10.1071/FP14040_AC

Supplementary Material: *Functional Plant Biology*, 2015, 42(1), 63–83.

Supplementary Material

Foliar trait contrasts between African forest and savanna trees: genetic versus environmental effects

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S1. Details of sampling sites

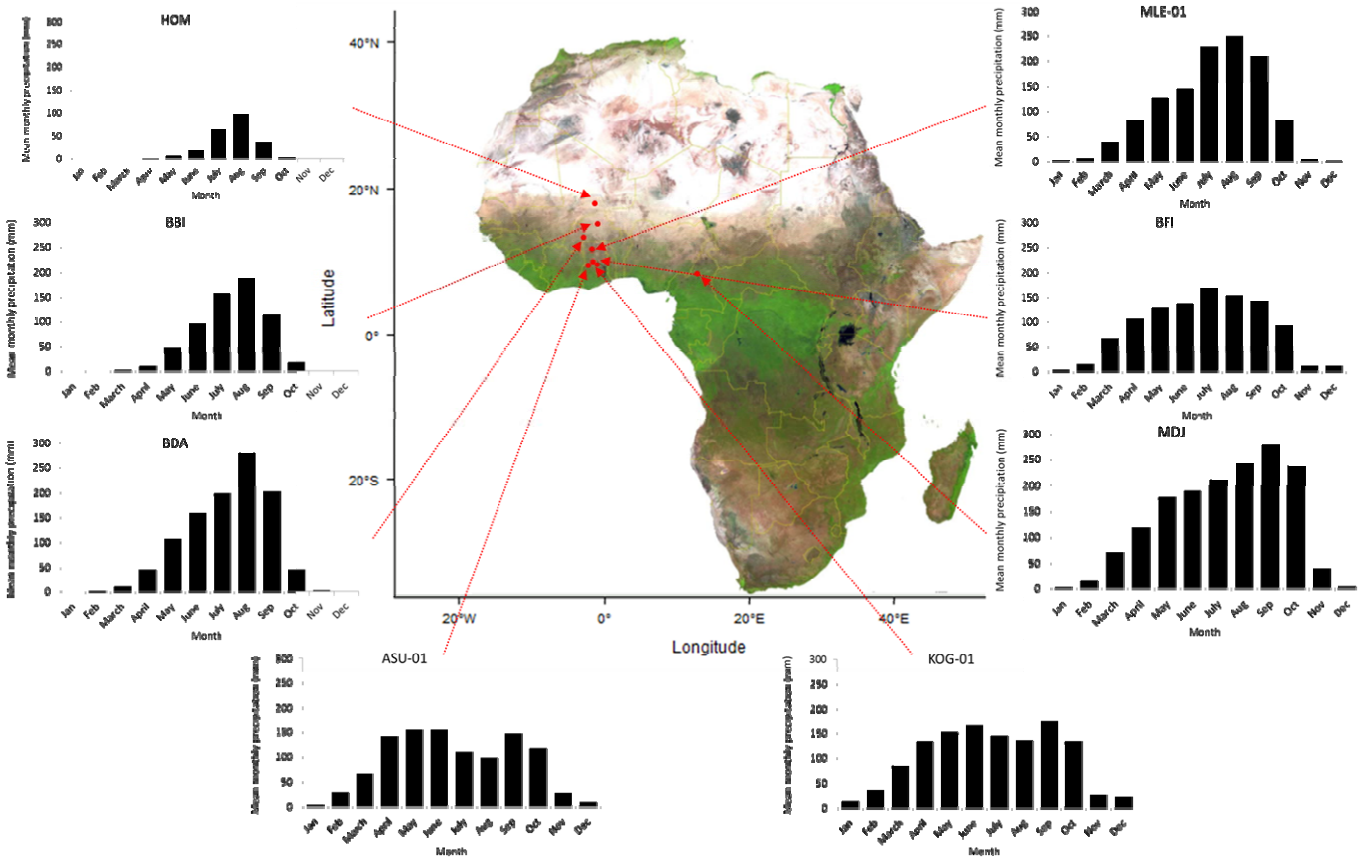

Figure S1.1 Map showing sampling sites and precipitation seasonality

Table S1.1 Plot coordinates, Torello-Raventos *et al.* (2013) vegetation classification $\mathbb{V}$, elevation above sea level E_V, mean annual temperature T_A, mean annual precipitation P_A, seasonality index υ, mean upper stratum canopy height $\langle H \rangle_U$, upper stratum canopy area index C_U, soil pH, soil exchangeable cations, soil extractable phosphorus and Wold Reference Base (WRB) soil classification for the study sites. Soil values represent the top 0.3 m of soil.

Plot	Lat.	Long.	$\mathbb{V}$	E_V (m)	T_A (ºC)	P_A (m)	υ	$\langle H \rangle_U$ (m)	C_U (m^2 m^{-2})	pH	$[Al]_e$	$[Ca]_{ex}$	$[K]_{ex}$	$[Mg]_{ex}$	$[Na]_{ex}$ ($mmol_{eq}$ kg^{-1})	$[P]_{exch}$ ($\mu g\, g^{-1}$)	WRB Soil Classification
Cameroon																	
MDJ-01	6.168N	12.825E	Tall forest	773	23.8	1.61	0.50	17.3	2.73	6.53	0.4	14.1	1.1	5.9	0.0	414	Haplic Lixisol (Humic, Chromic)
MDJ-02	6.163N	12.824E	Long-grass savanna	867	23.4	1.62	0.50	6.4	0.39	5.42	1.5	6.3	0.3	2.5	0.1	392	Pisolithic Plinthosol (Humic)
MDJ-03	5.984N	12.869E	Stunted shrub-rich forest	761	23.9	1.59	0.48	15.6	2.45	4.88	2.4	3.4	2.8	4.2	0.2	120	Pisolithic Plinthosol (Dystric)
MDJ-04	5.999N	12.868E	Long-grass savanna	755	23.9	1.59	0.49	6.3	0.34	4.92	4.8	3.3	0.7	1.1	0.1	141	Haplic Ferralsol (Dystric)
MDJ-05	5.980N	12.868E	Stunted shrub-rich forest	768	23.9	1.59	0.48	11.6	1.64	4.50	5.2	0.8	0.2	0.5	0.1	285	Pisolithic Plinthosol (Dystric)
MDJ-06	6.003N	12.891E	Long-grass savanna	755	23.9	1.59	0.49	7.1	0.64	4.83	3.8	2.9	0.5	1.2	0.1	88	Pisolithic Plinthosol (Humic, Clayic)
MDJ-07	6.007N	12.886E	Tall forest	755	23.9	1.59	0.49	12.6	1.38	4.70	2.6	4.1	1.0	2.1	0.1	463	Pisolithic Plinthosol (Ferric, Dystric)
MDJ-08	6.213N	12.749E	Long-grass savanna	772	23.8	1.62	0.50	7.8	0.45	5.81	0.7	9.9	1.3	5.0	0.2	135	Haplic Lixisol (Humic, Endoskeletic)
MDJ-10	5.997N	12.894E	Tall closed woodland (wl)	766	23.8	1.59	0.49	14.8	1.78	4.93	2.1	1.1	0.8	1.3	0.1	ND	Pisolithic Plinthosol (Humic, Dystric)
Ghana																	
ASU-01	7.136N	2.447W	Tall forest	263	26.0	1.21	0.29	18.6	0.72	5.20	1.3	18.0	1.0	9.4	0.4	106	Endofluvic Cambisol (Dystric)
BFI-01	7.714N	1.694W	Tall closed wl	358	25.4	1.29	0.34	12.0	0.45	6.60	0.3	23.7	1.0	6.1	0.1	103	Haplic Alisol(Arenic, Hyperdystric, Rhodic)
BFI-02	7.715N	1.692W	Tall savanna wl	358	25.4	1.29	0.34	14.4	0.87	5.73	0.3	9.3	0.9	3.0	0.1	73	Brunic Arenosol (Alumic, Hyperdystric)
BFI-03	7.707N	1.698W	Tall forest	350	25.4	1.29	0.34	17.7	1.38	6.26	0.2	26.4	2.7	11.3	0.1	347	Haplic Nitosol (Dystric)
BFI-04	7.707N	1.698W	Tall forest	350	25.4	1.29	0.34	16.8	1.86	6.52	0.1	23.2	1.8	6.9	0.1	47	Haplic Nitosol (Dystric)
KOG-01	7.302N	1.180W	Tall savanna wl	201	26.3	1.25	0.33	10.0	0.68	5.56	0.3	7.1	0.5	2.5	0.1	62	Haplic Arenosol (Dystric)
MLE-01	9.304N	1.857W	Savanna wl	134	27.9	1.03	0.53	7.6	0.32	6.22	0.6	8.6	1.3	5.8	0.1	48	Brunic Arenosol (Dystric)
Burkina Faso																	
BBI-01	12.731N	1.165W	Savanna wl	275	28.3	0.69	0.76	6.5	0.52	5.74	0.6	23.9	0.9	15.9	0.9	59	Haplic Luvisol (Epidystric, Endosiltic)
BBI-02	12.733N	1.164W	Savanna wl	275	28.3	0.69	0.76	6.7	1.00	5.86	0.2	19.9	0.8	9.3	0.2	74	Pisolithic Plinthosol (Eutric)
BDA-01	10.940N	3.150W	Shrub-rich savanna wl	264	27.8	0.98	0.67	7.7	0.22	6.00	0.1	25.6	1.4	13.3	0.3	72	Haplic Fluvisol (Magniferric, Dystric, Siltic)
BDA-02	10.940N	3.154W	Shrub-rich savanna wl	258	27.9	0.98	0.67	7.8	0.03	5.60	1.2	16.8	0.7	9.6	0.5	49	Acric Stagnic Plinthosol (Magniferric, Dystric, Siltic)
Mali																	

Plot	Lat.	Long.	$\mathbb{V}$	E_V (m)	T_A (ºC)	P_A (m)	υ	$\langle H \rangle_U$ (m)	C_U (m^2 m^{-2})	pH	$[Al]_e$	$[Ca]_{ex}$	$[K]_{ex}$	$[Mg]_{ex}$	$[Na]_{ex}$	$[P]_{exch}$ ($\mu g\, g^{-1}$)	WRB Soil Classification
											$mmol_{eq}\, kg^{-1}$						
HOM-01	15.344N	1.468W	Savanna grassland	306	29.9	0.35	0.85	3.8	0.01	6.54	0.2	6.4	0.6	3.1	0.1	87	Rubic Arenosol (Dystric, Aridic)
HOM-02	15.335N	1.547W	Savanna grassland	310	30.0	0.35	0.85	5.6	0.08	6.83	0.2	7.6	1.3	2.7	0.1	43	Rubic Arenosol (Dystric, Aridic)

S2: Mixed model output and diagnostics

Table S2.1 Estimates for the mixed effects model of Eqn. 1 for leaf mass per unit area (g m^{-2}).

Fixed Effect

Parametric terms	**Coefficient**	**S.E.**	***t***	***p***
μ = intercept: $\mathbb{F}$ dataset mean, $\langle\mathbb{F}\rangle$	95.8	3.8	25.39	0.0001
α= savanna - forest difference: $\langle\mathbb{S}\rangle$-$\langle\mathbb{F}\rangle$	16.6	4.9	3.39	0.0009
Smooth terms		***d.f.***	***F***	***p***
$s(P_A)$		3.54	3.847	0.0064

Random effect	**Variance component**	**Fraction of total**
Level 2 variance $\tau_0^2 = \mathrm{var}(U_{0S})$	590.5	0.57
Level 2 variance $\sigma_0^2 = \mathrm{var}(R_{i,S})$	436.8	0.43

Table S2.2 Estimates for the mixed effects model of Eqn. 1 for leaf nitrogen (mg g^{-1}).

Fixed Effect

Parametric terms	**Coefficient**	**S.E.**	***t***	***p***
μ = intercept: $\mathbb{F}$ dataset mean, $\langle\mathbb{F}\rangle$	24.40	0.68	35.86	<0.0001
α= savanna - forest difference: $\langle\mathbb{S}\rangle$-$\langle\mathbb{F}\rangle$	-6.21	0.88	-7.09	<0.0001
Smooth terms		***d.f.***	***F***	***p***
$s(P_A)$		5.37	18.98	<0.0001

Random effect	**Variance component**	**Fraction of total**
Level 2 variance $\tau_0^2 = \mathrm{var}(U_{0S})$	16.72	0.70
Level 2 variance $\sigma_0^2 = \mathrm{var}(R_{i,S})$	6.92	0.30

Table S2.3 Estimates for the mixed effects model of Eqn. 1 for leaf phosphorus (mg g^{-1}).

Fixed Effect

Parametric terms	**Coefficient**	**S.E.**	***t***	***p***
μ = intercept: $\mathbb{F}$ dataset mean, $\langle\mathbb{F}\rangle$	1.180	0.058	20.23	<0.0001
α= savanna - forest difference: $\langle\mathbb{S}\rangle$-$\langle\mathbb{F}\rangle$	0.054	0.074	0.72	0.475
Smooth terms		***d.f.***	***F***	***p***
$s(P_A)$		3.40	2.71	0.038

Random effect	Variance component	Fraction of total
Level 2 variance $\tau_0^2 = \mathrm{var}(U_{0S})$	0.104	0.43
Level 2 variance $\sigma_0^2 = \mathrm{var}(R_{i,S})$	0.139	0.57

Table S2.4 Estimates for the mixed effects model of Eqn. 1 for leaf carbon (mg g^{-1}).

Fixed Effect

Parametric terms	**Coefficient**	**S.E.**	***t***	***p***
μ = intercept: $\mathbb{F}$ dataset mean, $\langle \mathbb{F} \rangle$	455.3	3.1	147.0	<0.0001
α= savanna - forest difference: $\langle \mathbb{S} \rangle$-$\langle \mathbb{F} \rangle$	13.6	3.9	-3.46	<0.0001
Smooth terms		***d.f.***	***F***	***p***
$s(P_A)$		1.00	14.36	0.0002

Random effect	Variance component	Fraction of total
Level 2 variance $\tau_0^2 = \mathrm{var}(U_{0S})$	309.1	0.52
Level 2 variance $\sigma_0^2 = \mathrm{var}(R_{i,S})$	277.9	0.48

Table S2.5 Estimates for the mixed effects model of Eqn. 1 for leaf potassium (mg g^{-1}).

Fixed Effect

Parametric terms	**Coefficient**	**S.E.**	***t***	***p***
μ = intercept: $\mathbb{F}$ dataset mean, $\langle \mathbb{F} \rangle$	8.49	0.37	22.83	<0.0001
α= savanna - forest difference: $\langle \mathbb{S} \rangle$-$\langle \mathbb{F} \rangle$	-2.31	0.47	-4.91	<0.0001
Smooth terms		***d.f.***	***F***	***p***
$s(P_A)$		1.00	70.73	<0.0001

Random effect	Variance component	Fraction of total
Level 2 variance $\tau_0^2 = \mathrm{var}(U_{0S})$	5.54	0.55
Level 2 variance $\sigma_0^2 = \mathrm{var}(R_{i,S})$	4.45	0.45

Table S2.6 Estimates for the mixed effects model of Eqn. 1 for leaf magnesium (mg g^{-1}).

Fixed Effect

Parametric terms	**Coefficient**	**S.E.**	***t***	***p***
μ = intercept: $\mathbb{F}$ dataset mean, $\langle \mathbb{F} \rangle$	3.64	0.19	19.02	<0.0001
α= savanna - forest difference: $\langle \mathbb{S} \rangle$-$\langle \mathbb{F} \rangle$	-0.19	0.24	-0.81	0.421
Smooth terms		***d.f.***	***F***	***p***
$s(P_A)$		2.4	4.41	0.0086

Random effect	Variance component	Fraction of total

Level 2 variance $\tau_0^2 = \mathrm{var}(U_{0S})$	1.31	0.49
Level 2 variance $\sigma_0^2 = \mathrm{var}(R_{i,S})$	1.33	0.51

Table S2.7 Estimates for the mixed effects model of Eqn. 1 for leaf calcium (mg g^{-1}).

Fixed Effect

Parametric terms	**Coefficient**	**S.E.**	***t***	***p***
μ = intercept: $\mathbb{F}$ dataset mean, $\langle \mathbb{F} \rangle$	14.77	0.81	18.21	<0.0001
α= savanna - forest difference: $\langle \mathbb{S} \rangle$-$\langle \mathbb{F} \rangle$	-1.86	1.02	-1.81	0.0705
Smooth terms		***d.f.***	***F***	***p***
$s(P_A)$		1.00	3.72	0.0548

Random effect	**Variance component**	**Fraction of total**
Level 2 variance $\tau_0^2 = \mathrm{var}(U_{0S})$	23.53	0.51
Level 2 variance $\sigma_0^2 = \mathrm{var}(R_{i,S})$	21.72	0.49

S3. Multivariate analysis of variance

Table S3.1. Two-way non-parametric MANOVA on Bray-Curtis distances for leaf trait characteristics compared for forest *vs.* savanna trees (affiliation) and the four initial categories of leaf habit (evergreen, deciduous, semi-deciduous and brevi-deciduous).

Source	*d.f.*	*SS*	*MS*	*F*	*p*
Affiliation	1	0.2277	0.2277	7.973	0.001
Leaf Habit	3	0.1465	0.0488	1.710	0.080
Residual	154	4.3988	0.0286		
Total	158	4.7730			

S4: Principal Component analysis

Table S4.1. Summary of the Principal Components Analysis of the correlation matrix for the derived environmental effects on observed foliar traits.

Variable	$\mathcal{Y}_1$	$\mathcal{Y}_2$	$\mathcal{Y}_3$	$\mathcal{Y}_4$	$\mathcal{Y}_5$	$\mathcal{Y}_6$
$^{\ell}M_a$	0.465	-0.068	0.208	-0.269	-0.800	-0.152
$^{\ell}[N]_m$	-0.357	-0.631	-0.399	-0.303	-0.066	-0.466
$^{\ell}[P]_m$	-0.367	-0.643	0.292	-0.235	0.339	0.443
$^{\ell}[C]_m$	0.381	-0.210	0.785	0.321	-0.051	-0.297
$^{\ell}[K]_m$	-0.471	-0.188	-0.131	0.188	-0.484	0.675
$^{\ell}[Mg]]_m$	-0.392	0.322	0.279	-0.801	0.060	0.137
Eigenvalue	2.00	0.94	0.73	0.63	0.36	0.26