Supplementary Material

Separating species and environmental determinants of leaf functional traits in temperate rainforest plants along a soil-development chronosequence

Matthew H. Turnbull[A,H], *Kevin L. Griffin*[B], *Nikolaos M. Fyllas*[C], *Jon Lloyd*[D,E], *Patrick Meir*[F,G] *and Owen K. Atkin*[F]

[A]Centre for Integrative Ecology, School of Biological Sciences, University of Canterbury, Private Bag 4800, Christchurch, New Zealand.

[B]Department of Earth and Environmental Sciences, Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY 10964-8000, USA.

[C]Department of Ecology and Systematics, Faculty of Biology, National and Kapodistrian University of Athens, Athens 15784, Greece.

[D]Department of Life Sciences, Imperial College London, Silwood Park Campus, Buckhurst Road, Ascot, Berkshire SL5 7PY, UK.

[E]School of Marine and Tropical Biology, James Cook University, Cairns, Qld 4870, Australia.

[F]Research School of Biology, The Australian National University, Canberra, ACT 2601, Australia.

[G]School of Geosciences, University of Edinburgh, Edinburgh EH8 9XP, UK.

[H]Corresponding author. Email: matthew.turnbull@canterbury.ac.nz

Table S1. Average (± s.e., n = 3–5) values of leaf dry mass per unit area (M_A), leaf fresh mass per unit area (F_A), leaf dry matter content (Φ), nitrogen concentration, phosphorus concentration, area-based rates of photosynthesis at 1500 μmol photons m⁻² s⁻¹ PPFD (A), rates of leaf respiration (R), the ratio of leaf R to A, soluble sugar concentration and starch content for each species growing at each site

Site	Species	M_A (g m⁻²)	F_A (g m⁻²)	Φ (g g⁻¹)	N (mg g⁻¹)	P (mg g⁻¹)	A_A (μmol m⁻² s⁻¹)	A_M (nmol g⁻¹ s⁻¹)	R_A (μmol m⁻² s⁻¹)	R_M (nmol g⁻¹ s⁻¹)	Glucose (mg g⁻¹)	Fructose (mg g⁻¹)	Sucrose (mg g⁻¹)	Sugars (mg g⁻¹)	Starch (mg g⁻¹)
1	*Aristotelia serrata*	68±4	208.7±11.6	0.33±0.01	22.6±0.5	1.8±0.1	12.1±0.5	177.7±5.8	1.4±0.2	20.8±2.2	90.9±6.6	27.5±3.5	5.0±2.6	123.3±5.9	97.8±22.8
(11y)	*Coriaria arborea*	115±14	315.1±10.1	0.36±0.03	24.1±1.3	1.6±0.2	9.5±1.4	84.2±12.0	1.3±0.2	11.7±1.7	82.2±3.2	14.5±1.2	10.2±0.6	106.9±2.8	40.0±10.3
	Griselinia littoralis	232±11	602.1±18.9	0.38±0.01	11.2±0.7	0.9±0.1	8.8±1.0	38.5±5.8	1.0±0.1	4.2±0.6	52.6±3.8	23.0±2.0	4.7±0.8	80.4±5.4	65.7±13.9
	Hebe salicifolia	117±9	333.6±13.5	0.35±0.01	20.1±1.5	1.3±0.4	15.8±0.3	137.5±14.2	1.1±0.2	9.9±2.9	41.7±1.2	4.7±0.3	10.9±1.9	57.3±1.1	82.7±18.0
	Olearia avicenniifolia	154±28	370.4±26.8	0.40±0.05	14.8±1.1	1.1±0.3	17.0±2.2	117.7±19.3	1.3±0.2	10.0±2.5	14.2±0.7	10.6±1.7	5.5±0.9	30.2±1.1	67.2±21.6
2	*Aristotelia serrata*	83±4	242.5±10.3	0.34±0.01	23.1±0.4	2.5±0.1	11.3±0.8	139.2±13.8	1.8±0.1	22.1±2.3	83.3±3.4	41.3±3.7	6.2±1.0	130.7±4.4	83.3±13.4
(65y)	*Coriaria arborea*	119±5	324.7±9.9	0.37±0.01	20.4±0.2	1.3±0.1	7.2±1.4	61.7±12.6	1.6±0.1	14.0±1.4	70.1±14.4	13.2±0.6	9.1±1.4	116.4±8.7	60.2±12.7
	Coprosma lucida	95±17	315.6±25.9	0.29±0.04	17.2±2.9	1.1±0.2	7.6±1.0	84.7±10.4	0.7±0.2	7.1±0.8	51.9±14.0	31.7±4.3	4.3±0.9	88.0±16.2	20.4±5.1
	Melicytus ramiflorus	64±10	238.1±9.6	0.27±0.04	26.0±2.6	2.5±0.5	6.1±1.0	94.9±11.3	1.0±0.1	16.8±2.4	46.7±4.3	31.7±6.3	8.6±2.0	87.1±11.2	27.1±10.7
	Olearia arborescens	80±3	282.4±9.8	0.28±0.00	17.7±1.8	1.7±0.2	12.5±0.9	158.4±15.6	0.9±0.1	12.1±1.5	17.1±2.9	5.6±0.5	4.6±0.8	27.2±3.5	36.4±2.4
	Schefflera digitata	69±6	211.4±11.7	0.33±0.01	21.6±1.0	1.7±0.1	6.1±0.9	91.1±15.5	1.0±0.1	15.6±1.8	36.1±1.5	32.1±3.5	3.3±1.8	71.6±3.0	91.6±15.0
3	*Fuchsia excorticata*	50±4	209.9±19.1	0.25±0.03	22.0±1.9	2.3±0.2	17.8±3.0	369.4±72.1	1.9±0.3	40.6±9.4	83.4±6.8	1.0±0.4	0±0.7	84.3±7.2	15.5±0.20
(135y)	*Griselinia littoralis*	236±13	643.1±32.5	0.37±0.01	7.5±1.4	0.8±0.1	7.4±0.9	31.6±2.8	0.8±0.2	3.2±0.4	44.6±3.5	18.6±1.8	3.0±0.23	66.3±4.9	71.9±12.7
	Metrosideros umbellata	231±12	474.6±22.1	0.49±0.01	8.7±0.1	0.8±0.1	2.2±0.5	10.5±4.5	1.1±0.2	4.4±0.8	30.8±2.5	7.7±2.2	6.5±0.5	45.0±4.3	54.3±2.5
	Olearia illicifolia	111±17	335.4±14.1	0.33±0.04	21.0±2.8	2.3±0.5	24.5±4.4	249.2±65.6	2.7±0.4	25.6±4.4	22.5±2.7	15.8±4.6	6.0±1.3	44.6±8.0	15.3±2.7
	Pseudopanax colensoi	271±16	608.9±38.2	0.44±0.01	9.1±0.7	1.0±0.2	6.0±1.7	21.1±5.1	1.1±0.2	3.9±0.6	32.8±1.6	18.1±1.9	7.0±0.8	57.9±3.4	44.4±10.6
	P. crassifolius	280±31	602.1±44.7	0.46±0.02	8.9±0.9	0.6±0.1	10.2±3.4	39.7±15.6	1.0±0.2	3.8±1.0	25.7±2.8	12.5±1.1	1.6±0.5	39.8±2.6	30.1±6.9
	Weinmannia racemosa	230±14	466.9±24.5	0.49±0.01	10.1±0.7	0.8±0.1	4.7±1.0	20.2±3.9	1.2±0.2	5.1±0.5	75.7±3.6	3.9±0.71	0±0.5	78.3±4.3	76.0±4.1
4	*Griselinia littoralis*	162±25	460.5±53.7	0.35±0.01	9.7±1.1	0.9±0.1	3.7±1.3	17.3±5.0	1.2±0.5	5.2±2.4	51.1±3.5	21.7±4.2	6.0±2.6	78.8±9.7	67.0±14.4
(500y)	*M. umbellata*	245±10	476.7±19.7	0.51±0.00	9.4±0.6	0.7±0.1	7.8±1.8	33.6±8.3	1.1±0.3	4.4±1.0	43.7±1.7	11.4±1.0	4.1±0.8	59.2±2.5	26.1±1.0
	Weinmannia racemosa	231±23	477.0 ±36.9	0.48±0.01	10.0 ±0.6	0.9±0.2	1.9±0.3	8.4±1.6	0.7±0.1	3.1±0.3	76.7±0.9	6.2±0.4	0±1.2	82.8±1.3	71.0±7.7
5	*Dacrydium cupressinum*	294±40	595.6±82.1	0.50±0.02	8.8±0.4	0.5±0.1	1.7±0.8	6.0±2.6	0.5±0.1	1.9±0.4	18.7±0.5	5.8±0.7	6.2±0.6	30.7±0.5	67.7±7.8

(12ky)	*M. umbellata*	199±14	410.8±14.9	0.48±0.02	7.9±0.2	0.4±0.1	2.9±0.6	13.1±3.5	0.8±0.1	3.8±0.3	35.0±0.9	7.1±0.5	2.3±0.4	44.4±1.3	65.7±20.2
	Weinmannia racemosa	189±12	394.6±17.9	0.48±0.01	7.8±0.3	0.4±0.1	na	na	na	1.5±0.1	79.3±4.1	10.5±0.5	4.4±0.3	94.2±4.5	94.0±17.0
6 (120ky)	*D. cupressinum*	480±10	922.5±35.8	0.52±0.01	7.7±0.4	0.3±0.1	2.1±0.2	4.4±0.4	1.1±0.4	2.3±0.7	18.1±1.0	5.7±0.3	4.8±0.3	28.7±1.0	59.3±9.4
	M. umbellata	248±7	501.9±6.7	0.49±0.01	7.5±0.6	0.4±0.1	5.5±1.1	22.6±4.5	1.4±0.4	5.7±1.8	40.3±2.1	7.1±0.4	3.0±0.4	50.3±2.4	43.9±10.2
	Weinmannia racemosa	219±14	466.8±24.3	0.47±0.01	8.2±0.5	0.3±0.1	1.1±0.3	6.5±1.4	0.8±0.1	2.8±0.7	89.5±4.4	9.6±0.9	3.8±0.6	102.9±5.4	60.9±4.8

Table S2.   Pearson's correlation coefficients and probability table

Correlation Table of Raw data pvalues/correlation

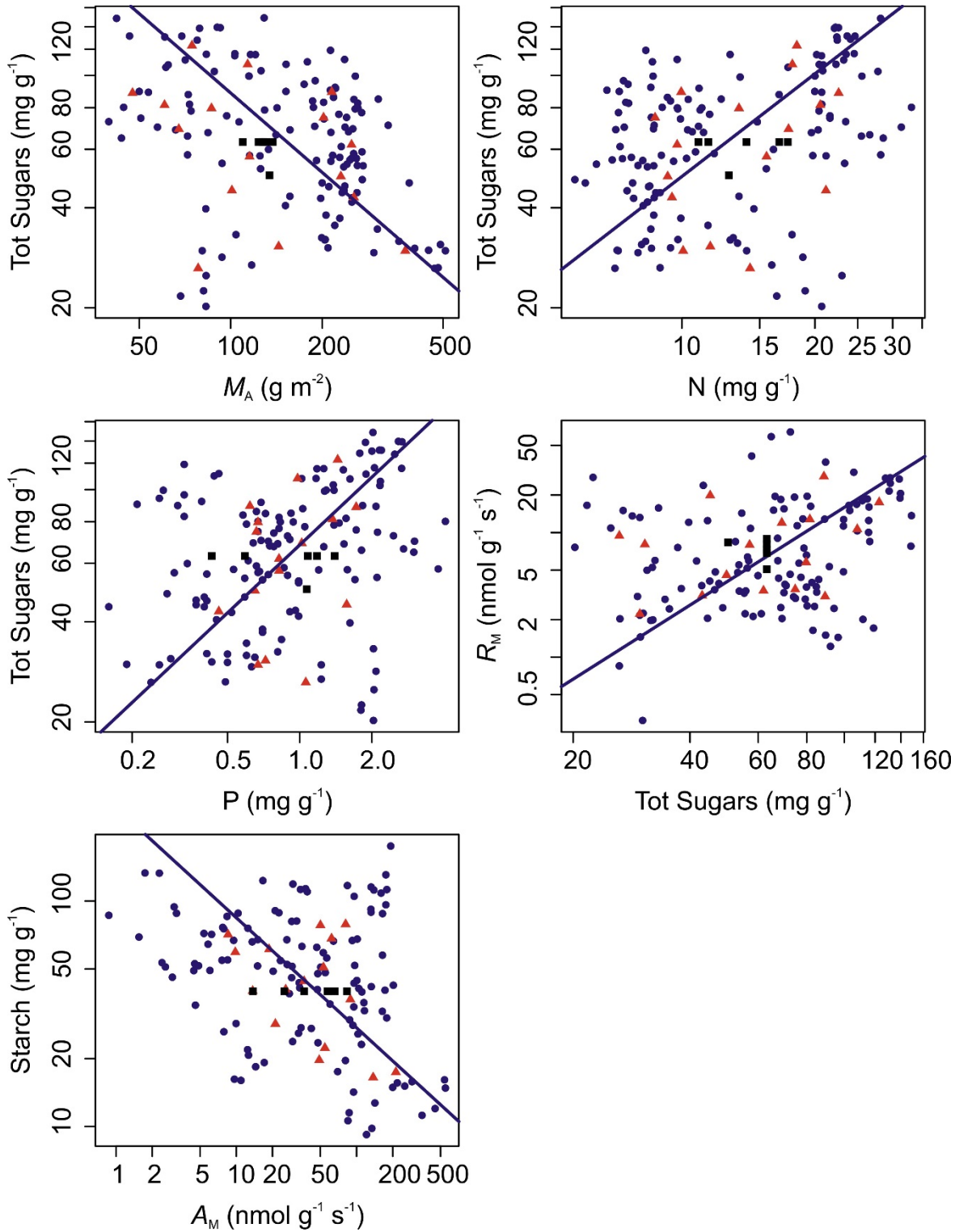|	N	P	N_P	Gluc	Fruc	Suc	totSug	Starch	TNC	LMA	DMC	FMA	Rdark	A1500M	RdarkM	A1500N	RdarkN	A1500P	RdarkP
N		0.885	-0.324	0.260	0.431	0.315	0.418	-0.124	0.179	-0.764	-0.793	-0.715	0.360	0.604	0.706	0.415	0.458	0.311	0.227
P	0.000		-0.582	0.192	0.413	0.166	0.334	-0.118	0.131	-0.695	-0.792	-0.618	0.424	0.638	0.749	0.471	0.548	0.216	0.132
N_P	0.000	0.000		-0.058	-0.263	0.084	-0.134	-0.001	-0.085	0.363	0.430	0.274	-0.301	-0.323	-0.360	-0.314	-0.353	0.063	0.185
Gluc	0.003	0.027	0.509		0.198	-0.054	0.860	0.136	0.688	-0.312	-0.137	-0.349	0.005	0.089	0.209	-0.019	0.136	-0.091	0.066
Fruc	0.000	0.000	0.002	0.022		0.219	0.541	0.092	0.416	-0.388	-0.435	-0.321	0.103	0.029	0.210	-0.032	0.099	-0.061	-0.040
Suc	0.000	0.057	0.339	0.540	0.011		0.150	-0.044	0.074	-0.169	-0.197	-0.128	0.074	-0.030	0.023	-0.089	-0.077	0.046	-0.021
totSug	0.000	0.000	0.125	0.000	0.000	0.085		0.186	0.670	-0.437	-0.306	-0.437	0.078	0.068	0.263	-0.039	0.142	-0.095	0.039
Starch	0.157	0.180	0.994	0.118	0.291	0.616	0.032		0.734	0.033	0.149	-0.004	-0.145	-0.218	-0.163	-0.241	-0.194	-0.250	-0.178
TNC	0.040	0.134	0.331	0.000	0.000	0.396	0.000	0.000		-0.233	-0.078	-0.262	-0.085	-0.087	0.043	-0.188	-0.041	-0.229	-0.095
LMA	0.000	0.000	0.000	0.000	0.000	0.057	0.000	0.708	0.008		0.795	0.959	-0.236	-0.598	-0.626	-0.508	-0.492	-0.413	-0.258
DMC	0.000	0.000	0.000	0.122	0.000	0.026	0.000	0.094	0.382	0.000		0.627	-0.275	-0.644	-0.689	-0.537	-0.525	-0.376	-0.209
FMA	0.000	0.000	0.002	0.000	0.000	0.151	0.000	0.960	0.003	0.000	0.000		-0.217	-0.561	-0.588	-0.468	-0.468	-0.398	-0.292
A1500	0.000	0.000	0.002	0.172	0.844	0.428	0.257	0.008	0.022	0.000	0.000	0.000	0.588	0.815	0.589	0.888	0.638	0.829	0.459
Rdark	0.000	0.000	0.001	0.959	0.262	0.423	0.395	0.112	0.355	0.010	0.002	0.017		0.527	0.696	0.519	0.806	0.397	0.728
A1500M	0.000	0.000	0.000	0.341	0.758	0.746	0.467	0.018	0.349	0.000	0.000	0.000	0.000		0.843	0.949	0.801	0.760	0.518
RdarkM	0.000	0.000	0.000	0.023	0.022	0.805	0.004	0.077	0.643	0.000	0.000	0.000	0.000	0.000		0.719	0.914	0.504	0.622
A1500N	0.000	0.000	0.001	0.842	0.735	0.340	0.675	0.009	0.044	0.000	0.000	0.000	0.000	0.000	0.000		0.776	0.846	0.532
RdarkN	0.000	0.000	0.000	0.144	0.286	0.407	0.127	0.036	0.657	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.568	0.783
A1500P	0.001	0.020	0.501	0.330	0.512	0.623	0.311	0.007	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.580
RdarkP	0.014	0.155	0.046	0.477	0.666	0.820	0.673	0.055	0.308	0.005	0.024	0.001	0.000	0.000	0.000	0.000	0.000	0.000	

Fig. S1. Log-log plots of area- and mass-based leaf gas exchange traits in relation to leaf mass per unit leaf area (M_A), foliar N and foliar P concentrations. Relationships shown for the complete data set (blue symbols), the genetically-driven (G) response (i.e. with the E component removed; red symbols) and for site averages (black squares). For these traits there was no difference between the complete and G-only relationships, so a single line is drawn. Details as for Figure 5.