Supplementary Material - Interspecific variation in tropical tree height and crown allometries in relation to life history traits

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Table S1. Sources of field measurement data for tree heights and crown dimensions, methods, site of measurement and the number of data points. Where crown areas were not measured directly, they were estimated as pi times the geometric mean crown radius.

	Source	Crown method	Height method	Site	Years	N Crowns	N Heights	Observers	Reference
1	O´Brien	8 radii[1]	Telescoping pole[2] or tangent method[3]	BCI	1993	171	171	S. O'Brien	O'Brien et al. 1995
2	Spiro	8 radii[1]	Telescoping pole[2] or tangent method[3]	BCI	1993	195	194	Spiro	Bohlman & O'Brien 2006
3	Thomas	–	Telescoping pole[2] or tangent method[3]	BCI	2000	–	43	Thomas	Thomas (unpubl data)
4	Bohlman	8 radii[1]	Sine method[4]	BCI	1997	175	182	S. A. Bohlman	Bohlman & O'Brien 2006
5	Wright	8 radii[1]	Telescoping pole[2] or tangent method[3]	BCI	2007	760	824	M. C. Ruiz-Jaen & C. Salvador	Wright et al. 2010
6	Wright	–	Telescoping pole[2] or tangent method[3]	Gigante	1998-1999	–	4720	A. Peterson, C. Korine, O. Hernandez & R. Gonzalez	NA
7	Muller-Landau	Longest diameter and perpendicular diameter[5]	Telescoping pole[2]	BCI	1996-1999	505	1019	H. Muller-Landau	NA
8	Muller-Landau	–	Telescoping pole[2] or sine method[4]	BCI		–	2113	P. Ramos, P. Villareal	NA
9	Muller-Landau	Photogrammetry [6]	Photogrammetry minus lidar DEM[7]	BCI	2014	619	619	J. Dandois	NA
	Total					2425	9885		

[1] The horizontal distance from the trunk to the vertical projection of the edge of the canopy was measured in eight compass directions 45 degrees apart, including magnetic north.

[2] These measurements were all on small saplings. The horizontal distance spanning the longest dimension of the crown was measured together with the perpendicular horizontal dimension of the crown.

[3] Height measurements were made with a height-marked telescoping pole for individuals that could be reached by this pole (typically to 5 or 8 m height).

[4] Height estimates for trees to large to be measured with a telescoping pole were based on combining measurements of the angle to the top of the tree and the distance to the base of the tree. In early studies, the distance to the base of the tree was measured manually; in later studies, with a laser rangefinder.

[5] Height measurements to large to be measured with a telescoping pole were based on measurements of the vertical distance to the highest leaf as measured with a laser rangefinder. See Larjavaara & Muller-Landau (2013) for details.

[6] Overlapping aerial photos taken by an unmanned aerial vehicle in October 2014were processed using Agisoft Photoscan to obtain a 3D point cloud, from which orthomosaics and canopy surface elevation maps were produced at a resolution of 7 cm. The orthomosaic and canopy surface maps were georeferenced by comparison with 2009 1-m resolution airborne lidar data. Individual tree crowns greater than 50 m2 in area were manually delineated, and were assigned to tagged trees in the 50 ha forest dynamics plot through ground-based field work that also assessed whether they were fully sun-exposed. Crown area was estimated as the area of the delineated crown, including only fully sun-exposed individuals.

[7] A 1-m ground digital elevation model from airborne lidar (2009) was subtracted from the canopy surface elevation calculated from the aerial photos as above to obtain a map of canopy height across the 50 ha plot. For each delineated crown linked to a tagged, fully sun-exposed tree, tree height was assessed as the maximum canopy height within the delineated crown area.

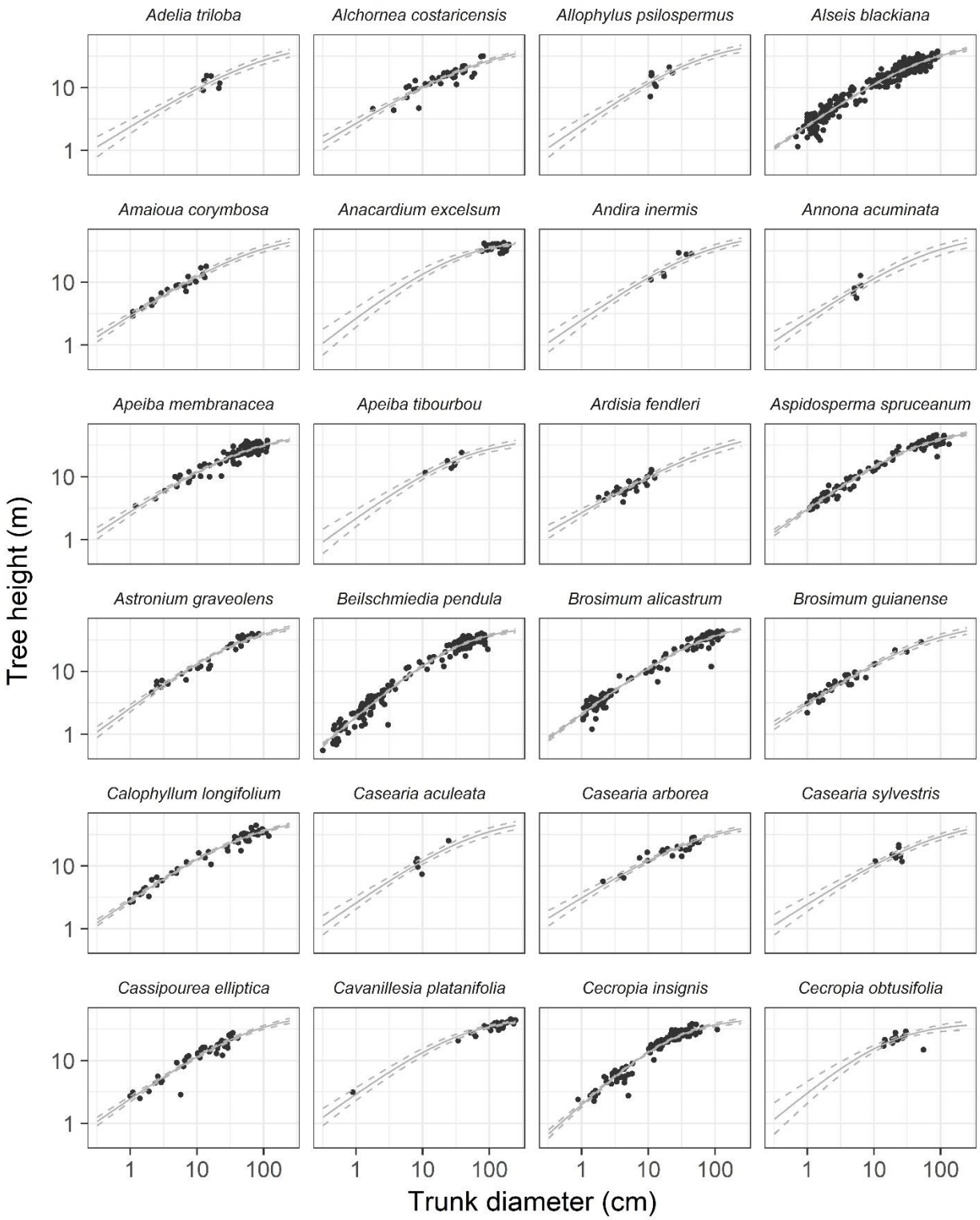
Table S2. Posterior, species-level parameter estimates (median and 90% posterior interval) of the best allometric models for predicting tree height (m) and crown area (m^2) from trunk diameter (cm) (Table 1). The standard error, σ_v, of the best models was 0.181 (0.179, 0.183) and 0.549 (0.536, 0.563) for tree height and crown area, respectively. Michaelis-Menten (gMM) used for tree height and power law used for crown area. Note that table gives raw parameter estimates (*i.e.* see equations 3 and 2 in the main text for tree height and crown area, respectively).

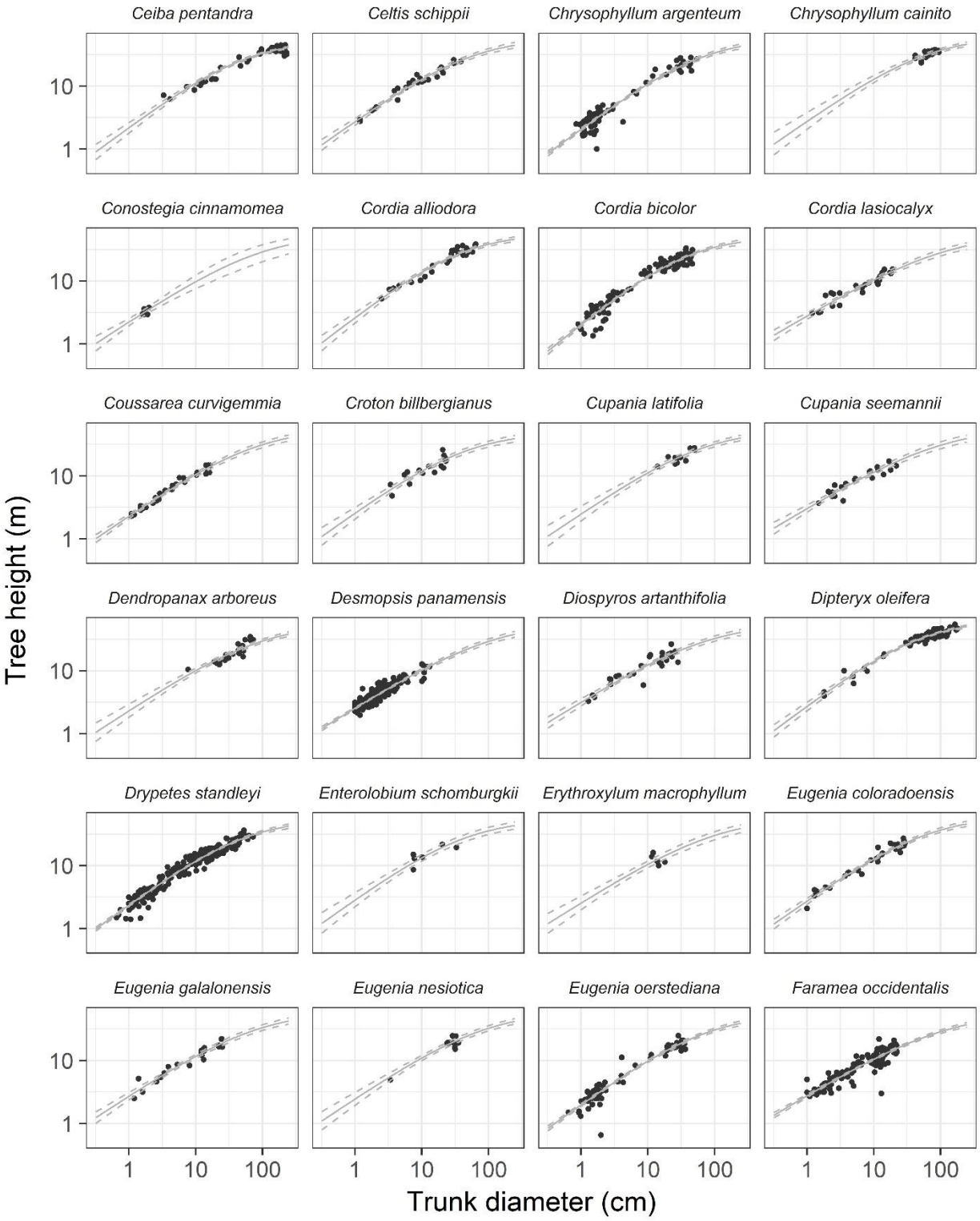
	Tree height			***Crown area***	
Species	***a***	***b***	***k***	***a***	***b***
Adelia triloba	57.1 (48.1, 67.9)	0.66 (0.55, 0.77)	23.2 (17.7, 29.1)	0.800 (0.371, 1.783)	1.34 (1.07, 1.60)
Alchornea costaricensis	53.0 (44.4, 63.3)	0.64 (0.57, 0.72)	18.8 (15.0, 23.2)	0.553 (0.255, 1.203)	1.33 (1.11, 1.55)
Allophylus psilospermus	57.9 (48.9, 69.0)	0.74 (0.63, 0.85)	22.0 (16.6, 28.0)	0.660 (0.302, 1.415)	1.35 (1.10, 1.62)
Alseis blackiana	56.2 (48.6, 65.0)	0.73 (0.71, 0.77)	21.7 (18.8, 25.0)	0.228 (0.195, 0.265)	1.49 (1.42, 1.54)
Amaioua corymbosa	63.0 (53.0, 75.3)	0.70 (0.62, 0.77)	20.7 (16.9, 25.3)	0.721 (0.378, 1.452)	1.30 (1.04, 1.53)
Anacardium excelsum	48.5 (42.8, 56.3)	0.82 (0.70, 0.95)	17.6 (11.1, 24.3)	0.611 (0.262, 1.387)	1.32 (1.15, 1.50)
Andira inermis	63.5 (53.6, 75.5)	0.74 (0.64, 0.84)	24.6 (18.7, 31.0)	0.444 (0.187, 1.051)	1.38 (1.12, 1.64)
Annona acuminata	62.2 (52.1, 74.5)	0.72 (0.59, 0.84)	23.5 (18.0, 29.4)	0.669 (0.364, 1.258)	1.32 (1.08, 1.55)
Apeiba membranacea	53.9 (46.2, 62.9)	0.71 (0.65, 0.78)	18.5 (15.6, 21.6)	0.997 (0.454, 2.338)	1.15 (0.95, 1.34)
Apeiba tibourbou	42.5 (34.5, 52.3)	0.78 (0.65, 0.90)	18.7 (12.9, 25.3)	0.562 (0.239, 1.299)	1.34 (1.09, 1.59)
Ardisia fendleri	62.3 (52.3, 74.2)	0.62 (0.53, 0.72)	22.4 (17.9, 27.3)	0.737 (0.380, 1.415)	1.32 (1.07, 1.55)
Aspidosperma spruceanum	62.5 (54.6, 72.4)	0.77 (0.72, 0.82)	19.6 (17.2, 22.5)	0.692 (0.328, 1.515)	1.24 (1.05, 1.42)
Astronium graveolens	63.9 (55.3, 74.9)	0.79 (0.72, 0.85)	23.7 (19.8, 28.1)	0.578 (0.234, 1.282)	1.30 (1.09, 1.53)
Beilschmiedia pendula	52.4 (47.2, 58.4)	0.91 (0.88, 0.95)	26.9 (24.2, 30.1)	0.583 (0.500, 0.677)	1.27 (1.21, 1.33)
Brosimum alicastrum	63.2 (56.4, 71.2)	0.80 (0.77, 0.84)	29.4 (26.5, 32.9)	0.939 (0.795, 1.116)	1.28 (1.22, 1.33)
Brosimum guianense	62.0 (52.5, 73.6)	0.71 (0.64, 0.78)	19.6 (16.2, 23.5)	0.790 (0.458, 1.364)	1.30 (1.10, 1.51)
Calophyllum longifolium	61.1 (53.3, 71.0)	0.74 (0.69, 0.79)	20.7 (17.8, 24.1)	0.495 (0.267, 0.911)	1.37 (1.22, 1.52)
Casearia aculeata	61.7 (52.1, 73.4)	0.74 (0.63, 0.85)	23.1 (17.6, 29.0)	0.603 (0.302, 1.189)	1.34 (1.09, 1.57)
Casearia arborea	56.4 (47.1, 68.3)	0.67 (0.59, 0.76)	17.3 (13.5, 21.9)	0.624 (0.262, 1.473)	1.29 (1.06, 1.53)
Casearia sylvestris	57.7 (48.4, 68.4)	0.69 (0.58, 0.79)	22.6 (16.7, 28.9)	0.594 (0.262, 1.389)	1.34 (1.10, 1.60)
Cassipourea elliptica	59.9 (51.2, 70.4)	0.74 (0.69, 0.80)	23.5 (19.7, 27.9)	0.536 (0.313, 0.908)	1.39 (1.21, 1.56)
Cavanillesia platanifolia	51.7 (45.5, 60.2)	0.77 (0.68, 0.87)	16.9 (12.5, 22.0)	0.524 (0.220, 1.245)	1.21 (1.04, 1.39)
Cecropia insignis	47.1 (41.6, 54.1)	0.96 (0.90, 1.03)	22.9 (20.3, 25.9)	0.254 (0.195, 0.328)	1.65 (1.56, 1.75)
Cecropia obtusifolia	40.1 (32.3, 50.2)	0.88 (0.71, 1.05)	12.4 (7.1, 18.8)	0.665 (0.304, 1.678)	1.20 (0.93, 1.44)
Ceiba pentandra	53.6 (48.1, 60.7)	0.79 (0.72, 0.88)	23.8 (20.2, 28.1)	0.288 (0.143, 0.576)	1.51 (1.36, 1.65)
Celtis schippii	58.8 (50.2, 69.6)	0.76 (0.69, 0.83)	20.8 (17.2, 25.1)	0.633 (0.277, 1.434)	1.37 (1.14, 1.63)
Chrysophyllum argenteum	57.6 (49.7, 66.3)	0.79 (0.75, 0.84)	27.0 (23.4, 31.3)	0.758 (0.625, 0.924)	1.24 (1.13, 1.35)
Chrysophyllum cainito	63.0 (53.6, 75.8)	0.75 (0.65, 0.85)	22.3 (15.7, 29.3)	0.585 (0.243, 1.405)	1.36 (1.14, 1.58)
Conostegia cinnamomea	56.9 (48.3, 67.0)	0.71 (0.55, 0.86)	24.7 (20.4, 29.6)	1.380 (0.871, 2.189)	1.15 (0.94, 1.36)
Cordia alliodora	56.6 (48.7, 66.4)	0.82 (0.74, 0.91)	21.0 (17.0, 25.6)	0.530 (0.221, 1.312)	1.29 (1.05, 1.53)
Cordia bicolor	49.9 (42.5, 57.9)	0.86 (0.82, 0.92)	23.9 (20.5, 27.6)	0.270 (0.216, 0.335)	1.44 (1.35, 1.53)
Cordia lasiocalyx	58.3 (49.4, 69.1)	0.64 (0.57, 0.71)	20.1 (16.4, 24.5)	0.340 (0.200, 0.581)	1.36 (1.16, 1.56)
Coussarea curvigemmia	57.1 (49.1, 66.2)	0.74 (0.68, 0.80)	24.2 (20.3, 28.3)	0.577 (0.360, 0.955)	1.31 (1.12, 1.50)
Croton billbergianus	50.0 (42.0, 59.8)	0.77 (0.66, 0.87)	18.9 (14.4, 23.8)	0.732 (0.336, 1.627)	1.34 (1.09, 1.59)
Cupania latifolia	55.9 (47.3, 66.5)	0.73 (0.63, 0.83)	21.9 (15.9, 27.9)	0.612 (0.267, 1.418)	1.36 (1.13, 1.60)
Cupania seemannii	61.4 (51.3, 73.1)	0.65 (0.57, 0.73)	19.4 (15.6, 23.8)	0.800 (0.436, 1.430)	1.36 (1.15, 1.59)
Dendropanax arboreus	57.1 (48.6, 68.0)	0.71 (0.62, 0.79)	24.1 (18.6, 30.2)	0.531 (0.243, 1.112)	1.38 (1.18, 1.59)
Desmopsis panamensis	60.1 (51.4, 70.6)	0.67 (0.63, 0.71)	22.7 (19.2, 26.9)	0.603 (0.362, 1.016)	1.34 (1.13, 1.54)
Diospyros artanthifolia	58.8 (49.5, 70.0)	0.67 (0.60, 0.74)	17.8 (14.4, 21.8)	0.470 (0.202, 1.043)	1.35 (1.09, 1.61)
Dipteryx oleifera	64.5 (57.4, 74.4)	0.80 (0.73, 0.87)	23.0 (19.5, 26.8)	0.530 (0.222, 1.178)	1.47 (1.30, 1.67)
Drypetes standleyi	55.4 (47.4, 64.3)	0.78 (0.75, 0.82)	22.6 (19.5, 26.2)	0.794 (0.679, 0.933)	1.27 (1.19, 1.34)
Enterolobium schomburgkii	55.5 (46.8, 66.3)	0.77 (0.65, 0.89)	18.9 (13.8, 24.4)	0.880 (0.452, 1.830)	1.23 (0.99, 1.46)
Erythroxylum macrophyllum	60.6 (51.2, 72.1)	0.68 (0.57, 0.79)	23.0 (17.4, 29.3)	0.544 (0.266, 1.202)	1.35 (1.08, 1.61)
Eugenia coloradoensis	62.5 (53.4, 74.3)	0.75 (0.69, 0.81)	22.1 (18.4, 26.7)	0.560 (0.273, 1.126)	1.35 (1.12, 1.57)
Eugenia galalonensis	61.8 (52.7, 73.2)	0.71 (0.64, 0.78)	22.0 (18.0, 26.6)	0.598 (0.341, 1.030)	1.33 (1.14, 1.54)
Eugenia nesiotica	61.8 (51.9, 73.6)	0.72 (0.63, 0.81)	24.4 (18.9, 30.5)	0.650 (0.277, 1.386)	1.38 (1.15, 1.63)
Eugenia oerstediana	54.8 (46.9, 63.1)	0.77 (0.73, 0.81)	26.9 (23.0, 31.1)	0.803 (0.632, 1.020)	1.34 (1.23, 1.45)
Faramea occidentalis	59.1 (50.0, 69.2)	0.65 (0.61, 0.68)	20.5 (17.2, 24.3)	0.663 (0.489, 0.902)	1.25 (1.12, 1.38)
Ficus costaricana	59.6 (50.6, 71.1)	0.70 (0.61, 0.79)	23.4 (17.0, 30.2)	0.564 (0.233, 1.391)	1.18 (0.98, 1.37)
Ficus maxima	51.6 (43.7, 61.8)	0.81 (0.69, 0.93)	19.5 (14.5, 25.3)	0.382 (0.183, 0.767)	1.41 (1.17, 1.65)

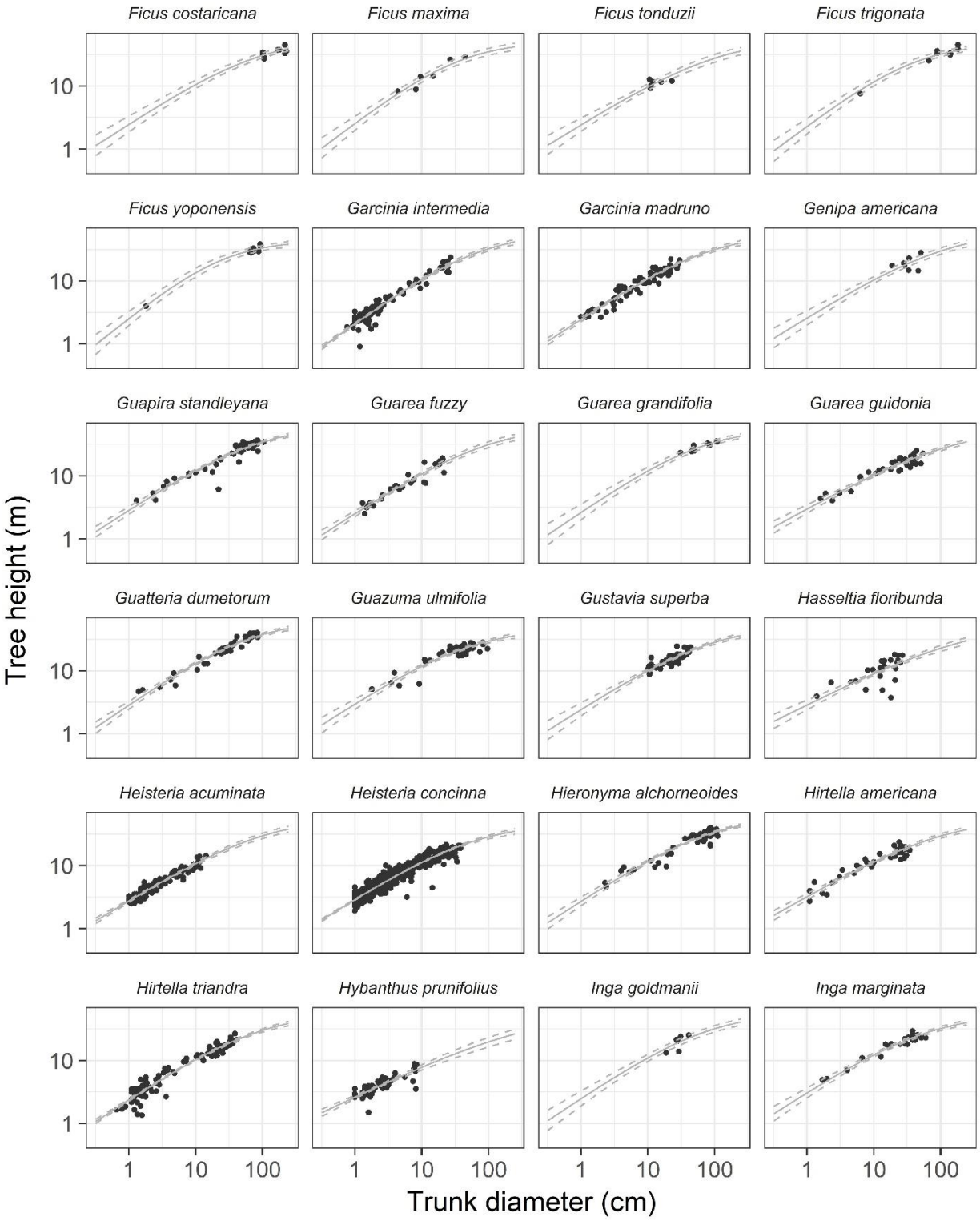
Ficus tonduzii	58.3 (49.3, 69.2)	0.66 (0.56, 0.77)	23.3 (18.0, 29.2)	0.573 (0.260, 1.282)	1.33 (1.07, 1.60)
Ficus trigonata	48.5 (41.8, 57.3)	0.81 (0.70, 0.93)	20.4 (15.1, 26.3)	0.651 (0.314, 1.392)	1.30 (1.13, 1.49)
Ficus yoponensis	44.1 (37.5, 53.4)	0.86 (0.74, 1.00)	16.7 (12.2, 22.2)	0.491 (0.249, 0.937)	1.44 (1.27, 1.61)
Garcinia intermedia	57.6 (49.8, 66.6)	0.77 (0.73, 0.81)	26.7 (22.9, 30.9)	0.819 (0.675, 0.985)	1.26 (1.15, 1.38)
Garcinia madruno	58.0 (49.4, 68.1)	0.72 (0.67, 0.77)	22.8 (19.3, 26.9)	0.616 (0.275, 1.396)	1.36 (1.09, 1.63)
Genipa americana	63.8 (53.3, 77.4)	0.66 (0.57, 0.76)	24.0 (18.0, 30.5)	0.594 (0.249, 1.327)	1.40 (1.16, 1.65)
Guapira standleyana	64.4 (55.0, 76.4)	0.70 (0.65, 0.77)	21.9 (18.2, 26.1)	0.597 (0.280, 1.353)	1.29 (1.09, 1.49)
Guarea grandifolia	59.3 (50.4, 70.1)	0.74 (0.64, 0.84)	21.8 (15.5, 28.6)	0.601 (0.256, 1.403)	1.34 (1.13, 1.55)
Guarea guidonia	60.5 (50.5, 73.1)	0.60 (0.53, 0.66)	19.5 (15.5, 23.9)	0.517 (0.239, 1.100)	1.32 (1.10, 1.54)
Guarea fuzzy	61.9 (52.5, 73.2)	0.70 (0.63, 0.77)	23.9 (19.8, 28.5)	0.263 (0.141, 0.474)	1.44 (1.25, 1.67)
Guatteria dumetorum	65.0 (55.8, 76.5)	0.74 (0.68, 0.81)	22.0 (18.2, 26.4)	0.635 (0.314, 1.253)	1.29 (1.10, 1.47)
Guazuma ulmifolia	48.3 (39.7, 58.2)	0.70 (0.62, 0.79)	15.4 (12.0, 19.4)	0.618 (0.275, 1.462)	1.30 (1.08, 1.52)
Gustavia superba	54.6 (46.0, 65.2)	0.69 (0.59, 0.78)	21.8 (16.8, 27.4)	0.615 (0.275, 1.364)	1.31 (1.08, 1.52)
Hasseltia floribunda	60.7 (51.1, 72.1)	0.54 (0.47, 0.62)	20.3 (16.0, 25.2)	0.683 (0.339, 1.410)	1.28 (1.04, 1.50)
Heisteria acuminata	58.9 (49.9, 69.6)	0.66 (0.61, 0.71)	20.5 (17.0, 24.3)	0.875 (0.439, 1.822)	1.32 (1.04, 1.57)
Heisteria concinna	48.2 (39.4, 57.5)	0.68 (0.65, 0.72)	15.7 (12.8, 18.8)	0.652 (0.370, 1.153)	1.37 (1.18, 1.55)
Hirtella americana	59.3 (49.9, 71.0)	0.62 (0.56, 0.68)	17.6 (14.2, 21.5)	0.485 (0.254, 0.904)	1.42 (1.17, 1.67)
Hirtella triandra	57.3 (48.9, 67.2)	0.71 (0.68, 0.74)	23.3 (19.8, 27.3)	0.927 (0.768, 1.130)	1.25 (1.14, 1.36)
Hybanthus prunifolius	61.8 (52.3, 72.8)	0.51 (0.45, 0.58)	22.6 (19.0, 27.0)	0.834 (0.508, 1.365)	1.26 (1.05, 1.47)
Hieronyma alchorneoides	64.3 (55.3, 76.2)	0.70 (0.64, 0.77)	23.0 (18.9, 27.4)	0.554 (0.234, 1.337)	1.38 (1.19, 1.58)
Inga goldmanii	59.0 (49.8, 70.2)	0.72 (0.62, 0.82)	23.1 (17.1, 29.5)	0.639 (0.271, 1.454)	1.37 (1.13, 1.61)
Inga marginata	56.1 (47.2, 67.2)	0.69 (0.61, 0.77)	17.5 (13.8, 21.8)	0.658 (0.264, 1.504)	1.40 (1.17, 1.66)
Inga acuminata	54.6 (45.5, 65.2)	0.67 (0.57, 0.77)	18.7 (13.6, 24.5)	0.735 (0.366, 1.456)	1.40 (1.17, 1.62)
Inga sapindoides	58.3 (49.5, 69.3)	0.74 (0.64, 0.83)	22.9 (17.2, 29.0)	0.657 (0.295, 1.463)	1.38 (1.13, 1.63)
Inga spectabilis	53.5 (45.3, 63.6)	0.73 (0.62, 0.83)	22.1 (16.3, 28.3)	0.541 (0.233, 1.231)	1.37 (1.12, 1.61)
Inga umbellifera	63.5 (53.0, 76.4)	0.59 (0.51, 0.66)	17.2 (14.0, 21.2)	0.881 (0.408, 1.959)	1.32 (1.05, 1.57)
Jacaranda copaia	51.4 (45.1, 60.0)	0.75 (0.68, 0.83)	14.6 (12.3, 17.1)	0.500 (0.269, 0.977)	1.36 (1.20, 1.52)
Lacistema aggregatum	62.0 (52.5, 73.8)	0.71 (0.66, 0.77)	21.9 (18.3, 26.4)	0.467 (0.198, 1.074)	1.35 (1.09, 1.63)
Lacmellea panamensis	53.4 (44.9, 63.6)	0.69 (0.62, 0.77)	17.4 (14.0, 21.3)	0.538 (0.245, 1.371)	1.31 (1.06, 1.55)
Laetia procera	48.2 (40.6, 57.8)	0.81 (0.71, 0.93)	17.2 (13.2, 21.8)	0.591 (0.253, 1.422)	1.40 (1.16, 1.63)
Laetia thamnia	60.3 (50.8, 72.1)	0.65 (0.59, 0.70)	18.0 (14.8, 21.7)	0.705 (0.311, 1.577)	1.38 (1.10, 1.65)
Licania hypoleuca	62.5 (52.6, 74.2)	0.67 (0.63, 0.71)	20.7 (17.2, 24.8)	0.725 (0.323, 1.560)	1.36 (1.11, 1.61)
Licania platypus	61.0 (51.7, 72.8)	0.72 (0.63, 0.82)	23.4 (17.5, 29.7)	0.639 (0.310, 1.432)	1.24 (1.00, 1.44)
Lindackeria laurina	57.4 (48.2, 68.6)	0.71 (0.60, 0.80)	23.3 (17.5, 29.3)	0.488 (0.219, 1.090)	1.35 (1.10, 1.59)
Lonchocarpus heptaphyllus	63.9 (54.5, 75.5)	0.75 (0.70, 0.81)	21.4 (17.8, 25.7)	0.189 (0.112, 0.320)	1.53 (1.38, 1.70)
Luehea seemannii	55.1 (48.7, 62.9)	0.78 (0.74, 0.83)	26.9 (23.6, 30.5)	0.526 (0.230, 1.262)	1.33 (1.13, 1.52)
Macrocnemum roseum	59.4 (50.2, 70.6)	0.71 (0.61, 0.81)	23.7 (17.6, 30.0)	0.569 (0.247, 1.312)	1.30 (1.06, 1.54)
Mosannona garwoodii	60.1 (50.8, 70.9)	0.70 (0.65, 0.76)	20.4 (16.9, 24.3)	0.468 (0.212, 1.030)	1.37 (1.11, 1.62)
Maquira guianensis	59.1 (50.2, 69.5)	0.68 (0.63, 0.74)	21.2 (17.6, 25.4)	0.517 (0.297, 0.902)	1.33 (1.12, 1.53)
Marila laxiflora	56.2 (48.0, 65.9)	0.64 (0.51, 0.77)	23.0 (19.1, 27.6)	0.647 (0.406, 1.032)	1.33 (1.13, 1.52)
Maytenus schippii	61.4 (51.8, 73.6)	0.75 (0.64, 0.85)	21.7 (15.5, 28.0)	0.525 (0.226, 1.230)	1.34 (1.07, 1.61)
Miconia argentea	50.8 (42.7, 60.1)	0.79 (0.74, 0.85)	18.2 (15.3, 21.7)	0.626 (0.480, 0.814)	1.34 (1.22, 1.46)
Miconia nervosa	54.9 (46.3, 64.2)	0.70 (0.56, 0.84)	24.3 (19.9, 29.2)	0.862 (0.556, 1.301)	1.26 (1.06, 1.46)
Mouriri myrtilloides	62.5 (52.7, 74.2)	0.51 (0.46, 0.57)	19.4 (16.2, 23.4)	0.898 (0.579, 1.406)	1.32 (1.12, 1.53)
Myrcia gatunensis	61.2 (51.5, 73.5)	0.64 (0.56, 0.72)	17.8 (14.3, 21.8)	0.642 (0.325, 1.301)	1.34 (1.08, 1.58)
Myrospermum frutescens	66.4 (55.8, 79.6)	0.76 (0.65, 0.86)	20.7 (14.6, 27.4)	0.423 (0.180, 0.923)	1.47 (1.24, 1.73)
Nectandra cissiflora	55.6 (46.3, 66.4)	0.75 (0.62, 0.87)	17.2 (11.6, 23.6)	0.518 (0.238, 1.146)	1.35 (1.10, 1.61)
Nectandra purpurea	55.0 (46.7, 64.9)	0.74 (0.68, 0.80)	19.5 (16.1, 23.3)	0.665 (0.319, 1.384)	1.34 (1.09, 1.57)
Ochroma pyramidale	34.6 (28.1, 44.7)	0.90 (0.73, 1.08)	13.4 (6.4, 21.0)	0.702 (0.260, 1.815)	1.39 (1.14, 1.64)
Ocotea oblonga	51.4 (43.2, 61.2)	0.75 (0.64, 0.85)	20.5 (14.7, 26.5)	0.562 (0.239, 1.312)	1.31 (1.07, 1.54)
Ocotea puberula	56.5 (47.9, 67.1)	0.75 (0.65, 0.86)	20.9 (14.6, 27.9)	0.584 (0.232, 1.364)	1.37 (1.14, 1.60)
Ocotea whitei	57.4 (49.3, 67.6)	0.78 (0.69, 0.88)	22.0 (16.9, 27.5)	0.717 (0.339, 1.584)	1.24 (1.04, 1.43)
Ormosia coccinea	60.0 (51.0, 71.6)	0.77 (0.66, 0.88)	21.3 (15.9, 27.0)	0.391 (0.192, 0.850)	1.33 (1.13, 1.55)
Ormosia macrocalyx	58.2 (50.1, 68.2)	0.81 (0.73, 0.91)	28.1 (23.2, 33.5)	0.264 (0.150, 0.467)	1.43 (1.26, 1.61)
Ouratea lucens	66.2 (55.9, 79.0)	0.74 (0.67, 0.82)	21.2 (17.6, 25.6)	0.288 (0.147, 0.527)	1.47 (1.24, 1.72)
Perebea xanthochyma	59.7 (50.6, 70.9)	0.66 (0.62, 0.71)	19.7 (16.5, 23.4)	0.666 (0.306, 1.493)	1.33 (1.06, 1.58)
Cinnamomum triplinerve	55.3 (47.2, 65.4)	0.72 (0.65, 0.81)	19.2 (15.2, 23.6)	0.291 (0.133, 0.659)	1.39 (1.14, 1.64)
Picramnia latifolia	63.4 (53.2, 76.2)	0.56 (0.48, 0.64)	19.7 (15.7, 24.3)	0.147 (0.070, 0.281)	1.77 (1.54, 2.04)
Piper reticulatum	56.7 (48.3, 67.3)	0.72 (0.60, 0.84)	22.1 (17.0, 27.8)	0.660 (0.338, 1.342)	1.32 (1.04, 1.56)
Platymiscium pinnatum	65.7 (56.1, 78.3)	0.68 (0.60, 0.75)	18.7 (14.7, 23.3)	0.479 (0.199, 1.174)	1.35 (1.12, 1.56)
Platypodium elegans	59.3 (52.0, 68.8)	0.77 (0.70, 0.85)	23.3 (19.9, 27.3)	0.811 (0.353, 1.804)	1.22 (1.04, 1.41)
Pachira sessilis	58.1 (50.2, 68.3)	0.78 (0.72, 0.84)	20.4 (17.2, 24.4)	0.504 (0.299, 0.861)	1.25 (1.07, 1.41)

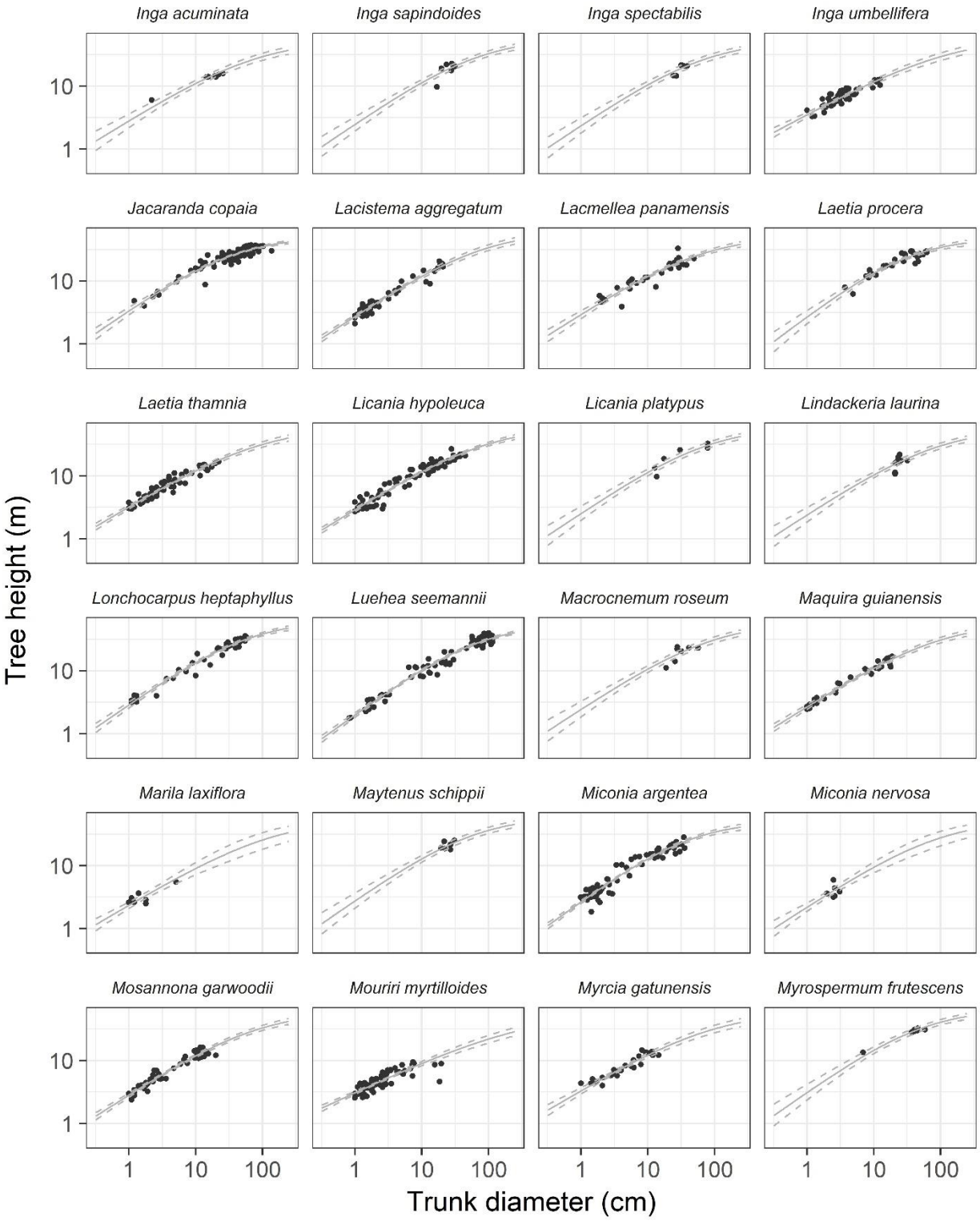
Poulsenia armata	57.4 (51.4, 64.8)	0.86 (0.82, 0.91)	33.1 (29.4, 37.4)	0.332 (0.168, 0.636)	1.32 (1.16, 1.50)
Pourouma bicolor	51.1 (42.4, 61.2)	0.71 (0.64, 0.78)	16.4 (13.4, 19.8)	0.600 (0.237, 1.520)	1.39 (1.14, 1.65)
Pouteria reticulata	63.3 (54.5, 75.0)	0.71 (0.66, 0.75)	20.6 (17.5, 24.5)	0.690 (0.400, 1.225)	1.32 (1.16, 1.47)
Prioria copaifera	60.1 (55.4, 65.7)	0.86 (0.83, 0.89)	36.5 (33.9, 39.5)	0.908 (0.787, 1.050)	1.18 (1.14, 1.22)
Protium costaricense	60.8 (51.0, 72.9)	0.61 (0.54, 0.69)	19.3 (15.2, 23.9)	0.661 (0.328, 1.308)	1.38 (1.14, 1.61)
Protium panamense	61.8 (52.2, 73.8)	0.68 (0.65, 0.72)	19.8 (16.7, 23.7)	0.356 (0.201, 0.636)	1.42 (1.22, 1.62)
Protium confusum	54.5 (45.5, 64.7)	0.68 (0.62, 0.75)	16.7 (13.7, 20.2)	0.760 (0.482, 1.179)	1.25 (1.05, 1.44)
Protium tenuifolium	50.1 (40.8, 59.7)	0.75 (0.71, 0.81)	21.2 (17.5, 25.2)	0.565 (0.436, 0.743)	1.37 (1.26, 1.47)
Pseudobombax septenatum	52.7 (45.6, 62.2)	0.80 (0.70, 0.90)	20.6 (14.6, 26.9)	0.550 (0.240, 1.351)	1.28 (1.06, 1.48)
Psychotria marginata	56.9 (48.5, 66.6)	0.68 (0.55, 0.81)	26.1 (21.5, 31.0)	0.552 (0.347, 0.868)	1.36 (1.17, 1.56)
Pterocarpus rohrii	62.8 (53.9, 73.8)	0.75 (0.69, 0.81)	23.3 (19.8, 27.6)	0.534 (0.289, 1.044)	1.37 (1.17, 1.55)
Quararibea asterolepis	57.8 (52.1, 64.6)	0.86 (0.82, 0.89)	32.0 (29.1, 35.5)	1.052 (0.884, 1.253)	1.09 (1.03, 1.14)
Quassia amara	63.9 (53.9, 76.2)	0.56 (0.50, 0.62)	21.5 (17.8, 26.0)	0.591 (0.280, 1.264)	1.34 (1.07, 1.60)
Randia armata	61.3 (51.8, 72.9)	0.52 (0.45, 0.60)	20.6 (16.3, 25.4)	0.771 (0.351, 1.651)	1.35 (1.11, 1.59)
Rinorea sylvatica	61.2 (52.3, 71.6)	0.64 (0.59, 0.69)	24.9 (21.1, 29.4)	1.095 (0.593, 2.023)	1.27 (1.03, 1.50)
Sapium glandulosum	57.1 (49.2, 67.2)	0.80 (0.71, 0.90)	22.2 (16.6, 28.3)	0.489 (0.206, 1.084)	1.40 (1.19, 1.63)
Simarouba amara	39.9 (35.8, 44.8)	1.01 (0.97, 1.06)	21.9 (19.7, 24.6)	0.538 (0.458, 0.631)	1.32 (1.25, 1.40)
Siparuna guianensis	58.6 (49.3, 69.6)	0.76 (0.64, 0.89)	21.7 (16.7, 27.3)	0.680 (0.358, 1.274)	1.30 (1.06, 1.55)
Sloanea terniflora	55.7 (49.4, 62.8)	0.92 (0.87, 0.97)	33.0 (29.4, 37.0)	0.546 (0.429, 0.690)	1.35 (1.27, 1.43)
Sorocea affinis	61.6 (52.1, 72.8)	0.61 (0.57, 0.65)	21.5 (17.9, 25.6)	0.356 (0.210, 0.611)	1.37 (1.16, 1.58)
Spondias mombin	50.1 (42.4, 59.7)	0.78 (0.68, 0.89)	20.0 (14.2, 26.3)	0.526 (0.223, 1.248)	1.42 (1.21, 1.63)
Spondias radlkoferi	54.2 (47.1, 62.2)	0.80 (0.76, 0.85)	28.3 (24.5, 32.3)	0.238 (0.179, 0.314)	1.54 (1.44, 1.65)
Sterculia apetala	59.3 (52.3, 67.5)	0.82 (0.76, 0.89)	26.9 (23.2, 31.2)	0.487 (0.247, 0.966)	1.39 (1.23, 1.57)
Swartzia simplex grandiflora	64.9 (54.6, 78.0)	0.56 (0.50, 0.62)	18.6 (15.0, 23.0)	0.482 (0.254, 0.870)	1.48 (1.30, 1.69)
Swartzia simplex ochnacea	64.6 (54.4, 76.7)	0.60 (0.56, 0.64)	22.1 (18.5, 26.5)	0.378 (0.216, 0.637)	1.55 (1.37, 1.75)
Symphonia globulifera	58.6 (49.8, 69.9)	0.78 (0.67, 0.88)	20.5 (14.1, 27.0)	0.546 (0.227, 1.295)	1.36 (1.13, 1.61)
Tabebuia guayacan	58.4 (51.1, 67.5)	0.80 (0.74, 0.86)	25.6 (22.4, 29.4)	0.388 (0.210, 0.685)	1.37 (1.23, 1.53)
Tabebuia rosea	58.9 (52.3, 66.5)	0.92 (0.86, 0.98)	28.8 (25.5, 32.6)	0.384 (0.289, 0.506)	1.42 (1.33, 1.51)
Tabernaemontana arborea	62.0 (53.5, 73.3)	0.66 (0.61, 0.71)	23.4 (19.5, 27.8)	0.552 (0.298, 1.013)	1.29 (1.13, 1.45)
Tachigali versicolor	49.7 (44.1, 55.8)	0.97 (0.92, 1.03)	28.9 (26.0, 32.2)	0.647 (0.540, 0.778)	1.43 (1.36, 1.49)
Talisia nervosa	65.2 (54.7, 77.4)	0.60 (0.55, 0.66)	23.5 (19.4, 28.1)	0.216 (0.103, 0.436)	1.48 (1.23, 1.75)
Talisia princeps	63.0 (53.1, 75.3)	0.73 (0.61, 0.85)	23.8 (18.1, 30.1)	0.131 (0.064, 0.260)	1.48 (1.23, 1.75)
Terminalia amazonia	58.7 (50.5, 69.3)	0.77 (0.66, 0.88)	19.4 (13.7, 25.8)	0.556 (0.232, 1.316)	1.44 (1.21, 1.66)
Terminalia oblonga	59.9 (52.2, 69.7)	0.85 (0.77, 0.93)	25.0 (20.6, 30.0)	0.624 (0.281, 1.390)	1.43 (1.23, 1.63)
Tetragastris panamensis	57.0 (50.0, 65.2)	0.72 (0.70, 0.75)	19.9 (17.5, 22.8)	0.467 (0.397, 0.556)	1.46 (1.40, 1.52)
Tocoyena pittieri	53.3 (45.0, 63.7)	0.73 (0.63, 0.83)	22.4 (17.2, 28.1)	0.678 (0.339, 1.314)	1.32 (1.12, 1.53)
Trattinnickia aspera	50.4 (42.7, 60.5)	0.74 (0.64, 0.84)	14.9 (11.7, 18.6)	0.537 (0.221, 1.255)	1.36 (1.13, 1.58)
Trema micrantha	38.6 (31.0, 49.0)	0.88 (0.72, 1.04)	15.0 (8.4, 22.4)	0.605 (0.241, 1.403)	1.42 (1.20, 1.66)
Trichilia pallida	57.1 (48.3, 68.0)	0.68 (0.58, 0.78)	23.3 (17.5, 29.3)	0.598 (0.266, 1.327)	1.35 (1.10, 1.60)
Trichilia tuberculata	57.9 (51.0, 65.7)	0.83 (0.80, 0.85)	27.7 (24.4, 31.5)	0.847 (0.728, 0.988)	1.19 (1.13, 1.24)
Triplaris cumingiana	59.0 (50.4, 70.4)	0.79 (0.68, 0.90)	19.8 (13.4, 26.4)	0.474 (0.204, 1.150)	1.27 (1.01, 1.50)
Turpinia occidentalis	48.5 (40.3, 57.8)	0.72 (0.62, 0.81)	22.5 (17.0, 28.5)	0.561 (0.232, 1.448)	1.20 (0.94, 1.43)
Unonopsis pittieri	58.5 (49.5, 69.7)	0.76 (0.66, 0.87)	21.3 (15.4, 27.7)	0.428 (0.194, 1.007)	1.30 (1.03, 1.55)
Virola sebifera	57.9 (49.7, 67.4)	0.79 (0.75, 0.84)	24.4 (21.0, 28.2)	0.871 (0.499, 1.553)	1.19 (1.01, 1.36)
Virola multiflora	55.3 (47.4, 64.7)	0.78 (0.72, 0.84)	20.2 (17.1, 23.8)	0.489 (0.217, 1.306)	1.31 (1.06, 1.53)
Virola surinamensis	65.0 (57.2, 75.4)	0.76 (0.71, 0.81)	24.1 (20.9, 27.8)	0.477 (0.231, 1.056)	1.35 (1.15, 1.52)
Vochysia ferruginea	50.0 (41.8, 59.8)	0.78 (0.66, 0.90)	18.4 (13.1, 24.4)	0.470 (0.210, 1.030)	1.42 (1.18, 1.67)
Xylopia macrantha	54.0 (46.0, 63.9)	0.76 (0.72, 0.79)	19.1 (16.1, 22.6)	0.992 (0.537, 1.908)	1.24 (1.02, 1.45)
Zanthoxylum ekmanii	44.1 (38.3, 52.4)	0.89 (0.77, 1.01)	16.8 (13.1, 21.0)	0.442 (0.200, 0.950)	1.41 (1.21, 1.62)
Zanthoxylum panamense	60.1 (50.9, 71.5)	0.77 (0.67, 0.88)	20.1 (14.1, 26.7)	0.496 (0.206, 1.111)	1.43 (1.21, 1.67)

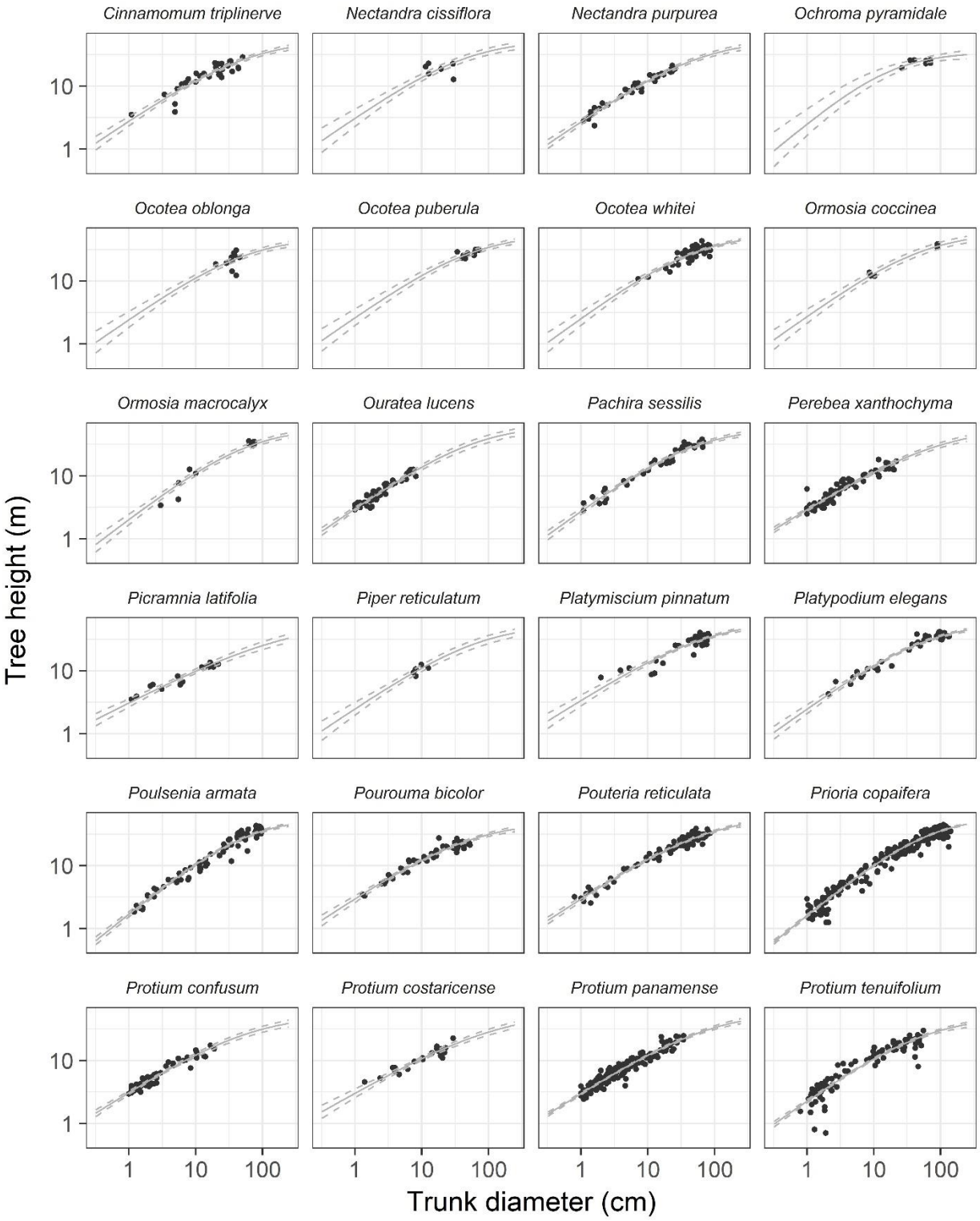
Figure S1. Species-specific relationships of tree height with trunk diameter, showing the data (points) and fitted relationships (solid lines) together with their 90% posterior central intervals (dashed lines). Note the log–log axes (multiple pages).

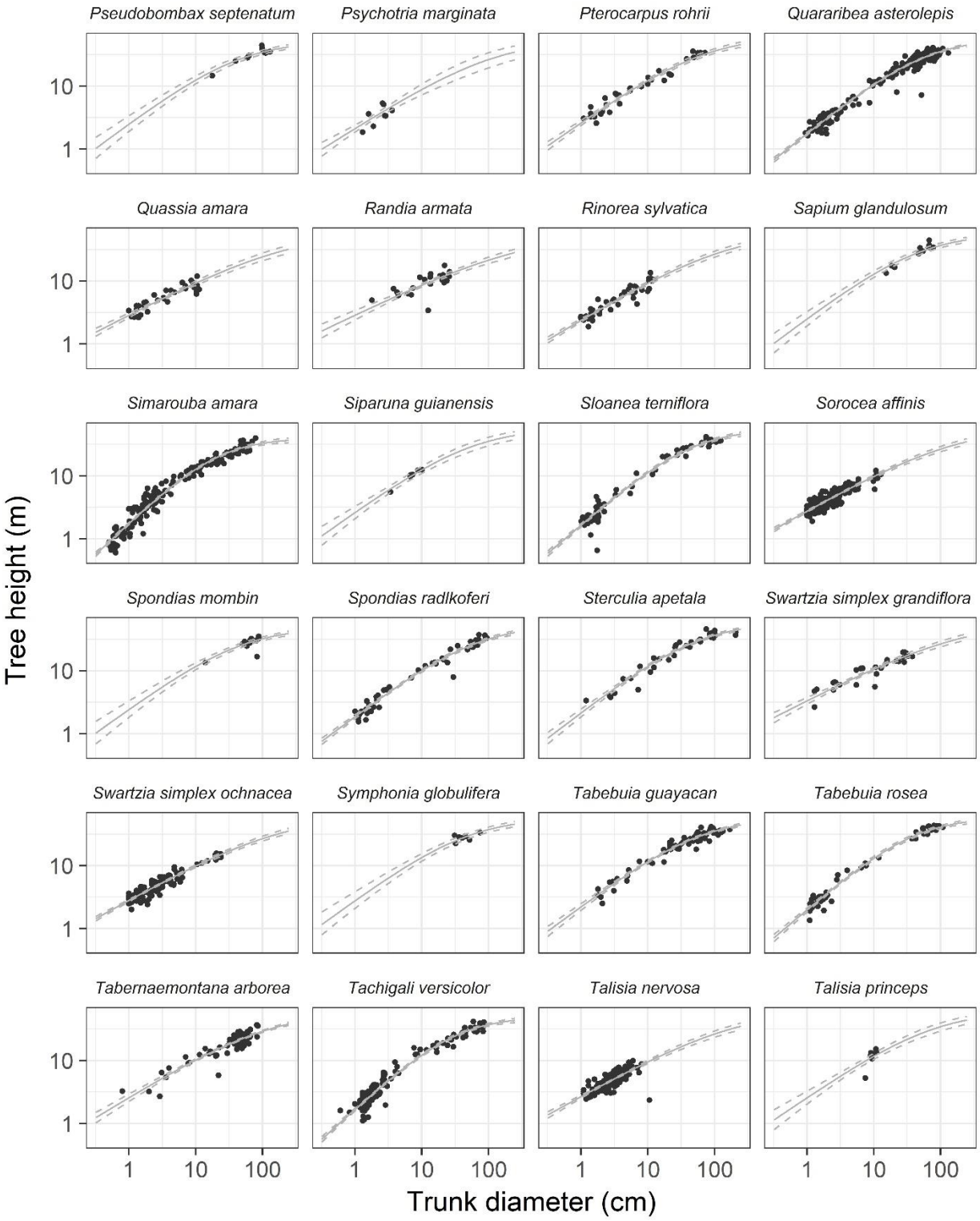



Ceiba pentandra
Celtis schippii
Chrysophyllum argenteum
Chrysophyllum cainito
Conostegia cinnamomea
Cordia alliodora
Cordia bicolor
Cordia lasiocalyx
Coussarea curvigemmia
Croton billbergianus
Cupania latifolia
Cupania seemannii
Dendropanax arboreus
Desmopsis panamensis
Diospyros artanthifolia
Dipteryx oleifera
Drypetes standleyi
Enterolobium schomburgkii
Erythroxylum macrophyllum
Eugenia coloradoensis
Eugenia galalonensis
Eugenia nesiotica
Eugenia oerstediana
Faramea occidentalis
Tree height (m)
Trunk diameter (cm)
1
10
100


Ficus costaricana
Ficus maxima
Ficus tonduzii
Ficus trigonata
Ficus yoponensis
Garcinia intermedia
Garcinia madruno
Genipa americana
Guapira standleyana
Guarea fuzzy
Guarea grandifolia
Guarea guidonia
Guatteria dumetorum
Guazuma ulmifolia
Gustavia superba
Hasseltia floribunda
Heisteria acuminata
Heisteria concinna
Hieronyma alchorneoides
Hirtella americana
Hirtella triandra
Hybanthus prunifolius
Inga goldmanii
Inga marginata
Tree height (m)
10
1
1
10
100
Trunk diameter (cm)


Inga acuminata
Inga sapindoides
Inga spectabilis
Inga umbellifera
Jacaranda copaia
Lacistema aggregatum
Lacmellea panamensis
Laetia procera
Laetia thamnia
Licania hypoleuca
Licania platypus
Lindackeria laurina
Lonchocarpus heptaphyllus
Luehea seemannii
Macrocnemum roseum
Maquira guianensis
Marila laxiflora
Maytenus schippii
Miconia argentea
Miconia nervosa
Mosannona garwoodii
Mouriri myrtilloides
Myrcia gatunensis
Myrospermum frutescens
Tree height (m)
10
1
1
10
100
Trunk diameter (cm)


Cinnamomum triplinerve
Nectandra cissiflora
Nectandra purpurea
Ochroma pyramidale
Ocotea oblonga
Ocotea puberula
Ocotea whitei
Ormosia coccinea
Ormosia macrocalyx
Ouratea lucens
Pachira sessilis
Perebea xanthochyma
Picramnia latifolia
Piper reticulatum
Platymiscium pinnatum
Platypodium elegans
Poulsenia armata
Pourouma bicolor
Pouteria reticulata
Prioria copaifera
Protium confusum
Protium costaricense
Protium panamense
Protium tenuifolium
Tree height (m)
10
1
1
10
100
Trunk diameter (cm)


Pseudobombax septenatum
Psychotria marginata
Pterocarpus rohrii
Quararibea asterolepis
Quassia amara
Randia armata
Rinorea sylvatica
Sapium glandulosum
Simarouba amara
Siparuna guianensis
Sloanea terniflora
Sorocea affinis
Spondias mombin
Spondias radlkoferi
Sterculia apetala
Swartzia simplex grandiflora
Swartzia simplex ochnacea
Symphonia globulifera
Tabebuia guayacan
Tabebuia rosea
Tabernaemontana arborea
Tachigali versicolor
Talisia nervosa
Talisia princeps
Tree height (m)
10
1
1
10
100
Trunk diameter (cm)

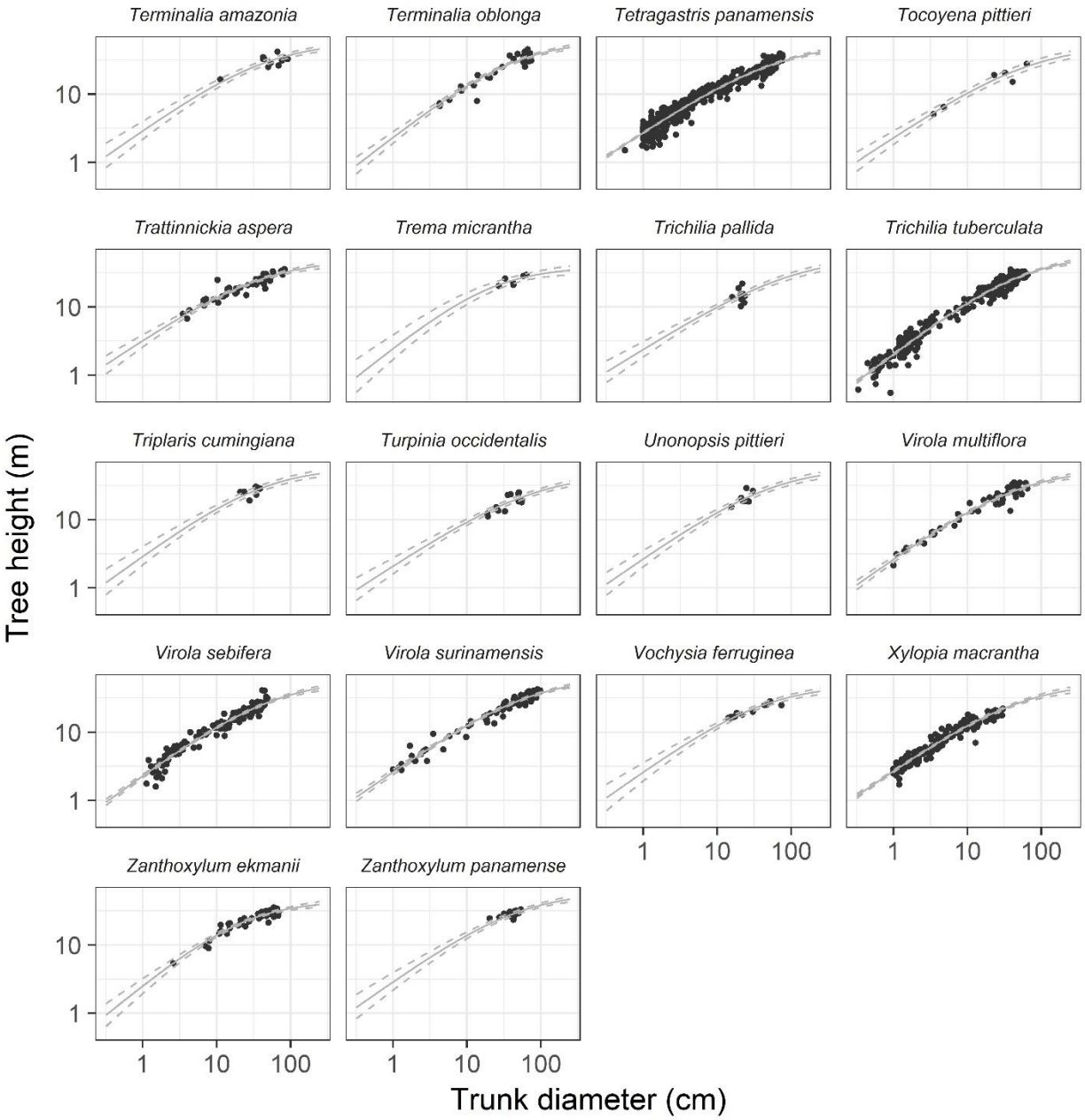
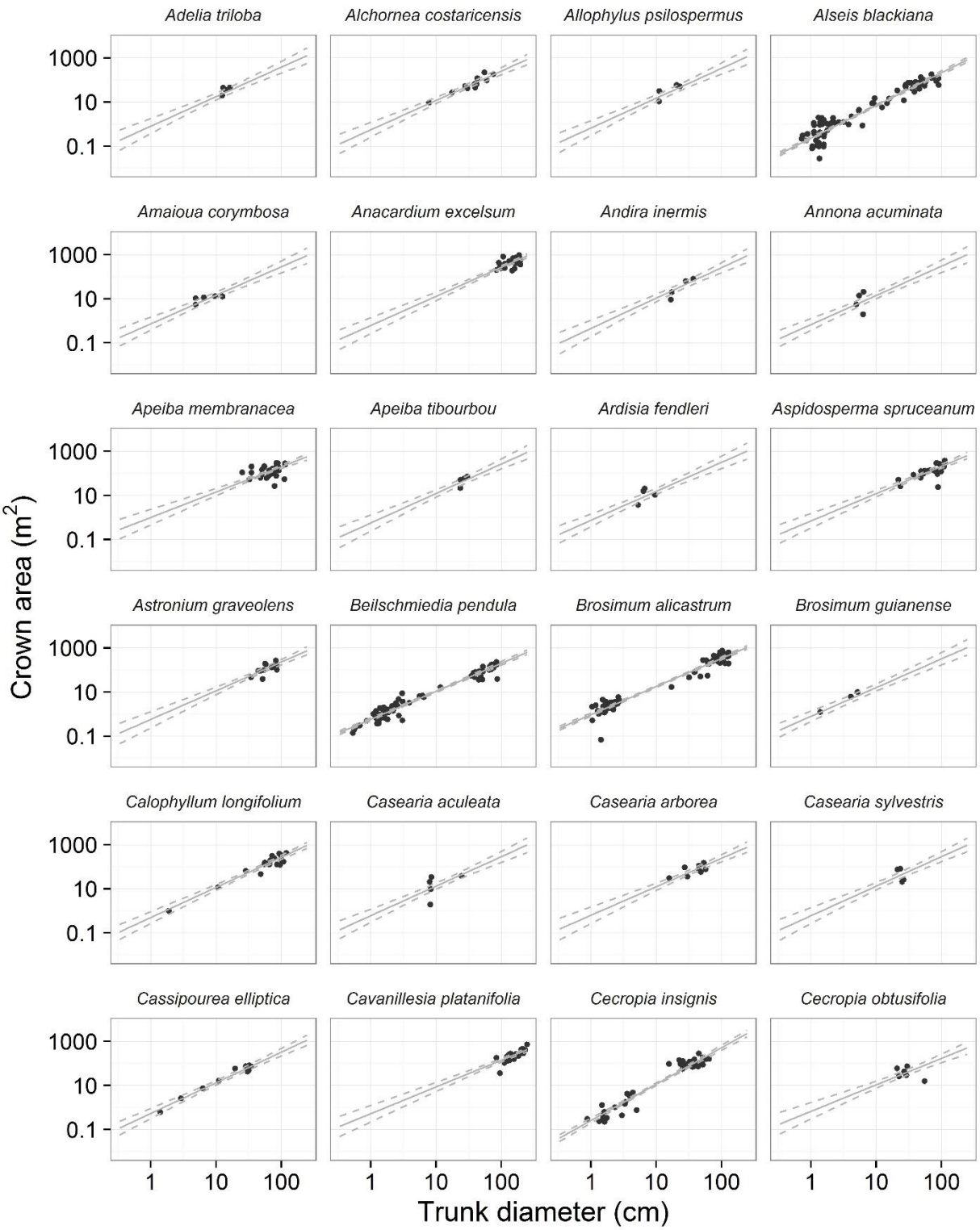
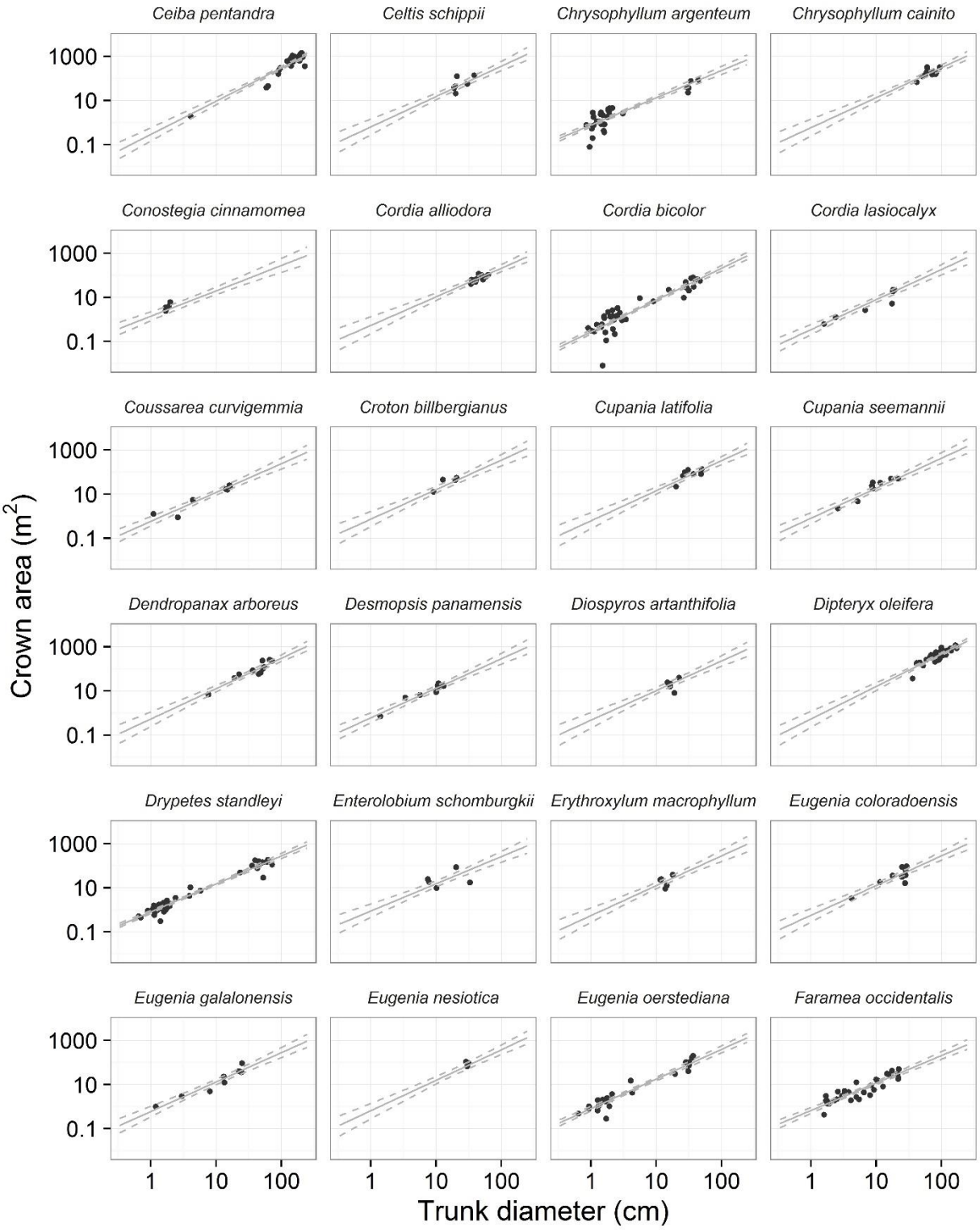
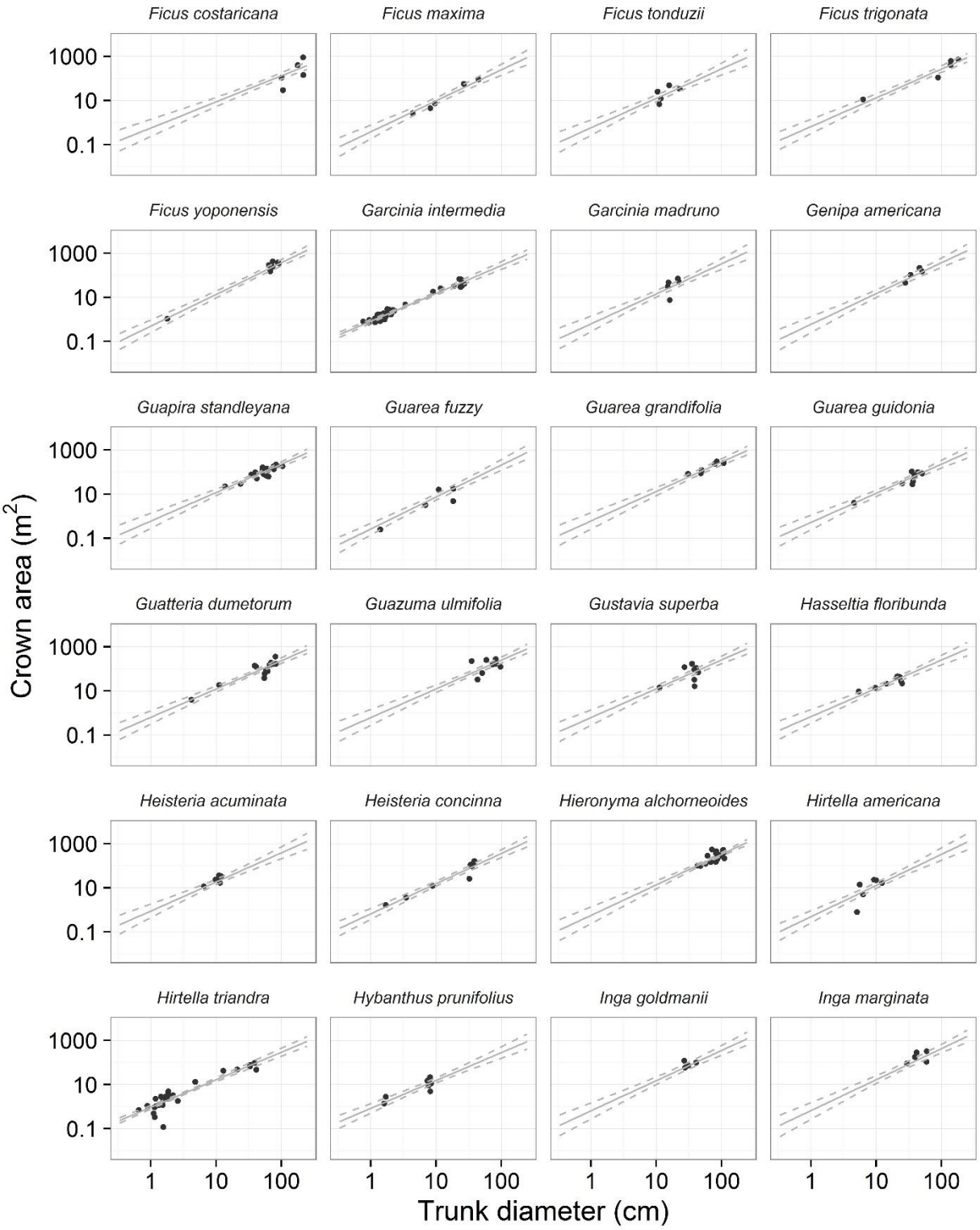
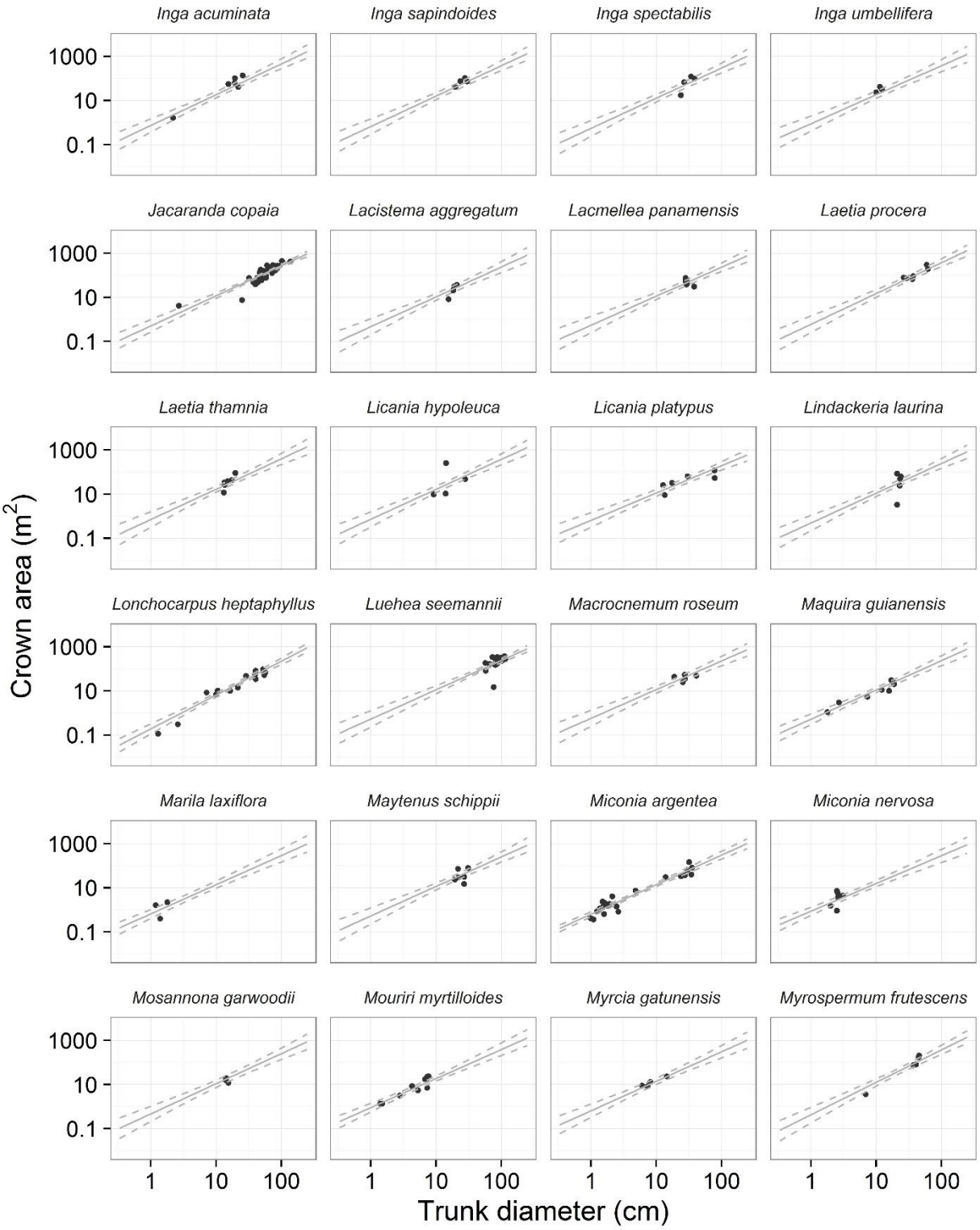

Terminalia amazonia
Terminalia oblonga
Tetragastris panamensis
Tocoyena pittieri
Trattinnickia aspera
Trema micrantha
Trichilia pallida
Trichilia tuberculata
Triplaris cumingiana
Turpinia occidentalis
Unonopsis pittieri
Virola multiflora
Virola sebifera
Virola surinamensis
Vochysia ferruginea
Xylopia macrantha
Zanthoxylum ekmanii
Zanthoxylum panamense
Tree height (m)
Trunk diameter (cm)
1
10
100

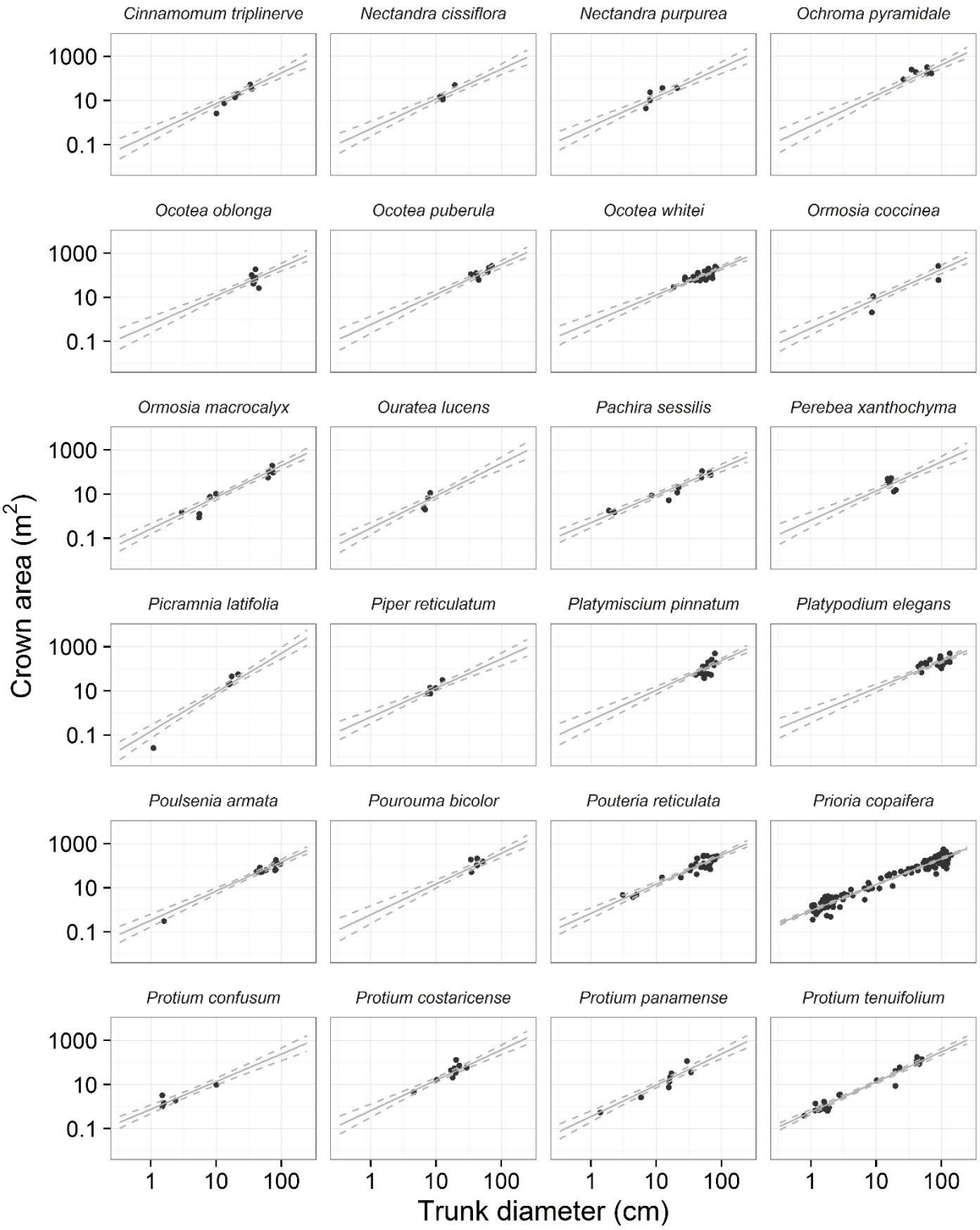
Figure S2. Species-specific relationships of crown area with trunk diameter, showing the data (points) and fitted relationships (solid lines) together with their 90% posterior central intervals (dashed lines). Note the log–log axes (multiple pages).

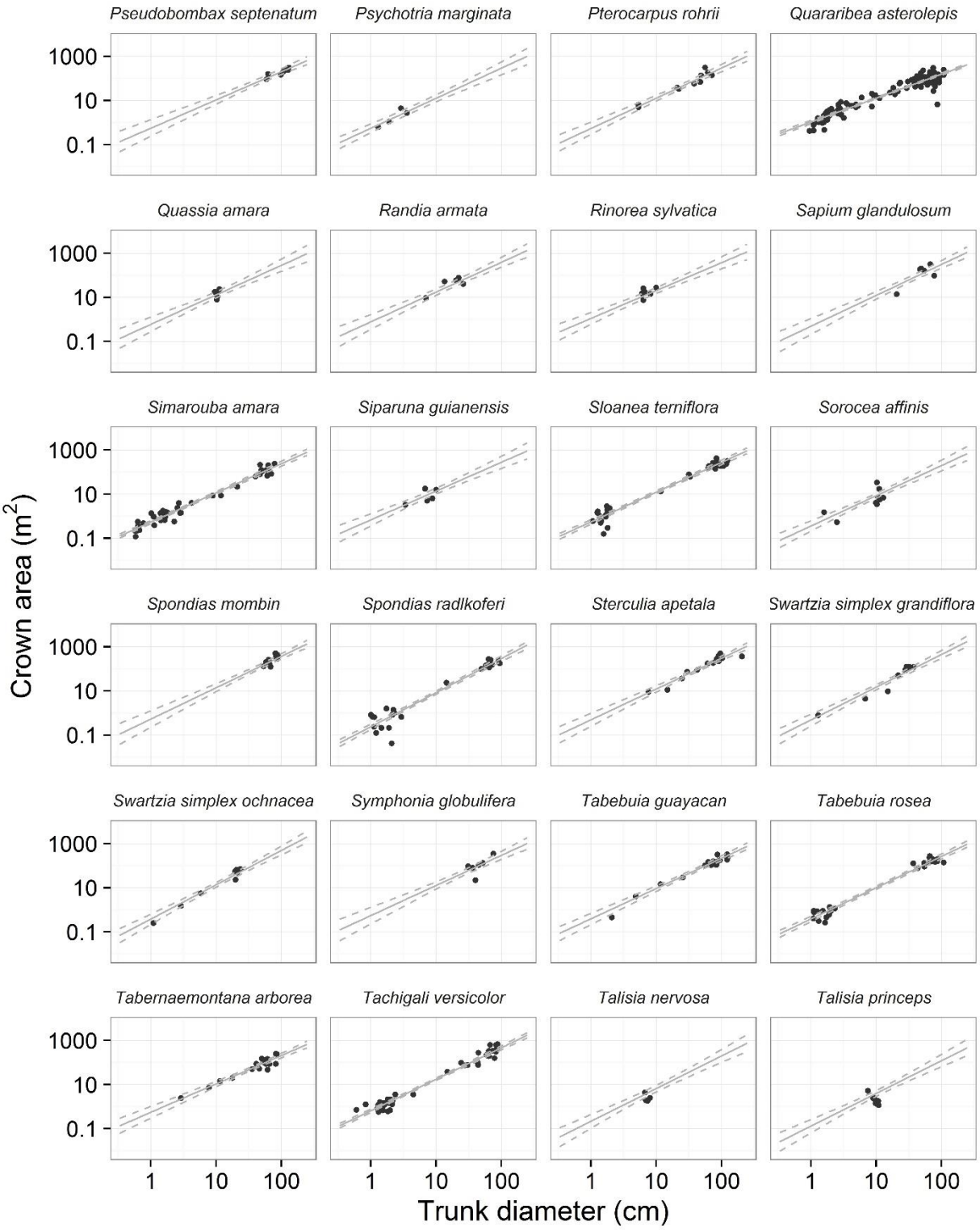


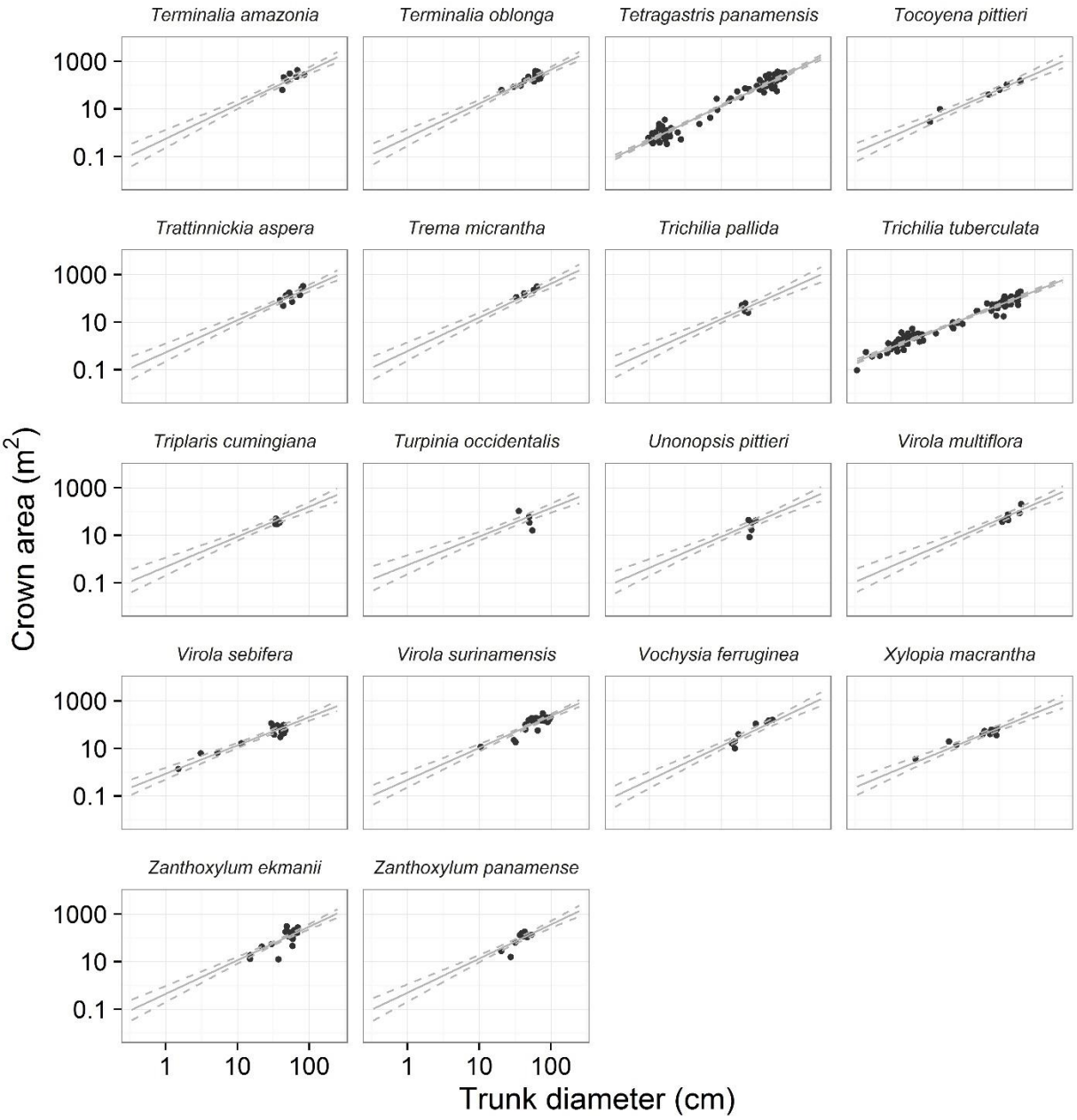

Ceiba pentandra
Celtis schippii
Chrysophyllum argenteum
Chrysophyllum cainito
Conostegia cinnamomea
Cordia alliodora
Cordia bicolor
Cordia lasiocalyx
Coussarea curvigemmia
Croton billbergianus
Cupania latifolia
Cupania seemannii
Dendropanax arboreus
Desmopsis panamensis
Diospyros artanthifolia
Dipteryx oleifera
Drypetes standleyi
Enterolobium schomburgkii
Erythroxylum macrophyllum
Eugenia coloradoensis
Eugenia galalonensis
Eugenia nesiotica
Eugenia oerstediana
Faramea occidentalis
Crown area (m2)
1000
10
0.1
1
10
100
Trunk diameter (cm)


Ficus costaricana
Ficus maxima
Ficus tonduzii
Ficus trigonata
Ficus yoponensis
Garcinia intermedia
Garcinia madruno
Genipa americana
Guapira standleyana
Guarea fuzzy
Guarea grandifolia
Guarea guidonia
Guatteria dumetorum
Guazuma ulmifolia
Gustavia superba
Hasseltia floribunda
Heisteria acuminata
Heisteria concinna
Hieronyma alchorneoides
Hirtella americana
Hirtella triandra
Hybanthus prunifolius
Inga goldmanii
Inga marginata
Crown area (m2)
1000
10
0.1
1
10
100
Trunk diameter (cm)


Inga acuminata
Inga sapindoides
Inga spectabilis
Inga umbellifera
Jacaranda copaia
Lacistema aggregatum
Lacmellea panamensis
Laetia procera
Laetia thamnia
Licania hypoleuca
Licania platypus
Lindackeria laurina
Lonchocarpus heptaphyllus
Luehea seemannii
Macrocnemum roseum
Maquira guianensis
Marila laxiflora
Maytenus schippii
Miconia argentea
Miconia nervosa
Mosannona garwoodii
Mouriri myrtilloides
Myrcia gatunensis
Myrospermum frutescens
Crown area (m2)
1000
10
0.1
1
10
100
Trunk diameter (cm)


Cinnamomum triplinerve
Nectandra cissiflora
Nectandra purpurea
Ochroma pyramidale
Ocotea oblonga
Ocotea puberula
Ocotea whitei
Ormosia coccinea
Ormosia macrocalyx
Ouratea lucens
Pachira sessilis
Perebea xanthochyma
Picramnia latifolia
Piper reticulatum
Platymiscium pinnatum
Platypodium elegans
Poulsenia armata
Pourouma bicolor
Pouteria reticulata
Prioria copaifera
Protium confusum
Protium costaricense
Protium panamense
Protium tenuifolium
1000
10
0.1
1
10
100
Crown area (m2)
Trunk diameter (cm)


Pseudobombax septenatum
Psychotria marginata
Pterocarpus rohrii
Quararibea asterolepis
Quassia amara
Randia armata
Rinorea sylvatica
Sapium glandulosum
Simarouba amara
Siparuna guianensis
Sloanea terniflora
Sorocea affinis
Spondias mombin
Spondias radlkoferi
Sterculia apetala
Swartzia simplex grandiflora
Swartzia simplex ochnacea
Symphonia globulifera
Tabebuia guayacan
Tabebuia rosea
Tabernaemontana arborea
Tachigali versicolor
Talisia nervosa
Talisia princeps
Crown area (m2)
1000
10
0.1
1
10
100
Trunk diameter (cm)


Terminalia amazonia
Terminalia oblonga
Tetragastris panamensis
Tocoyena pittieri
Trattinnickia aspera
Trema micrantha
Trichilia pallida
Trichilia tuberculata
Triplaris cumingiana
Turpinia occidentalis
Unonopsis pittieri
Virola multiflora
Virola sebifera
Virola surinamensis
Vochysia ferruginea
Xylopia macrantha
Zanthoxylum ekmanii
Zanthoxylum panamense
1000
10
0.1
1
10
100
Crown area (m2)
Trunk diameter (cm)

Appendix S2: *Stan code*

Power function model

```
// Linear mixed model with varying parameters among species and one group level covariate
// for a power function allometric model
data {
  int< lower=0 > N; // number of samples
  int< lower=0 > Ng; // number of groups
  int< lower=0 > p; // number of parameters

  vector[ N ] y; // dependent variable: natural logarithm of tree height or crown area
  vector[ N ] x; // independent variable: natural logarithm of trunk diameter
  int g[ N ]; // species indicator
  real xbar; // mean of x

  vector[ Ng ] z; // covariate
  real zbar; real zs; // mean and standard deviation of the covariate z across species
}
transformed data{
  vector[ Ng ] zc; // centered and scaled covariate
  for ( i in 1 : Ng )
  {
      zc[ i ] = ( z[ i ] - zbar ) / zs;
  }
}
parameters {
  // species parameters of the allometric model:
  //      log a and b for the power function
  //      log a, b and k for the rescaled Weibull and the generalized Michaelis Menten
  vector[ p ] beta[ Ng ];
  vector[ p ] mu; // community level means (means of parameters across species)
  vector[ p ] theta; // community level effects of the covariate 'z' on each parameter
  // across species parameter variances
  real< lower=0 > sigmaa;
  real< lower=0 > sigmab;
  // standard deviation for observation error
  real< lower=0 > serror;
}
transformed parameters {
  vector[ N ] y_hat; // predicted mean for each y

  for ( n in 1 : N )
  {
    // power function
    y_hat[ n ] = beta[ g[ n ], 1 ] + beta[ g[ n ], 2 ] * ( x[ n ] - xbar );
  }
}
model {
  // prior distribution for community level covariate effects
  theta[ 1 ] ~ normal( 0, 100 ); theta[ 2 ] ~ normal( 0, 100 );

  // prior distribution for the parameters of the regression predicting population level
parameters
  mu[ 1 ] ~ normal( 0, 100 ); mu[ 2 ] ~ normal( 0, 100 );

  // community level parameters act as priors of species level parameters
  for ( i in 1 : Ng )
  {
    beta[ i, 1 ] ~ normal( mu[ 1 ] + theta[ 1 ] * zc[ i ], sigmaa ); // prior for group level
parameter log a
```

```
    beta[ i, 2 ] ~ normal( mu[ 2 ] + theta[ 2 ] * zc[ i ], sigmab ); // prior for group level
parameter b
  }

  // data model
  y ~ normal( y_hat, serror );
}
generated quantities {
  // pointwise log-likelihoods for WAIC estimation
  vector[ N ] log_lik;
  for ( n in 1 : N )
  {
    log_lik[ n ] = normal_lpdf( y[ n ] | y_hat[ n ], serror );
  }
}
```

Generalized Michaelis-Menten model

```
// Nonlinear mixed model with varying parameters among species and one group level covariate
// for a generalized Michaelis Menten allometric model
data {
  int< lower=0 > N; // number of samples
  int< lower=0 > Ng; // number of groups
  int< lower=0 > p; // number of parameters

  vector[ N ] y; // dependent variable: natural logarithm of tree height or crown area
  vector[ N ] x; // independent variable: natural logarithm of trunk diameter
  int g[ N ]; // species indicator
  real xbar; // mean of x

  vector[ Ng ] z; // covariate
  real zbar; real zs; // mean and standard deviation of the covariate z across species
}
transformed data{
  vector[ Ng ] zc; // centered and scaled covariate
  for ( i in 1 : Ng )
  {
      zc[ i ] = ( z[ i ] - zbar ) / zs;
  }
}
parameters {
  // species parameters of the allometric model:
  //      a and b for the power function
  //      log a, b and k for the rescaled Weibull and the generalized Michaelis Menten
  vector[ p ] beta[ Ng ];
  vector[ p ] mu; // community level means (means of parameters across species)
  vector[ p ] theta; // community level effects of the covariate 'z' on each parameter
  // across species parameter variances
  real< lower=0 > sigmaa;
  real< lower=0 > sigmab;
  real< lower=0 > sigmak;
  // standard deviation for observation error
  real< lower=0 > serror;
}
transformed parameters {
  vector[ N ] y_hat; // predicted mean for each y

  for ( n in 1 : N )
  {
    // generalized Michaelis Menten
    y_hat[ n ] = beta[ g[ n ], 1 ] + beta[ g[ n ], 2 ] * log( x[ n ] ) - log( beta[ g[ n ], 3
] + pow( x[ n ], beta[ g[ n ], 2 ] ) );
  }
}
model {
  // prior distribution for community level covariate effects
  theta[ 1 ] ~ normal( 0, 100 ); theta[ 2 ] ~ normal( 0, 100 ); theta[ 3 ] ~ normal( 0, 100 );

  // prior distribution for the parameters of the regression predicting population level
parameters
  mu[ 1 ] ~ normal( 0, 100 ); mu[ 2 ] ~ normal( 0, 100 )T[0,]; mu[ 3 ] ~ normal( 0, 100
)T[0,];

  // community level parameters act as priors of species level parameters
  for ( i in 1 : Ng )
  {
    beta[ i, 1 ] ~ normal( mu[ 1 ] + theta[ 1 ] * zc[ i ], sigmaa ); // prior for group level
parameter log a
```

```
    beta[ i, 2 ] ~ normal( mu[ 2 ] + theta[ 2 ] * zc[ i ], sigmab )T[0,]; // prior for group
level parameter b
    beta[ i, 3 ] ~ normal( mu[ 3 ] + theta[ 3 ] * zc[ i ], sigmak )T[0,]; // prior for group
level parameter k
  }

  // data model
  y ~ normal( y_hat, serror );
}
generated quantities {
  // pointwise log-likelihoods for WAIC estimation
  vector[ N ] log_lik;
  for ( n in 1 : N )
  {
    log_lik[ n ] = normal_lpdf( y[ n ] | y_hat[ n ], serror );
  }
}
```

Rescaled Weibull model

```
// Nonlinear mixed model with varying parameters among species and one group level covariate
// for a rescaled Weibull allometric model
data {
  int< lower=0 > N; // number of samples
  int< lower=0 > Ng; // number of groups
  int< lower=0 > p; // number of parameters

  vector[ N ] y; // dependent variable: natural logarithm of tree height or crown area
  vector[ N ] x; // independent variable: natural logarithm of trunk diameter
  int g[ N ]; // species indicator
  real xbar; // mean of x

  vector[ Ng ] z; // covariate
  real zbar; real zs; // mean and standard deviation of the covariate z across species
}
transformed data{
  vector[ Ng ] zc; // centered and scaled covariate
  for ( i in 1 : Ng )
  {
    zc[ i ] = ( z[ i ] - zbar ) / zs;
  }
}
parameters {
  // species parameters of the allometric model:
  //      a and b for the power function
  //      log a, b and k for the rescaled Weibull and the generalized Michaelis Menten
  vector[ p ] beta[ Ng ];
  vector< lower=0 >[ p ] mu; // community level means (means of parameters across species)
  vector[ p ] theta; // community level effects of the covariate 'z' on each parameter
  // across species parameter variances
  real< lower=0 > sigmaa;
  real< lower=0 > sigmab;
  real< lower=0 > sigmak;
  // standard deviation for observation error
  real< lower=0 > serror;
}
transformed parameters {
  vector[ N ] y_hat; // predicted mean for each y

  for ( n in 1 : N )
  {
    // rescaled Weibull
    //y_hat[ n ] = log( beta[ g[ n ], 1 ] * ( 1.0 - exp( - beta[ g[ n ], 2 ] * pow( x[ n ],
beta[ g[ n ], 3 ] ) ) ) );
    // improve numerical scatability??; http://mc-stan.org/misc/warnings.html#exception-
hamiltonian-proposal-rejected
    y_hat[ n ] = log( beta[ g[ n ], 1 ] ) + log1m_exp( - beta[ g[ n ], 2 ] * pow( x[ n ],
beta[ g[ n ], 3 ] ) );
  }
}
model {
  // prior distribution for community level covariate effects
  theta[ 1 ] ~ normal( 0, 100 ); theta[ 2 ] ~ normal( 0, 100 ); theta[ 3 ] ~ normal( 0, 100 );

  // prior distribution for the parameters of the regression predicting population level
parameters
  mu[ 1 ] ~ normal( 0, 100 )T[0,]; mu[ 2 ] ~ normal( 0, 100 )T[0,]; mu[ 3 ] ~ normal( 0, 100
)T[0,];

  // community level parameters act as priors of species level parameters
  for ( i in 1 : Ng )
```

```
  {
    beta[ i, 1 ] ~ normal( mu[ 1 ] + theta[ 1 ] * zc[ i ], sigmaa )T[0,]; // prior for group
level parameter a
    beta[ i, 2 ] ~ normal( mu[ 2 ] + theta[ 2 ] * zc[ i ], sigmab )T[0,]; // prior for group
level parameter b
    beta[ i, 3 ] ~ normal( mu[ 3 ] + theta[ 3 ] * zc[ i ], sigmak )T[0,]; // prior for group
level parameter k
  }

  // data model
  y ~ normal( y_hat, serror );
}
generated quantities {
  // pointwise log-likelihoods for WAIC estimation
  vector[ N ] log_lik;
  for ( n in 1 : N )
  {
    log_lik[ n ] = normal_lpdf( y[ n ] | y_hat[ n ], serror );
  }
}
```