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Appendix 1

Table A1. Localization and description of the three study zones and the nine sampling sites.

Zone	Plot	Latitude	Longitude	Altitude (m.a.s.l.)	Dominant vegetation
Virgen de Linares (VL)	Upper	37° 56´ 95"N	4° 46´ 22"W	253	Evergreen oak (*Quercus coccifera*) mixed with shrub species.
	Medium	37° 55´ 83"N	4° 46´ 93"W	217	Evergreen oak (*Quercus ilex*) mixed with shrub species.
	Lower	37° 55´ 73"N	4° 46´ 16"W	176	Deciduous species (*Celtis australis* and *Ulmus minor*) mixed with riparian species.
Baños de Popea (BP)	Upper	37° 56´ 81"N	4° 53´ 44"W	329	Evergreen oak (*Quercus coccifera*) mixed with shrub species.
	Medium	37° 56´ 64"N	4° 53´ 62"W	312	Deciduous oak (*Quercus faginea*) mixed with shrub species.
	Lower	37° 56´ 90"N	4° 53´ 60"W	281	Deciduous species (*Alnus glutinosa*, *Fraxinus angustifolia*) mixed with riparian species
Las Tonadas (LT)	Upper	38° 1´ 32"N	5° 1´ 65"W	550	Evergreen oaks (*Quercus coccifera* and *Quercus ilex*) mixed with *Arbutus unedo* and shrubs species.
	Medium	38° 1´ 09"N	5° 1´ 57"W	510	Evergreen oak (*Quercus ilex*) mixed with deciduous species (*Pyrus bourgaeana*) and shrub species.
	Lower	38° 1´ 73"N	5° 1´ 54"W	499	Deciduous species (*Alnus glutinosa*, *Fraxinus angustifolia*) mixed with riparian vegetation

Table A2. Species studied and the plant abundance (% of lineal cover) in the different sampling sites.

Species	**Family**	**Life habit**	**Leaf habit**	Virgen de Linares			Baños de Popea			Las Tonadas		
				Upper	Medium	Lower	Upper	Medium	Lower	Upper	Medium	Lower
Alnus glutinosa	Betulaceae	Tree	Winter deciduous	-	-	-	-	-	27.23	-	-	12.65
Arbutus unedo	Ericaceae	Arborescent shrub	Evergreen	-	-	-	5.25	-	-	19.63	3.62	-
Celtis australis	Cannabaceae	Tree	Winter deciduous	-	-	18.34	-	-	-	-	-	-
Cistus albidus	Cistaceae	Shrub	Evergreen	19.16	2.58	-	2.83	-	-	4.88	-	-
Cistus crispus	Cistaceae	Shrub	Evergreen	7.35	-	-		-	-	-	-	-
Cistus ladanifer	Cistaceae	Shrub	Evergreen	4.29	-	-	10.49	-	-	10.8	-	-
Cistus monspeliensis	Cistaceae	Shrub	Evergreen	-	-	-	-	-	-	-	2.8	-
Cistus salvifolius	Cistaceae	Shrub	Evergreen	-	7.74	-		-	-	-	-	-
Crataegus monogyna	Rosaceae	Arborescent shrub	Winter deciduous	-	-	5.27	-	-	-	-	-	-
Cydonia oblonga	Rosaceae	Tree	Winter deciduous	-	-	-	-	-	-	-	2.25	-
Ficus carica	Moraceae	Tree	Winter deciduous	-	-	-	-	-	10.12	-	-	-
Fraxinus angustifolia	Oleaceae	Tree	Winter deciduous	-	-	-	-	-	30.6	-	-	37.96
Genista hirsuta	Fabaceae	Shrub	Summer deciduous	5.92	4.78	-	13.27	-	-	15.15	-	-
Jasminum fruticans	Oleaceae	Shrub	Evergreen	-	-	-	-	7.02	-	-	-	-
Lavandula stoechas	Lamiaceae	Shrub	Evergreen	4.32	2.58	-	-	-	-	-	-	-
Myrtus communis	Mirtaceae	Shrub	Evergreen	-	6.89	-	-	2.72	-	4.48	-	-
Nerium oleander	Apocynaceae	Arborescent shrub	Evergreen	-	-	11.71	-	5.22	7.21	-	-	-
Phlomis purpurea	Lamiaceae	Shrub	Evergreen	5.56	-	-	-	-	-	-	-	-
Phillyrea angustifolia	Oleaceae	Arborescent shrub	Evergreen	-	-	-	4.62	-	-	9.1	4.36	-
Phillyrea latifolia	Oleaceae	Arborescent shrub	Evergreen	-	-	-	-	45.05	-	-	-	-
Pistacia lentiscus	Anacardiaceae	Arborescent shrub	Evergreen	10.02	33.61	17.63	-	2.99	-	-	5.65	-
Pistacia terebinthus	Anacardiaceae	Arborescent shrub	Winter deciduous	-	-	-	-	2.54	-	-	-	-
Populus alba	Salicaceae	Tree	Winter deciduous	-	-	-	-	-	-	-	-	6.68
Pyrus bourgaeana	Rosaceae	Tree	Winter deciduous	-	-	-	-	-	-	-	7.22	-
Quercus coccifera	Fagaceae	Arborescent shrub	Evergreen	19.71	7.74	-	23.5	7.37	-	9.29	7.96	-
Quercus faginea	Fagaceae	Tree	Winter deciduous	-	-	-	-	2.65	-	-	-	-
Quercus ilex	Fabaceae	Tree	Evergreen	18.06	25.32	-	-	-	-	16.33	25.24	-
Rhamnus lycioides	Rhamnaceae	Shrub	Evergreen	-	-	5.64	-	-	-	-	-	-
Rosa canina	Rosaceae	Shrub	Winter deciduous	-	-	-	-	-	-	-	2.55	-
Rosmarinus officinalis	Lamiaceae	Shrub	Evergreen	-	-	-	31.06	-	-	-	-	-
Rubus ulmifolius	Rosaceae	Shrub	Evergreen	-	-	11.89	-	-	8.71	-	13.44	25.65
Ruscus aculeatus	Asparagaceae	Shrub	Evergreen	-	-	-	-	4.57	-	-	3.44	-
Salix atrocinerea	Salicaceae	Tree	Winter deciduous	-	-	-	-		-	-	-	6.21
Smilax aspera	Smilacaceae	Vine	Evergreen	-	-	-	-	2.61	-	-	-	-
Teucrium fruticans	Lamiaceae	Shrub	Evergreen	-	-	-	2.89	-	-	-	-	-
Ulmus minor	Ulmaceae	Tree	Winter deciduous	-	-	17.21	-	-	7.13	-	-	-
Viburnum tinus	Adoxaceae	Arborescent shrub	Evergreen	-	-	-	-	7.75	-	-	11.37	-
Vitis vinifera	Vitaceae	Vine	Winter deciduous	-	-	7.62	-	-	-	-	-	-

Table A3. Climatological information for the three zones. Data were obtained from Global-PET Database and Worldclim.

Zone	EVTP (l/m²)	AAT (ºC)	AAP (mm)	DTR (ºC)	AWT (ºC)	ACT (ºC)	SP
Las Tonadas	1296	15.5	668	12.4	34.8	2.1	57
Baños de Popea	1324	16.3	647	12.3	35.5	3	58
Virgen de Linares	1338	16.5	638	12.2	35.5	3.2	59

Appendix 2

Measurements of plant functional traits

Nine above-ground and two below-ground functional traits related to morphology, physiology and chemical composition were measured. These traits, at leaf, stem, root and whole plant level (Table 1) are related to the ability to acquire, transport and fulfill plant water and nutrient requirements.

Plant height and cover were measured in ten individuals, per species and site, with a tape except for the taller species, whose height was estimated with the ´Christen height` meter based on trigonometric principles (Klein 2007). Plant cover area was estimated by ellipse area equation (major and minor diameter of the canopy projection).

For leaf and stem measurements, six individuals per species and site were chosen. A few branches with young, fully expanded leaves and a portion of stem of the previous year were collected from each individual plant. These branches were stored in plastic bags to prevent water loss and further transported to the laboratory, where they were maintained with the basal portion of the stem submerged in water at 10 ºC for 24h in darkness to allow a complete re-hydration.

A subsample of leaves was removed from the stem, the petiole was excised and the leaves were fresh-weighted and scanned. The leaf area was calculated using image analysis software (Image-Pro 4.5). Leaves were oven-dried for at least 48 h at 60ºC, and further weighed with a precision of 0.001 g. Specific leaf area (SLA, $m^2\ kg^{-1}$) was calculated as the ratio between the leaf lamina area and its dry mass. Leaf dry matter content (LDMC, $mg\ g^{-1}$) was calculated as the ratio between dry and saturated fresh mass of the leaf lamina.

Leaves were ground with a stainless steel mill for nitrogen and $\delta^{13}C$ content analysis. The nitrogen concentration was measured using an elemental analyser. The isotopic analysis of C ($\delta^{13}C$) was carried out at the Laboratorio de Isótopos Estables of the Estación Biológica de Doñana (LIE-EBD, Spain). All samples were combusted at 1020ºC using a continuous flow isotope-ratio mass spectrometry system by means of an elemental analyzer coupled to an isotope ratio mass spectrometer . Replicate assays of laboratory standards routinely inserted within the sampling sequence, and previously calibrated with international standards, indicated analytical measurement errors of ±0.1‰.

For chlorophyll tissue concentration (LChl, μg g^{-1}), one circular portion of a leaf fresh lamina was cut and weighed. For plants with smaller leaves, where it was not possible to obtain a circular portion, such as *R. officinalis* and *L. stoechas,* three or four leaves were chosen and weighed. For *Genista hirsuta,* which possess photosynthetic spikes and no functional leaves, three or four spikes were selected and weighed. The chlorophyll concentration was obtained following the method of Wintermans and de Mons (1965), using methanol for the extraction of chlorophyll in the leaf portion during 24 h under dark conditions. The absorbance of the supernatant was analyzed by spectrophotometry at 650 and 655nm. The equation used was: leaf chlorophyll content = $25.5 \times A_{650} + 4 \times A_{665}$. Leaf chlorophyll content was divided by the leaf fresh mass portion used to obtain LChl (μg g^{-1}).

For stem traits, we selected young stems from the last growing season with an approximate length of 10 cm. Stems were oven-dried for at least 48 h at 60ºC and weighed to obtain stem dry mass. Stem dry matter content (SDMC, mg g^{-1}) was obtained as the ratio between dry and saturated fresh mass.

To better understand the plant-soil interactions, we measured two functional traits from fine roots (< 2 mm in diameter), which are related to water and nutrient uptake (Jackson 1997). We collected the root samples in the first 20–30 cm of soil digging close to the plant basal stem and we collected only those fine roots emerging from these primary roots. Sampling roots were stored in plastic bags to be transported to the laboratory and washed there with distilled water to remove soil residuals. Cleaned roots were maintained in water at 4ºC for 24 h in darkness for a complete rehydration. Root measurements were obtained from fine roots (< 2 mm in diameter). Roots were weighed for saturated mass and scanned. Images were analyzed with WinRHIZO 2009 for root length. Root dry mass was obtained after oven-drying them at 60ºC for 48h. Specific root length

(SRL, m kg^{-1}) was calculated as the ratio between root length and root dry mass. Root dry matter content (RDMC, mg g^{-1}) was obtained by dividing dry mass by saturated fresh mass.

References

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Appendix 3

Details of the method used to disentangle the relative importance of species occurrence, abundance and intraspecific variability on changes in community functional structure.

First, we calculated the three types of CWM parameters proposed by Lepš et al. (2011):

1) '*specific*' average traits, using trait values of each species within each site, whose variation can be caused by both species turnover and intraspecific trait variability:

$$\textbf{Specific parameter} = \sum_{i=1}^{S} p_i x_{i\_habitat}$$

where p_i is the abundance of the i-th species in a given community, S is the number of species in this community, and x_i_habitat is the specific mean trait value of the i-th species, which is valid just for a given habitat sampled.

2) '*fixed*' trait values, using mean trait values of each species along the whole environmental gradient (i.e. site-independent trait values), whose variation is only due to changes in species turnover:

$$\textbf{Fixed parameter} = \sum_{i=1}^{S} p_i x_i$$

Where x_i is the fixed mean trait value of the i-th species for all communities where the species is found.

3) ´*intraspecific variabilitity*` trait values, which are calculated from the differences between '*specific*' and '*fixed*' average traits and permit an estimation of the pure effects of the intraspecific variability:

intraspecific variability parameter = *specific* parameter – *fixed* parameter

Second, we computed two new community parameters with the aim of disentangling the effects of the two components of species turnover (species occurrence and species abundance):

1) '*unweighted*' trait values (UWM), which were calculated similarly to the above-mentioned '*fixed*' trait values but without weighting them by their relative species abundances:

$$\textbf{Unweighted parameter} = \sum_{i=1}^{S} \frac{1}{S} x_i$$

2) ‘*species-abundance*’ trait values, calculated from differences between ‘*fixed*` and ‘*unweighted*’ trait values. Thus, variation in the ‘*unweighted*’ trait values is solely affected by changes in species occurrence (presence/absence of species) whereas variation in ‘*species-abundance*’ trait values allows us to estimate the pure effects of changes in species abundance as follows:

species abundance parameter = *fixed* parameter (´species turnover`) – *unweighted parameter* (´species occurrence`)

Thus, the complete formula can be defined as:

$$\mathrm{Spi} = \left(\sum_{i=1}^{S} p_i x_{i\_habitat} - \sum_{i=1}^{S} p_i x_i \right) + \left(\sum_{i=1}^{S} p_i x_i - \sum_{i=1}^{S} \frac{1}{S} x_i \right) + \sum_{i=1}^{S} \frac{1}{S} x_i$$

Finally, we explored ‘CWM traits – environment’ linkages for the two new types of community parameters (‘*unweighted*’ and ‘*species-abundance*’ trait values) as well as for that used to estimate the pure effects of the intraspecific variability (‘*intraspecific variability*’ parameter). To quantify how much variability is accounted for by each individual component (species occurrence, abundance and intraspecific variability), we used the method based on the sum of squares (SS) decomposition from Lepš et al. 2011, using the best likelihood models previously calculated. The SS can be decomposed into the amount of variability explained by individual terms of the model and the unexplained variability (error). Since the effects of the above-explained community parameters do not always vary independently, we also considered the effect of their covariation. In turn, covariation was partitioned into two different components, as specified in the equations: the covariation between species turnover and intraspecific variation (covSSI), and the covariation between species occurrence and abundance (covSSII), as specified in the following equations:

covSSI = SS specific – SS fixed – SS intraspecific variability

covSSII = SS fixed – SS species occurrence – SS species abundance

In summary, the maximum variability included in 'specific' average traits (i.e. that due to changes in species occurrence, abundance and intraspecific trait variability) can be defined as:

SSspecific = SS species occurrence + SS species abundance + SS intraspecific variability + covSSI + covSSII

Example

To illustrate this method we developed the results for the case of specific leaf area (SLA).

Table A4. Results from linear regression model analysis for SLA along the gradient of SWS. The variability effects were analysed separately (species occurrence and abundance, intraspecific variability, turnover and specific average). Note that SS (sum of squares) corresponds to the amount of variability explained by each component.

Parameter	SS	F	p
Species occurence (UWM)	177.59	18.92	0.003
Species abundance (UWM-Fixed)	0.84	4.46	0.073
Intraspecific variability (CWM-Fixed)	1.17	0.37	0.963
Turnover (Fixed)	202.96	19.59	0.003
Specific average (CWM)	234.92	16.66	0.005

Table A5. Variability of individual components of SLA variation (SSvar) and proportions of variability (SS%) explained by individual factors. (A) Covariation II (covSSII) is obtained by subtracting the first two columns from the last one (covSSII = SSfixed - SS species occurrence - SS species abundance). (B) Covariation I (covSSI) is obtained by subtracting the first four columns from the last one (covSSI = SS specific - SS fixed - SS intraspecific).

(A)	Species occurence	Species abundance	covSSII	Turnover (Fixed)
SSvar	177.59	0.84	24.53	202.96
SS%	53.23	0.25	7.35	60.83

(B)	Species occurence	Species abundance	Intraspecific variability	covSSII	covSSI	Total= Specific
SSvar	177.59	0.84	1.17	24.53	30.79	234.92
SS%	53.23	0.25	0.35	7.35	9.23	70.42

Appendix 4

Table A6. Matrix of correlations among the 8 environmental variables considered in this study. Pearson correlation coefficients are shown in bold type when significant (p<0.05*, p <0.01**). The variables which were highly correlated among them (K, Ca and OM) were removed from the regression analysis. See Table 2 for variable abbreviations.

	pH	N	P	K	Ca	Mg	OM
SWS	0.64	-0.32	0.26	-0.44	0.22	-0.47	-0.61
pH		0.23	0.64	0.18	**0.76***	-0.24	-0.05
N			0.31	**0.84****	**0.72***	0.49	**0.91****
P				0.13	**0.77***	0.19	0.18
K					0.57	0.42	**0.80****
Ca						0.27	0.51
Mg							0.49

Table A7. Results of a one-way ANOVA between zones and between slopes for non-correlated abiotic variables.

	Zones								Slope										
	Vlinares		Popea		Villaviciosa		F	P	Upper			Medium			Lower			F	P
	Mean	S.E	Mean	S.E	Mean	S.E			Mean	S.E		Mean	S.E		Mean	S.E			
SWS ($\mathrm{l\ m^{-2}}$)	34.17	7.14	28.38	7.14	25.67	7.14	0.37	ns	19.40	3.76	b	27.06	3.76	b	41.76	3.76	a	9.1	0.01
N (%)	0.14	0.02	0.18	0.02	0.12	0.02	2.73	ns	0.16	0.02		0.15	0.02		0.12	0.02		1.35	ns
P ($\mathrm{mg\ kg^{-1}}$)	2.38	2.07	7.34	2.07	3.00	2.07	1.7	ns	2.73	2.45		4.28	2.45		5.71	2.45		0.37	ns
Mg ($\mathrm{mg\ kg^{-1}}$)	216.2	68.1	478.5	68.1	348.9	68.1	3.7	ns	329.3	88.0		444.3	88.0		270.0	88.0		1.01	ns
pH	6.83	0.29	7.09	0.29	6.66	0.29	0.57	ns	6.80	0.24		6.53	0.24		7.24	0.24		2.27	ns

Appendix 5

Table A8. PERMANOVA based on the Bray–Curtis dissimilarities of the multivariate data. SWS: Soil water storage, P: Phosphorous soil concentration, N: Nitrogen soil concentration, pH: Soil pH, Mg: Magnesium soil concentration.

Soil variable	Df	SumsOfSqs	MeanSqs	F.Model	R^2	Pr(>F)
SWS	1	0.88	0.88	3.39	0.31	0.008
P	1	0.26	0.26	1.01	0.09	0.423
N	1	0.19	0.19	0.74	0.07	0.66
pH	1	0.32	0.32	1.21	0.11	0.323
Mg	1	0.43	0.43	1.66	0.15	0.135
Residual	3	0.78	0.26		0.27	
Total	8	2.86			1.00	