at a local site, and assume relatively complete sampling (see eg. (56)). However, we are attempting to estimate the total number of species across the full Amazon (6 million km^2) rather than at any one site, and our sampling intensity is very low (ca. 0.002%).

There is no consensus in the abundant literature on which predictor is the most efficient, nor regarding the choice of a parametric distribution. There are, however, two important points in our case study: 1) we were able to estimate the community size, a dimension generally ignored by estimators and 2) an empirical approach allowed us to build an estimated RAD of the most abundant species for the total area (i.e. Amazon) - the model of abundances distribution all methods try to estimate.

The log series fits our data well (Fig. S6) and also fits well the left part of the Amazonian RAD we obtained by estimating the populations sizes of Amazonian trees (Fig s7). So the assumption that this is the best form for the RAD of Amazonian trees (1) can actually be met.

Based on the above we concluded that the log series was the best fit for our data and based our species richness estimate on this distribution.

Estimating species richness with Fisher's alpha

If species were randomly distributed across Amazonia and we sampled at random throughout that area, our relative abundance distribution would have the same form and the same Fisher's alpha as the Amazonian RAD. Fisher's alpha would also reach an asymptote after a sufficiently large sample had been made. Because conspecific trees are clumped at various spatial scales (due to seed dispersal, preference for soil types) and our sampling was not random, our RAD differs in some respects from the true Amazon-wide RAD. Specifically, it underestimates Fisher's alpha and therefore provides an underestimate of gamma diversity (Fig. S8).

Hyper-dominant species by plot and forest

The median percentage of individuals that belong to hyper-dominant species within an individual plot was 40.7% (range = 0-93.9%, Fig. S9). Comparable figures for the five forest types are: igapó 32.9%, white sand forest 43.6%, swamp 35.9%, várzea 34.7%, and terra firme 30.1%. The median number of hyper-dominant species was 32 per plot (range = 0-78. The 438 plots containing fewer than 20 hyper-dominant species were evenly distributed across Amazonia but not across forest type. Only 15.1% of all terra firme plots have less than 20 hyper-dominants. For the other forest types the percentage is: igapó 76.6%, white sand forest 78.9%, swamp 50.0%, várzea 42.8%.

Species richness by country

Our data provide estimates of the number of tree species occurring in each country in the study area (i.e., in the Amazonian portions of Bolivia, Brazil, Colombia, Ecuador, and Peru; in the three Guianan countries, which were pooled for this exercise; and in the Guianan and Amazonian portions of Venezuela; see Fig. 1) by constructing a Rank-Abundance Distribution of the estimated populations of all species predicted to occur in a country (Fig. S10). Population sizes were estimated by summing the number of trees of each species in all the 1-degree grids cells whose centroids were in that country.

Table S1. The number of tree plots with compositional data in each of the five forest types and six regions used in the study.

Region	IG	PZ	SW	TF	VA	Total
CA	13	5	4	213	48	283
EA	3			71	30	104
GS	7	47	5	222	8	289
NWA	21	19	4	140	40	224
SA			2	71	18	91
SWA	3		7	133	36	179
Total	47	71	22	850	180	1170

Terra firme forest plots

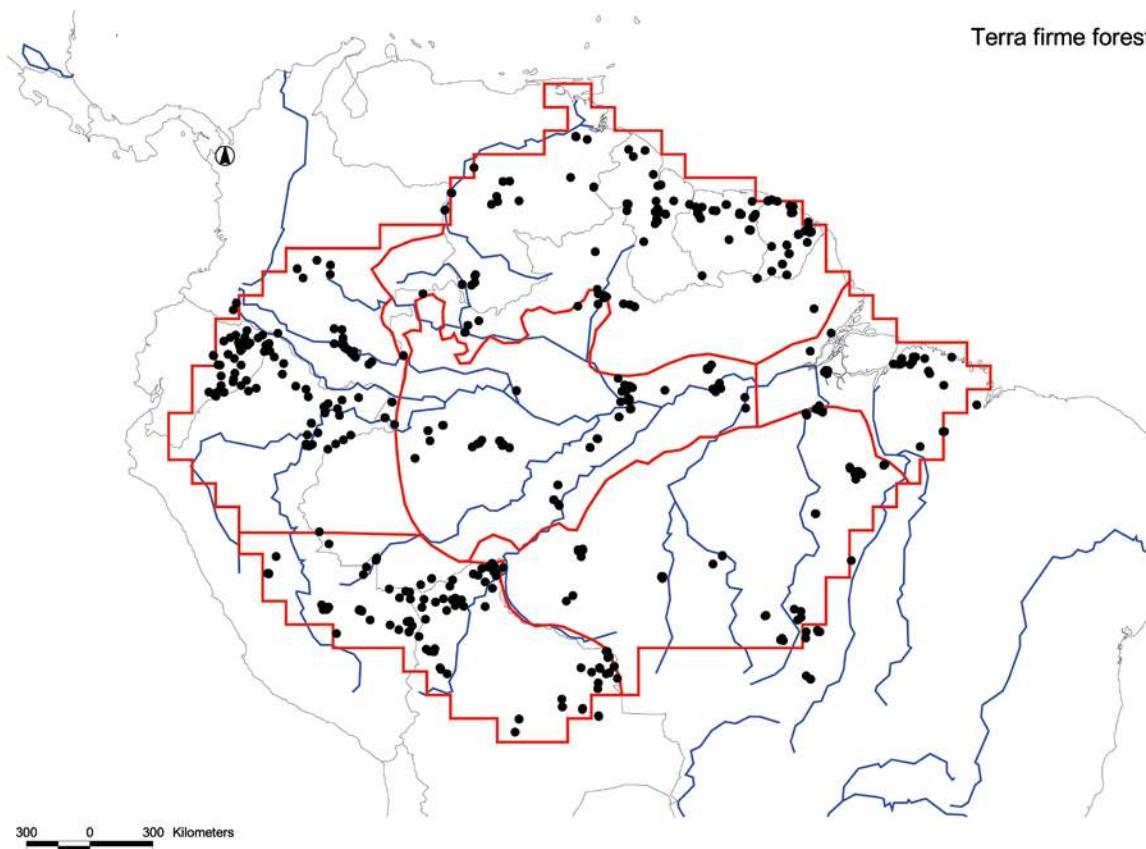


Figure S1.

Map of all plots in terra firme forest. Amazonian regions delimited in red after (33).

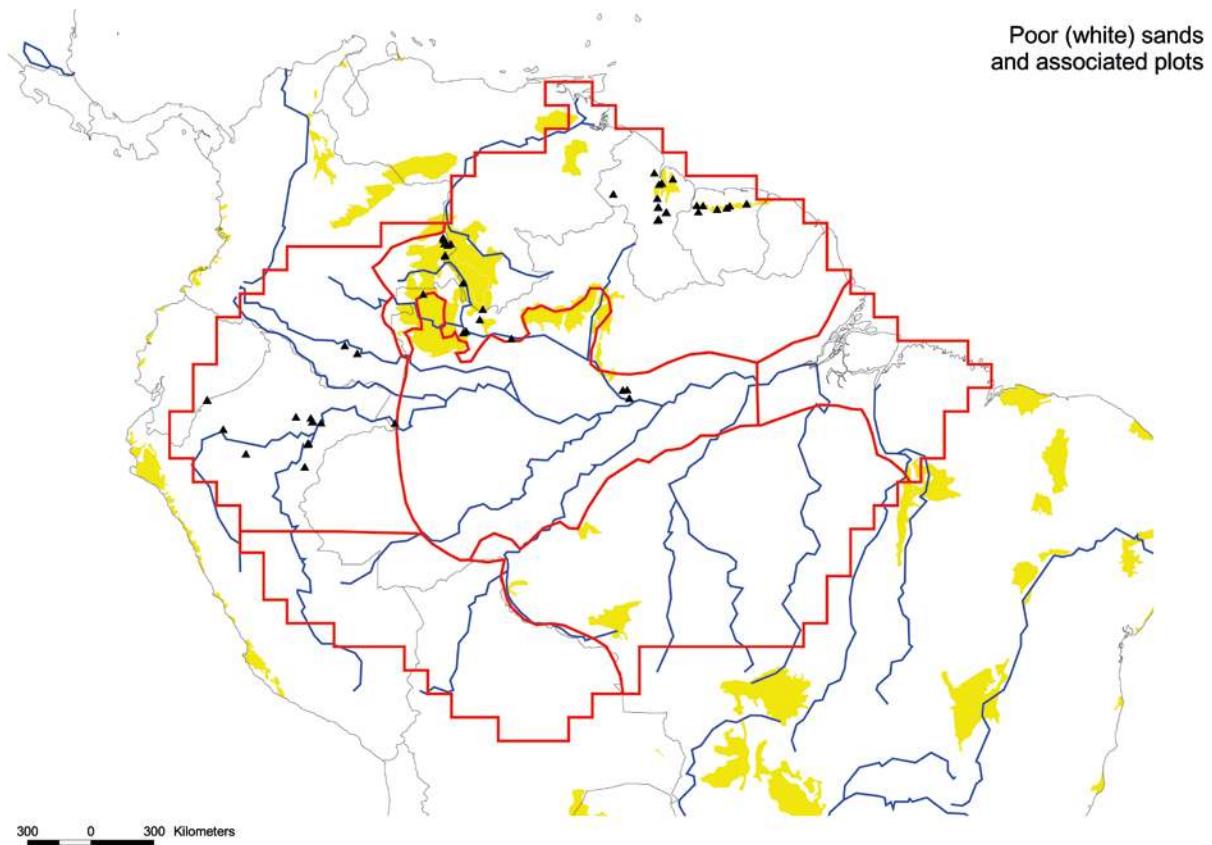


Figure S2.

Map of all plots in podzol forest, with the extent of white sand Podzol (Pz) and very poor Arenosol (Ar) soils in yellow according to (33, 66). Amazonian regions delimited in red after (33).

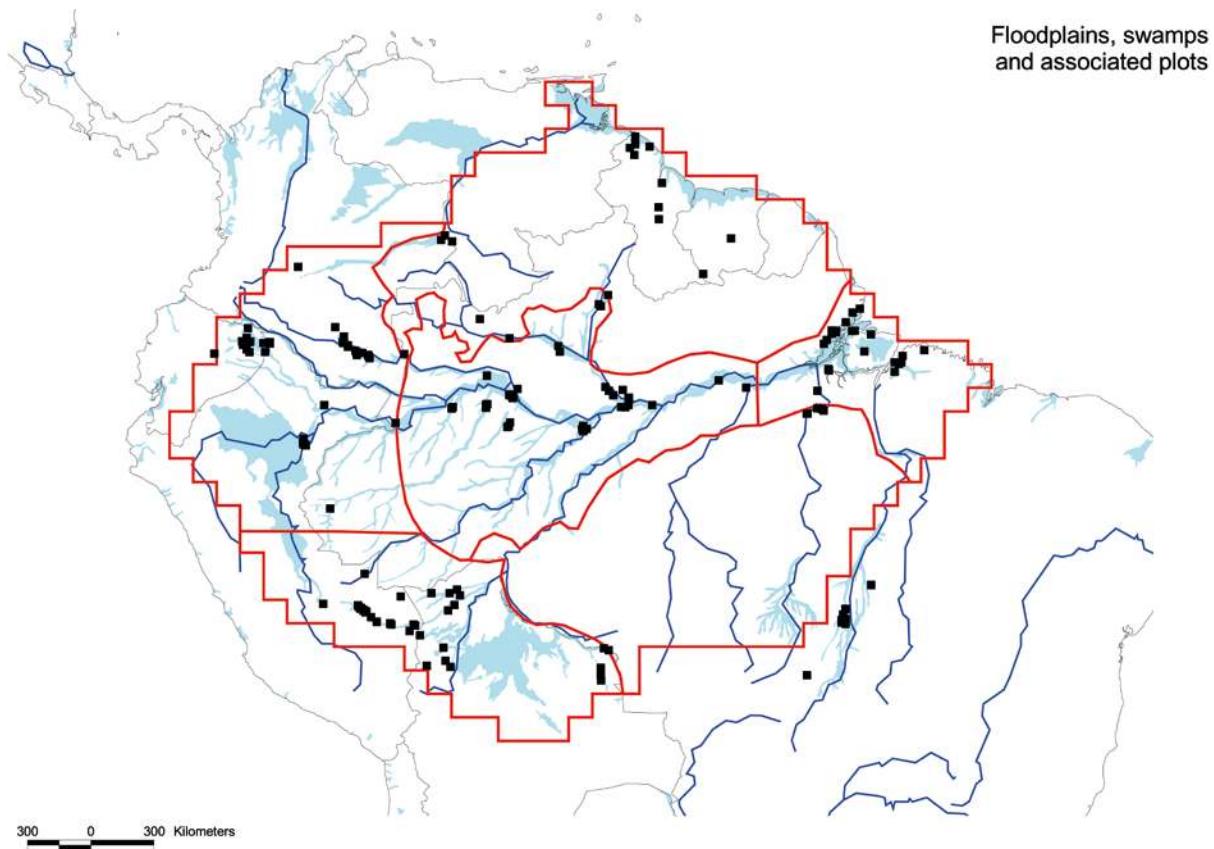


Figure S3.

Map of all plots in várzea, igapó, and swamp forests, with the extent of floodplain soils (Gleysoils (Gl), Fluvisols (Fl) and Histosols (Hs)) in blue according to (33, 66). Amazonian regions delimited in red after (1).

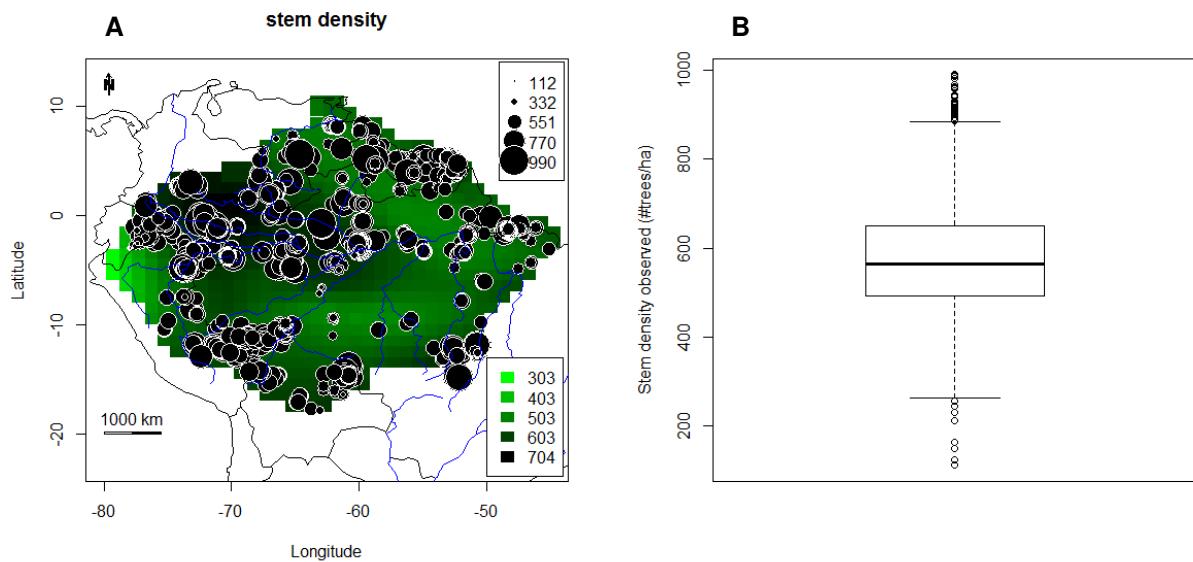


Figure S4.

A. Stem density (no. of trees ≥ 10 cm dbh per ha) in 1195 tree plots across Amazonia. The black circles show the empirical data (range 112 – 990 trees/ha), while the green background color shows the loess interpolation of plot data for one-degree grid cells (range 303 – 705 trees/ha). **B.** Boxplot of observed stem densities ($n = 1195$). The box encloses the 2nd and 3rd quartile of the data, and the horizontal bold line is the median. The errors bars indicate the approximate 95% confidence intervals for the median. Outliers are shown as data points (circles) outside the 95% confidence interval.

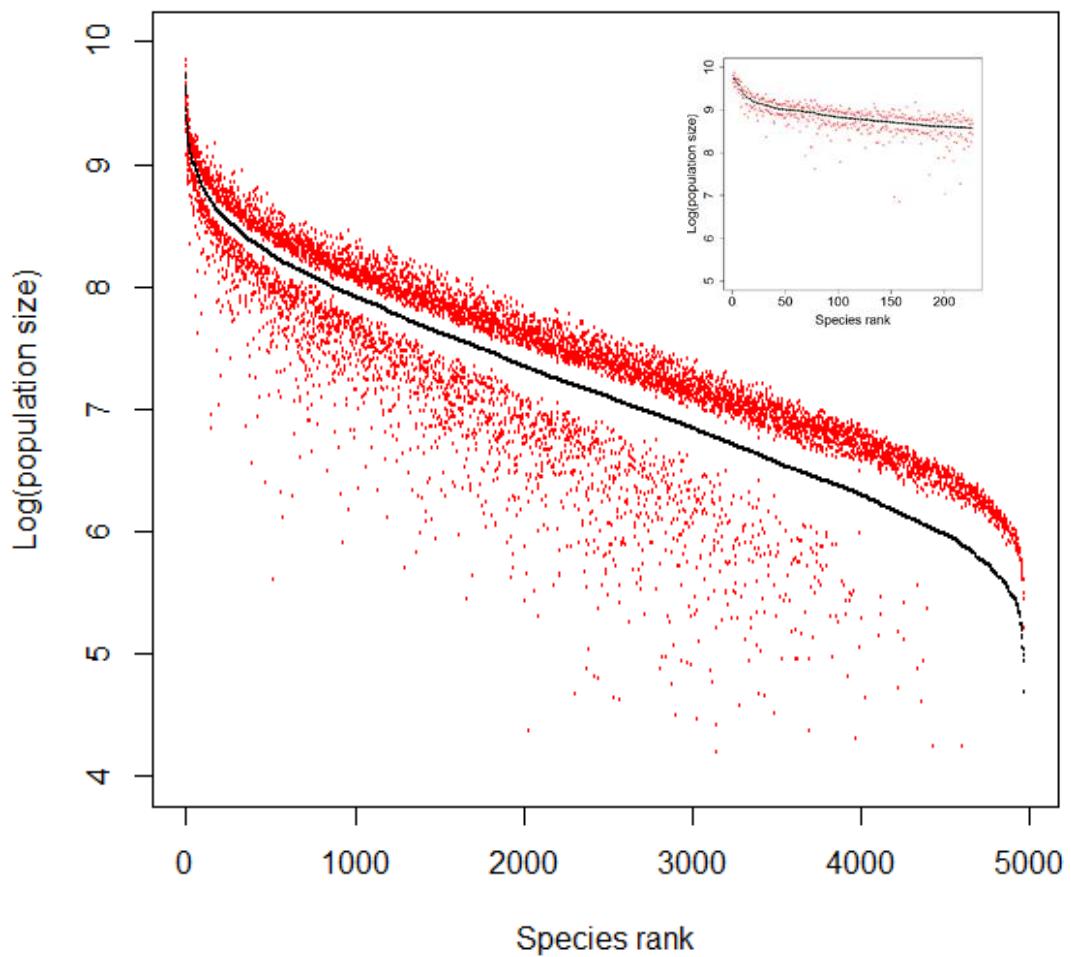


Figure S5.

Rank-abundance distribution of mean estimated Amazonian tree population sizes (500 bootstraps of 1000 plots drawn with replacement, black dots) and 95% confidence intervals (red dots) for 4962 valid species. Population size is measured as the number of trees ≥ 10 cm dbh. The inset shows mean estimated population sizes and 95% confidence intervals for the 227 hyper-dominants. Data for all species is provided in Appendix S1. For further information on the bootstraps see main text.

Table S2.

Output of CatchAll (54) and SPECIES for the total number of species, estimated from our sample and the boundaries of the 95% confidence interval (Lower CB, Upper CB). The cut-off parameter Tau was set automatically by the program.

Model	Tau	Estimated C	Lower CB	Upper CB	Programme
FourMixedExp	1472	6083	5919	6275	CatchAll
FourMixedExp	1510	6080	5917	6270	CatchAll
FourMixedExp	3030	6029	5884	6196	CatchAll
FourMixedExp (Best selected)	4857	6024	5881	6188	CatchAll
FourMixedExp_Max Tau	9048	5992	5859	6146	CatchAll
ThreeMixedExp	4857	4015	3947	4163	CatchAll
WLRM_UnTransf	10	11712	6020	48275	CatchAll
WLRM_LogTransf	181	5109	5079	5147	CatchAll
Chao1	2	5577	5466	5713	SPECIES
ACE	10	5467	5394	5553	SPECIES
ACE1_Max Tau	9048	23544	16612	34603	SPECIES
Jackknife 1	.	5631	5560	5702	SPECIES
Jackknife 4	.	6319	5989	6649	SPECIES
Chao1984 (Chao1)	10	5592	5480	5730	SPECIES
ChaoBunge	10	5723	5577	5876	SPECIES
ChaoLee1992 - ACE	10	5467	5394	5553	SPECIES
ChaoLee1992 - ACE1	10	5615	5507	5726	SPECIES
pcg	35	6412	.	.	SPECIES

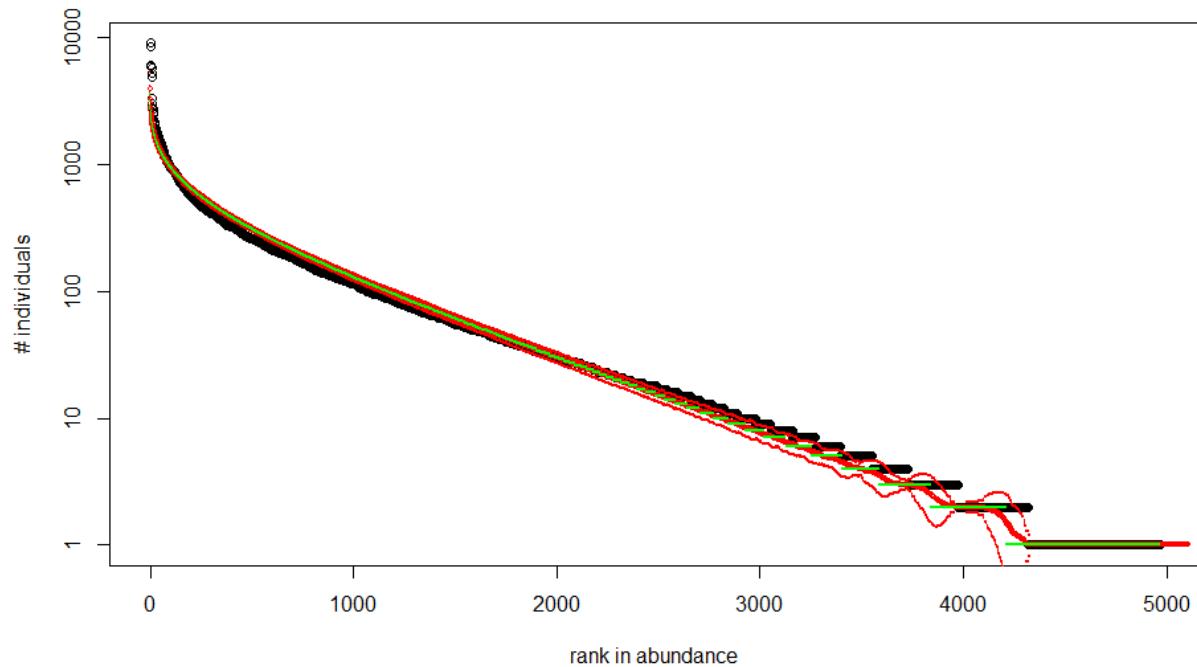


Fig S6.

A rank-abundance diagram (RAD) showing the empirical tree data (black) of 4962 species (column **n.ind** of appendix 1). Bold red line: average of 100 runs of Hubbell's species generator (p. 290–291 of (67), calculated with r script by Jari Oksanen, library Hubbell. Thin red lines: 95% confidence intervals. Green line: analytical expansion of the log-series ($\Phi_n = (\alpha/n) \cdot x^n$). Both log-series provides a good fit, albeit not a completely perfect one.

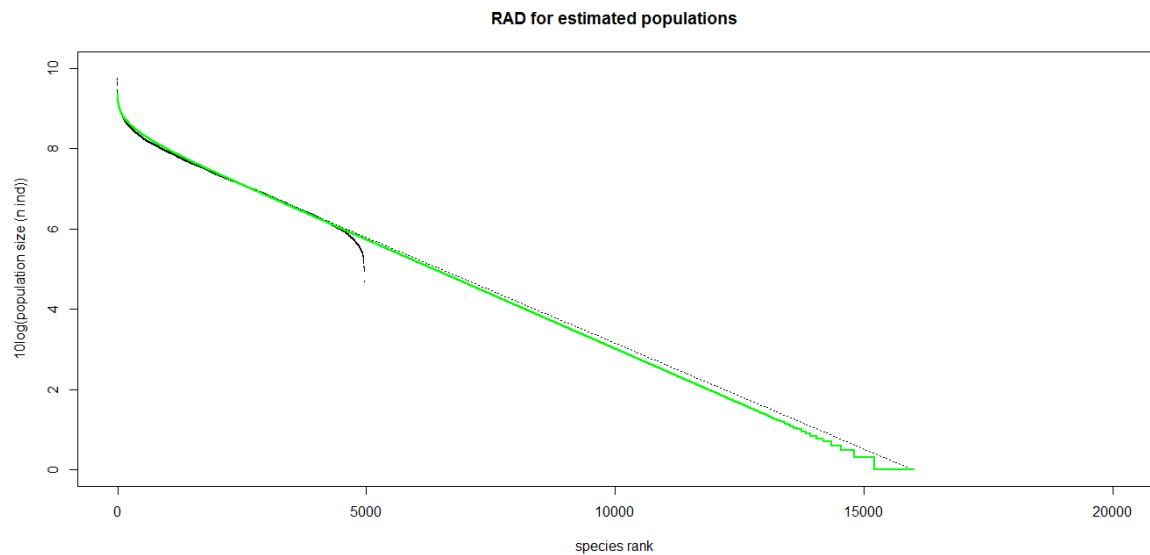


Fig S7.

Rank-abundance diagram (RAD) of Fig. 1 showing the empirical tree data (black) of 4962 species. In green: analytical expansion of the logseries ($\Phi_n = (\alpha/n) \cdot x^n$) for $S = 16,000$ and $n = 3.9 \cdot 10^{11}$. The log series is consistent with a linear extrapolation of the 2nd-3rd quartile of the population data.

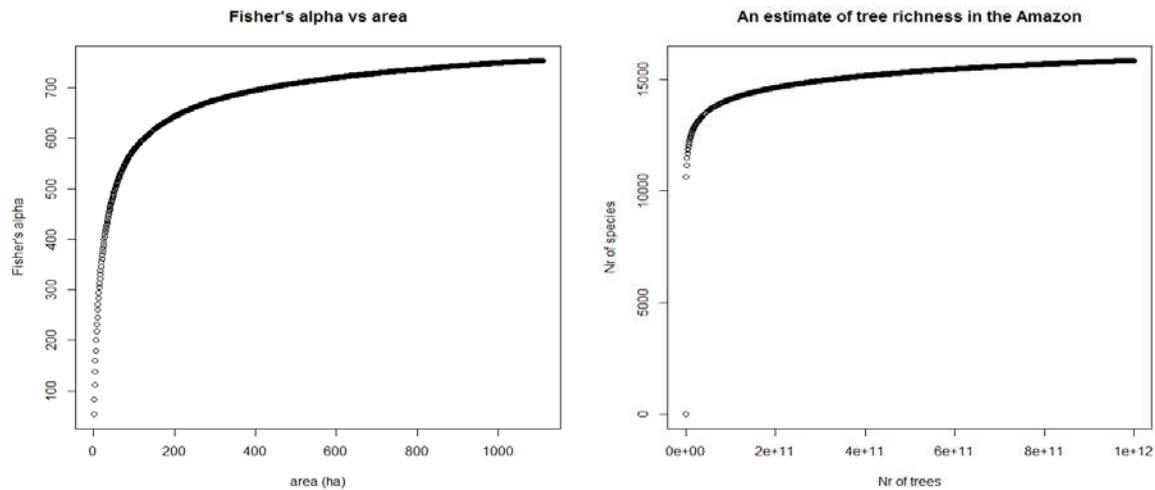


Figure S8.

A. Fisher's alpha as a function of cumulative plot area, based on 100 randomizations of the plot data. The final Fisher's alpha value is 754. **B.** Species richness as a function of the number of trees in Amazonia, calculated as $S = FA * \ln(1 + N/FA)$; where $FA = \text{Fisher's alpha}$ (754), and N is the number of trees. Even an error of 50% in the number of trees causes little variation in final species richness. The final estimate (underestimate) of the number of tree species in the greater Amazon is 15,182 ($N = 3.9 \times 10^{11}$, $FA = 754$) (62).

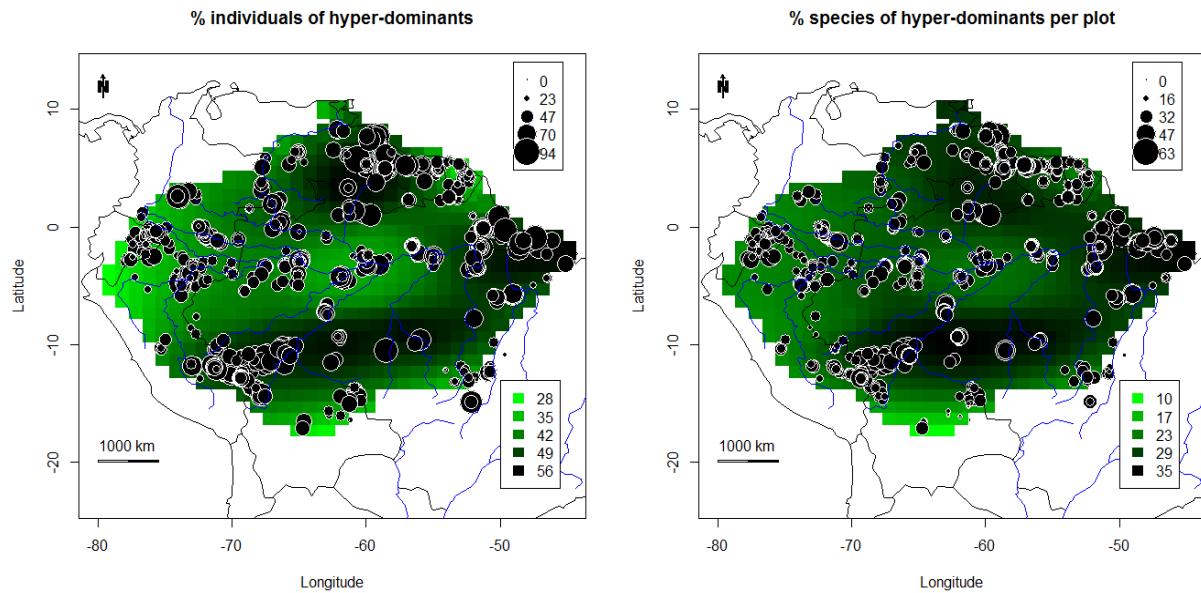


Figure S9.

A. The percentage of trees that belong to the 227 hyper-dominant species at the individual plot level. Black circles show the empirical data from individual tree plots, while the green background shows the loess interpolation of plot data for one-degree grid cells. Percentages are highest in the low-diversity areas of the Amazon (Guiana Shield and eastern and southern Amazon) but decrease towards the edges as species from neighboring biomes increase in importance. **B.** The percentage of species in each plot that are on the list of the 227 hyper-dominant species.

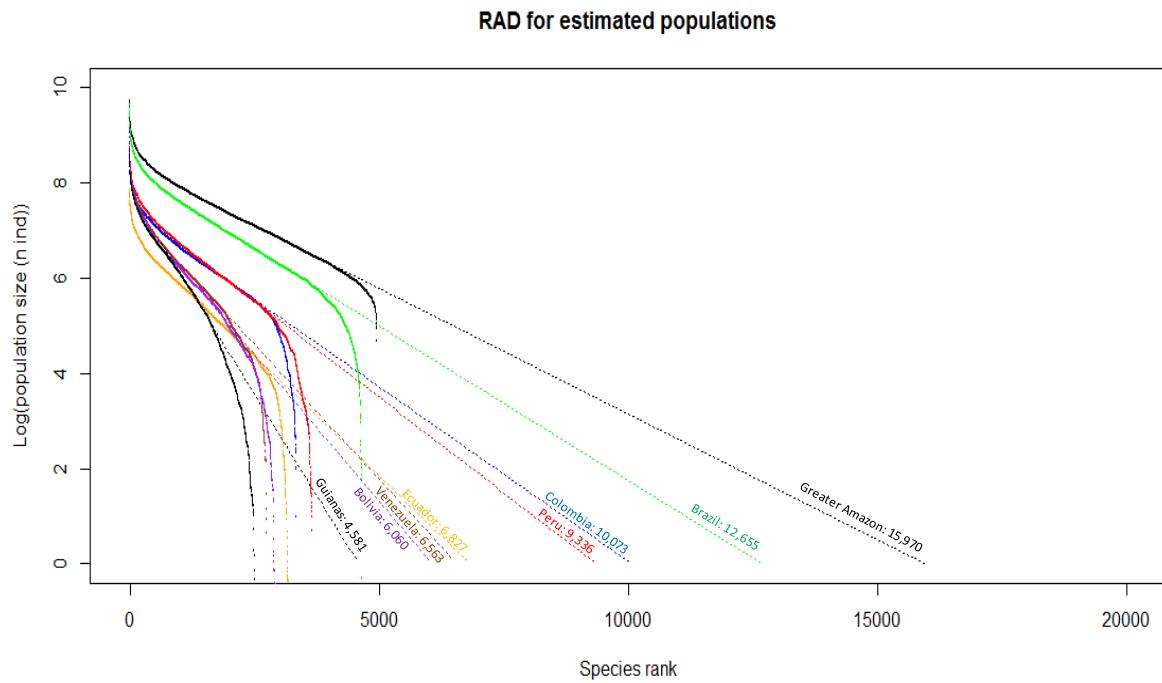


Figure S10.

Rank-Abundance Distributions for countries in the greater Amazon, constructed from estimated population sizes in the Amazonian and/or Guianan portions of their territories, and linear extrapolations that yield the estimated number of tree species in each country (see text for explanation). Estimates based on one run of the full dataset for 1170 plots.

Table S3.

Families with significantly more (hi) or significantly fewer (lo) hyper-dominant species than expected by chance are few. Palms (Arecaceae) have nearly five times more hyper-dominant species than expected by chance. Some very large and well-known families in the Amazon (Fabaceae, Sapotaceae, and Chrysobalanaceae) have as many hyper-dominant species as expected by chance (Appendix S2). Family: name according to Tropicos (13), N ind: Number of individuals in the 1170 plots, N species: Number of species in the 1170 plots, HyperDom: Observed number of hyper-dominant species in family/genus, HypDomExp: Expected number of hyper-dominant species in family/genus (based on 1000 randomizations), ci.lo: lower 95% confidence limit for expected number of hyper-dominant species (based on 1000 randomizations), ci.hi: upper 95% confidence limit for expected number of hyper-dominant species (based on 1000 randomizations), hilo: significant deviation from expected number of hyper-dominants.

Family	N ind	N species	HyperDom	HypDomExp	ci.lo	ci.hi	hilo
Arecaceae	52507	70	15	3.196	-0.183	6.575	hi
Lecythidaceae	46332	107	19	4.846	0.698	8.994	hi
Malvaceae	29424	168	15	7.743	2.619	12.867	hi
Burseraceae	28762	94	11	4.186	0.215	8.157	hi
Moraceae	28069	135	11	6.194	1.542	10.846	hi
Euphorbiaceae	25955	143	14	6.496	1.650	11.342	hi
Myristicaceae	21648	57	11	2.564	-0.420	5.548	hi
Meliaceae	14134	71	8	3.261	-0.269	6.791	hi
Urticaceae	11869	67	7	3.205	-0.096	6.506	hi
Violaceae	10814	35	5	1.664	-0.816	4.144	hi
Goupiaceae	1670	1	1	0.037	-0.333	0.407	hi
Annonaceae	22378	289	4	13.21	6.424	19.996	lo
Lauraceae	18629	311	4	14.26	7.367	21.153	lo
Rubiaceae	11490	277	1	12.678	6.217	19.139	lo
Melastomataceae	8225	168		7.662	2.650	12.674	lo
Myrtaceae	7912	176		8.049	2.717	13.381	lo

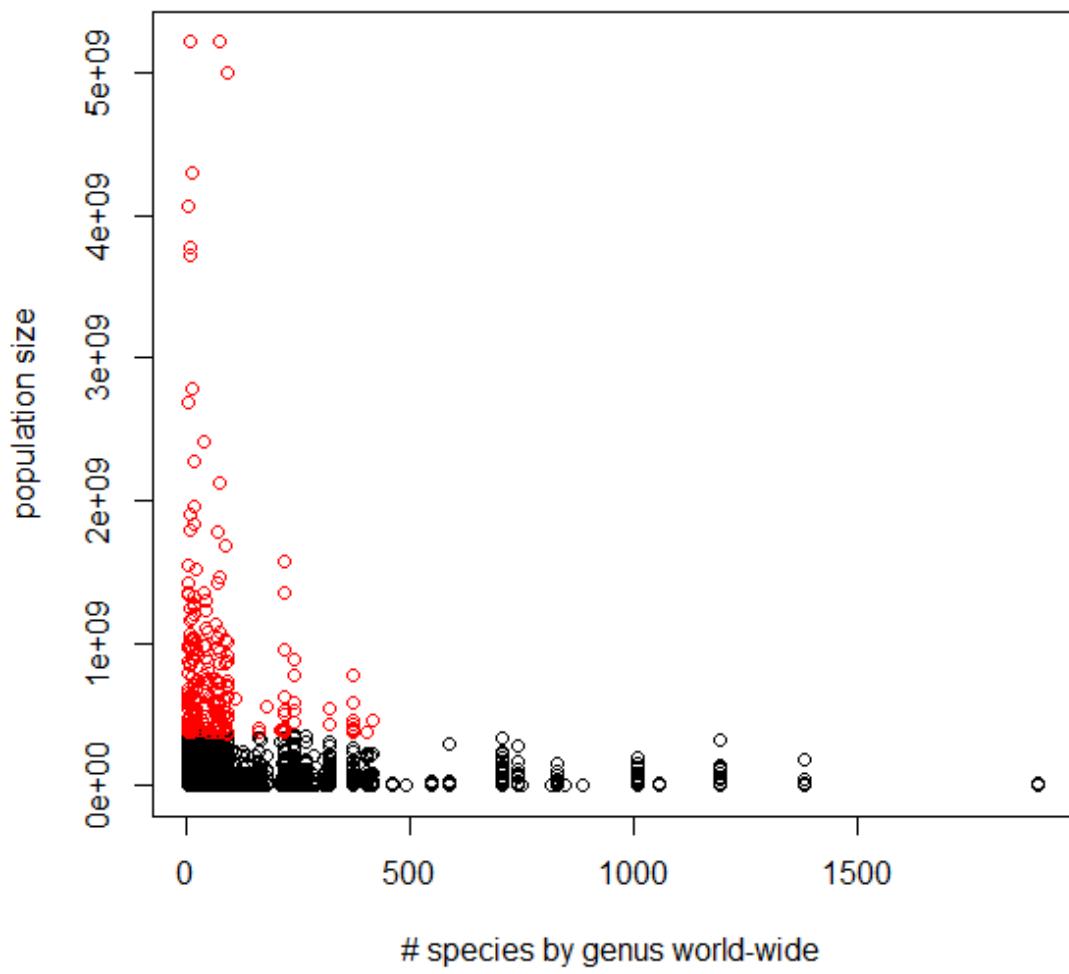


Figure S11.

Hyper-dominant species are found more often (101 times) in genera that have few (20) species worldwide than expected by chance (59 times, $p < 0.001$). Hyper-dominants in red. NB: this figure does not correct for phylogeny nor account for the different ages of each genus.

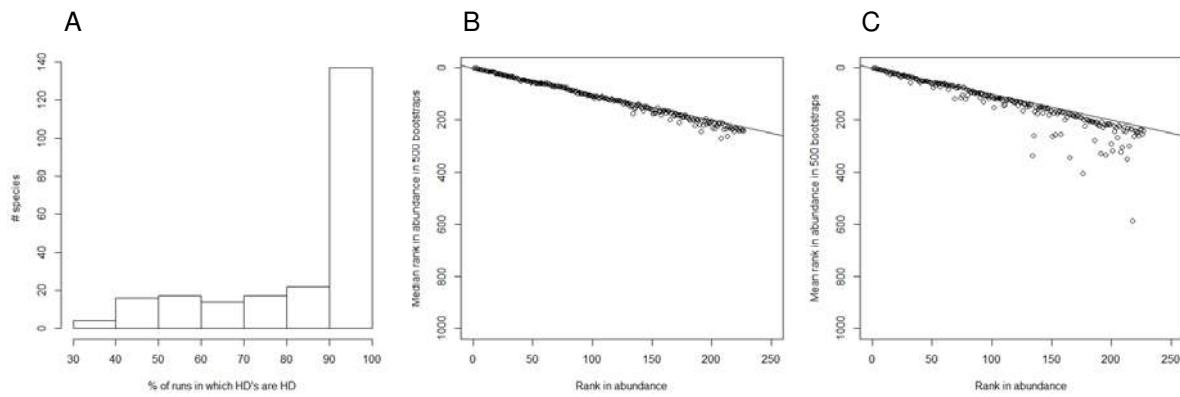


Figure S12.

Most hyper-dominant species qualified as hyper-dominant species (ranks 1 - 227) in most of the 500 bootstrap runs (A). Median rank (B) and mean rank (C) were both close to the species' final rank based on mean estimated population size. B and C: straight line : $y=x$

Herbaria contributing tropical plant collection records used to estimate species range extents.

Data were accessed through the Global Biodiversity Information Facility (<http://www.gbif.org/>) and SpeciesLink (<http://splink.cria.org.br>) in March 2009.

GBIF:

1. AIMS - Bioresources Library (OBIS Australia) (<http://data.gbif.org/datasets/resource/396>)
2. Andes to Amazon Biodiversity Program (<http://data.gbif.org/datasets/resource/56>)
3. Arizona State University (<http://data.gbif.org/datasets/resource/1294>)
4. Arizona State University Vascular Plant Herbarium (<http://data.gbif.org/datasets/resource/676>)
5. Australian National Herbarium (CANB) (<http://data.gbif.org/datasets/resource/47>)
6. Belo Horizonte, Herbario (<http://data.gbif.org/datasets/resource/1318>)
7. BioCentro-UNELLEZ (<http://data.gbif.org/datasets/resource/1310>)
8. Biologiezentrum Linz (<http://data.gbif.org/datasets/resource/1104>)
9. Bishop Museum Natural History Specimen Data (<http://data.gbif.org/datasets/resource/54>)
10. BoGART (<http://data.gbif.org/datasets/resource/1087>)
11. Botanische Staatssammlung Munchen (<http://data.gbif.org/datasets/resource/1289>)
12. Botanischer Garten und Botanisches Museum Berlin-Dahlem, Zentraleinrichtung der Freien Universitat Berlin (<http://data.gbif.org/datasets/resource/1309>)
13. CABI Bioscience Genetic Resource Collection (<http://data.gbif.org/datasets/resource/166>)
14. California Academy of Sciences (<http://data.gbif.org/datasets/resource/1352>)
15. California State University, Chico (<http://data.gbif.org/datasets/resource/737>)
16. Canadian Museum of Nature Herbarium (<http://data.gbif.org/datasets/resource/123>)
17. Centre for Plant Biodiversity Research (<http://data.gbif.org/datasets/resource/1340>)
18. CGN-PGR (<http://data.gbif.org/datasets/resource/1102>)
19. CIBIO, Alicante:ABH-GBIF (<http://data.gbif.org/datasets/resource/251>)
20. CSIRO (<http://data.gbif.org/datasets/resource/1283>)
21. DAO Herbarium Type Specimens (<http://data.gbif.org/datasets/resource/527>)
22. Database Schema for UC Davis [Herbarium Labels] (<http://data.gbif.org/datasets/resource/734>)
23. Database Schema for UC Davis [TGRC] (<http://data.gbif.org/datasets/resource/735>)
24. Department of Botany and Microbiology, Ohio Wesleyan University, Delaware, Ohio (<http://data.gbif.org/datasets/resource/1274>)
25. Desmidiaceae Engels (<http://data.gbif.org/datasets/resource/1089>)
26. EASIANET (<http://data.gbif.org/datasets/resource/206>)
27. EMBRAPA (<http://data.gbif.org/datasets/resource/1262>)
28. Embrapa Amazonia Oriental (<http://data.gbif.org/datasets/resource/1288>)
29. EMBRAPA Recursos Genéticos e Biotecnologia - CENARGEN (<http://data.gbif.org/datasets/resource/1279>)
30. EURISCO (<http://data.gbif.org/datasets/resource/1396>)
31. EURISCO, The European Genetic Resources Search Catalogue (<http://data.gbif.org/datasets/resource/1905>)
32. Fairchild Tropical Botanic Garden Virtual Herbarium Darwin Core format (<http://data.gbif.org/datasets/resource/202>)
33. Field Museum of Natural History (<http://data.gbif.org/datasets/resource/1190>)

34. Flora of Japan Specimen Database (<http://data.gbif.org/datasets/resource/586>)
35. Florida Atlantic University (<http://data.gbif.org/datasets/resource/1320>)
36. Forschungsinstitut Senckenberg (<http://data.gbif.org/datasets/resource/1130>)
37. Friedrich-Schiller-Universitat Jena (<http://data.gbif.org/datasets/resource/1247>)
38. Fruit and seed collection database (<http://data.gbif.org/datasets/resource/1093>)
39. Fundacio CETEC (<http://data.gbif.org/datasets/resource/1312>)
40. Gent University (<http://data.gbif.org/datasets/resource/1292>)
41. Goteborg University (<http://data.gbif.org/datasets/resource/1282>)
42. Gothenburg Herbarium - Types (GBIF:IH:GB:Herbarium)
(<http://data.gbif.org/datasets/resource/1766>)
43. Harvard University Herbaria (<http://data.gbif.org/datasets/resource/1827>)
44. HerbarImages (<http://data.gbif.org/datasets/resource/1095>)
45. Herbario (<http://data.gbif.org/datasets/resource/566>)
46. Herbario del Instituto de Ecología, A.C., México (IE-XAL)
(<http://data.gbif.org/datasets/resource/1597>)
47. Herbario Nacional de Bolivia (<http://data.gbif.org/datasets/resource/1313>)
48. Herbario Universidad de Málaga: MGC-Cormófitos
(<http://data.gbif.org/datasets/resource/259>)
49. Herbarium (UNA) (<http://data.gbif.org/datasets/resource/775>)
50. Herbarium Barroso (<http://data.gbif.org/datasets/resource/1281>)
51. Herbarium Descoigns (<http://data.gbif.org/datasets/resource/1299>)
52. Herbarium Fromm-Trinta (<http://data.gbif.org/datasets/resource/1354>)
53. Herbarium hermogenes (<http://data.gbif.org/datasets/resource/1297>)
54. Herbarium Pederson (<http://data.gbif.org/datasets/resource/1270>)
55. Herbarium S.C.H. Barrett (<http://data.gbif.org/datasets/resource/1334>)
56. Herbarium Sigrid Liede (<http://data.gbif.org/datasets/resource/1277>)
57. Herbarium Specimens of Museum of Nature and Human Activities, Hyogo Pref., Japan
(<http://data.gbif.org/datasets/resource/1798>)
58. Herbarium Stace (<http://data.gbif.org/datasets/resource/1302>)
59. Herbarium Taylor (<http://data.gbif.org/datasets/resource/1355>)
60. Herbarium Universitat Ulm (<http://data.gbif.org/datasets/resource/1224>)
61. Herbarium Webster (<http://data.gbif.org/datasets/resource/1346>)
62. Herbier de la Guyane (<http://data.gbif.org/datasets/resource/1436>)
63. Ilha Solteira, Herbario (<http://data.gbif.org/datasets/resource/1266>)
64. Institut Botanic de Barcelona, BC (<http://data.gbif.org/datasets/resource/299>)
65. Institut de Recherche pour le Développement (IRD)
(<http://data.gbif.org/datasets/resource/1265>)
66. Institut für Allgemeine Botanik (<http://data.gbif.org/datasets/resource/1263>)
67. Instituto de Botanica (<http://data.gbif.org/datasets/resource/1252>)
68. Instituto de Botanica Darwinion (<http://data.gbif.org/datasets/resource/1295>)
69. Instituto de Botanica del Nordeste (<http://data.gbif.org/datasets/resource/1287>)
70. Instituto de Pesquisas Científicas e Tecnológicas do Estado do Amapá
(<http://data.gbif.org/datasets/resource/1246>)
71. Instituto Nacional de Pesquisas da Amazonia (<http://data.gbif.org/datasets/resource/1141>)
72. Internation Botanical Collections (S) (<http://data.gbif.org/datasets/resource/1983>)
73. IPK Genebank (<http://data.gbif.org/datasets/resource/1851>)

74. Jardi Botanic de Valencia: VAL (<http://data.gbif.org/datasets/resource/238>)
75. Jardim Botanico do Rio de Janeiro (<http://data.gbif.org/datasets/resource/1273>)
76. Johannes Gutenberg-Universitat (<http://data.gbif.org/datasets/resource/1301>)
77. Lichen Herbarium Berlin (<http://data.gbif.org/datasets/resource/1097>)
78. Lichen herbarium, Oslo (O) (<http://data.gbif.org/datasets/resource/1067>)
79. LPT (<http://data.gbif.org/datasets/resource/1306>)
80. Ludwig-Maximilians-Universitat (<http://data.gbif.org/datasets/resource/1291>)
81. Lund Botanical Museum (LD) (<http://data.gbif.org/datasets/resource/1028>)
82. Manaus, Herbario da Universidade do Amazonas
(<http://data.gbif.org/datasets/resource/1249>)
83. MEXU/Plantas Vasculares (<http://data.gbif.org/datasets/resource/780>)
84. Missouri Botanical Garden (<http://data.gbif.org/datasets/resource/621>)
85. Museo Ecuatoriano de Ciencias Naturales (<http://data.gbif.org/datasets/resource/1268>)
86. Museu Botanico Municipal (<http://data.gbif.org/datasets/resource/1239>)
87. Museu Paraense Emilio Goeldi (<http://data.gbif.org/datasets/resource/1235>)
88. Museum National d'Histoire Naturelle, Paris (<http://data.gbif.org/datasets/resource/1146>)
89. Nationaal Herbarium Nederland (<http://data.gbif.org/datasets/resource/1211>)
90. Nationaal Herbarium Nederland, Leiden University branch
(<http://data.gbif.org/datasets/resource/1275>)
91. Nationaal Herbarium Nederland, Utrecht University branch
(<http://data.gbif.org/datasets/resource/1242>)
92. National Botanic Garden Belgium - Albertian Rift Rubiaceae (ENBI wp13)
(<http://data.gbif.org/datasets/resource/90>)
93. National Botanic Garden Belgium - Myxomycetes
(<http://data.gbif.org/datasets/resource/88>)
94. National Museum in Prague (<http://data.gbif.org/datasets/resource/1324>)
95. Naturhistorisches Museum Wien (<http://data.gbif.org/datasets/resource/1157>)
96. NSW herbarium collection (<http://data.gbif.org/datasets/resource/968>)
97. Old Dominion University (<http://data.gbif.org/datasets/resource/1296>)
98. Online Zoological Collections of Australian Museums
(<http://data.gbif.org/datasets/resource/623>)
99. Orchid Herbarium Collection (<http://data.gbif.org/datasets/resource/1495>)
100. Paleobiology Database (<http://data.gbif.org/datasets/resource/563>)
101. Phanerogamie (<http://data.gbif.org/datasets/resource/1506>)
102. Planetary Biodiversity Inventory Eumycetozoan Databank
(<http://data.gbif.org/datasets/resource/1515>)
103. Plants of Papua New Guinea (<http://data.gbif.org/datasets/resource/969>)
104. Pontificia Universidad Catolica del Ecuador (<http://data.gbif.org/datasets/resource/1258>)
105. Pontificia Universidad Catolica Madre y Maestra
(<http://data.gbif.org/datasets/resource/1341>)
106. Real Jardin Botanico (Madrid), Vascular Plant Herbarium (MA)
(<http://data.gbif.org/datasets/resource/240>)
107. Royal Botanic Gardens, Kew (<http://data.gbif.org/datasets/resource/629>)
108. Royal Ontario Museum (<http://data.gbif.org/datasets/resource/1348>)
109. Ruhr-Universitat Bochum (<http://data.gbif.org/datasets/resource/1317>)
110. SANT herbarium vascular plant collection (<http://data.gbif.org/datasets/resource/222>)

111. SERNEC - University of North Carolina at Chapel Hill - Plants
(<http://data.gbif.org/datasets/resource/895>)
112. Smithsonian Institution (<http://data.gbif.org/datasets/resource/1250>)
113. Species of Eastern Brazil Vascular Plant Specimens
(<http://data.gbif.org/datasets/resource/729>)
114. SysTax (<http://data.gbif.org/datasets/resource/1875>)
115. Systematic Botany and Mycology Laboratory, USDA/ARS
(<http://data.gbif.org/datasets/resource/1264>)
116. The AAU Herbarium Database (<http://data.gbif.org/datasets/resource/224>)
117. The Deaver Herbarium, Northern Arizona University
(<http://data.gbif.org/datasets/resource/678>)
118. The Myxomycetes Collections at the Botanische Staatssammlung Munchen - Collection of Hermann Neubert (<http://data.gbif.org/datasets/resource/1443>)
119. The Natural History Museum (<http://data.gbif.org/datasets/resource/1172>)
120. The System-wide Information Network for Genetic Resources (SINGER)
(<http://data.gbif.org/datasets/resource/1430>)
121. The University of Hong Kong Herbarium (<http://data.gbif.org/datasets/resource/724>)
122. Type herbarium, Gottingen (GOET) (<http://data.gbif.org/datasets/resource/1494>)
123. UCD Botanical Conservatory (<http://data.gbif.org/datasets/resource/739>)
124. ULNM (<http://data.gbif.org/datasets/resource/1300>)
125. United States National Herbarium (<http://data.gbif.org/datasets/resource/1248>)
126. United States National Plant Germplasm System Collection
(<http://data.gbif.org/datasets/resource/1429>)
127. Universidad de Buenos Aires (<http://data.gbif.org/datasets/resource/1345>)
128. Universidad de Costa Rica (<http://data.gbif.org/datasets/resource/1184>)
129. Universidad de M laga: MGC-Algae (<http://data.gbif.org/datasets/resource/1864>)
130. Universidad de Murcia, Dpto. Biología Vegetal (Bot nica), Murcia: MUB-HEPATICAЕ
(<http://data.gbif.org/datasets/resource/1522>)
131. Universidad de Oviedo. Departamento de Biología de Organismos y Sistemas: FCO
(<http://data.gbif.org/datasets/resource/245>)
132. Universidad Nacional Autonoma de Mexico (<http://data.gbif.org/datasets/resource/1322>)
133. Universidad Nacional de Colombia (<http://data.gbif.org/datasets/resource/1290>)
134. Universidad Nacional de Loja (<http://data.gbif.org/datasets/resource/1284>)
135. Universidad Politcnica de Madrid, Dpto. Biología Vegetal, Banco de Germoplasma
(<http://data.gbif.org/datasets/resource/1521>)
136. Universidade de Brasilia (<http://data.gbif.org/datasets/resource/1272>)
137. Universidade de Sao Paulo (<http://data.gbif.org/datasets/resource/1311>)
138. Universidade Estadual de Campinas (<http://data.gbif.org/datasets/resource/1255>)
139. Universidade Federal de Juiz de Fora (<http://data.gbif.org/datasets/resource/1260>)
140. Universidade Federal de Mato Grosso (<http://data.gbif.org/datasets/resource/1254>)
141. Universidade Federal de Santa Catarina (<http://data.gbif.org/datasets/resource/1335>)
142. Universidade Federal do Maranhao (<http://data.gbif.org/datasets/resource/1305>)
143. Universidade Federal do Parana (<http://data.gbif.org/datasets/resource/1337>)
144. Universidade Federal do Rio Grande do Sul (<http://data.gbif.org/datasets/resource/1280>)
145. Universitat Wien (<http://data.gbif.org/datasets/resource/1286>)
146. Universitat Zurich (<http://data.gbif.org/datasets/resource/1276>)

147. University of Aarhus (<http://data.gbif.org/datasets/resource/1349>)
148. University of Alabama (<http://data.gbif.org/datasets/resource/1316>)
149. University of Calicut (<http://data.gbif.org/datasets/resource/1343>)
150. University of California (<http://data.gbif.org/datasets/resource/1245>)
151. University of California Botanical Garden DiGIR provider (<http://data.gbif.org/datasets/resource/1412>)
152. University of Michigan (<http://data.gbif.org/datasets/resource/1285>)
153. University of Texas at Austin (<http://data.gbif.org/datasets/resource/1243>)
154. University of Victoria (<http://data.gbif.org/datasets/resource/1261>)
155. University of Wisconsin Oshkosh (<http://data.gbif.org/datasets/resource/1293>)
156. USDA (<http://data.gbif.org/datasets/resource/1342>)
157. Vanderbilt University (<http://data.gbif.org/datasets/resource/1241>)
158. Vascular Plant Collection - University of Washington Herbarium (WTU) (<http://data.gbif.org/datasets/resource/126>)
159. Vascular Plant Type Specimens (<http://data.gbif.org/datasets/resource/731>)
160. Wageningen University (<http://data.gbif.org/datasets/resource/1267>)
161. Westfälische Wilhelms-Universität (<http://data.gbif.org/datasets/resource/1271>)

SpeciesLink:

1. Banco de DNA do Jardim Botânico do Rio de Janeiro Carpoteca UFP
2. Coleção de Fanerógamas do Herbário do Estado "Maria Eneyda P. Kaufmann Fidalgo"
3. Coleção de plantas medicinais e aromáticas
4. Herbário - IPA Dárdano de Andrade Lima
5. Herbário "Irina Delanova Gemtchújnicov"
6. Herbário Central da Universidade Federal do Espírito Santo VIES
7. Herbário da Escola Superior de Agricultura Luiz de Queiroz
8. Herbário da Universidade Estadual de Campinas
9. Herbário da Universidade Estadual de Londrina
10. Herbário da Universidade Estadual de Ponta Grossa
11. Herbário da Universidade Federal de Sergipe
12. Herbário Dárdano de Andrade Lima
13. Herbário de Ilha Solteira
14. Herbário de São José do Rio Preto
15. Herbário Dimitri Sucre Benjamin
16. Herbário do Departamento de Botânica, SPF-IB/USP
17. Herbário do Instituto Agronômico de Campinas
18. Herbário do Museu Botânico Municipal
19. Herbário Dom Bento Pickel
20. Herbário Dr. Roberto Miguel Klein
21. Herbário Graziela Barroso
22. Herbário Jaime Coelho de Moraes
23. Herbário Lauro Pires Xavier
24. Herbário Mogiense
25. Herbário Pe. Camille Torrand
26. Herbário Prisco Bezerra
27. Herbário Professor Vasconcelos Sobrinho

28. Herbário Rioclarense
29. Herbário Sérgio Tavares
30. Herbário UEM
31. Herbário UFP - Geraldo Mariz
32. Herbário UFRN
33. INPA - Coleção de Madeiras - Xiloteca
34. INPA-Carpoteca - Carpoteca
35. INPA-Herbario - Herbário
36. MBML-Herbario
37. SPFw - Xiloteca do Instituto de Biociências da Universidade de São Paulo
38. UPCB - Herbário do Departamento de Botânica
39. Xiloteca "Profa. Dra. Maria Aparecida Mourão Brasil"
40. Xiloteca Calvino Mainieri
41. Xiloteca do Jardim Botânico do Rio de Janeiro

Appendices

S1 species.data

Basic information for all 4962 valid tree species. Note that a few of these species are variable in habit, and are more often recorded as treelets, or even climbers, than as trees.

Accepted_family:	Family according to Tropicos (43)
Accepted_genus:	Genus according to Tropicos (43)
Accepted_species:	Species according to Tropicos (43)
n.ind:	Number of individuals in ATDN database for 1170 plots
n.plots:	Number of plots (of 1170) in which the species is present
maxabund:	Number of individuals per ha in the plot where the species has it highest abundance
est.ind:	Population size based on 1 run with all 1170 plots
population.mean:	Mean population size of 500 runs with 1000 plots (with replacement)
population.sd:	SD of population size of 500 runs with 1000 plots (with replacement)
species.relmax:	Fraction of individuals in the plot where the species has it highest dominance
IV.maxcls:	Forest type in which species has highest IV-value (1 = igapó, 2 = podzol, 3 = swamp, 4 = terra firme, 5 = várzea)
IV.indcls:	IV value
IV.pval:	p value for IV value

S2/S3 Families/Genera

Family/Genus:	name according to Tropicos (43)
N ind:	Number of individuals in the 1170 plots
N species:	Number of species in the 1170 plots
HyperDom:	Observed number of hyper-dominant species in family/genus
HypDomExp:	Expected number of hyper-dominant species in family/genus (based on 1000 randomizations)
ci.lo:	lower 95% confidence limit for expected number of hyper-dominant species (based on 1000 randomizations)
ci.hi:	upper 95% confidence limit for expected number of hyper-dominant species (based on 1000 randomizations)
hilo:	significant deviation from expected number of hyper-dominants

S4 Plot meta data

ATDNNR:	number in ATDN database
Country:	country in which plot is located
Subdivision:	mostly province
Site:	site name
PlotCode:	Unique ATDN plot code
Latitude, Longitude	
PlotSize:	plot size in ha.
PlotType:	single: 1 single contiguous area; combi; few plots very close added together; pcq: plots built from point center quarter data. Plot size equivalent calculated from tree density estimate.
DBHmin:	min dbh cut off
Year_est:	Year in which the plot was established (not necessarily the census year)
Owner/contact:	Owner of plot data
Source:	literature reference of plot data. This source does not always contain the full data set.

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