

Forests Supporting Information

Article title:

Classification of Tree Functional Types in a Megadiverse Tropical Mountain Forest from Leaf Optical Metrics and Functional Traits for Two Related Ecosystem Functions

Authors:

Limberger, O., Homeier, J., Farwig, N., Pucha-Cofrep, F., Fries, A., Leuschner, C., Trachte, K., Bendix, J.

Article acceptance date:

The following Supporting Information is available for this article:

Table S1: Mean and standard deviation of climate variables for the study site by elevation.

	1051 m 4.11444° S, 78.965° W	1957 m 3.964° S, 79.077° W	3400 m 4.10432° S, 79.1611° W
	Bombuscaro¹ 2007-2018	ECSF² 1998-2018	Cajanuma Paramo³ 1998-2018
Rain (mm/day)			
Mean	5.0	5.5	6.8
sd	6.9	7.8	8.3
Radiation			
daily max (W/m²)			
Mean	571.5	577.2	516.7
sd	349.1	460.7	231.4
daily total (MJ/m²)			
Mean	9.8	12.5	10.8
sd	5.2	6.3	5.0
Temperature (°C)			
Mean	19.9	14.6	6.5
sd	3.3	1.3	1.0

¹Peters, T. ; Richter, M. (2009): Climate Station Data at Bombuscaro. Available online (http://www.tropicalmountainforest.org/data_pre.do?citid=501) from DFG-FOR816dw.

¹Dobbermann, M.; Bendix, J.; Werner, N. (2018): Climate station data from Bombuscaro Thies station 2018. Available online (http://www.tropicalmountainforest.org/data_pre.do?citid=1712) from DFG-FOR816dw.

²Bendix, J. (2020): ECSF Climate station best estimate Ver. 3 1998 – 2020. Available online (http://www.tropicalmountainforest.org/data_pre.do?citid=1876) from DFG-FOR816dw.

³Bendix, J. (2020): Climate Station Data Cajanuma Paramo - daily estimate 1998 – 2018. Available online (http://www.tropicalmountainforest.org/data_pre.do?citid=1858) from DFG-FOR816dw.

Table S2. Overview of sampled species. MidSucTall = tall mid-successional trees, MidSucSmall = small mid-successional trees, LateSucTall = tall late-successional trees, LateSucSmall = small late-successional trees, EarlySuc = early successional trees.

Genus species	Family	Elevation (m)	Successional stage
Saurauia JH5994	Actinidiaceae	1000	Pioneer
Alchornea cf glandulosa	Euphorbiaceae	1000	Pioneer
Miconia aff. punctata	Melastomataceae	1000	Pioneer
Pourouma cecropiifolia	Urticaceae	1000	Pioneer
Parkia sp1	Fabaceae	1000	MidSucTall
Mollia gracilis	Malvaceae	1000	MidSucTall
Otoba parvifolia	Myristicaceae	1000	MidSucTall
Ladenbergia oblongifolia	Rubiaceae	1000	MidSucTall
Guatteria pastazae	Annonaceae	1000	MidSucSmall
Ocotea JH6030	Lauraceae	1000	MidSucSmall
Hieronyma oblonga	Phyllanthaceae	1000	MidSucSmall
Warszewiczia coccinea	Rubiaceae	1000	MidSucSmall
Aspidosperma rigidum	Apocynaceae	1000	LateSucTall
Clarisia racemosa	Moraceae	1000	LateSucTall
Pouteria torta	Sapotaceae	1000	LateSucTall
Leonia crassa	Violaceae	1000	LateSucTall
Chrysochlamys sp.	Clusiaceae	1000	LateSucSmall
Grias peruviana	Lecythidaceae	1000	LateSucSmall
Guarea macrophylla	Meliaceae	1000	LateSucSmall
Pseudolmedia laevis	Moraceae	1000	LateSucSmall

Hedyosmum cf goudotianum	Chloranthaceae	2000	Pioneer
Heliocarpus americanus	Malvaceae	2000	Pioneer
Miconia calophylla	Melastomataceae	2000	Pioneer
Cecropia angustifolia	Urticaceae	2000	Pioneer
Tapirira guianensis	Anacardiaceae	2000	MidSucTall
Alchornea lojaensis	Euphorbiaceae	2000	MidSucTall
Meriania franciscana	Melastomataceae	2000	MidSucTall
Ruagea glabra	Meliaceae	2000	MidSucTall
Ocotea andina	Lauraceae	2000	MidSucSmall
Graffenrieda emarginata	Melastomataceae	2000	MidSucSmall
Hieronyma fendleri	Phyllanthaceae	2000	MidSucSmall
Myrsine coriacea	Primulaceae	2000	MidSucSmall
Alzatea verticillata	Alzateaceae	2000	LateSucTall
Clusia ducuoides	Clusiaceae	2000	LateSucTall
Naucleopsis francisci	Moraceae	2000	LateSucTall
Podocarpus oleifolius	Podocarpaceae	2000	LateSucTall
Weinmannia microphylla	Cunoniaceae	2000	LateSucSmall
Myrcia spnov	Myrtaceae	2000	LateSucSmall
Elaeagia mollis	Rubiaceae	2000	LateSucSmall
Matayba inelegans	Sapindaceae	2000	LateSucSmall
Critoniopsis pycnantha	Asteraceae	3000	EarlySuc
Hedyosmum purpurascens	Chloranthaceae	3000	EarlySuc

Miconia cf jahnii	Melastomataceae	3000	EarlySuc
Siparuna muricata	Siparunaceae	3000	EarlySuc
Oreopanax sessiliflorus	Araliaceae	3000	LateSucTall
Aiouea dubia	Lauraceae	3000	LateSucTall
Ocotea rotundata	Lauraceae	3000	LateSucTall
Ilex laurina	Aquifoliaceae	3000	LateSucSmall
Clethra revoluta	Clethraceae	3000	LateSucSmall
Clusia elliptica	Clusiaceae	3000	LateSucSmall
Gordonia fruticosa	Theaceae	3000	LateSucSmall
Weinmannia elliptica	Cunoniaceae	3000	--

Table S3. Species affiliation to TFT for productivity (P). Bold TFT numbers indicate the reference species (cluster center) of the respective TFT. Tree successional stages (Suc) were determined a priori from pre-existing measurements for specific leaf area and wood specific gravity and further separated by tree height. Biochemical leaf traits were calculated with respect to dry mass. LWC = leaf water content, SLA = specific leaf area.

TFT	Genus species	Family	Elevation (m)	Successional stage	SLA (cm/g)	total leaf area (cm ²)	leaf thickness (mm)	C (mg/g)	N (mg/g)	P (mg/g)	C/N ratio	N/P ratio	LWC (mg/g)
P1	Oreopanax sessiliflorus	Araliaceae	3000	LateSucTall	54.77	34.97	0.39	479.91	15.46	NA	31.32	NA	615.45
P1	Clusia elliptica	Clusiaceae	3000	LateSucSmall	43.63	21.11	0.59	497.91	10.52	0.68	47.39	15.96	672.37
P1	Miconia cf jahnii	Melastomataceae	3000	EarlySuc	39.72	13.62	0.50	442.13	10.79	0.57	42.14	19.12	591.30
P2	Alzatea verticillata	Alzateaceae	2000	LateSucTall	57.77	39.73	0.41	493.44	10.59	0.81	46.67	13.09	620.12
P2	Ilex laurina	Aquifoliaceae	3000	LateSucSmall	53.87	11.82	0.35	498.72	11.45	0.70	44.09	16.84	498.16
P2	Ocotea rotundata	Lauraceae	3000	LateSucTall	49.43	29.66	0.43	490.21	14.70	0.99	36.33	15.55	556.15
P2	Ocotea andina	Lauraceae	2000	MidSucSmall	51.21	103.14	0.36	528.21	16.15	0.97	32.95	17.06	540.47
P2	Graffenrieda emarginata	Melastomataceae	2000	MidSucSmall	64.22	310.47	0.35	NA	NA	NA	NA	NA	603.04
P2	Naucleopsis francisci	Moraceae	2000	LateSucTall	49.00	56.63	0.35	478.31	19.46	0.89	24.63	22.03	562.66
P2	Hieronyma fendleri	Phyllanthaceae	2000	MidSucSmall	90.68	22.78	0.31	475.92	15.10	1.01	31.59	15.08	671.74

P2	Myrsine coriacea	Primulaceae	2000	MidSucSmall	69.46	15.40	0.32	525.54	12.10	0.67	46.39	17.98	608.41
P3	Critoniopsis pycnantha	Asteraceae	3000	EarlySuc	52.38	25.49	0.36	480.75	14.66	0.93	32.96	15.77	582.23
P3	Hedyosmum purpurascens	Chloranthaceae	3000	EarlySuc	72.50	13.82	0.44	450.08	18.72	1.07	24.21	17.71	733.97
P3	Hedyosmum cf goudotianum	Chloranthaceae	2000	Pioneer	88.52	41.01	0.38	NA	NA	NA	NA	NA	766.22
P3	Clusia ducuoides	Clusiaceae	2000	LateSucTall	59.41	19.59	0.53	494.24	12.34	0.78	40.14	16.04	726.64
P3	Weinmannia elliptica	Cunoniaceae	3000		52.24	3.16	0.40	473.56	9.86	0.52	49.07	18.96	NA
P3	Alchornea lojaensis	Euphorbiaceae	2000	MidSucTall	47.55	34.38	0.48	534.17	15.07	1.15	36.04	13.35	629.87
P3	Miconia calophylla	Melastomataceae	2000	Pioneer	61.56	52.68	0.34	488.88	13.09	0.71	37.60	18.48	687.39
P3	Ruagea glabra	Meliaceae	2000	MidSucTall	84.64	37.67	0.30	NA	NA	NA	NA	NA	668.87
P3	Myrcia spnov	Myrtaceae	2000	LateSucSmall	44.53	37.80	0.48	482.31	10.37	0.60	46.66	17.37	576.34
P3	Podocarpus oleifolius	Podocarpaceae	2000	LateSucTall	61.75	6.33	0.34	490.58	11.62	0.76	42.44	15.42	595.15
P3	Gordonia fruticosa	Theaceae	3000	LateSucSmall	63.03	4.60	0.39	478.33	13.78	0.69	35.94	20.37	569.36
P4	Clethra revoluta	Clethraceae	3000	LateSucSmall	55.09	38.35	0.39	481.53	14.44	0.97	33.54	14.96	636.15

P4	Weinmannia microphylla	Cunoniaceae	2000	LateSucSmall	98.83	7.23	0.24	480.80	12.75	0.70	38.06	18.49	608.50
P4	Aiouea dubia	Lauraceae	3000	LateSucTall	58.23	17.22	0.34	488.12	17.59	1.13	28.16	15.70	574.77
P4	Matayba inelegans	Sapindaceae	2000	LateSucSmall	95.76	26.62	0.22	501.03	25.17	1.33	20.00	19.01	618.16
P4	Siparuna muricata	Siparunaceae	3000	EarlySuc	86.99	41.98	0.29	457.38	29.64	2.34	15.68	12.86	788.03
P5	Miconia aff punctata	Melastomataceae	1000	Pioneer	96.10	100.75	0.28	491.05	23.58	0.70	20.87	33.71	645.44
P6	Tapirira guianensis	Anacardiaceae	2000	MidSucTall	76.93	78.59	NA	NA	NA	NA	NA	NA	NA
P6	Guatteria pastazae	Annonaceae	1000	MidSucSmall	97.98	94.33	0.22	477.03	17.22	0.71	27.94	24.20	577.33
P6	Aspidosperma rigidum	Apocynaceae	1000	LateSucTall	159.63	53.76	0.26	447.44	25.22	1.79	17.81	14.31	737.67
P6	Chrysochlamys sp	Clusiaceae	1000	LateSucSmall	100.99	167.80	0.43	428.34	14.66	0.80	29.35	19.42	749.33
P6	Parkia sp1	Fabaceae	1000	MidSucTall	149.09	13.70	0.13	473.09	35.43	1.78	13.50	20.92	567.45
P6	Ocotea JH6030	Lauraceae	1000	MidSucSmall	101.09	235.37	0.30	485.18	22.75	2.65	21.49	15.31	686.17
P6	Grias peruviana	Lecythidaceae	1000	LateSucSmall	72.83	353.23	0.22	445.13	15.46	1.30	28.96	12.06	659.25
P6	Guarea macrophylla	Meliaceae	1000	LateSucSmall	145.00	80.84	0.20	465.18	27.54	2.07	16.94	13.81	710.98
P6	Clarisia racemosa	Moraceae	1000	LateSucTall	119.29	39.36	0.17	445.95	22.19	1.20	20.17	19.06	604.12

P6	Otoba parvifolia	Myristicaceae	1000	MidSucTall	98.46	97.37	0.32	477.55	15.63	0.91	30.76	17.44	718.44
P6	Hieronyma oblonga	Phyllanthaceae	1000	MidSucSmall	133.01	65.77	0.24	463.99	19.19	1.06	24.27	18.26	750.47
P6	Ladenbergia oblongifolia	Rubiaceae	1000	MidSucTall	87.77	322.11	0.27	483.52	17.35	1.03	28.12	17.45	613.09
P6	Pourouma cecropiifolia	Urticaceae	1000	Pioneer	81.49	1632.01	0.21	468.05	18.85	0.90	25.12	21.26	0.00
P6	Cecropia angustifolia	Urticaceae	2000	Pioneer	60.14	1354.33	0.28	NA	NA	NA	NA	NA	653.67
P6	Leonia crassa	Violaceae	1000	LateSucTall	93.80	180.23	0.28	449.55	20.45	1.26	22.19	16.54	680.22
P7	Saurauia JH5994	Actinidiaceae	1000	Pioneer	129.13	239.50	0.21	448.41	19.04	1.26	23.68	15.72	737.71
P7	Alchornea cf glandulosa	Euphorbiaceae	1000	Pioneer	164.52	72.27	0.11	459.59	26.24	1.42	17.53	18.55	609.33
P7	Mollia gracilis	Malvaceae	1000	MidSucTall	157.35	75.37	0.14	469.41	24.28	1.15	19.50	21.65	624.20
P7	Heliocarpus americanus	Malvaceae	2000	Pioneer	187.50	198.70	0.16	NA	NA	NA	NA	NA	796.38
P7	Meriania franciscana	Melastomataceae	2000	MidSucTall	0.00	0.00	0.23	NA	NA	NA	NA	NA	552.75
P7	Pseudolmedia laevis	Moraceae	1000	LateSucSmall	127.28	54.15	0.16	438.45	19.63	0.84	22.41	23.49	555.33
P7	Warszewiczia coccinea	Rubiaceae	1000	MidSucSmall	127.20	299.63	0.19	458.79	27.81	1.18	16.93	23.76	721.83
P7	Elaeagia mollis	Rubiaceae	2000	LateSucSmall	121.95	144.23	0.24	NA	NA	NA	NA	NA	718.72

P7	Pouteria torta	Sapotaceae	1000	LateSucTall	86.02	75.43	0.17	503.68	15.85	0.69	32.15	23.80	536.21
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Table S4. Species affiliation to TFT for energy fluxes (E). Bold TFT numbers indicate the reference species (cluster center) of the respective TFT. Tree successional stages (Suc) were determined a priori from pre-existing measurements for specific leaf area and wood specific gravity and further separated by tree height. Biochemical leaf traits were calculated with respect to dry mass. LWC = leaf water content. SLA = specific leaf area.

TFT	Genus species	Family	Elevation (m)	Successional stage	SLA (cm/g)	total leaf area (mm)	leaf thickness (mm)	C (mg/g)	N (mg/g)	C/N ratio	N/P ratio	LWC (mg/g)	VIS albedo	NIR albedo
E1	Miconia aff punctata	Melastomataceae	1000	Pioneer	96.10	100.75	0.28	491.05	23.58	20.87	33.71	645.44	0.07	0.25
E2	Oreopanax sessiliflorus	Araliaceae	3000	LateSucTall	54.77	34.97	0.39	479.91	15.46	31.32	0.00	615.45	0.07	0.24
E2	Critoniopsis pycnantha	Asteraceae	3000	EarlySuc	52.38	25.49	0.36	480.75	14.66	32.96	15.77	582.23	0.07	0.23
E2	Miconia cf jahnii	Melastomataceae	3000	EarlySuc	39.72	13.62	0.50	442.13	10.79	42.14	19.12	591.30	0.06	0.24
E2	Ruagea glabra	Meliaceae	2000	MidSucTall	84.64	37.67	0.30	NA	NA	NA	NA	668.87	0.07	0.23
E2	Podocarpus oleifolius	Podocarpaceae	2000	LateSucTall	61.75	6.33	0.34	490.58	11.62	42.44	15.42	595.15	0.08	0.24
E3	Clusia elliptica	Clusiaceae	3000	LateSucSmall	43.63	21.11	0.59	497.91	10.52	47.39	15.96	672.37	0.07	0.23
E4	Alzatea verticillata	Alzateaceae	2000	LateSucTall	57.77	39.73	0.41	493.44	10.59	46.67	13.09	620.12	0.07	0.21
E4	Ilex laurina	Aquifoliaceae	3000	LateSucSmall	53.87	11.82	0.35	498.72	11.45	44.09	16.84	498.16	0.06	0.20
E4	Hedyosmum purpurascens	Chloranthaceae	3000	EarlySuc	72.50	13.82	0.44	450.08	18.72	24.21	17.71	733.97	0.06	0.21
E4	Hedyosmum cf goudotianum	Chloranthaceae	2000	Pioneer	88.52	41.01	0.38	NA	NA	NA	NA	766.22	0.06	0.21
E4	Weinmannia elliptica	Cunoniaceae	3000		52.24	3.16	0.40	473.56	9.86	49.07	18.96	0.00	0.07	0.22
E4	Alchornea lojaensis	Euphorbiaceae	2000	MidSucTall	47.55	34.38	0.48	534.17	15.07	36.04	13.35	629.87	0.06	0.20
E4	Ocotea rotundata	Lauraceae	3000	LateSucTall	49.43	29.66	0.43	490.21	14.70	36.33	15.55	556.15	0.07	0.22

E4	Ocotea andina	Lauraceae	2000	MidSucSmall	51.21	103.14	0.36	528.21	16.15	32.95	17.06	540.47	0.07	0.23
E4	Graffenrieda emarginata	Melastomataceae	2000	MidSucSmall	64.22	310.47	0.35	0.00	0.00	0.00	0.00	603.04	0.06	0.20
E4	Miconia calophylla	Melastomataceae	2000	Pioneer	61.56	52.68	0.34	488.88	13.09	37.60	18.48	687.39	0.07	0.22
E4	Naucleopsis francisci	Moraceae	2000	LateSucTall	49.00	56.63	0.35	478.31	19.46	24.63	22.03	562.66	0.06	0.20
E4	Myrcia spnov	Myrtaceae	2000	LateSucSmall	44.53	37.80	0.48	482.31	10.37	46.66	17.37	576.34	0.08	0.23
E4	Hieronyma fendleri	Phyllanthaceae	2000	MidSucSmall	90.68	22.78	0.31	475.92	15.10	31.59	15.08	671.74	0.07	0.22
E4	Myrsine coriacea	Primulaceae	2000	MidSucSmall	69.46	15.40	0.32	525.54	12.10	46.39	17.98	608.41	0.07	0.22
E4	Gordonia fruticosa	Theaceae	3000	LateSucSmall	63.03	4.60	0.39	478.33	13.78	35.94	20.37	569.36	0.07	0.23
E5	Grias peruviana	Lecythidaceae	1000	LateSucSmall	72.83	353.23	0.22	445.13	15.46	28.96	12.06	659.25	0.09	0.21
E5	Heliocarpus americanus	Malvaceae	2000	Pioneer	187.50	198.70	0.16	0.00	0.00	0.00	0.00	796.38	0.08	0.18
E5	Clarisia racemosa	Moraceae	1000	LateSucTall	119.29	39.36	0.17	445.95	22.19	20.17	19.06	604.12	0.10	0.23
E5	Pourouma cecropiifolia	Urticaceae	1000	Pioneer	81.49	1632.01	0.21	468.05	18.85	25.12	21.26	0.00	0.10	0.21
E6	Tapirira guianensis	Anacardiaceae	2000	MidSucTall	76.93	78.59	NA	NA	NA	NA	NA	NA	0.06	0.20
E6	Guatteria pastazae	Annonaceae	1000	MidSucSmall	97.98	94.33	0.22	477.03	17.22	27.94	24.20	577.33	0.07	0.20
E6	Aspidosperma rigidum	Apocynaceae	1000	LateSucTall	159.63	53.76	0.26	447.44	25.22	17.81	14.31	737.67	0.08	0.22
E6	Alchornea cf glandulosa	Euphorbiaceae	1000	Pioneer	164.52	72.27	0.11	459.59	26.24	17.53	18.55	609.33	0.08	0.20
E6	Parkia sp1	Fabaceae	1000	MidSucTall	149.09	13.70	0.13	473.09	35.43	13.50	20.92	567.45	0.08	0.21
E6	Ocotea JH6030	Lauraceae	1000	MidSucSmall	101.09	235.37	0.30	485.18	22.75	21.49	15.31	686.17	0.07	0.22
E6	Mollia gracilis	Malvaceae	1000	MidSucTall	157.35	75.37	0.14	469.41	24.28	19.50	21.65	624.20	0.08	0.20

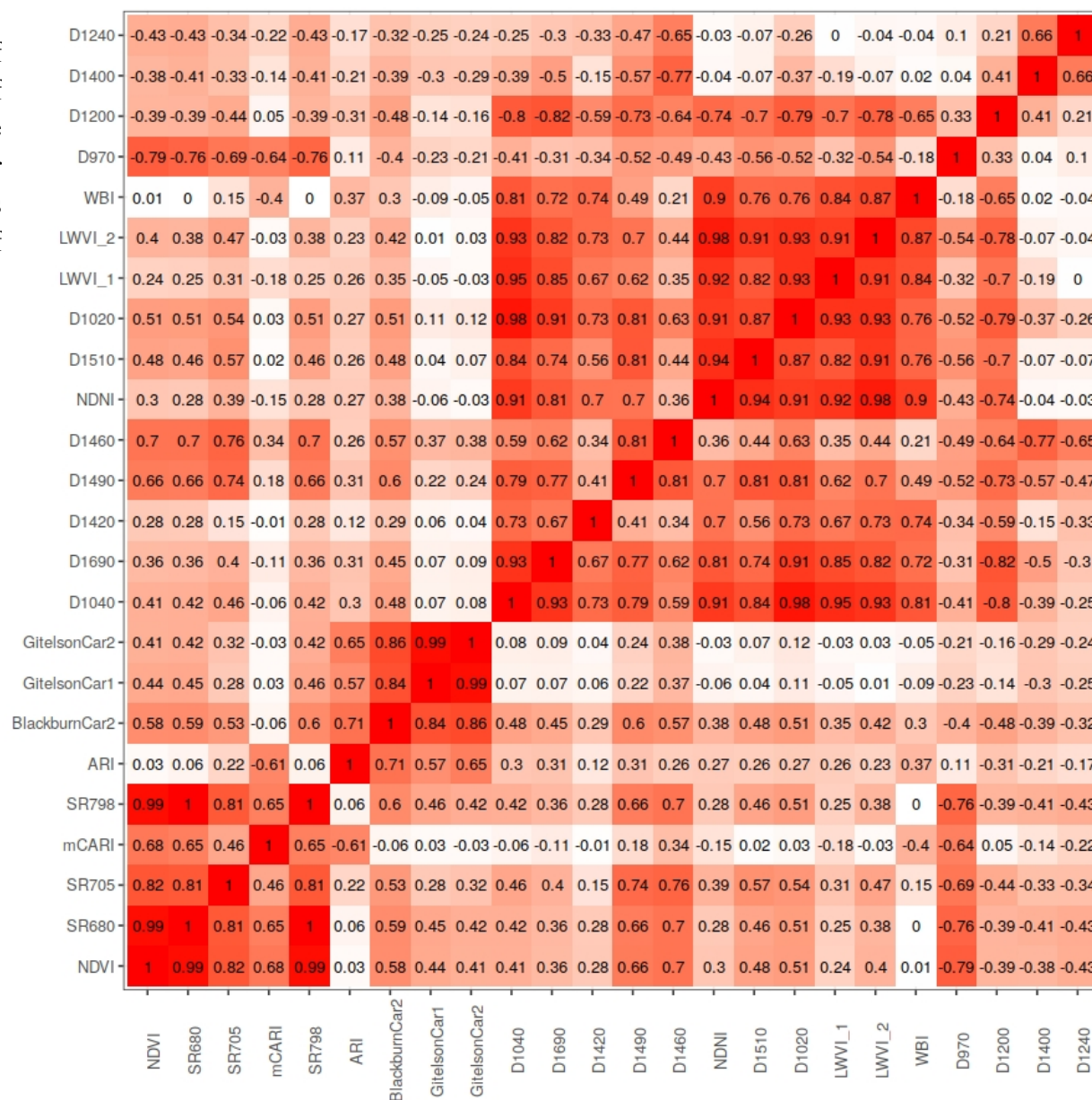
E6	Guarea macrophylla	Meliaceae	1000	LateSucSmall	145.00	80.84	0.20	465.18	27.54	16.94	13.81	710.98	0.07	0.21
E6	Pseudolmedia laevis	Moraceae	1000	LateSucSmall	127.28	54.15	0.16	438.45	19.63	22.41	23.49	555.33	0.07	0.20
E6	Elacagia mollis	Rubiaceae	2000	LateSucSmall	121.95	144.23	0.24	NA	NA	NA	NA	718.72	0.06	0.18
E6	Pouteria torta	Sapotaceae	1000	LateSucTall	86.02	75.43	0.17	503.68	15.85	32.15	23.80	536.21	0.08	0.20
E6	Leonia crassa	Violaceae	1000	LateSucTall	93.80	180.23	0.28	449.55	20.45	22.19	16.54	680.22	0.08	0.21
E7	Saurauia JH5994	Actinidiaceae	1000	Pioneer	129.13	239.50	0.21	448.41	19.04	23.68	15.72	737.71	0.08	0.19
E7	Chrysochlamys sp	Clusiaceae	1000	LateSucSmall	100.99	167.80	0.43	428.34	14.66	29.35	19.42	749.33	0.08	0.20
E7	Clusia ducuoides	Clusiaceae	2000	LateSucTall	59.41	19.59	0.53	494.24	12.34	40.14	16.04	726.64	0.08	0.21
E7	Meriania franciscana	Melastomataceae	2000	MidSucTall	NA	NA	0.23	NA	NA	NA	NA	552.75	0.06	0.17
E7	Otoba parvifolia	Myristicaceae	1000	MidSucTall	98.46	97.37	0.32	477.55	15.63	30.76	17.44	718.44	0.08	0.21
E7	Hieronyma oblonga	Phyllanthaceae	1000	MidSucSmall	133.01	65.77	0.24	463.99	19.19	24.27	18.26	750.47	0.08	0.20
E7	Ladenbergia oblongifolia	Rubiaceae	1000	MidSucTall	87.77	322.11	0.27	483.52	17.35	28.12	17.45	613.09	0.08	0.20
E7	Warszewiczia coccinea	Rubiaceae	1000	MidSucSmall	127.20	299.63	0.19	458.79	27.81	16.93	23.76	721.83	0.08	0.20
E7	Cecropia angustifolia	Urticaceae	2000	Pioneer	60.14	1354.33	0.28	0.00	0.00	0.00	0.00	653.67	0.08	0.20
E8	Clethra revoluta	Clethraceae	3000	LateSucSmall	55.09	38.35	0.39	481.53	14.44	33.54	14.96	636.15	0.07	0.19
E8	Weinmannia microphylla	Cunoniaceae	2000	LateSucSmall	98.83	7.23	0.24	480.80	12.75	38.06	18.49	608.50	0.07	0.19
E8	Aiouea dubia	Lauraceae	3000	LateSucTall	58.23	17.22	0.34	488.12	17.59	28.16	15.70	574.77	0.07	0.20
E8	Matayba ineleans	Sapindaceae	2000	LateSucSmall	95.76	26.62	0.22	501.03	25.17	20.00	19.01	618.16	0.07	0.20

E8	Siparuna muricata	Siparunaceae	3000	EarlySuc	86.99	41.98	0.29	457.38	29.64	15.68	12.86	788.03	0.07	0.19
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Table S5. NIR albedo correlations (Spearman's rho) by excluding the single-species TFTs. As stressed in the main text, R-TFT1 NIR albedo is mainly related to the exceptionally high leaf N content, which masks the correlation between NIR albedo, altitude, SLA, and leaf water.

	Elevation	SLA	LT	LWC	N
All R-TFTs (Figure S5)	-0.07	-0.45	0.38	-0.19	-0.12
- R-TFT 1	0.4	-0.64	0.54	-0.36	-0.68
- R-TFTs 1 and 3	0.12	-0.49	0.37	-0.6	-0.54

Figure S1:
Correlation matrix of
commonly used leaf
optical metrics (see
Table 1.). Color
brightness indicates
strength of
correlation.



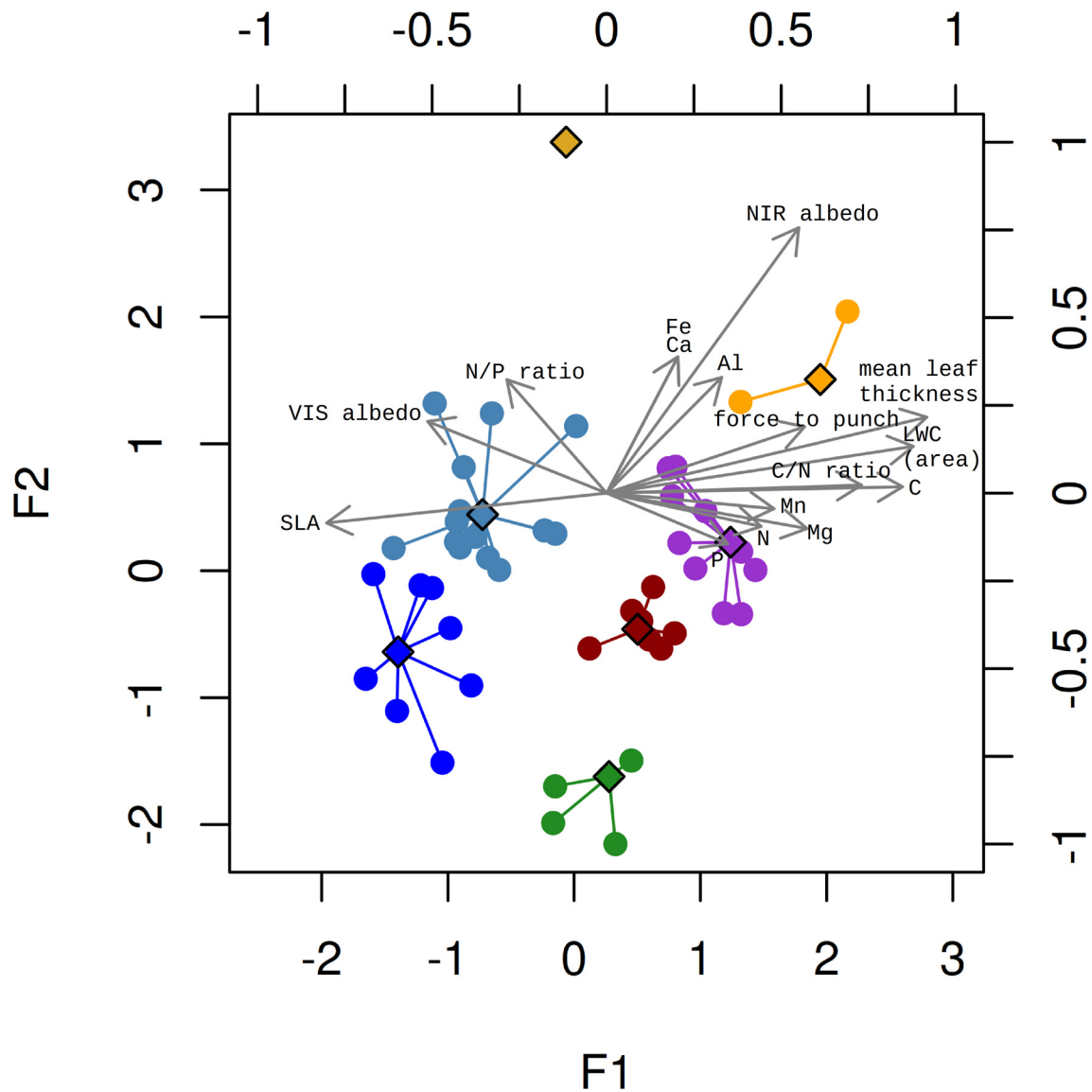


Figure S2. Clustering in the bivariate factor space for the ecosystem function of productivity. Cluster centers are marked by rectangles. Species scores are colored according to the P-TFT to which they were assigned. P1 = orange, P2 = red, P3 = violet, P4 = green, P5 = yellow, P6 = light blue, and P7 = dark blue. Productivity increases with decreasing species F1 scores and increasing F2 scores. F1 scores correlate with nutrient supply, and F2 scores are correlated with N/P-ratio, Fe and Ca. Gray arrows indicate significant correlation between leaf functional traits and species factor scores.

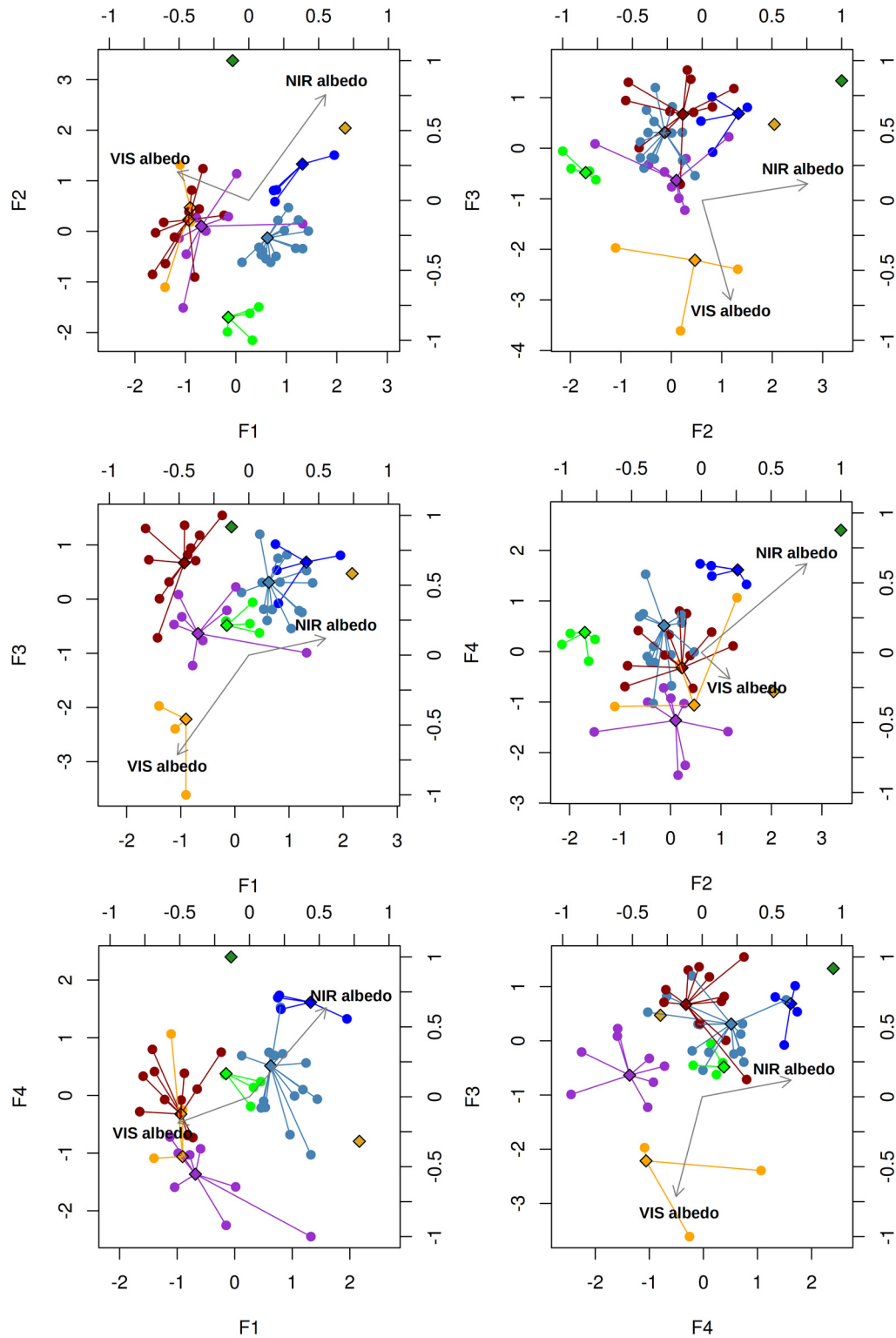


Figure S3. Clustering of the complete factor space. Cluster centers are marked by rectangles. Species scores are colored according to their assigned R-TFT: R1 = dark green, R2 = blue, R3 = yellow, R4 = light blue, R5 = orange, R6 = red, R7 = violet, and R8 = light green. Gray arrows indicate significant correlations between albedo and factor scores. F1 correlated negatively with

VIS albedo and positively with NIR albedo, thus positively affecting potential latent heat flux and negatively affecting potential sensible heat flux. F2 showed positive correlation with NIR albedo, which may lower potential sensible heat fluxes. F3 was negatively correlated with VIS albedo, thus increasing potential latent heat flux.

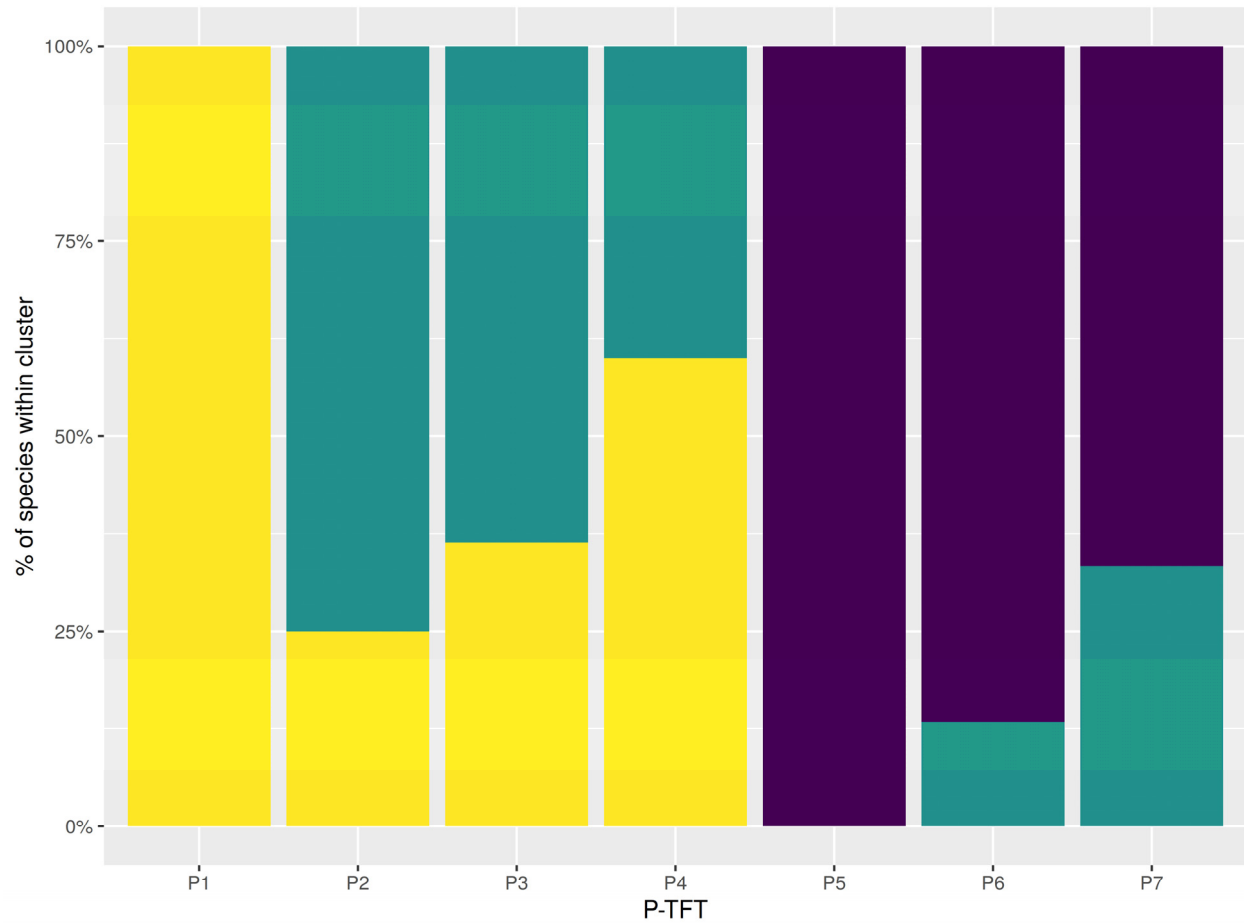


Figure S4. Altitudinal distribution of P-TFTs along the elevation gradient (for TFT, refer to Table 3 of the main text). Violet = 1000 m a.s.l., green = 2000 m a.s.l., and yellow = 3000 m a.s.l. TFTs P1-P4 mainly occur in the mid and higher parts of the study area. TFTs P5-P7 are dominated by species in the lower parts of the study area.

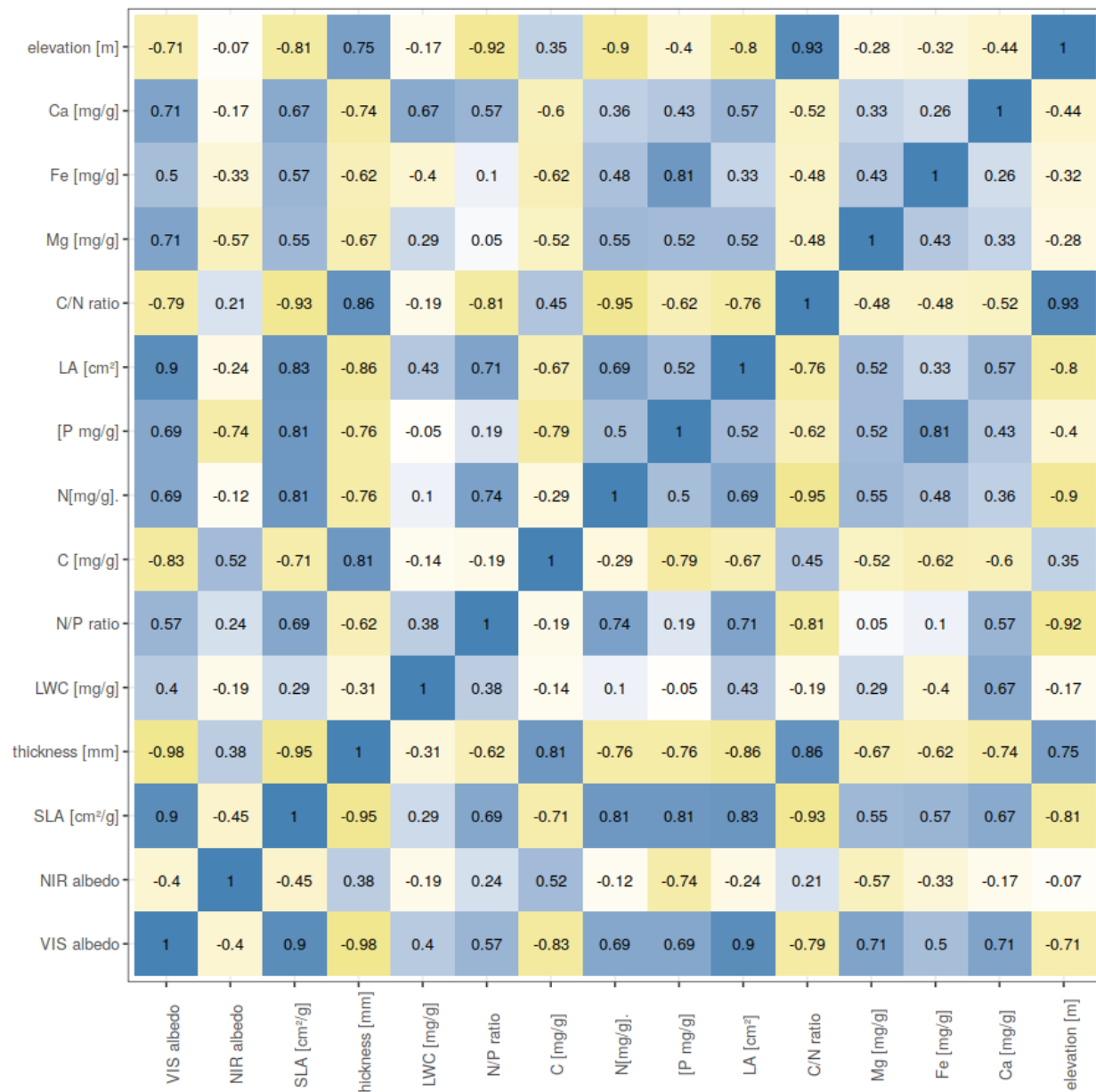


Figure S5. Cross-correlation matrix (Spearman's rho) of the R-TFT VIS and NIR and albedo with the median values of the functional traits (SLA = specific leaf area, LWC = leaf water content, and elevation = average elevation of species sampling) Figure S4 reveals a weak negative correlation ($\rho = -0.4$) between VIS and NIR albedo of the R-TFTs. The highest correlation coefficients for VIS albedo were with leaf thickness ($\rho = -0.98$), SLA/leaf area (both $\rho = 0.9$), leaf carbon (-0.83), and C:N ratio. Thus, structural leaf traits related to carbon and biomass are most relevant. The greater the carbon/structural biomass, the lower the VIS albedo because of higher leaf absorption. Of weaker importance are the biochemical leaf traits Mg and Ca (ρ of 0.71) as well as N and P ($\rho = 0.69$). All traits are positively related to the chlorophyll content and thus enhance the VIS albedo particularly in the green wavebands. Striking is the high correlation between leaf Ca and leaf water content (0.67). This occurred because the leaf Ca content is positively related to water fluxes in plants (e.g., transpiration; Gilliham et al. 2011). More complex is the relation between NIR albedo and leaf traits for the R-

TFTs. The positive relation with C ($\rho = 0.52$) points to the reflectance potential of leaf structural elements in the NIR. The more structured the leaf, the higher the NIR albedo. This is confirmed by the negative relation with SLA. A negative relation with the biochemical leaf traits P ($\rho = -0.74$) and Mg ($\rho = -0.57$) is obvious, which are both relevant for chlorophyll content. However, both traits are negatively correlated with leaf thickness and carbon, which might explain the negative correlation coefficients of P and Mg with R-TFT NIR albedo. Leaf water is negatively related to NIR albedo, as expected from the water absorption bands in the NIR. However, the relation is weak for the R-TFTs. Notably, VIS albedo decreases with height, while no direct relation with height was found for NIR albedo. Here, the relation is indirect via elevation-dependent structural traits such as SLA. It should be stressed that excluding the one-species TFTs from cross-correlation clarifies the correlation patterns particularly for NIR albedo (see Table S5).

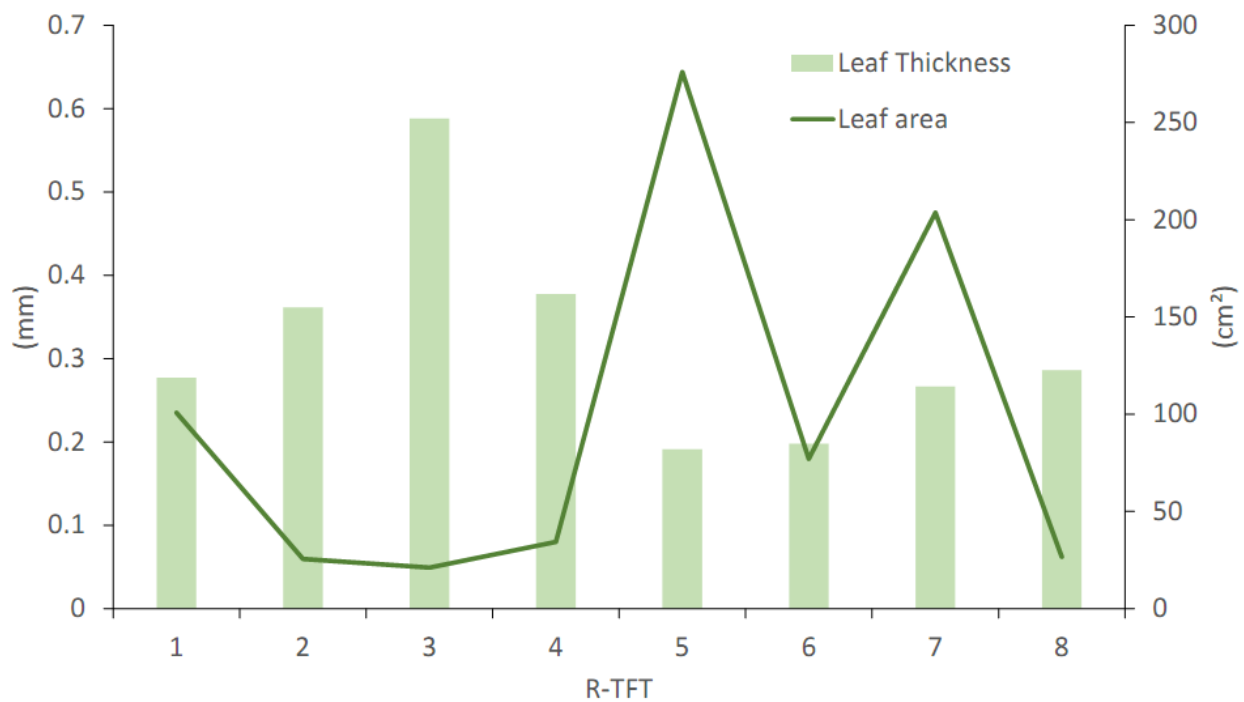


Figure S6. Leaf geometry for the R-TFT clusters. Leaf geometry clearly differs in the R-TFTs. Tree species of R-TFT groups 5 and 7 are characterized by large and thinner leaves, whereas the contrary is true for R-TFT 2-4. R-TFTs 1 and 6 reveal an intermediate thickness and leave size. The R-TFT with intermediate thickness but higher leave size is R-TFTs 7. R-TFT 8 is characterized by an intermediate leaf thickness and small leaves.

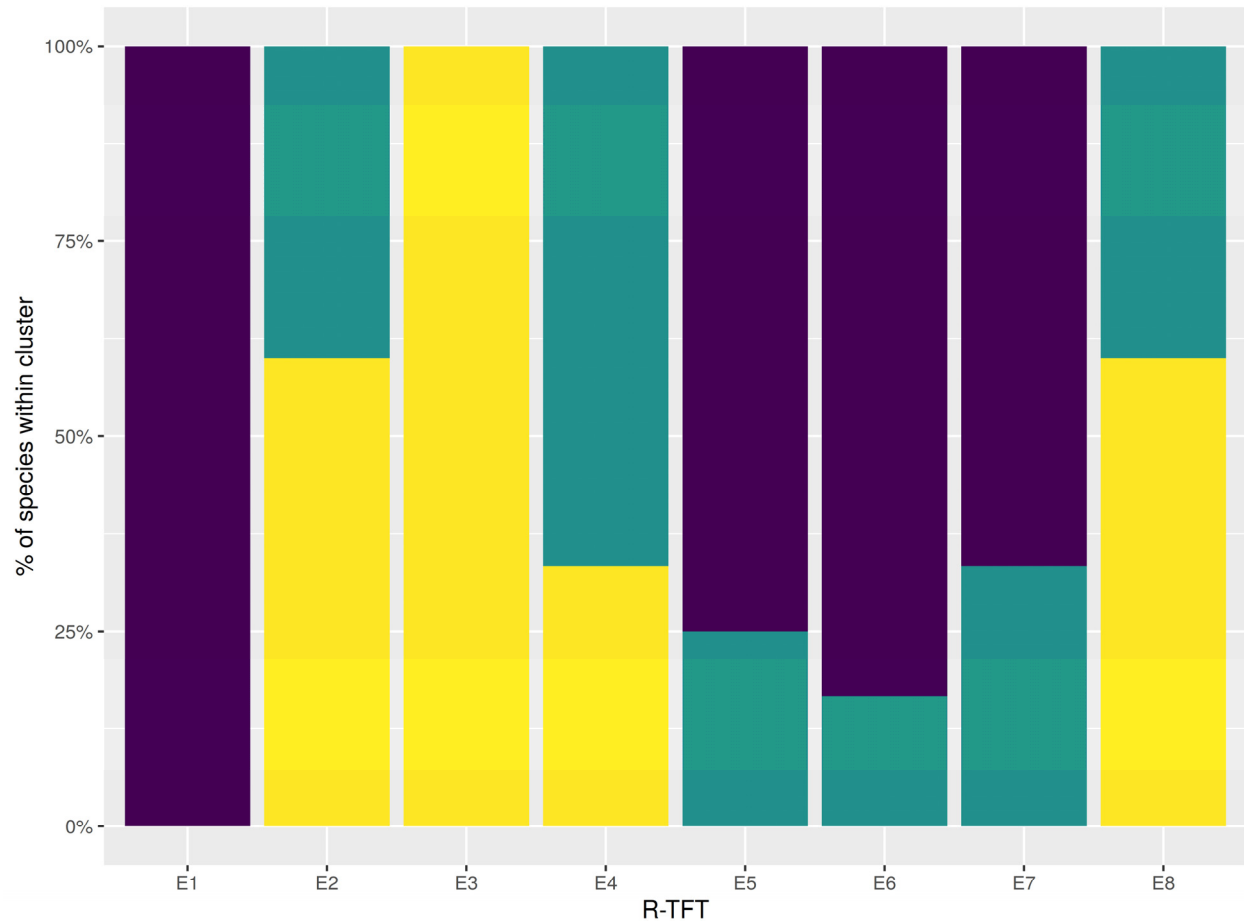


Figure S7. Altitudinal distribution of R-TFTs along the elevation gradient (for TFT number, refer to Table 4 of the main text). Violet = 1000 m a.s.l., green = 2000 m a.s.l., and yellow = 3000 m a.s.l. R-TFTs 2-4 and 8 mainly occur in the mid and higher parts of the study area. These are generally the species with greater leaf thickness and smaller leaf size (Figure S5). The bigger and thinner leaves of the R-TFTs 1 and 5-7 are mostly related to the species of the lower parts of the study area.

References:

Gilliam, M., Dayod, M., Hocking, B.J., Xu, B., Conn, S.J., Kaiser, B.N., Leigh, R.A. and Tyerman, S.D., 2011. Calcium delivery and storage in plant leaves: exploring the link with water flow. *Journal of experimental botany*, 62(7), pp.2233-2250.