Supplementary Information

Prediction scenarios of past, present, and future environmental suitability for the Mediterranean species *Arbutus unedo* L.

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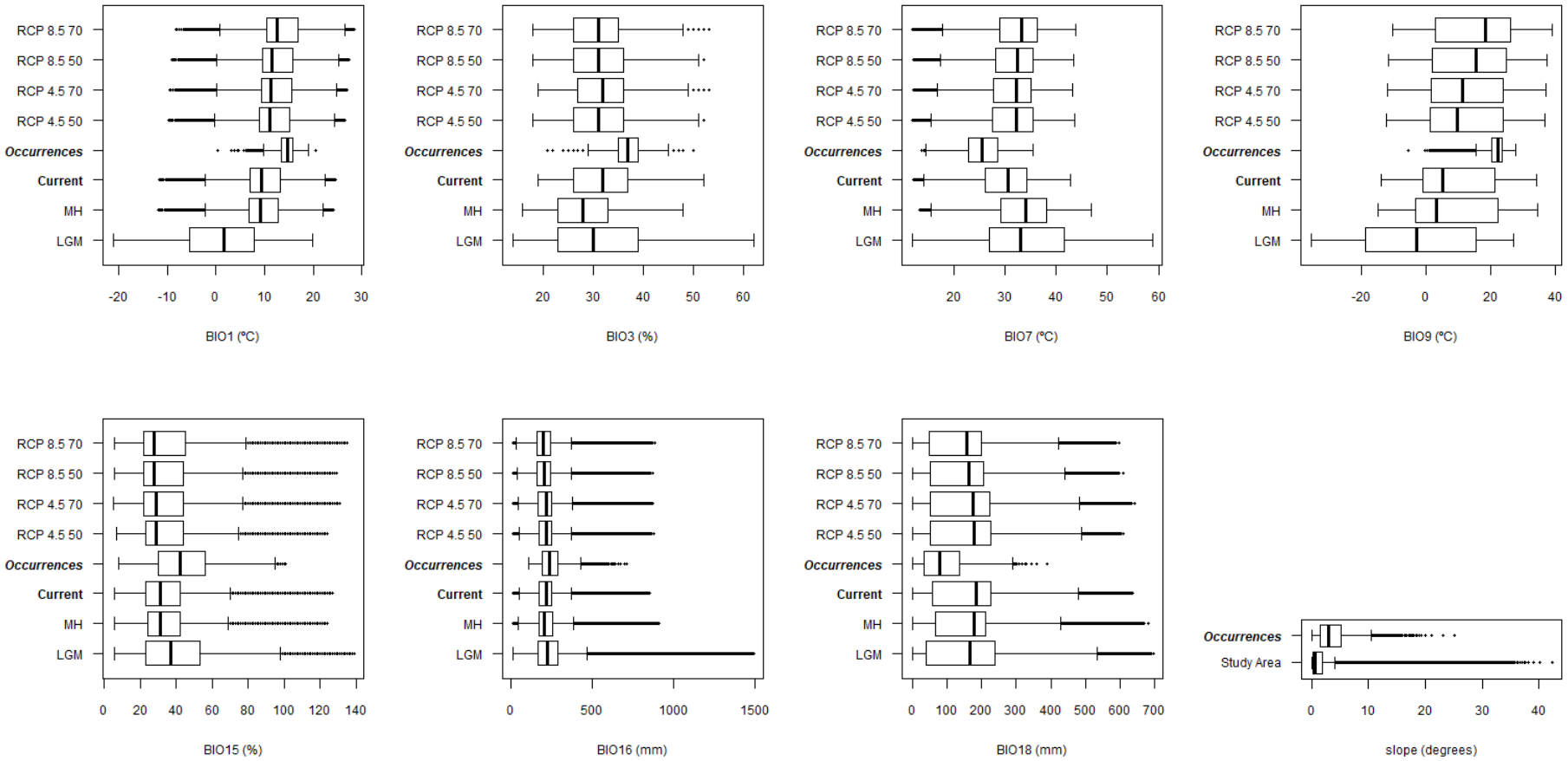
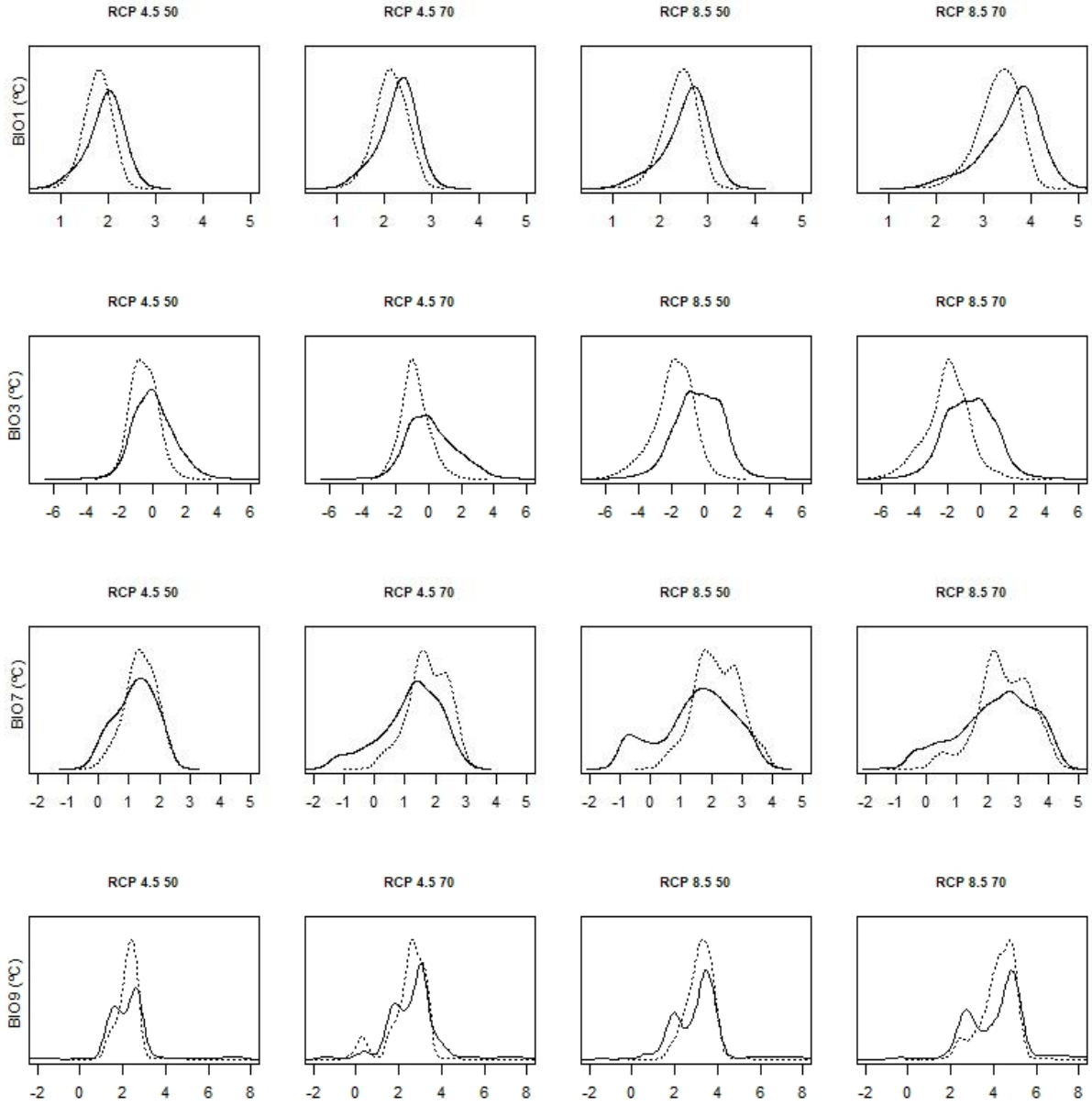
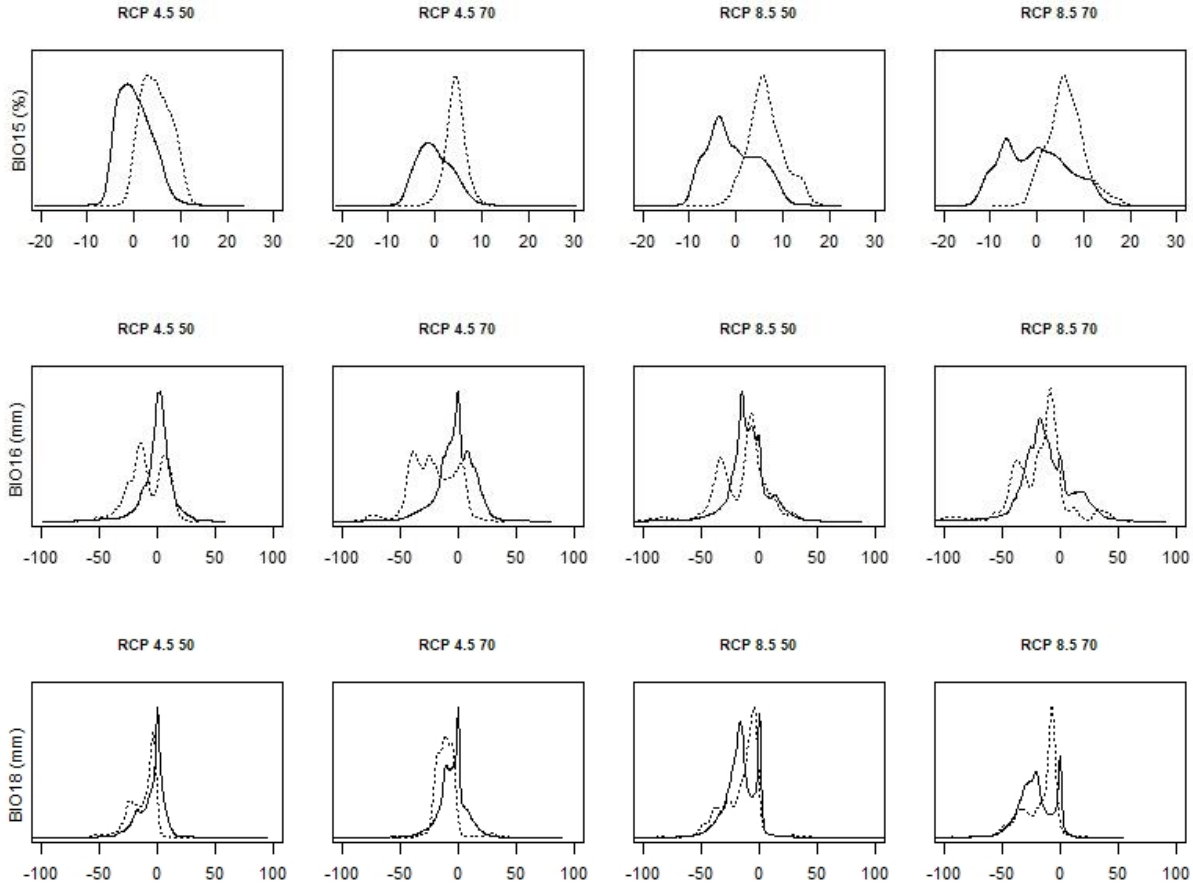


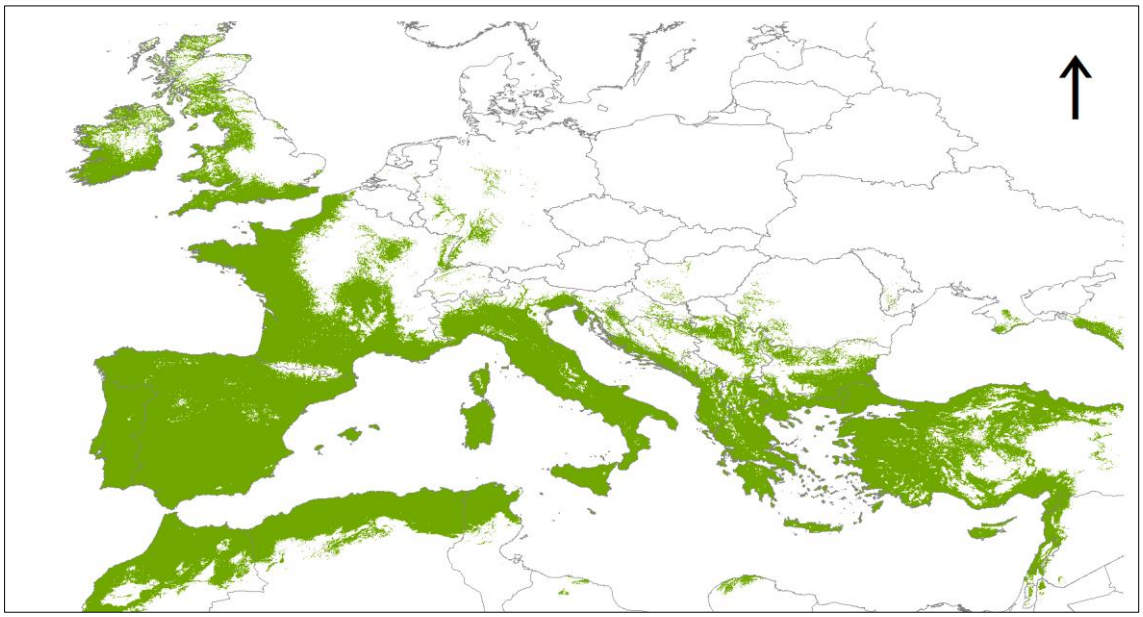
Supplementary Figure S1. Distribution of each variable included in the model, across all the considered time periods: past (LGM, MH), current and future.



Supplementary Figure S2. Distribution of differences between variables in future and in present. Solid lines for the study area and dashed lines for the current occurrences. BIO1 = annual mean temperature; BIO3= Isothermality (BIO2/BIO7); BIO7 = temperature annual range (max. temperature of warmest month - min. temperature of coldest month); BIO9 = mean temperature of driest quarter; BIO15 = precipitation seasonality (coefficient of variation); BIO16 = precipitation of wettest quarter; BIO18 = precipitation of warmest quarter.



Supplementary Figure S2. (Continuation). Distribution of differences between variables in future and in present. Solid lines for the study area and dashed lines for the current occurrences. BIO1 = annual mean temperature; BIO3= Isothermality (BIO2/BIO7); BIO7 = temperature annual range (max. temperature of warmest month - min. temperature of coldest month); BIO9 = mean temperature of driest quarter; BIO15 = precipitation seasonality (coefficient of variation); BIO16 = precipitation of wettest quarter; BIO18 = precipitation of warmest quarter.



Supplementary Figure S3. Regions (in green) where current suitability is higher than 0.03.

Source/Reference
GBIF | https://www.gbif.org/
iNaturalist | https://www.inaturalist.org/observations
Flora Croatica Database | https://hirc.botanic.hr/fcd/Search.aspx
Online Atlas of the British and Irish flora | https://www.brc.ac.uk/plantatlas/
FAO | http://www.fao.org/geonetwork/srv/en/metadata.show?id=56996
Portal to the Flora of Italy | http://dryades.units.it/floritaly/index.php?procedure=taxon_page&tipo=all&id=3730
Nadya Wahid | Personal communication
Acta Plantarum - Flora delle regioni italiane | https://www.actaplantarum.org/flora/flora_info.php?id=503730
Santiso et al. [1]
Ribeiro et al. [2]

Supplementary Table S1. Data gathering sources.

Variable	Code	Unit
Monthly average minimum temperature	tmin	°C * 10
Monthly average maximum temperature	tmax	°C * 10
Annual mean temperature	BIO1	°C * 10
Mean diurnal range (mean of monthly (max temp - min temp))	BIO2	°C * 10
Isothermality (BIO2/BIO7) (* 100)	BIO3	%
Temperature seasonality (standard deviation *100)	BIO4	-
Max. temperature of warmest month	BIO5	°C * 10
Min. Temperature of Coldest Month	BIO6	°C * 10
Temperature annual range (BIO5-BIO6)	BIO7	°C * 10
Mean temperature of wettest quarter	BIO8	°C * 10
Mean temperature of driest quarter	BIO9	°C * 10
Mean temperature of warmest quarter	BIO10	°C * 10
Mean temperature of coldest quarter	BIO11	°C * 10
Annual precipitation	BIO12	mm
Precipitation of wettest month	BIO13	mm
Precipitation of driest month	BIO14	mm
Precipitation seasonality (coefficient of variation)	BIO15	%
Precipitation of wettest quarter	BIO16	mm
Precipitation of driest quarter	BIO17	mm
Precipitation of warmest quarter	BIO18	mm
Precipitation of coldest quarter	BIO19	mm
Elevation	-	m
Slope	-	degrees

Supplementary Table S2. Original set of the 23 environmental variables (climatic and topographic) that were selected for modelling.

ID	Taxon	Country	Site name	Latitude	Longitude	Data type	Age oldest	Period	Reference
1	*Arbutus*	Spain	Navarrés	39.1000	-0.6833	p	34151	Late Pleistocene	3
2	*A. unedo*	Portugal	Serra do Sicó	39.9233	-8.5399	m	23920*	Late Pleistocene	4
3	*Arbutus*	Spain	Verdeospesoa mire	43.0550	-2.8614	p	21329	Late Pleistocene	5
4	*Arbutus*	Spain	Siles lake	38.3890	-2.5095	p	19427	Late Pleistocene	6
5	*A. unedo*	Spain	PRD-4	42.5333	-8.5167	p	12451	Late Pleistocene	7
6	*Arbutus*	France	Biot	43.8000	7.1000	p	11176	Early-Middle Holocene	8
7	*A. unedo*	Tunisia	Majen Ben H'mida	37.1333	9.0833	p	10975	Early-Middle Holocene	9
8	*A. unedo*	Italy	Lago dell'Accesa	42.9879	10.8952	p	10388	Early-Middle Holocene	10
9	*Arbutus*	Crete	Aghia Galini	35.1083	24.6944	p	10268	Early-Middle Holocene	11
10	*A. unedo*	Spain	Canaleja	40.9000	-2.4500	p	10241	Early-Middle Holocene	12
11	*Arbutus*	Italy	Lago dell'Accesa	42.9875	10.8924	p	10042	Early-Middle Holocene	13
12	*A. unedo*	Corsica	Bastani	42.0658	9.1342	p	8971	Early-Middle Holocene	14
13	*Arbutus*	Greece	Lake Voulkaria	38.8667	20.8333	p	7969	Early-Middle Holocene	15
14	*Arbutus*	Italy	Pavullo nel Frignano	44.3201	10.8387	p	7578	Early-Middle Holocene	16
15	*A. unedo*	France	Embouchac	43.5664	3.9167	p	7498	Early-Middle Holocene	17
16	*Arbutus*	Sardinia	Sa Curcurica	40.4555	9.7875	p	7219	Early-Middle Holocene	18
17	*Arbutus*	Greece	Lake Lerna	37.5778	22.7281	p	7203	Early-Middle Holocene	19
18	*A. unedo*	Portugal	Lagoa Travessa II	38.3044	-8.7725	p	7122	Early-Middle Holocene	20
19	*Arbutus*	Italy	Lago del Greppo	44.1199	10.6738	p	6969	Early-Middle Holocene	21
20	*Arbutus*	Spain	Sierra de Gádor	36.9316	-2.9050	p	6913	Early-Middle Holocene	22
21	*A. unedo*	France	Saint Sauveur	43.5664	3.9167	p	6811	Early-Middle Holocene	23
22	*Arbutus*	Turquia	Ova Gülü	36.2667	29.3000	p	6808	Early-Middle Holocene	24
23	*Arbutus*	France	Tourves	43.4131	5.9107	p	6783	Early-Middle Holocene	25
24	*A. unedo*	Portugal	Barbaroxa de Baixo	38.0791	-8.8098	p	6674	Early-Middle Holocene	26
25	*Arbutus*	Israel	Ein Gedi	31.4189	35.3883	p	6230	Early-Middle Holocene	27
26	*A. unedo*	Italy	Lago di Massaciuccoli	43.8378	10.3308	p	6071	Early-Middle Holocene	10
27	*Arbutus*	Spain	El Sabinar	38.2000	-2.1167	p	5994	Early-Middle Holocene	28
28	*Arbutus*	Ireland	Derrycunihy Wood	51.9628	-9.5819	p	5872	Early-Middle Holocene	29
29	*A. unedo*	Italy	Lago di Massaciuccoli	43.8378	10.3308	p	5757	Early-Middle Holocene	10
30	*A. unedo*	Tunisia	Majen El Orbi	37.1492	9.0991	p	5269	Early-Middle Holocene	9
31	*A. unedo*	Portugal	Lagoa Travessa II	38.3044	-8.7725	p	5213	Early-Middle Holocene	20
32	*Arbutus*	Greece	Trikhonis 5	38.5737	21.5454	p	5129	Early-Middle Holocene	30
33	*Arbutus*	Spain	Es Grau	39.9481	4.2586	p	4720	Early-Middle Holocene	31
34	*Arbutus*	Greece	Litochoro	40.1389	22.5461	p	4283	Early-Middle Holocene	32
35	*Arbutus*	Ireland	Rough Island	52.0313	-9.5332	p	4210	Early-Middle Holocene	33
36	*A. unedo*	Spain	Culazón	43.2328	-4.4892	p	4160	Late Holocene	34
37	*A. unedo*	Spain	Peña Negra	40.3347	-5.7922	p	3976	Late Holocene	35
38	*Arbutus*	Croatia	Bokanjacko	44.1833	15.2333	p	3964	Late Holocene	36
39	*Arbutus*	Spain	El Maíllo mire	40.5467	-6.2097	p	3799	Late Holocene	37
40	*Arbutus*	Spain	La Molina mire	43.3811	-6.3272	p	3675	Late Holocene	38
41	*Arbutus*	Sicilia	Biviere di Gela	37.0188	14.3446	p	3437	Late Holocene	39

42	*Arbutus*	Spain	Valdeyernos bog	39.4411	-4.0964	p	3397	Late Holocene	[40]
43	*Arbutus*	Ireland	Lough Inchiquin	51.8072	-9.6871	p	3325	Late Holocene	[41]
44	*A. unedo*	Spain	Botija bog	39.6030	-4.6967	p	3127	Late Holocene	[42]
45	*Arbutus*	Spain	El Payo	40.2533	-6.7711	p	3100	Late Holocene	[43]
46	*Arbutus*	Algeria	Bourdim	36.8033	8.2539	p	3057	Late Holocene	[44]
47	*Arbutus*	Ireland	Camillan Wood2	52.0184	-9.5322	p	3002	Late Holocene	[29]
48	*Arbutus*	Sicilia	Gorgo Basso	37.6000	12.6500	p	2827	Late Holocene	[45]
49	*Arbutus*	Tunisia	Djebel El Ghorra	36.5975	8.3947	p	2795	Late Holocene	[9]
50	*A. unedo*	Portugal	Charco da Candieira	40.3417	-7.5764	p	2555	Late Holocene	[46]
51	*A. unedo*	Tunisia	Majen El Orbi	37.1529	9.0984	p	2501	Late Holocene	[9]
52	*A. unedo*	Spain	Lanzahíta	40.2233	-4.9368	p	2434	Late Holocene	[47]
53	*Arbutus*	Spain	Patateros bog	39.5972	-4.6742	p	2068	Late Holocene	[48]
54	*Arbutus*	Spain	Cañada de la Cruz	38.0675	-2.6875	p	2061	Late Holocene	[49]
55	*Arbutus*	Crete	Asi Gonia1	35.2489	24.2782	p	1404	Late Holocene	[50]
56	*Arbutus*	Crete	Asi Gonia2	35.2489	24.2782	p	1242	Late Holocene	[50]
57	*Arbutus*	Sicilia	Lago di Venere	36.8169	11.9870	p	1101	Late Holocene	[51]
58	*A. unedo*	Ireland	Sheheree Bog	52.0403	-9.4809	p	849	Late Holocene	[52]
59	*A. unedo*	Spain	Labradillos mire	40.3449	-4.5707	p	839	Late Holocene	[53]
60	*Arbutus*	Greece	Halos I	39.1606	22.8378	p	827	Late Holocene	[54]
61	*Arbutus*	Ireland	Camillan Wood1	52.0184	-9.5322	p	403	Late Holocene	[33]
62	*A. unedo*	Spain	Las Lanchas	39.5858	-4.8943	p	310	Late Holocene	[42]
63	*Arbutus*	Spain	Turbera de la Panera Cabras	40.1658	-5.7581	p	137	Late Holocene	[55]

Supplementary Table S3. Summary of known fossil occurrences of *Arbutus* and *Arbutus unedo* from Pleistocene to present ranked by the age of the oldest record. The pollen data search was made in the Neotoma Paleoecology Database [56] by taxon ('Arbutus'=*Arbutus* or 'Arbutus unedo'=*A. unedo*), and only 'pollen' type dataset were found. Ages are indicated according to the chronostratigraphic charts in calibrated years before present (cal BP), except for the macroremains not possible to be calibrated* (number 2). Data type: p = pollen grains, m = macroremains (leaves, fruits, seeds, wood). Age oldest = is the age of the oldest *Arbutus* and *A. unedo* pollen record in the site. According to the pollen record oldest age the following labeling was used: Late Pleistocene (from 34-11.7 ka), Early-Middle Holocene (11.7-4.2 ka), and Late Holocene-Present (4.2-0 ka). Thousand years BP = ka.

Supplementary References

1 Santiso, X., Lopez, L., Retuerto, R. & Barreiro Lozano, R. Population structure of a widespread species under balancing selection: the case of *Arbutus unedo* L. *Front Plant Sci* **6**, doi:10.3389/fpls.2015.01264 (2016).

2 Ribeiro, M. M. *et al.* Genetic diversity and divergence at the *Arbutus unedo* L. (Ericaceae) westernmost distribution limit. *PLoS One* **12**, e0175239, doi:10.1371/journal.pone.0175239 (2017).

3 Carrión, J. S. & Van Geel, B. Fine-resolution Upper Weichselian and Holocene palynological record from Navarrés (Valencia, Spain) and a discussion about factors of Mediterranean forest succession. *Rev. Palaeobot. Palyno.* **106**, 209-236, doi:https://doi.org/10.1016/S0034-6667(99)00009-3 (1999).

4 Figueiral, I. & Terral, J. F. Late Quaternary refugia of Mediterranean taxa in the Portuguese Estremadura: charcoal based palaeovegetation and climatic reconstruction. *Quat Sci Rev* **21**, 549-558, doi:http://dx.doi.org/10.1016/S0277-3791(01)00022-1 (2002).

5 Pérez-Díaz, S. & López-Sáez, J. A. 33. Verdeospesoa mire (Basque Country, Northern Iberian Peninsula, Spain). *Grana* **56**, 315-317, doi:10.1080/00173134.2016.1271824 (2017).

6 Carrión, J. S. Patterns and processes of Late Quaternary environmental change in a montane region of southwestern Europe. *Quat. Sci. Rev.* **21**, 2047-2066, doi:https://doi.org/10.1016/S0277-3791(02)00010-0 (2002).

7 López-Merino, L., Silva Sánchez, N., Kaal, J., López-Sáez, J. A. & Martínez Cortizas, A. Post-disturbance vegetation dynamics during the Late Pleistocene and the Holocene: An example from NW Iberia. *Global and Planetary Change* **92-93**, 58-70, doi:https://doi.org/10.1016/j.gloplacha.2012.04.003 (2012).

8 Nicol-Pichard, S. & Dubar, M. Reconstruction of late-glacial and holocene environments in southeast France based on the study of a 66-m long core from Biot, Alpes Maritimes. *Vegetation History and Archaeobotany* **7**, 11-15, doi:10.1007/bf01393413 (1998).

9 Stambouli-Essassi, S., Roche, E. & Bouzid, S. Evolution de la végétation et du climat dans le nord-ouest de la Tunisie au cours des 40 derniers millénaires. *Geo-Eco-Trop* **31**, 171-214 (2007).

10 Colombaroli, D. *et al.* Response of broadleaved evergreen Mediterranean forest vegetation to fire disturbance during the Holocene: insights from the peri-Adriatic

region. *J Biogeogr* **36**, 314-326, doi:https://doi.org/10.1111/j.1365-2699.2008.01987.x (2009).

11 Bottema, S. Palynological investigations on crete. *Rev Palaeobot Palyno* **31**, 193-217, doi:https://doi.org/10.1016/0034-6667(80)90027-5 (1980).

12 Cerrillo-Cuenca, E. & González-Cordero, A. in *From the Origins: The Prehistory of the Inner Tagus Region* (ed Archaeopress) 21-42 (BAR International Series 2219, 2011).

13 Drescher-Schneider, R. *et al.* Vegetation history, climate and human impact over the last 15,000 years at Lago dell'Accesa (Tuscany, Central Italy). *Vegetation History and Archaeobotany* **16**, 279-299, doi:10.1007/s00334-006-0089-z (2007).

14 Lestienne, M. *et al.* Fires and human activities as key factors in the high diversity of Corsican vegetation. *The Holocene* **30**, 244-257, doi:10.1177/0959683619883025 (2019).

15 Jahns, S. The Holocene history of vegetation and settlement at the coastal site of Lake Voulkaria in Acarnania, western Greece. *Vegetation History and Archaeobotany* **14**, 55-66, doi:10.1007/s00334-004-0053-8 (2005).

16 Vescovi, E., Kaltenrieder, P. & Tinner, W. Late-Glacial and Holocene vegetation history of Pavullo nel Frignano (Northern Apennines, Italy). *Rev Palaeobot Palyno* **160**, 32-45, doi:https://doi.org/10.1016/j.revpalbo.2010.01.002 (2010).

17 Puertas, O. Premiers indices polliniques de néolithisation dans la plaine littorale de Montpellier (Hérault, France). *Bulletin de la Société préhistorique française* **96**, 15-20 (1999).

18 Beffa, G. *et al.* Vegetation and fire history of coastal north-eastern Sardinia (Italy) under changing Holocene climates and land use. *Vegetation History and Archaeobotany* **25**, 271-289, doi:10.1007/s00334-015-0548-5 (2016).

19 Jahns, S. On the Holocene vegetation history of the Argive Plain (Peloponnese, southern Greece). *Veg. Hist. Archaeobot.* **2**, 187-203, doi:10.1007/bf00198161 (1993).

20 Mateus, J. E. *Holocene and present-day ecosystems of the Carvalhal Region, Southwest Portugal. PhD thesis* PhD thesis, Universidade de Utreque, (1992).

21 Vescovi, E., Ammann, B., Ravazzi, C. & Tinner, W. A new Late-glacial and Holocene record of vegetation and fire history from Lago del Greppo, northern Apennines, Italy. *Vegetation History and Archaeobotany* **19**, 219-233, doi:10.1007/s00334-010-0243-5 (2010).

153 22 Carrión, J., Gómez, P., Poveda, J. F., Yll, R. & Chaín-Navarro, C. Holocene vegetation
154 dynamics, fire and grazing in the Sierra de Gádor, southern Spain. *Holocene* **13**, 839-
155 849, doi:10.1191/0959683603hl662rp (2003).
156 23 Puertas, O. *Evolution de la vegetation depuis le dryas recent dans la plaine littorale de*
157 *montpellier (herault, france) a partir de l'analyse pollinique. Dynamique naturelle et*
158 *anthropisation du milieu. PhD thesis* PhD thesis, Université de Franche-Comté, (1997).
159 24 Bottema, S. & Woldring, H. Late Quaternary vegetation and climate of southwestern
160 Turkey. Part II. *Palaeohistoria 26*, 123-149 (1984).
161 25 Nicol-Pichard, S. Analyse pollinique d'une séquence tardi et postglaciaire à Tourves
162 (Var, France). *Ecologia mediterranea* **13**, 29-42,
163 doi:https://doi.org/10.3406/ecmed.1987.1609 (1987).
164 26 Connor, S., Araújo, J., Gomes, S. & Boski, T. *Final Report Project SWIRL. Centro de*
165 *Investigação Marinha e Ambiental, Universidade do Algarve.* (2013).
166 27 Litt, T., Ohlwein, C., Neumann, F. H., Hense, A. & Stein, M. Holocene climate
167 variability in the Levant from the Dead Sea pollen record. *Quat Sci Rev* **49**, 95-105,
168 doi:https://doi.org/10.1016/j.quascirev.2012.06.012 (2012).
169 28 Carrión, J., Yll, E. I., Willis, K. & Gómez, P. Holocene forest history of the eastern
170 plateaux in the Segura Mountains (Murcia, southeastern Spain). *Rev Palaeobot Palyno*
171 **132**, 219-236, doi:https://doi.org/10.1016/j.revpalbo.2004.07.002 (2004).
172 29 Mitchell, F. J. G. The Vegetational History of the Killarney Oakwoods, SW Ireland:
173 Evidence from Fine Spatial Resolution Pollen Analysis. *J Ecol* **76**, 415-436,
174 doi:10.2307/2260603 (1988).
175 30 Bottema, S. Palynological investigations in Greece with special reference to pollen as
176 indicator of human activity. *Palaeohistoria 24*, 257–289 (1982).
177 31 Burjachs, F. *et al.* Overview of environmental changes and human colonization in the
178 Balearic Islands (Western Mediterranean) and their impacts on vegetation composition
179 during the Holocene. *Journal of Archaeological Science: Reports* **12**, 845-859,
180 doi:https://doi.org/10.1016/j.jasrep.2016.09.018 (2017).
181 32 Athanasiadis, N. Zur postglazialen Vegetationsentwicklung von Litochoro Katerinis
182 und Pertouli Trikalon (Griechenland). *Flora* **164**, 99-132,
183 doi:https://doi.org/10.1016/S0367-2530(17)31791-7 (1975).
184 33 Mitchell, F. J. G. The Impact of Grazing and Human Disturbance on the Dynamics of
185 Woodland in S. W. Ireland. *Journal of Vegetation Science* **1**, 245-254,
186 doi:10.2307/3235661 (1990).

34 López-Sáez, J. A. *et al.* 20. Culazón, Cantabrian Mountains (northern Spain). *Grana* **52**, 316-318, doi:10.1080/00173134.2013.768700 (2013).

35 Abel-Schaad, D. & López-Sáez, J. A. Vegetation changes in relation to fire history and human activities at the Peña Negra mire (Bejar Range, Iberian Central Mountain System, Spain) during the past 4,000 years. *Vegetation History and Archaeobotany* **22**, 199-214, doi:10.1007/s00334-012-0368-9 (2013).

36 Grüger, E. in *In supplement to: Grüger, E (1996): Vegetational change. Chapman, J; Shiel, R & Batovic, S (eds.): The changing face of Dalmatia. Archaeological and ecological investigations in a Mediterranean Landscape, Leicester University Press, 365 pp, 33-43* (PANGAEA, 1996).

37 Morales-Molino, C., García-Antón, M., Postigo-Mijarra, J. M. & Morla, C. Holocene vegetation, fire and climate interactions on the westernmost fringe of the Mediterranean Basin. *Quat Sci Rev* **59**, 5, doi:10.1016/j.quascirev.2012.10.027 (2013).

38 López-Merino, L., Cortizas, A. M. & López-Sáez, J. A. Human-induced changes on wetlands: a study case from NW Iberia. *Quat Sci Rev* **30**, 2745-2754, doi:https://doi.org/10.1016/j.quascirev.2011.06.004 (2011).

39 Noti, R. *et al.* Mid- and late-Holocene vegetation and fire history at Biviere di Gela, a coastal lake in southern Sicily, Italy. *Vegetation History and Archaeobotany* **18**, 371-387, doi:10.1007/s00334-009-0211-0 (2009).

40 Dorado-Valiño, M., López-Sáez, J. A. & García-Gómez, E. 26. Valdeyernos, Toledo Mountains (central Spain). *Grana* **53**, 315-317, doi:10.1080/00173134.2014.936490 (2014).

41 Mitchell, F. J. G. in *Biogeography of Ireland: past, present, and future* Vol. 2 (eds M J Costello & K S Kelly) 35-44 (Occasional Publication of the Irish Biogeographical Society, 1993).

42 Luelmo Lautenschlaeger, R., López-Sáez, J. A. & Pérez-Díaz, S. 40. Botija, Toledo Mountains (central Spain). *Grana* **57**, 1-3, doi:10.1080/00173134.2017.1400587 (2018).

43 Abel-Schaad, D. *et al.* Evolución de la vegetación en la Sierra de Gata (Cáceres-Salamanca, España) durante el Holoceno reciente. Implicaciones biogeográficas. *Revista Española de Micropaleontología* **41**, 91-105 (2009).

44 Benslama, M. *et al.* Nouvelles contributions à l'histoire tardiglaciaire et holocène de la végétation en Algérie : analyses polliniques de deux profils sédimentaires du complexe

humide d'El-Kala. *C R Biologies* **333**, 744-754, doi:https://doi.org/10.1016/j.crvi.2010.08.002 (2010).

45 Tinner, W. *et al.* Holocene environmental and climatic changes at Gorgo Basso, a coastal lake in southern Sicily, Italy. *Quat Sci Rev* **28**, 1498-1510, doi:https://doi.org/10.1016/j.quascirev.2009.02.001 (2009).

46 van der Knaap, W. O. & van Leeuwen, J. F. N. Late Glacial and early Holocene vegetation succession, altitudinal vegetation zonation, and climatic change in the Serra da Estrela, Portugal. *Rev Palaeobot Palyno* **97**, 239-285, doi:https://doi.org/10.1016/S0034-6667(97)00008-0 (1997).

47 López-Sáez, J. A. *et al.* Late Holocene ecological history of Pinus pinaster forests in the Sierra de Gredos of central Spain. *Plant Ecol* **206**, 195, doi:10.1007/s11258-009-9634-z (2010).

48 Dorado-Valiño, M., López-Sáez, J. A. & Gómez, E. Contributions to the European Pollen Database. 21. Patateros, Toledo mountains (central Spain). *Grana* **53**, 171-173 (2014).

49 Carrión, J. S., Munuera, M., Dupré, M. & Andrade, A. Abrupt vegetation changes in the Segura Mountains of southern Spain throughout the Holocene. *J Ecol* **89**, 783-797, doi:https://doi.org/10.1046/j.0022-0477.2001.00601.x (2001).

50 Atherden, M. A. & Hall, J. A. Human impact on vegetation in the White Mountains of Crete since AD 500. *The Holocene* **9**, 183-193, doi:10.1191/095968399673523574 (1999).

51 Calò, C. *et al.* 1200 years of decadal-scale variability of Mediterranean vegetation and climate at Pantelleria Island, Italy. *The Holocene* **23**, 1477-1486, doi:10.1177/0959683613493935 (2013).

52 Mitchell, F. J. G. & Cooney, T. in *Ross Island mining, metal and society in early Ireland* (ed W O'Brien) 481-493 (Bronze Age Studies no. 6, 2004).

53 Robles López, S., Manzano-Rodríguez, S., Pérez-Díaz, S. & López-Sáez, J. A. 35. Labradillos mire, Gregos Range (central Spain). *Grana* **56**, 398-400, doi:10.1080/00173134.2017.1282976 (2017).

54 Bottema, S. in *New Halos: a Hellenistic town in Thessalía, Greece.* (ed H R Reinders) (H&S Publishers, 1988).

55 Abel-Schaad, D., Am, H., L, L. & López-Sáez, J. A. Cabras y quemorros: Tres siglos de cambios en el paisaje de la vertiente extremeña de la Sierra de Gredos. *Revista de estudios extremeños* **65**, 449-478 (2009).

56 Williams, J. W. *et al.* The Neotoma Paleoecology Database, a multiproxy, international, community-curated data resource. *Quaternary Research* **89**, 156-177, doi:10.1017/qua.2017.105 (2018).