

Ecography

**ECOG-05405**

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**Supplementary material**

## Supplementary material - Appendix 1

**Table A1.** Species occurrences (i.e., number of quadrats where the different species were present), mean cover (i.e., the mean percent cover of each species) and average functional trait values for each species. Abbreviations: SM, seed mass; LT, leaf thickness; LDMC, leaf dry matter content; SLA, specific leaf area; and VH, vegetative height. Nomenclature follows Benito (2005).

Species	Species occurrence	Mean Cover (%)	SM (g)	LT ( $\mu\text{m}$ )	LDMC ( $\text{mg}\cdot\text{g}^{-1}$ )	SLA ( $\text{mm}^2\cdot\text{mg}^{-1}$ )	VH (mm)
<i>Achillea millefolium</i>	10	1.88	0.200	180.4	245.2	11.39	26.8
<i>Acinos alpinus</i>	8	1.71	0.368	115.5	278.3	12.80	36.2
<i>Agrostis</i> sp.	15	10.98	0.083	142.4	376.9	15.91	75.0
<i>Alchemilla flabellata</i>	4	0.34	0.702	91.7	229.9	14.99	25.2
<i>Alchemilla</i> gr. <i>alpina</i>	21	8.68	0.508	108.2	356.6	13.01	21.0
<i>Androsace villosa</i>	56	18.61	1.123	76.4	226.5	16.52	19.5
<i>Androsace vitaliana</i>	16	5.79	4.718	83.4	251.9	18.43	14.0
<i>Antennaria dioica</i>	8	4.51	0.067	125.1	229.7	18.41	9.5
<i>Anthyllis montana</i>	8	5.29	4.376	132.0	290.7	10.13	22.6
<i>Anthyllis</i> gr. <i>vulneraria</i>	36	6.40	4.391	264.7	183.8	14.54	24.5
<i>Arenaria grandiflora</i>	5	0.73	0.546	58.2	568.7	15.52	13.4
<i>Arenaria moehringioides</i>	5	0.42	0.100	58.2	568.7	15.52	13.4
<i>Arenaria purpurascens</i>	37	24.43	0.767	127.2	242.9	13.28	20.2
<i>Asperula hirta</i>	5	2.16	0.750	116.3	254.2	11.74	14.0
<i>Asperula pyrenaica</i>	47	6.87	1.181	116.3	254.2	11.74	14.0
<i>Aster alpinus</i>	20	8.56	0.963	158.8	254.0	13.61	10.0
<i>Astragalus sempervirens</i>	32	17.94	3.277	97.6	305.8	12.98	50.5
<i>Borderea pyrenaica</i>	14	4.01	8.498	172.6	164.1	15.08	22.0
<i>Brassica repanda</i>	41	11.92	1.935	236.1	187.2	11.08	17.5
<i>Brimeura amethystina</i>	1	0.08	1.800	279.6	122.9	16.45	50.1
<i>Bromus erectus</i>	5	5.63	4.720	102.7	339.6	15.08	49.5
<i>Bupleurum ranunculoides</i>	14	4.33	1.786	139.0	347.6	13.38	14.0
<i>Campanula scheuchzeri</i>	27	4.16	0.093	78.3	264.8	16.03	64.0
<i>Carex caryophyllea</i>	14	15.98	1.000	140.2	310.0	21.13	175.0
<i>Carex ornithopoda</i>	15	9.76	0.839	140.2	262.7	30.58	115.0
<i>Carex rupestris</i>	20	15.39	0.900	140.2	398.7	12.47	57.7
<i>Crepis pygmaea</i>	8	2.75	1.653	210.6	146.5	14.55	16.0
<i>Draba aizoides</i>	1	0.21	0.208	79.8	256.1	14.12	18.9
<i>Echium vulgare</i>	7	1.49	3.000	263.1	197.6	9.35	29.5
<i>Erigeron alpinus</i>	6	0.55	0.233	101.5	219.2	16.49	9.3
<i>Erodium glandulosum</i>	15	10.49	3.684	179.9	251.6	9.99	60.0
<i>Eryngium bourgatii</i>	3	0.32	5.364	238.7	219.6	8.99	32.5
<i>Euphorbia cyparissias</i>	5	0.99	1.910	66.6	291.2	20.36	39.0
<i>Euphrasia</i> sp.	23	3.17	0.170	46.1	239.1	16.67	25.7
<i>Festuca pyrenaica</i>	16	16.76	1.153	194.0	313.1	12.94	38.0
<i>Festuca scoparia</i>	84	151.02	1.153	256.1	443.8	5.69	67.0
<i>Galium pyrenaicum</i>	81	28.07	0.665	37.4	174.0	34.12	10.6

<i>Galium verum</i>	3	0.51	0.611	74.1	285.1	14.03	54.4
<i>Gentiana verna</i>	24	3.63	0.131	187.3	253.7	11.70	13.5
<i>Geranium cinereum</i>	19	12.24	4.711	141.9	290.6	12.21	17.0
<i>Globularia nudicaulis</i>	8	9.52	0.166	227.6	273.9	9.20	14.6
<i>Globularia repens</i>	7	4.55	0.162	157.4	395.9	6.72	255.0
<i>Helianthemum alpestre</i>	11	13.04	1.216	154.7	426.5	7.58	18.0
<i>Helianthemum nummularium</i>	1	0.08	1.100	120.5	253.6	11.45	25.7
<i>Helictotrichon sedenense</i>	66	79.74	1.999	157.0	337.5	11.00	66.0
<i>Hieracium glaucinum</i>	9	6.99	0.200	217.8	194.3	13.04	21.5
<i>Hieracium pilosella</i>	34	9.12	0.200	145.4	181.8	15.37	12.4
<i>Hippocrepis comosa</i>	13	6.14	3.680	143.4	275.0	12.15	7.5
<i>Jurinea humilis</i>	5	2.81	5.576	169.2	218.9	10.29	22.0
<i>Koeleria vallesiana</i>	92	174.50	0.928	177.9	312.5	10.61	31.7
<i>Leontodon hispidus</i>	2	0.38	0.971	165.1	162.2	16.21	18.0
<i>Leucanthemopsis alpina</i>	3	0.54	0.380	260.4	166.7	13.56	20.4
<i>Lotus alpinus</i>	23	11.82	1.897	118.7	298.8	20.26	7.0
<i>Medicago suffruticosa</i>	6	1.81	2.700	90.9	322.3	17.38	17.5
<i>Minuartia verna</i>	19	2.96	0.180	68.6	296.4	17.56	20.8
<i>Onobrychis pyrenaica</i>	21	11.49	14.700	125.2	282.0	14.14	12.0
<i>Ononis cristata</i>	28	13.22	6.205	107.0	238.5	13.92	8.0
<i>Oxytropis campestris</i>	9	3.85	1.919	127.7	227.1	12.32	10.1
<i>Oxytropis foucaudi</i>	23	7.58	2.764	91.0	246.6	15.53	21.1
<i>Oxytropis neglecta</i>	39	20.34	2.764	91.0	246.6	15.53	21.0
<i>Paronychia kapela</i>	17	5.90	0.701	160.3	439.0	5.96	21.2
<i>Phyteuma orbiculare</i>	28	8.91	0.256	104.6	239.0	15.49	14.5
<i>Plantago alpina</i>	20	5.51	0.647	369.9	186.0	10.16	24.5
<i>Plantago lanceolata</i>	2	0.17	1.300	184.0	232.2	11.46	18.4
<i>Plantago major</i>	3	0.40	0.200	234.9	184.5	11.73	16.7
<i>Plantago monosperma</i>	8	1.55	2.457	227.9	250.6	8.95	38.4
<i>Poa alpina</i>	24	20.26	0.359	99.5	366.8	13.88	22.0
<i>Poa alpina</i> subsp. <i>breviculis</i>	5	4.33	0.359	125.2	412.2	13.94	23.4
<i>Polygala alpina</i>	2	0.17	1.740	93.8	198.5	22.92	16.7
<i>Potentilla alchemilloides</i>	1	0.53	0.543	132.0	390.2	10.09	39.0
<i>Potentilla crantzii</i>	31	7.08	0.521	101.4	294.9	13.02	8.0
<i>Potentilla nivalis</i>	5	0.93	0.200	86.4	370.0	14.65	38.6
<i>Ptychotis saxifraga</i>	11	1.42	1.200	134.9	253.3	12.66	32.0
<i>Pulsatilla alpina</i>	13	3.68	5.360	159.5	267.9	8.72	58.5
<i>Ranunculus bulbosus</i>	3	0.76	2.555	187.0	212.0	12.51	32.6
<i>Ranunculus parnassifolius</i>	52	15.20	0.200	314.5	233.3	9.30	5.0
<i>Rhinanthus minor</i>	2	0.17	2.680	134.6	167.4	20.54	133.0
<i>Sanguisorba minor</i>	18	7.16	0.410	89.7	343.9	17.02	17.0
<i>Saponaria caespitosa</i>	26	30.58	2.157	283.6	247.0	9.72	29.5
<i>Saxifraga oppositifolia</i>	22	14.15	0.108	147.6	259.5	13.85	24.0
<i>Sedum atratum</i>	5	0.64	0.035	1202.2	56.3	10.36	9.0
<i>Seseli montanum</i> subsp. <i>nanum</i>	55	11.36	1.634	152.4	207.3	14.17	7.0
<i>Sesleria albicans</i>	19	38.04	1.297	86.8	373.8	16.39	50.1
<i>Sideritis hyssopifolia</i>	42	21.13	1.339	95.5	285.6	13.50	17.5
<i>Silene acaulis</i>	18	10.21	0.323	131.4	186.0	22.01	8.8
<i>Taraxacum dissectum</i>	53	9.28	1.043	152.4	150.4	15.10	11.0
<i>Thalictrum alpinum</i>	5	1.50	0.857	102.2	383.8	15.67	42.0
<i>Thymelaea tinctoria</i> subsp. <i>nivalis</i>	59	66.20	0.460	238.6	286.3	8.29	23.7
<i>Thymus</i> gr. <i>serpyllum</i>	110	62.48	0.194	103.3	306.9	14.92	16.2
<i>Trifolium montanum</i>	13	2.01	2.000	102.6	296.1	16.38	26.2
<i>Trifolium pratense</i>	18	4.66	1.431	84.5	242.9	14.88	20.7

<i>Trifolium thalii</i>	14	6.17	0.861	104.9	238.8	16.36	13.0
<i>Valeriana apula</i>	5	3.04	0.428	117.8	176.4	20.16	38.4
<i>Veronica nummularia</i>	6	0.59	0.050	88.4	290.0	14.71	30.0
<i>Vicia pyrenaica</i>	1	0.08	1.400	112.7	247.9	15.81	40.0
<i>Viola rupestris</i>	28	4.21	1.319	116.3	313.9	13.29	8.0

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**Table A2.** Loadings for each environmental factor on the four axes of a principal component analysis after a varimax rotation. Abbreviations: SOC, Soil organic carbon; N, soil total nitrogen; P, total phosphorus; K, potassium; Glu and Phos, activity of  $\beta$ -glucosidase and phosphatase, respectively; pH, soil pH; Cond, electric conductivity; and PSR, potential solar radiation.

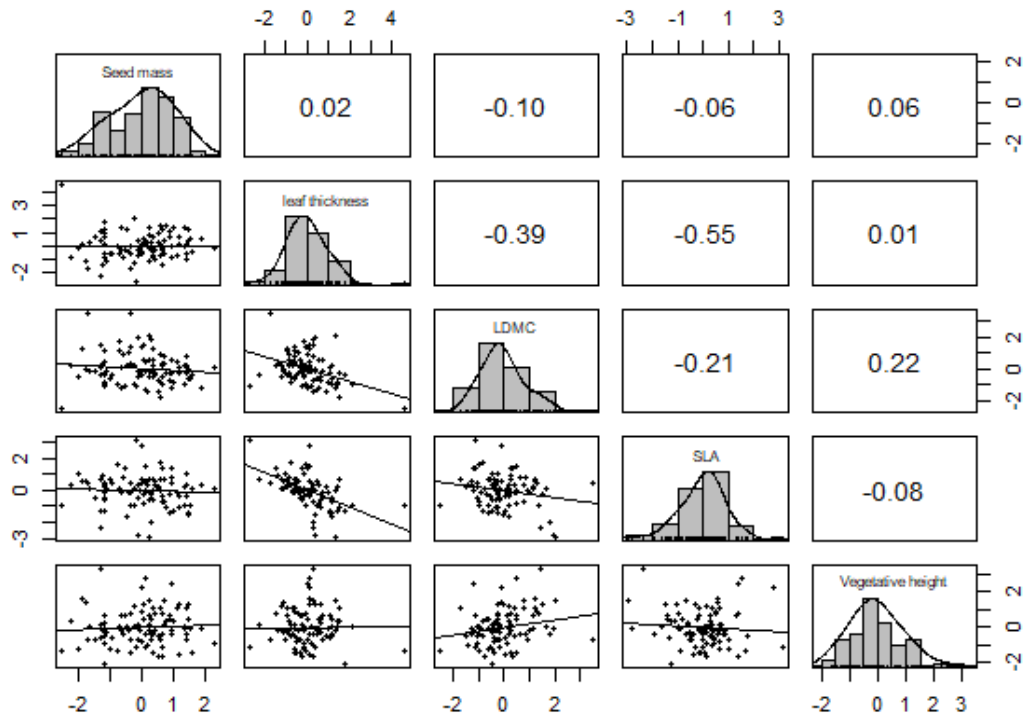
Abiotic variable	PCA 1	PCA 2	PCA 3	PCA 4
SOC	<b>0.931</b>	0.146		0.18
N	<b>0.863</b>	-0.244		0.338
P	0.349			<b>0.918</b>
K	0.144	<b>-0.707</b>	0.366	
Glu	<b>0.841</b>	-0.269	0.116	
Phos	<b>0.901</b>	-0.248		
pH	<b>-0.753</b>	-0.294	0.171	
Cond	0.13	<b>0.827</b>		-0.126
Elevation	-0.432	<b>0.66</b>	0.359	
PSR	-0.179		<b>0.862</b>	
Slope	-0.235	0.12	<b>-0.746</b>	
Proportion of variance	0.375	0.177	0.147	0.094
Cumulative Proportion of variance	0.375	0.553	0.7	0.794

**Table A3.** Effects of environmental variables on species composition. Marginal permutation test of the predictors in the RDA (i.e., the four axes of a principal component analysis after a varimax rotation; Table A2). P-values indicate significance of the F statistic (Legendre et al. 2011) after 999 permutations. \*\*\* $p < 0.001$ , \*\*  $p < 0.01$ , \*  $p < 0.05$ .

	df	Variance	F	Pr(>F)	
C and N stocks	1	8.04	7.1751	0.001	***
Elevation and K	1	5.634	5.0278	0.002	**
Slope and PSR	1	5.208	4.6481	0.003	**
Total phosphorus	1	1.386	1.2369	0.279	
Residual	110	123.259			

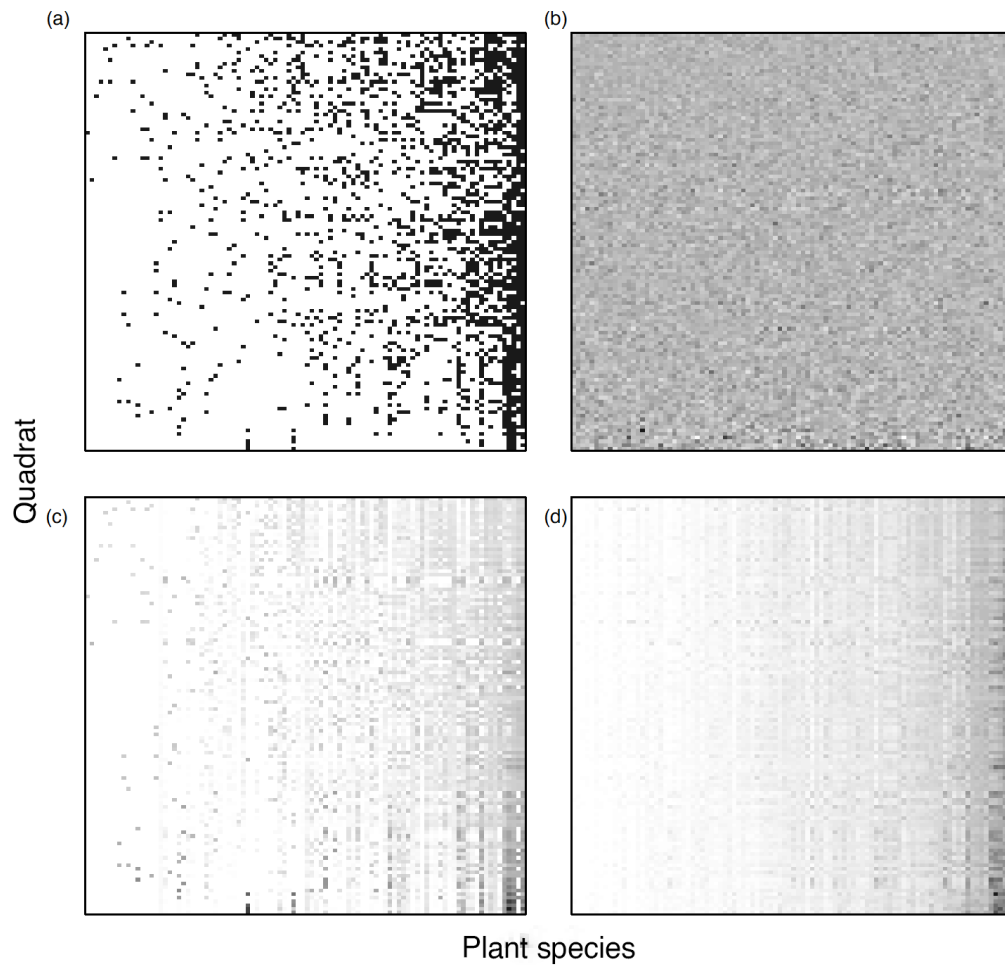
**Figure A1.** Panoramic view of the study area showing the location of some sampled plots in the central Pyrenees (northern Spain). Purple squares show locations of plots included in the dataset and red bars indicate the position of those plots which remains hidden due to their slope orientation.

**Figure A2:** Correlation between the considered functional traits. The diagonal shows the histograms of each trait. The upper right numbers indicate pairwise Pearson correlations. The lower left shows scatterplots of pairs of traits and a trend-line fitted by linear models. Traits were transformed as needed to improve normality and scaled. LDMC: leaf dry matter content, SLA: specific leaf area.

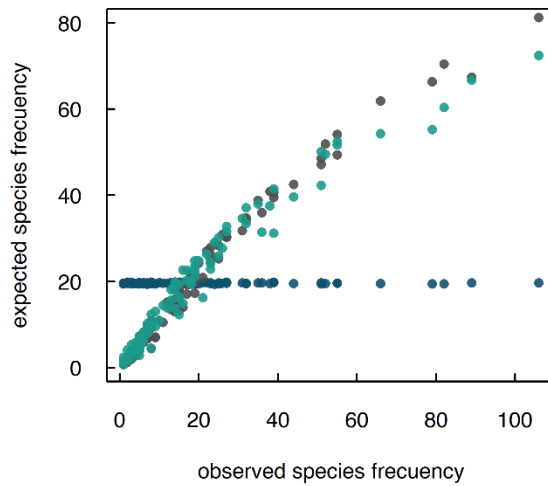




**Figure A3.** Occurrence matrices of (a) the observed data (i.e., presence/absence data), and the mean occurrence derived from the (b) stochastic, (c) independence, and (d) co-occurrence null models. The intensity of the colour indicates number of occurrences that the specie in each site for the average of 999 randomizations, except for the overserved data (0 and 1).



**Figure A4.** Relationship between the observed and expected species frequency derived from the stochastic null model (blue points), independence null model (grey points), and co-occurrence null model (green points). The expected species frequency was calculated based on the average of 999 randomizations. Note that in the stochastic null model species frequencies are equiprobable whereas in the independence and co-occurrence null models the frequencies are maintained similar to the observed ones.



**References:**

Benito, J. L. 2005. Flora y vegetación del Parque Nacional de Ordesa y Monte Perdido

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Legendre, P., Oksanen, J. and ter Braak, C.J.F. (2011). Testing the significance of

canonical axes in redundancy analysis. *Methods in Ecology and Evolution* 2, 269--277.