nature portfolio

Corresponding author(s): José Ignacio Querejeta

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Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our Editorial Policies and the Editorial Policy Checklist.

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a	Confirmed	
☐	☒	The exact sample size (*n*) for each experimental group/condition, given as a discrete number and unit of measurement
☐	☒	A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
☐	☒	The statistical test(s) used AND whether they are one- or two-sided *Only common tests should be described solely by name; describe more complex techniques in the Methods section.*
☐	☒	A description of all covariates tested
☐	☒	A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
☐	☒	A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
☐	☒	For null hypothesis testing, the test statistic (e.g. *F*, *t*, *r*) with confidence intervals, effect sizes, degrees of freedom and *P* value noted *Give P values as exact values whenever suitable.*
☐	☒	For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
☐	☒	For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
☒	☐	Estimates of effect sizes (e.g. Cohen's *d*, Pearson's *r*), indicating how they were calculated

Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection	Climate data were obtained from the Terraclimate database (Abatzoglou, J.T., S.Z. Dobrowski, S.A. Parks, K.C. Hegewisch, 2018, Terraclimate, a high-resolution global dataset of monthly climate and climatic water balance from 1958-2015, Scientific Data)
Data analysis	All data analysis were performed using R, working with packages lme4 (1.1-36), phyr (1.1.0), V.phylomaker and MixSIAR (3.1.12).

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio guidelines for submitting code & software for further information.

Data

Policy information about availability of data

All manuscripts must include a data availability statement. This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our policy

The data generated in this study are provided in the Source Data file and are available in the in the Figshare repository using the following link (https://doi.org/10.6084/m9.figshare.27939669).

Research involving human participants, their data, or biological material

Policy information about studies with human participants or human data. See also policy information about sex, gender (identity/presentation), and sexual orientation and race, ethnicity and racism.

Reporting on sex and gender	Not applicable
Reporting on race, ethnicity, or other socially relevant groupings	Not applicable
Population characteristics	Not applicable
Recruitment	Not applicable
Ethics oversight	Not applicable

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences ☐ Behavioural & social sciences ☒ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	We assessed the diversity of plant water use strategies among coexisting woody plant species at 10 Mediterranean ecosystems in the Iberian Peninsula with contrasting climatic conditions (62 species in total nested within site, ranging between 5-27 species per site). The total number of individual plants sampled across study sites was 771.
Research sample	We sampled 10 different Mediterranean shrubland, open woodland and closed-canopy forest communities with contrasting climate. Vegetation structure differs dramatically among study sites, from open pine woodlands and shrublands dominated by Pinus halepensis and large shrubs (Rhamnus lycioides, Periploca angustifolia) at the southern and drier coastal sites, to closed-canopy forests dominated by Pinus pinaster in more mesic sites located further inland (e.g. Ayna and Yeste), to multi-layer, mature closed-canopy forests dominated by Fagus sylvatica and Quercus petraea in the northernmost and more humid location. Our 10 study sites are thus broadly representative of the large climatic, ecological and taxonomic diversity of ecosystems and vegetation across the Mediterranean Region.
Sampling strategy	We collected samples from at least 6 randomly chosen replicate individuals of the most dominant woody species in each plant community, i.e. those encompassing 90% of the total cover in the community. In total, we sampled 771 individuals of 62 woody species belonging to 21 plant families, resulting in 121 species-site combinations. The sampling size per species and site combination was chosen based on the findings of previous studies showing that such sampling effort is sufficient to reliably characterize the water use strategies of coexisting species in Mediterranean-type ecosystems, considering the multiple time, funding and staff constraints and limitations involved in field research at multiple remote field locations (Moreno-Gutierrez et al. 2012; Prieto et al. 2018; Illuminati et al. 2022; cited in the manuscript).
Data collection	For each plant individual, we sampled one basal 5 cm segment of fully-lignified stem from a terminal branch for xylem water extractions at all the 10 study sites. We also sampled sun-exposed, fully expanded and healthy-looking leaves from the same branches collected for xylem water extractions in each individual plant. In a subset of 6 study sites, we also measured photosynthetic rates (A), stomatal conductance (gs) and transpiration rate (E) during the 2022 sampling campaign using a portable infrared gas analyzer (IRGA, LI-6800, LI-COR Inc. Lincoln, NE, USA). For leaf gas exchange we sampled 40 species present in the 6 study areas, measuring 6 individuals of each species at each site (the same individuals used for isotopic measurements). We measured the leaf area to sapwood area ratio of terminal shoots in three randomly selected individuals of each woody species present at the two most diverse and taxonomically rich study sites (Montejo in 2021, 18 sp; Yeste in 2023, 16 sp). At each site, we sampled a minimum of 2 and up to 6 soil water profiles, using a cylindrical hand auger with 4 cm diameter. Soil samples were taken, every 5 cm in the topsoil layer (down to 20 cm) and every 10 cm below 20 cm deep, until we reached impenetrable bedrock layers (which were located between 30 and 120 cm deep, depending on soil characteristics at each study site). All the coauthors of this study participated in the field sampling of plant and soil materials.
Timing and spatial scale	Field sampling was always performed at the peak of growing season in mid-late spring in 2008 (Cuadros Repoblación, Cuadros Natural, Venta del Olivo), 2017 (Calblanque), 2019 (Pulpí, Pliego, Majarazán, Ayna and Yeste), 2021 (Montejo). A second field sampling campaign was performed in mid-late spring of 2022 in a subset of the study sites (Pulpí, Pliego, Majarazán, Ayna, Yeste and Montejo). The study sites span 600 km across the Iberian Peninsula.
Data exclusions	Leaf area: Sapwood area Ratio data for Cytisus purgans were excluded from the analysis because this shrub species has thorny photosynthetic stems with tiny or absent leaves.

Reproducibility	The detailed location of the study sites and the complete list of plant species sampled at each study site are described in the main text or supporting information section. At the 6 sites where two samplig campaings were carried out in separate years, very similar results were obtained between years, as explained in the text and figures.
Randomization	Replicate neighboring individuals of each woody species were randomly selected for leaf and stem sampling at each study site. No covariates were considered in the statistical analyses, as the main focus of the study is to assess within-site differences in water use strategies among coexisting woody species.
Blinding	Not applicable in this study.

Did the study involve field work? [x] Yes [ ] No

Field work, collection and transport

Field conditions	We sequentially sampled all study sites matching the peak of growing season in each site, wich is in mid-late spring in Mediterranean-type ecosystems. Mean annual precipitation at our study sites ranged from 272 mm near the Mediterranean coast to 726 mm at the Central Ranges of the Castilian Plateau. Mean annual temperature ranged from 18.5 °C at the coastal sites to 8.6 °C at the Central Ranges site. A detailed description of the environmental conditions at each site is provided in Table S9 of the supplementary material section.
Location	These sites were distributed along a 600 km transect from the south-eastern (most arid) to the central part (wettest) of the Iberian Peninsula. Mean altitude above sea level of the study sites ranged from 10 m near the Mediterranean coast to 1450 m at the Central Ranges site. The exact locations (latitude and longitude) for each study site are the following: Calblanque 37.6040, - 0.7471; Pulpí 37.3601,- 1.7331; Cuadros Natural 38.0864, -1.1044; Cuadros Repoblación 38.0864, -1.1044; Venta del Olivo 38.372, -1.4931; Pliego 37.9546, -1.5013; Ayna 38.5224, -2.0874; Majarazán 38.0997, -2.0709; Yeste 38.3899, -2.4575; Montejo 41.1114, -3.5011.
Access & import/export	All the study sites are located in Spain outside protected natural areas. All the plant and soil samples were collected in full compliance with local, regional, national and international laws.
Disturbance	We collected the minimum plant material amount (leafs, stems) necessary to perform the analyses in the laboratory, thus minimizing the negative impact on plant individuals, and excluded the use of endangered species.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
[x]	[ ] Antibodies
[x]	[ ] Eukaryotic cell lines
[x]	[ ] Palaeontology and archaeology
[x]	[ ] Animals and other organisms
[x]	[ ] Clinical data
[x]	[ ] Dual use research of concern
[ ]	[x] Plants

Methods

n/a	Involved in the study
[x]	[ ] ChIP-seq
[x]	[ ] Flow cytometry
[x]	[ ] MRI-based neuroimaging

Dual use research of concern

Policy information about dual use research of concern

Hazards

Could the accidental, deliberate or reckless misuse of agents or technologies generated in the work, or the application of information presented in the manuscript, pose a threat to:

No	Yes	
☒	☐	Public health
☒	☐	National security
☒	☐	Crops and/or livestock
☒	☐	Ecosystems
☒	☐	Any other significant area

Experiments of concern

Does the work involve any of these experiments of concern:

No	Yes	
☒	☐	Demonstrate how to render a vaccine ineffective
☒	☐	Confer resistance to therapeutically useful antibiotics or antiviral agents
☒	☐	Enhance the virulence of a pathogen or render a nonpathogen virulent
☒	☐	Increase transmissibility of a pathogen
☒	☐	Alter the host range of a pathogen
☒	☐	Enable evasion of diagnostic/detection modalities
☒	☐	Enable the weaponization of a biological agent or toxin
☒	☐	Any other potentially harmful combination of experiments and agents

Plants

Seed stocks	All plant specimens were collected from the field from natural plant communities. We sampled 10 different Mediterranean shrubland, open woodland and closed-canopy forest communities with contrasting climate, as descrived previously. Six of these sites were sampled twice in two separate years with contrasting climatic conditions and rainfall patterns (2019 and 2022), whereas the remaining 4 sites were sampled once (2008 , 2017). No novel plant genotypes were used in this study.
Novel plant genotypes	Not applicable
Authentication	We collected samples from at least 6 individuals of the most dominant woody species in each plant community, i.e. those encompassing 90% of the total cover in the community. In total, we sampled 771 individuals of 62 woody species belonging to 21 plant families, resulting in 121 species-site combinations. We collected a couple of leaves and one branch segment per individual.
	Not applicable