



HAL
open science

Vegetation dynamics and land-use history during the Holocene in Corsica (Western Mediterranean): Regional patterns and local landscape transformation in changing coastal ecosystems

Jordi Revelles, Ralph Fyfe, Matthieu Ghilardi, Andrés Currás, Federico Di Rita

► To cite this version:

Jordi Revelles, Ralph Fyfe, Matthieu Ghilardi, Andrés Currás, Federico Di Rita. Vegetation dynamics and land-use history during the Holocene in Corsica (Western Mediterranean): Regional patterns and local landscape transformation in changing coastal ecosystems. *Quaternary Science Reviews*, 2025, 365, pp.109469. <10.1016/j.quascirev.2025.109469>. <hal-05111293>

HAL Id: hal-05111293

<https://hal.science/hal-05111293v1>

Submitted on 13 Jun 2025

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



HAL Authorization

1 **Vegetation dynamics and land-use history during the Holocene in Corsica (Western Mediterranean):**
2 **Regional patterns and local landscape transformation in changing coastal ecosystems.**

3 **Jordi Revelles^{1,2}, Ralph Fyfe³, Matthieu Ghilardi⁴, Andrés Currás⁵, Federico Di Rita⁶**

4 1- Institut Català de Paleoecologia Humana i Evolució Social (IPHES-CERCA), Zona Educacional 4, Campus Sescelades URV (Edifici W3),
5 43007 Tarragona, Spain; jordi.revelles@gmail.com

6 2- Departament d'Història i Història de l'Art, Universitat Rovira i Virgili, Avinguda de Catalunya 35, 43002 Tarragona, Spain.

7 3- School of Geography, Earth and Environmental Sciences, University of Plymouth, Plymouth PL4 8AA, UK.

8 4- CEREGE Aix Marseille University, CNRS UMR 7330, IRD, Collège de France, INRA, Europôle de l'Arbois BP 80 13545, Aix-en-Provence,
9 CEDEX 04, France.

10 5- Institute of Heritage Sciences (Incipit), Spanish National Research Council (CSIC), Avda. de Vigo s/n, 15705, Santiago de Compostela,
11 Spain.

12 6- Department of Environmental Biology, Sapienza University of Rome, Piazzale Aldo Moro 5, 00185 Rome, Italy.

13

14 **Abstract**

15 The archaeoecological research conducted in Corsica underscores the critical role of integrating palynological
16 studies from sedimentary deposits to reconstruct past human-environment interactions. This approach
17 sheds new light on evidence of farming activities and redefines archaeological territories and human
18 occupation temporalities. Understanding the influence of human activities on coastal ecosystems requires
19 outlining natural and climatic dynamics at a regional scale while evaluating landscape transformations at
20 local scale, where human imprints are clearly evidenced. To achieve this, we applied quantitative
21 methodologies to disentangle regional pollen loading from local vegetation signals. The Landscape
22 Reconstruction Algorithm (LRA) was employed as an advanced tool to quantify vegetation cover within the
23 source area of pollen sites, enabling the estimation of the relative abundance of key taxa around pollen sites
24 and distinguishing these from the regional vegetation background. Specifically, the REVEALS and LOVE
25 models were used to reconstruct vegetation history at two spatial scales: regional and local.

26 This study reconstructs Holocene vegetation dynamics and human impact in Corsica using quantitative
27 pollen-based models (REVEALS, LOVE) applied to fifteen coastal wetland records and one high-mountain lake.
28 Results reveal that farming activities began around 7400 cal yr BP and intensified during the Roman period,
29 profoundly altering Mediterranean forests and maquis. Coastal landscape evolution was shaped by marine
30 transgression, deltaic progradation, and anthropogenic transformation, with key phases of environmental
31 change aligning with major climatic oscillations and land-use intensification. These findings offer valuable
32 insights into long-term Mediterranean socio-ecological dynamics.

33 *Keywords: Coastal ecosystems, Landscape Reconstruction Algorithm, Corsica, Holocene, Palynology,*
34 *Landscape transformation, Western Mediterranean*

35 **1. Introduction.**

36 The Mediterranean region is in the focal point of current challenges concerning global warming and relative
37 sea-level (RSL) rise, and long-term paleoecological data is crucial for providing a reference period against
38 which current conditions are compared to understand the dynamics linking climate, vegetation and human
39 activities (Gillson et al., 2019). While environmental changes during the early Holocene were primarily driven
40 by climate, human activities became increasingly influential during the middle Holocene (8.2-4.2 cal ka BP)
41 and expanded exponentially from the Late Holocene onwards (Roberts et al., 2019). Indeed, the complex

42 combination of climatic and anthropogenic factors since ~8.0 cal ka BP makes it difficult to distinguish the
43 influence of these two variables on the Mediterranean landscape (Fyfe et al., 2019).

44 The Island of Corsica becomes an interesting case study due to its early human occupations within the
45 Western Mediterranean and its diverse ecosystems, shaped by a broad altitudinal range and several forest
46 zones. The earliest evidence of human presence on the island dates to the early Holocene, represented by
47 hunter-gatherer communities inhabiting caves and other shelters (Perrin et al., 2022). A population gap
48 during the late 9th to the early 8th millennium cal BP suggests agropastoral colonisation occurred in
49 depopulated areas, confirmed by genetic discontinuity between these two populations (Lugliè, 2018).
50 Archaeoecological research in Corsica has demonstrated that understanding past human settlement
51 dynamics and economic activities requires not only archaeological data but also the integration of
52 palynological studies from sedimentary deposits. This combined approach can uncover evidence of farming
53 activities and redefine archaeological territories and human occupation temporalities (Ghilardi et al. 2017;
54 Revelles et al., 2019; Ghilardi, 2021). Mediterranean coastal landscapes have undergone significant
55 modifications due to RSL rise and climate change since the Last Glacial Maximum (~26.0 cal ka BP; Vacchi et
56 al. 2018, 2021) and pollen analysis is a valuable tool for documenting these processes, as local herbaceous
57 and aquatic vegetation in coastal environments respond directly to changes in humidity and salinity linked
58 to RSL variability (Di Rita and Magri, 2012; Melis et al., 2018; Revelles et al., 2019).

59 Previous palynological studies in Corsica have highlighted a long history of human-induced landscape
60 transformation. Early signs of cereal cultivation during the Neolithic are linked to the regression of
61 Mediterranean maquis in the south (Piantarella record, 7.3-7.2 cal ka BP) and the regression of riparian
62 forests and maquis in the north (Saint Florent record, 5.9 cal ka BP) (Revelles et al., 2019). However,
63 traditional pollen studies often merge local vegetation changes and regional processes. To address the
64 influence of human activities on coastal ecosystems, it is essential to both outline the evolution of natural
65 and climatic dynamics at a regional scale in the Western Mediterranean, and evaluate landscape
66 transformations at a local scale, where human impacts are more evident. Achieving this requires the
67 application of quantitative methodologies to disentangle regional pollen loading from local vegetation
68 signals, and account for the non-linear relationship between pollen proportions and vegetation cover (Sugita
69 et al., 1999). This non-linearity arises from differences in pollen production and dispersal among taxa and the
70 composition of regional vegetation. The Landscape Reconstruction Algorithm (LRA, Sugita 2007a,b) provides
71 an enhanced framework for quantifying vegetation cover within pollen source areas, enabling the estimation
72 of relative abundance of key taxa around pollen sites and separating them from the regional vegetation
73 backgrounds (Fyfe et al., 2018). In regions with networks of pollen sites, such as Corsica, the LRA can be used
74 to generate spatially explicit, quantified reconstructions of past local vegetation abundances. Reconstructing
75 regional vegetation enables an assessment of the role of climate in shaping vegetation dynamics during the
76 Holocene in Corsica and the broader Western Mediterranean.

77 In this context, this study addresses the following research questions:

78 - Do modern patterns of regional diversity in the vegetation of Corsica have historical precedents throughout
79 the Holocene?

80 - How did past climatic changes (e.g. the 4.2 cal ka BP and 3.2-2.8 cal ka BP cooling and dry events, the Roman
81 Warm Period, and the Little Ice Age) impact environmental dynamics in Corsica, and can vegetation changes
82 across different areas of Corsica be linked to these climatic events?

83 - What role did human activities play in transforming landscapes from Late Prehistory to the Middle Ages,
84 particularly regarding forest composition and cover, and when did human activities begin to cause significant

85 regional-scale vegetation changes, surpassing local landscape modifications to become a dominant force in
86 regional landscape dynamics?

87 **2. The environmental settings in Corsica.**

88 The climate of Corsica exhibits a steep altitudinal gradient, from warm and dry conditions at lower elevations
89 (average annual temperature of 14-17 °C) to colder and more humid conditions at higher elevations (9-13
90 °C). North Corsica is generally cooler and wetter, with Bastia recording a mean annual temperature of 15.5
91 °C and precipitation of 771 mm, whereas South Corsica is warmer and drier, with Bonifacio reporting 16.4 °C
92 and 542 mm of annual rainfall. The geological substrate plays a pivotal role in shaping vegetation distribution
93 in Corsica, as soil properties, water retention, and nutrient availability differ significantly between granitic
94 and calcareous terrains. Granitic substrates, prevalent in much of western Corsica, are acidic and low in
95 nutrients, favouring the growth of sclerophyllous vegetation such as *Quercus ilex*, *Pinus pinaster*, and
96 Mediterranean maquis species like *Pistacia lentiscus* and *Cistus* spp. These soils often support vegetation
97 well-adapted to poor, shallow soils and steep slopes. Conversely, calcareous substrates, more commonly
98 found in eastern Corsica and some isolated pockets in the south, are alkaline and nutrient-rich, promoting
99 the growth of more diverse flora.

100 Corsica is one of the most wooded islands in the Mediterranean, offering diverse environments that range
101 from littoral zones to mountain summits (Reille, 1992). The island's broad altitudinal range results in distinct
102 forest zones. Low elevations are dominated by sclerophyllous evergreen oak forests (*Quercus ilex*, *Q. suber*)
103 and Mediterranean scrublands (*Erica arborea*, *Pistacia lentiscus*, *Cistus monspeliensis* and *Juniperus*
104 *phoenicea*). Intermediate elevations host mesophyllous pine forests (*Pinus pinaster*) and mixed deciduous
105 forests (*Quercus pubescens*, *Q. petraea*, *Ostrya carpinifolia*, *Alnus cordata*, *Castanea sativa*).

106 In North Corsica, the *Pointe du Cap Corse* near Macinaggio features Mediterranean maquis, primarily *Erica*
107 *arborea*, *Arbutus unedo*, *Pistacia lentiscus* and *Myrtus*. Coastal rocky substrates support communities of
108 *Crithmum maritimum* (Apiaceae), *Limonium* (Plumbaginaceae) and *Frankenia laevis* (Frankeniaceae) in rocky
109 substrates, alongside *Euphorbia* species. Surrounding Biguglia lagoon, Mediterranean maquis (*Erica arborea*,
110 *Cistus*, *Arbutus unedo*, *Pistacia lentiscus*) coexists with sclerophyllous trees (*Olea europaea*, *Quercus ilex*,
111 *Quercus suber*), sunny-side pines (*Pinus pinaster*) and shade-tolerant *Quercus pubescens*. The Saint Florent
112 Bay hosts varied maquis communities: wild olive (*Olea europaea*) and lentisk (*Pistacia lentiscus*) in warm
113 coastal areas; tall maquis with *Arbutus unedo*; evergreen oak and heather (*Calluna vulgaris*) in the cooler
114 areas; and low maquis dominated by *Cistus*, *Salvia rosmarinus*, and *Lavandula stoechas* on sandy and rocky
115 soils. Riparian forests here are primarily composed of alder (*Alnus*), willow (*Salix*) and poplar (*Populus*).

116 In the northwest, the Crovani pond and surroundings features *Tamarix africana* fringes and palustrine
117 meadows dominated by *Bolboschoenus maritimus*, *Juncus acutus* and *J. maritimus*. The coastal bar is
118 occupied by *Pistacia lentiscus* and *Vitex agnus-castus*. Dense forests near the Fangu river mouth comprise
119 *Alnus glutinosa*, *Osmunda regalis*, and understory vines like *Vitis* and *Clematis vitalba*. The woody vegetation
120 of these sites consists of a degraded maquis with *Erica arborea*, *Arbutus unedo*, *Pistacia lentiscus*, *Phillyrea*
121 *angustifolia* and sparse *Quercus ilex* (Reille, 1992). In the surroundings of Girolata, the coastal plains are
122 characterized by forests and woodlands dominated by evergreen oaks (*Quercus ilex* and *Q. suber*), and pines
123 (*Pinus pinaster*, *P. nigra* subsp. *laricio*, *Pinus pinea* and *P. halepensis*). These forests thrive near the coast,
124 influenced by the granitic substrate. Typical Mediterranean maquis vegetation, dominated by *Olea europaea*
125 and *Pistacia lentiscus* covers the slopes, transitioning to arborescent sea spurge (*Euphorbia dendroides*) at
126 approximately 200 m elevation. Other common species include *Myrtus communis*, *Arbutus unedo*, *Phillyrea*
127 *media* and *P. angustifolia*. Sub-mediterranean maquis with tree heath (*Erica arborea*) and various rockrose
128 species (*Cistus* spp.) are also prevalent.

129 On the western coast, agricultural fields now cover the fluvial sedimentary deposits near Sagone. In areas
130 such as Sagone, where the hills (200 to 400 m asl.) are situated close to the sea, the meso-mediterranean
131 lower belt descends below its natural threshold, partially replacing the littoral vegetation (Reille, 1984). This
132 shift is characterized by the spread of Mediterranean maquis, including *Pistacia lentiscus*, *Phillyrea latifolia*,
133 *Fraxinus ornus* and *Euphorbia dendroides*. Near the sea, *Quercus ilex*, *Arbutus unedo* and *Erica arborea* are
134 common, with their frequency increasing at higher altitudes. Degradation of the maquis, often exacerbated
135 by fires, can lead to the proliferation of low-growing communities dominated by *Cistus monspeliensis* and
136 *Cistus salviifolius*. In the area of Caldanniccia, the local riverine forest is primarily composed of *Alnus viridis*
137 subsp. *suaveolens*, while open spaces support wetland herbs such as *Oenanthe crocata* (Apiaceae), *Rumex*
138 *conglomeratus*, *Urtica dioica*, *Veronica anagallis-aquatica* (Plantaginaceae) and *Iris pseudacorus* (Iridaceae).
139 In Casavone, swamps are predominantly occupied by *Juncus effusus*, *Convolvulus sepium*, and grasses like
140 *Thinopyrum acutum*.

141 The eastern plain of Corsica is situated in the thermo-mediterranean biogeographical zone, below 100 m asl.
142 Human activities have shaped the landscape with vineyards, olive groves and *Citrus* plantations. Patches of
143 former maquis and forest vegetation (*Erica arborea*, *Arbutus unedo*, *Quercus ilex* and *Quercus suber*) persist,
144 along with sclerophyllous vegetation such as *Pistacia lentiscus*, *Juniperus phoenicea*, *Phillyrea latifolia*,
145 *Viburnum tinus*, *Myrtus communis*, *Olea europaea* and *Salvia rosmarinus*. The saline environment of Aleria
146 Del Sale has allowed the spread of halophilous plants such as *Salicornia fruticosa*, *Arthrocaulon*
147 *macrostachyum*, *Halimione portulacoides*, *Suaeda maritima* (Amaranthaceae) and *Hordeum marinum*
148 (Poaceae) (Gamisans, 1999; Lorenzoni et al., 1995). Wetlands host communities of *Phragmites australis*
149 (Poaceae), *Bolboschoenus maritimus* (Cyperaceae) and *Juncus subulatus* (Juncaceae), while riparian zones
150 feature *Fraxinus angustifolia*, *Prunus spinosa* and *Tamarix africana*. At the local scale, l'étang de Palo is
151 occupied by *Salicornia* and *Atriplex* (Amaranthaceae), *Limonium vulgare* (Plumbaginaceae) and *Tamarix* in
152 halophytic environments, and by *Alnus glutinosa*, *Prunus spinosa*, *Rubus ulmifolius* and *Pteridium aquilinum*
153 in freshwater environments.

154 In southern Corsica, Piantarella lagoon is surrounded by Mediterranean maquis (*Cistus monspeliensis*,
155 *Juniperus phoenicea*, *Pistacia lentiscus*, *Olea europaea*, *Arbutus unedo*) and marshlands with *Armeria*
156 *maritima*, *Juncus* spp., and presence of *Tamarix* in coastal dunes. In San Ciprianu maquis vegetation shows
157 the dominance of *Erica arborea*, *Arbutus unedo* and *Pistacia lentiscus*. The southern isle of Cavallo is covered
158 by thermo-mediterranean scrublands dominated by *Pistacia lentiscus*, *Cistus monspeliensis* and *Juniperus*
159 *phoenicea* subsp. *turbinata*. Some thermo-xerophilous grasslands induced by goat grazing during the 20th
160 century are still locally present. Depressions subject to marine influence (salt rising during summer and sea
161 spray) are occupied by halophytes, such as *Atriplex prostrata*, *Salicornia perennans*, *Frankenia laevis* and
162 *Spergularia* spp. (Poher et al., 2017).

163 In high-mountain areas (Monte Renoso summit is 2325 m) surrounding Lake Bastani, grasslands and low
164 shrubby formations of *Alnus viridis* subsp. *suaveolens*, *Juniperus* and *Berberis* compose the local vegetation.
165 In the valley, dense mixed oak forests are composed of *Quercus ilex*, *Quercus pubescens*, *Pinus nigra*, *Erica*
166 *arborea* and *Arbutus unedo* (Lestienne et al., 2020).

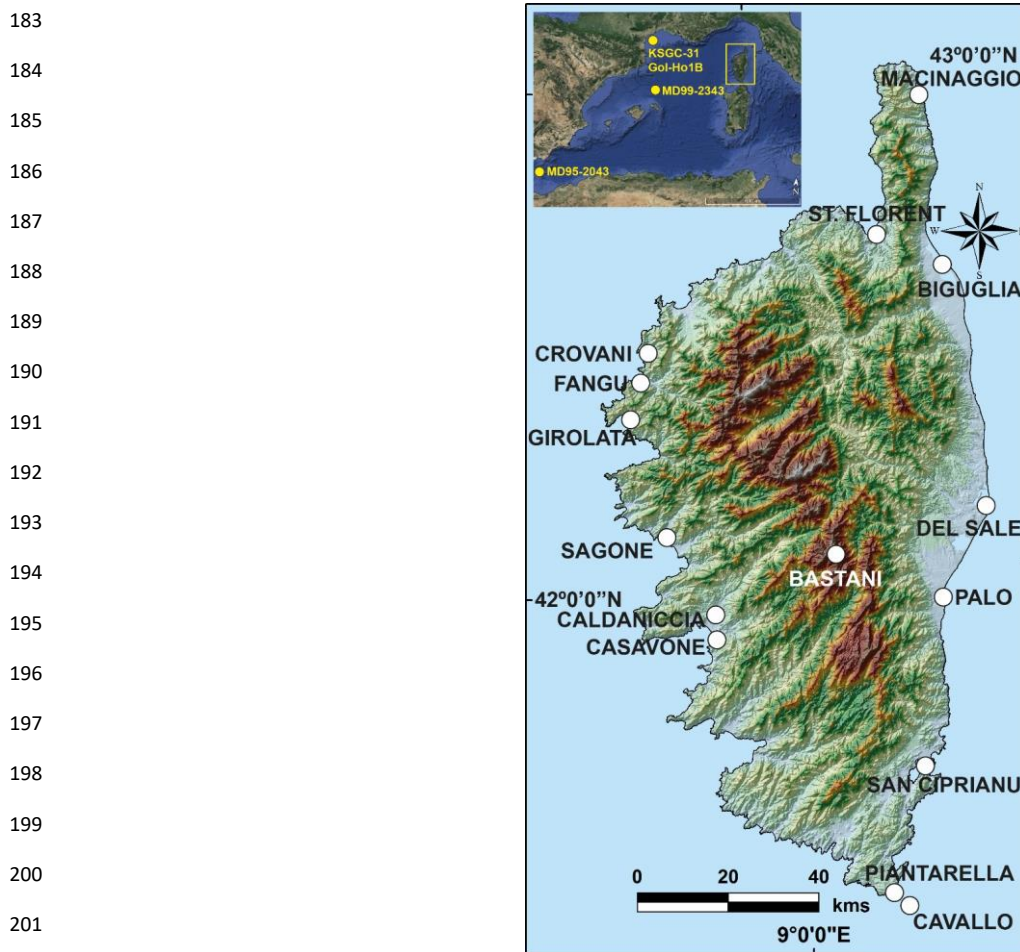
167 3. Material and methods

168 3.1. Description of sites

169 Corsica is the fourth largest Mediterranean island and has approximately two hundred coastal wetlands that
170 mainly formed over the last six millennia due to the post-glacial sea level rise slowdown (Ghilardi, 2020;
171 Vacchi et al., 2018). Some wetlands were formed due to the deltaic progradation of the main rivers of the
172 island while some other were created due to the combination of specific coastal configuration and the

173 Holocene spatial redistribution of the sediments by the sea (Ghilardi, 2021). This study includes fluvio-deltaic
174 wetlands as Biguglia, Del Sale, Saint-Florent, Palo, San Ciprianu, Sagone, Girolata 2, Caldaniccia and Fangu;
175 lagoons and marshlands created by the isolation of marine to brackish waters back of natural barriers, as
176 Crovani, Macinaggio, Casavone 2, Piantarella and Cavallo 2; and finally, the high mountain glacier lake
177 Bastani, which provides regional vegetation data beyond the coastal environments (Lestienne et al., 2020)
178 (Figure 1).

179 Pollen data from coastal sites are taken from our own studies (some of them unpublished, Table 1); the high-
180 mountain record Lake Bastani (Lestienne et al. 2020) was obtained from the European Pollen Database
181 datasets available in Neotoma Paleocological Database (<https://www.neotomadb.org/>). The site radius was
182 determined by vectorizing the swamplands using GIS.



202 Figure 1. Location map of the study area and the pollen records. Digital Elevation Model is derived from
203 BDAlti data from IGN.

204

Site name	Latitude Longitude	Altitude	Chronology (cal yr BP)	n ¹⁴ C dates	Size (surface ha)	Type (lake/bog)	References
Bastani	42°3'56.99"N 9°8'3.0012"E	+2094m	11732-0	14	4.4 ha	Lake	Lestienne et al. 2020
Biguglia	42°36'34.36"N 9°28'47.36"E	+0,10 m	1095-353	5	1450 ha	Lagoon	Ghilardi et al., 2025
Caldanicia	41°56'58.80"N 8°48'45.22"E	+8 m	7000-938	2	2 ha	Bog	Revelles, unpublished
Casavone2	41°54'7.55"N 8°48'16.31"E	+1,1 m	1280-408	3	9 ha	Freshwater pond	Revelles, unpublished
Cavallo2	41°22'5.69"N 9°15'50.98"E	+2.74 m	3938-26	4	1.3 ha	Freshwater pond	Revelles, unpublished
Crovani	42°28'21.68"N 8°40'51.31"E	+0,75 m	6081-0	14	3.5 ha	Freshwater pond	Di Rita et al., 2022
Del Sale	42° 5'34.31"N 9°31'30.61"E	+0,36 m	5342-0	8	280 ha	Lagoon	Currás et al., 2017
Fangu	42°25'7.83"N 8°39'34.07"E	+0,25 m	5031-318	10	7 ha	Lagoon	Ghilardi et al., 2023
Girolata2	42°21'0.03"N 8°36'44.17"E	+0,45 m	2876-75	6	1.5 ha	Lagoon	Ghilardi et al., 2023
Macinaggio	42°57'50.93"N 9°27'3.75"E	+0,15 m	4694-167	3	4.2 ha	Lagoon	Ghilardi et al., 2025
Palo	41°57'34.42"N 9°24'48.86"E	+0,42 m	2876-75	7	200 ha	Lagoon	Revelles et al., 2019
Piantarella	41°22'29.34"N 9°13'12.62"E	+0,36 m	7406-51	12	4 ha	Lagoon	Revelles et al., 2019
Sagone	42° 7'10.30"N 8°41'37.35"E	+1,61 m	3463-2229	8	10 ha	Freshwater swamps	Ghilardi et al., 2016
Saint Florent	42°40'19.82"N 9°18'15.91"E	+0,47 m	6301-20	7	60 ha	Lagoon	Revelles et al., 2019
San Ciprianu	41°37'30.81"N 9°20'20.67"E	+0,12 m	4816-583	13	25 ha	Lagoon	Revelles, unpublished

205 Table 1. Pollen sites included in this study.

206 **3.2. Methodology**

207 *3.2.1. Pollen data compilation and preparation*

208 The taxonomy of fossil pollen datasets has been harmonised and simplified using the EPD and Neotoma
209 nomenclature. Since an age-depth model (in cal yr BP) is required for each pollen record for the application
210 of the LRA, we used the original published models, as they are based on site-specific expertise regarding
211 stratigraphy, sample contexts and local conditions (see Suppl. Mat. 1 for unpublished records). While newer
212 calibration curves, such as INTCAL20, are available, previous evaluations have shown that updating age-depth
213 models rarely results in significant changes. Count data from each site were aggregated into 500-year
214 contiguous time windows to facilitate correlation and comparison between sites. The use of 500-year-long
215 time windows is motivated by the need to obtain large pollen counts, which can reduce uncertainties in
216 REVEALS and LOVE reconstructions (Trondman et al., 2015). Pollen taxa were then assigned to RPP taxa
217 (Suppl. Mat. 2) resulting in RPP-harmonized pollen count data for each of the 16 pollen records.

218 *3.2.2. Principal Component Analysis and zonation*

219 Principal Component Analysis (PCA) and zonation of pollen data were conducted using the 'Rioja' R Package
220 (Juggins, 2015) and 'Vegan' R package (Oksanen et al., 2016). PCA and zonation were applied individually to
221 each site (Suppl. Mat. 3) and then PCA was performed on pollen percentage data. This approach ensures that
222 the analysis captures a broader spectrum of vegetation variability rather than being limited to the more
223 restricted set of RPP harmonised data. PCA was run at the regional scale for all sites to achieve two objectives:

224 first, to observe the ordination of samples and the influence of different taxa across the entire island; and
225 second, to classify each record into three temporal groups (before 4200 cal yr BP, 4200-2200 cal yr BP, after
226 2200 cal yr BP) for comparing vegetation evolution during distinct periods. These include the Neolithic (7800-
227 4000 cal yr BP), Bronze (4000-2700 cal yr BP) and Iron Ages (2700-2200 cal yr BP) and the Roman period
228 onwards (2200-1500 cal yr BP). To improve the assessment of forest history and human impacts (e.g.
229 deforestation and cultivation), the analysis was conducted twice: first, including all taxa, and second,
230 excluding local wetland and marshland herbs (Cyperaceae and Amaranthaceae). These plants can be
231 overrepresented in pollen records from coastal locations, complicating the interpretation of vegetation
232 dynamics related to local forests and human activity. Additionally, PCA was performed using LOVE results to
233 examine sample ordination without the influence of regional background vegetation, allowing a focus on
234 local vegetation dynamics. Detailed results of this analysis are available in Suppl. Mat. 7.

235 3.2.3. LRA algorithm, models LOVE and REVEALS

236 Local vegetation abundance was estimated using the Landscape Reconstruction Algorithm (LRA, Sugita,
237 2007a,b), a two-step model-based correction method applied to pollen count data. The first step employs
238 the REVEALS (REgional Vegetation EstimAtes from Large Sites) model to estimate regional vegetation from
239 pollen data that reflect regional vegetation patterns (Sugita, 2007a). The second step applies the LOVE (L
240 Vegetation Estimates) model to estimate local vegetation abundance, applied to pollen counts from target
241 sites, taking into account regional vegetation cover via the output of the REVEALS model (Sugita, 2007b).

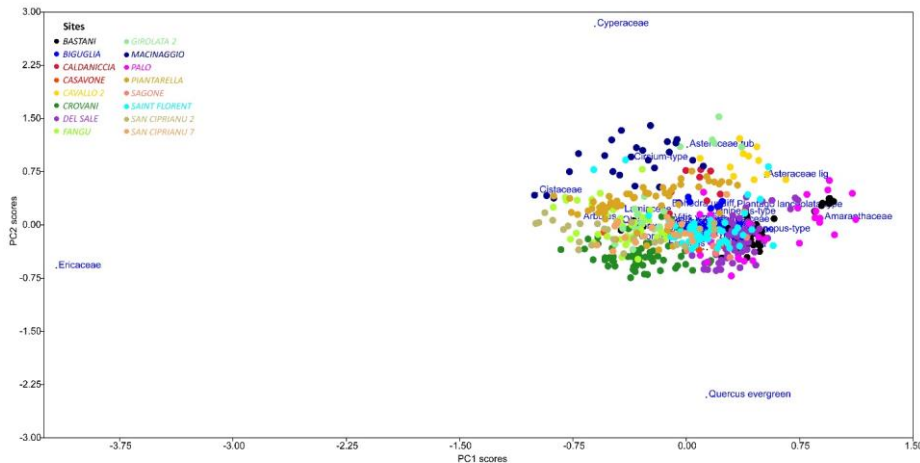
242 The LRA requires pollen count data from chronologically constrained sequences, site characteristics (e.g. lake
243 or bog, site size), relative pollen productivity (RPP) estimates expressed relative to a reference taxon, and fall
244 speed estimates for the key pollen taxa (Broström et al., 2008). For this study, harmonised raw pollen count
245 data from 16 pollen sequences, organized into continuous 500-year intervals, served as input for the LRA.
246 Not all sites spanned the same duration (Table 1). In the absence of large lakes, networks of smaller sites
247 have been validated for estimating regional vegetation abundance (Sugita et al. 2010; Fyfe et al. 2013;
248 Trondman et al. 2016). The RPP values were sourced from the LANDCLIM project (Githumbi et al., 2022),
249 representing averages from multiple European studies (Suppl. Mat. 2). A constant wind speed of 3 m s^{-1} was
250 assumed, with Z_{max} (maximum extent of regional vegetation) set to 50 km. Relevant Source Area of Pollen
251 was estimated by the backward LOVE (inverse modelling, Sugita 2007a,b), with values between 442-1942
252 meters.

253 The LRA was run separately for each site, excluding target-site data from the REVEALS regional vegetation
254 estimates, to produce percentage vegetation cover estimates within the necessary source area of pollen
255 (Sugita et al., 2007b) for each taxa around each site. As in the case of PCA and zonation analyses, the LRA was
256 conducted twice: once including all taxa and once excluding Cyperaceae and Amaranthaceae. The REVEALS
257 model outputs were used to calculate two pollen ratios indicative of changes in seasonal moisture patterns
258 (see Fig. 8). The ratio *Erica*/mesophilous trees (*Alnus* spp., *Quercus* deciduous, *Corylus*, *Fagus*, *Tilia*, *Ulmus*,
259 *Fraxinus*, *Salix*) reflects a gradient from arid or prolonged summer drought conditions toward cooler, moister
260 environments. Conversely, the ratio *Quercus* evergreen/*Erica* is interpreted here as an indicator of declining
261 summer drought stress, with *Q. ilex* expansion and *Erica* regression marking a shift from summer-dominated
262 drought to conditions with moister summers. The observed transition from *Erica*-dominated landscapes to
263 *Q. ilex* woodlands is thus interpreted as a signal of climatic reorganization, likely driven by declining summer
264 insolation (Magny et al., 2002), leading to wetter summers and reduced fire activity (Beffa et al., 2016). The
265 Biguglia record was excluded from the LOVE model reconstruction due to its large size (1450 ha), which
266 exceeded the model's suitability for target-site analysis. At San Ciprianu, two records were analyzed, with
267 San Ciprianu 7 plotted in Figure 6 instead of San Ciprianu 2 (details on SC2 LOVE reconstruction are provided
268 in Supplementary Material 6). However, both SC2 and SC7 were included in Figures 2, 3, 4, 5, 7, and 8.

269 **4. Results**

270 **4.1. Principal Component Analysis (PCA)**

271 The Principal Component Analysis was run for each site individually (see Suppl. Mat. 3) and, then for all sites
 272 together, firstly, including all taxa (Fig. 2); secondly, excluding Cyperaceae and Amaranthaceae (Fig. 3).



273 Figure 2. PCA plot for all taxa and all sites, using untransformed pollen percentages aggregated into 500 year time
 274 windows.

275 **All taxa (total inertia: 29.92):**

- 276 - PC1 (Inertia 7.6, eigenvalue 25.4 %): highest positive scores dominated by Amaranthaceae, Asteraceae
 277 liguliflorae and *Plantago lanceolata*-type; highest negative scores are dominated by Ericaceae and, to a
 278 lesser extent, by Cistaceae and Cyperaceae. Thus, in the left side of the PCA plot (Fig. 2), some samples
 279 from San Cipriano 2, Macinaggio, Girolata 2 and Piantarella are characterized by high values of Ericaceae
 280 and low values of Amaranthaceae; in the right, samples from Palo, and some samples from Del Sale and
 281 Lake Bastani are characterised by low values of Ericaceae and high values of Amaranthaceae, Asteraceae
 282 liguliflorae or *Plantago lanceolata*-type.
 283
- 284 - PC2 (Inertia 5.13, eigenvalue 17.2%): highest positive scores dominated by Cyperaceae and, to a lesser
 285 extent, Asteraceae tubuliflorae and *Cirsium*-type; highest negative scores dominated by *Quercus*
 286 evergreen. In that sense, uppermost samples show high values of Cyperaceae and low of *Quercus*
 287 evergreen at Macinaggio and Girolata 2; in the bottom, samples with high values of evergreen oak in
 288 Crovani and Del Sale (Fig. 2).

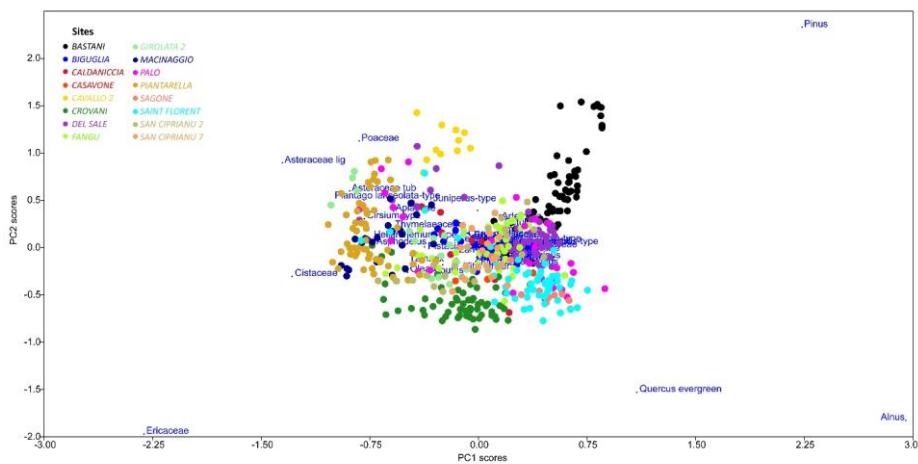
289 The PCA including all taxa shows a strong statistical weight of Amaranthaceae and Cyperaceae in the
 290 ordination of samples, suggesting that very local vegetation growing in swamps and marshlands are masking
 291 the evolution of local forests and maquis. For that reason, the analyses have been run twice, in the second
 292 step excluding Cyperaceae and Amaranthaceae taxa.

293 **Excluding Cyperaceae and Amaranthaceae (total inertia: 25.08):**

- 294 - PC1 (Inertia 6.17, eigenvalue 24.6%): highest positive scores dominated by *Alnus*, *Pinus* and *Quercus*
 295 evergreen; highest negative scores dominated by Ericaceae and, to a lesser extent, Asteraceae
 296 liguliflorae, Cistaceae, *Plantago lanceolata*-type and Poaceae. In the right side of the plot, samples from

297 Lake Bastani, Palo, Saint Florent and Del Sale, in relation to the importance of *Pinus* in high mountain
 298 areas (Bastani) and *Alnus* and *Quercus* evergreen in the eastern coast (Palo and Del Sale) and in some
 299 northern sites (Saint Florent). In the left, samples from sites where Mediterranean Ericaceae-dominated
 300 maquis and open spaces predominate, mainly Piantarella and also samples from Macinaggio and Girolata
 301 2.

302
 303 - PC2 (Inertia 4.2, eigenvalue 16.8%): highest positive scores dominated by *Pinus* and, to a lesser extent,
 304 Poaceae and Asteraceae liguliflorae; highest negative scores dominated by Ericaceae, *Quercus* evergreen
 305 and *Alnus*. Uppermost samples proceed from high-mountain Bastani, where *Pinus* predominates and
 306 Cavallo 2, where *Pinus* and open spaces with Poaceae and Asteraceae are the main components of the
 307 landscape. In the bottom, samples from Crovani and Saint Florent, where *Pinus* show low values and
 308 Ericaceae (Crovani) and *Alnus-Quercus* evergreen (Saint Florent) predominate.

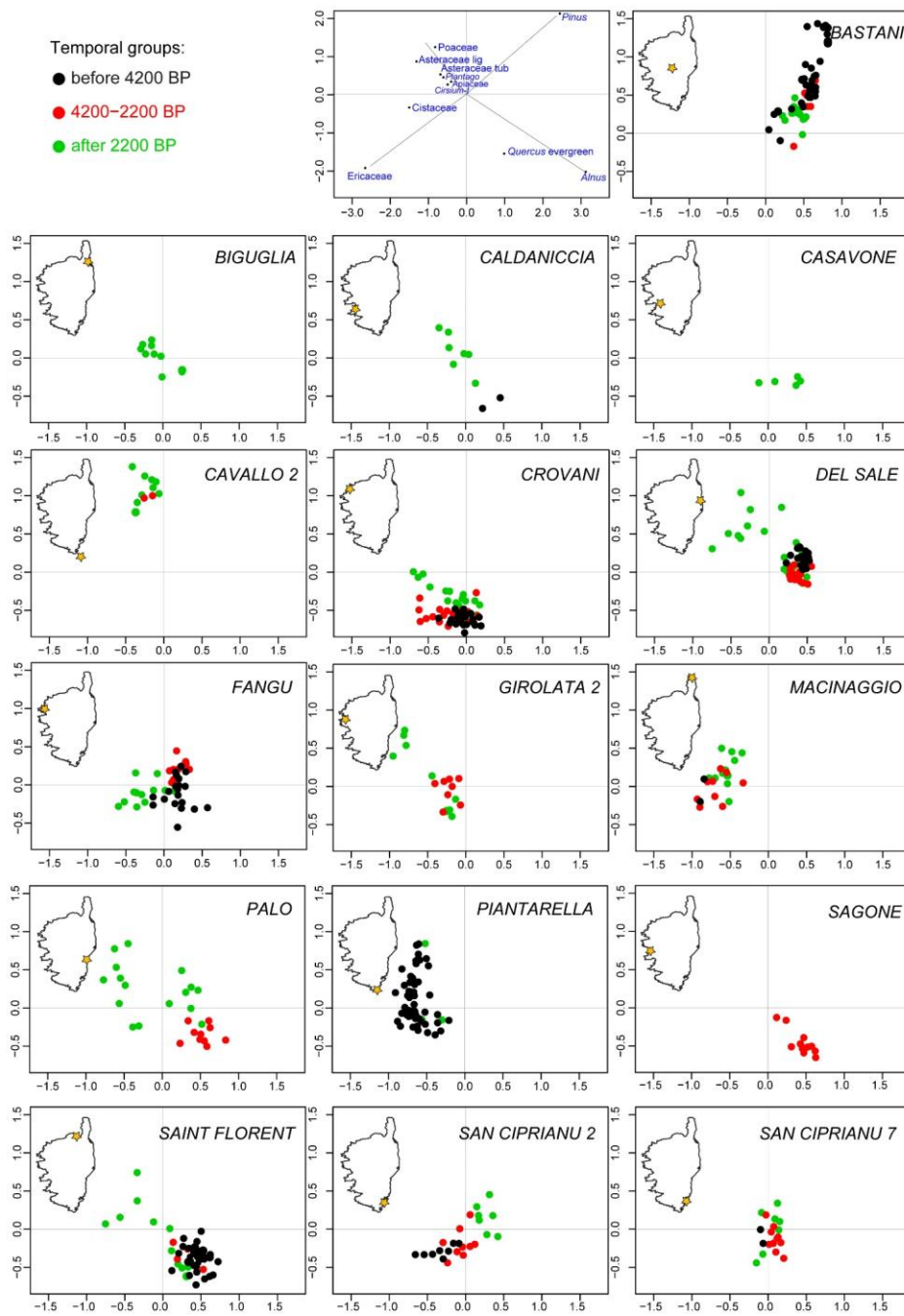


309 Figure 3. PCA plot excluding Cyperaceae and Amaranthaceae and all sites using untransformed pollen
 310 percentages aggregated into 500 year time windows.

311 In a second step, the PCA was divided in individual plots for every site and samples were aggregated in
 312 temporal groups (before 4200 cal yr BP, 4200-2200 cal yr BP, after 2200 cal yr BP) (Fig. 4), in order to show
 313 the landscape evolution during the Holocene at each site. This multi-site plot of PCA results was run for all
 314 taxa (Suppl. Mat. 4) and excluding Cyperaceae and Amaranthaceae (Fig. 4):

- 315 - Bastani: high predominance of *Pinus* in older samples, and expansion of *Quercus* evergreen yet in
 316 punctual samples before 4200 cal yr BP and 4200-2200 cal yr BP, but specially after 2200 cal yr BP, when
 317 trend towards increasing open spaces is also evident.
- 318 - Biguglia: predominance of Ericaceae and *Pinus* confers this central distribution of Biguglia samples.
- 319 - Caldaniccia: transition from predominant *Alnus* before 4200 cal yr BP to expansion of open spaces
 320 dominated by grasslands and cereals after 2200 cal yr BP.
- 321 - Casavone: from predominance of local *Alnus* forests and regional predominance of *Quercus* evergreen
 322 forests to the expansion of Ericaceae maquis in most recent samples.
- 323 - Cavallo 2: predominance of local herbs and a regional signal of *Pinus* in the whole sequence.

- 324 - Crovani: equilibrium between Ericaceae maquis and forests of *Alnus* and *Quercus* evergreen before 4200
325 cal yr BP, showing expansion of Ericaceae in 4200-2200 cal yr BP, herbs and shrubs (Cistaceae) after 2200
326 cal yr BP (Fig. 4).
- 327 - Del Sale: predominance of *Pinus* and *Quercus* evergreen before 2200 cal yr BP and later expansion of
328 herbs.
- 329 - Fangu: high values of *Alnus* before 4200 cal yr BP, expansion of *Pinus* in 4200-2200 cal yr BP and high
330 predominance of Ericaceae since 2200 cal yr BP onwards.
- 331 - Girolata 2: predominance of Ericaceae and *Quercus* evergreen in 4200-2200 cal yr BP and expansion of
332 herbs (Asteraceae) and shrubs (Cistaceae) after 2200 cal yr BP.
- 333 - Macinaggio: high predominance of Ericaceae in the whole sequence with expansion of herbs after 2200
334 cal yr BP.
- 335 - Palo: predominance of *Alnus* and *Quercus* evergreen in 4200-2200 cal yr BP, expansion of herbs
336 (Asteraceae and Poaceae) after 2200 cal yr BP and low values of Ericaceae in the whole sequence.
- 337 - Piantarella: high predominance of Ericaceae in the whole sequence (mainly before 4200 BP samples)
338 and, in some samples, high values of herbs (Asteraceae and Poaceae) and shrubs (Cistaceae).
- 339 - Sagone: high predominance of *Alnus* in 4200-2200 cal yr BP and expansion of herbs and Ericaceae in the
340 most recent samples.
- 341 - Saint Florent: predominance of *Alnus* before 4200 cal yr BP, expansion of *Quercus* evergreen in 4200-
342 2200 cal yr BP and of herbs (mainly Poaceae) after 2200 cal yr BP.
- 343 - San Cipriano 2: predominance of Ericaceae before 4200 cal yr BP, showing a decreasing trend, and
344 progressive expansion of *Quercus* evergreen and, especially *Pinus*, in 4200-2200 cal yr BP and after 2200
345 cal yr BP, respectively.
- 346 - San Cipriano 7: equilibrium between Ericaceae, *Alnus*, *Quercus* evergreen and *Pinus* during the whole
347 sequence.
- 348



349
350
351

Figure 4. PCA plot for individual sites with samples aggregated by temporal groups, excluding Cyperaceae and Amaranthaceae, using untransformed pollen percentages aggregated into 500-year time windows.

352 In summary, the PCA ordination reveals four different landscape composition patterns over successive 500-
353 year windows: 1) predominance of pine forests in high mountain areas (Lake Bastani); 2) a combination of
354 evergreen oak dominance at regional scale and riparian forests at local scale along the eastern coast and in
355 the north (Saint Florent); 3) predominance of Ericaceae maquis, with fluctuations showing increased
356 representation of low Cistaceae maquis in the south and north-west in later periods; 4) higher proportions
357 of open vegetation (grasslands), especially during the Middle Holocene in the south and in more recent
358 chronologies at various sites across the island.

359 **4.2. Quantified regional and local vegetation cover estimates.**

360 **4.2.1. Regional Vegetation Estimates in Corsica (REVEALS results).**

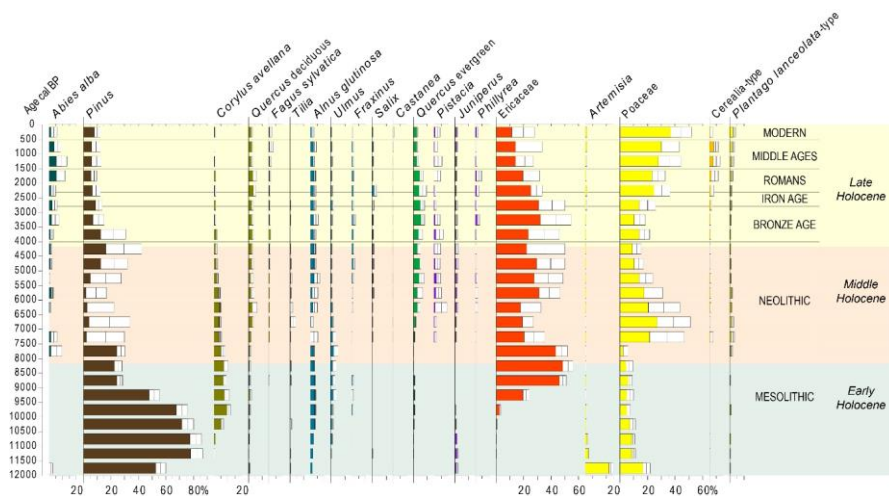
361 Regional Estimates of Vegetation (REVEALS model) were obtained using the 16 pollen records (Suppl. Mat.
362 5) and were used to build a synthesis diagram of Holocene Regional Vegetation Estimates for the whole Island
363 of Corsica (Figure 5). Early Holocene data are based exclusively on one high-mountain record (Lake Bastani),
364 due to the scarce organic sediments suitable for pollen analysis in coastal wetlands before the post-glacial
365 sea level rise slowdown in the Early to Middle Holocene transition. After the first centuries of the Early
366 Holocene, characterised by continued Late Glacial steppe dominated by *Artemisia* and Poaceae, *Pinus* forests
367 predominated from 11700 to 9500 cal yr BP. In the period 9500-8000 cal yr BP, regional cover of *Pinus* falls,
368 with an expansion of Ericaceae. This occurs in the context of the Holocene thermal optimum and more
369 frequent fire activity favouring the expansion of fire-adapted Ericaceae maquis (Lestienne et al., 2020). This
370 Holocene climate optimum is also correlated with the maxima of *Corylus avellana* in 10000-8000 cal yr BP
371 (Figure 5).

372 During the Middle Holocene, each time window includes between three to eight pollen records. This
373 increases standard errors (SEs) in the regional vegetation is due to regional vegetation diversity. The abrupt
374 decrease of *Pinus* shows that pine forests are not the main vegetation community in coastal areas in the
375 Island of Corsica, but that Ericaceae maquis is the predominant floristic element in the land cover. At the
376 same time, grasslands expand (Poaceae) and there is the appearance of the first evidence of cereal
377 agriculture. Peaks of Poaceae at the beginning of the Middle Holocene may also be explained by the
378 contribution of coastal sites. The oldest lagoon to provide pollen data (Piantarella) is located in the south,
379 where open spaces dominated by grasslands already existed by 7500-7000 cal BP, due to a combination of
380 anthropogenic pressure and more arid climate conditions in South Corsica. While riparian vegetation, mainly
381 *Alnus* spp., show high percentages in traditional pollen diagrams (i.e. Saint Florent, Revelles et al., 2019), the
382 REVEALS results suggest limited cover at the regional scale (Figure 5), demonstrating that their occurrence is
383 largely restricted to local riverbanks, wetlands and lakeshores. It is the same case for evergreen oak (*Quercus*
384 *ilex*-type) and deciduous oak (*Quercus* deciduous), which would have been growing at medium elevations
385 and on hills near the coast, but it is largely absent from coastal vegetation communities. The regional
386 vegetation estimates clearly show that Ericaceae maquis dominated the lowlands of Corsica until 1500 years
387 ago, when grasslands expanded into degraded maquis due to human activities. Evergreen oak forests had
388 limited cover and experienced their maxima during the Iron Age and Roman times (Figure 5). The continuous
389 presence of cereals since the early Neolithic indicated sustained land use over millennia, with maxima in
390 Roman times and during the Middle Ages. The appearance of *Castanea* since the Middle Ages suggests the
391 development of managed groves near the coast.

392

393

394



403 **Figure 5.** Synthesis diagram integrating Regional Vegetation Estimates for the 16 pollen records from Corsica.

404 **4.2.2. Local Vegetation Estimates (LOVE results) in coastal areas of Corsica.**

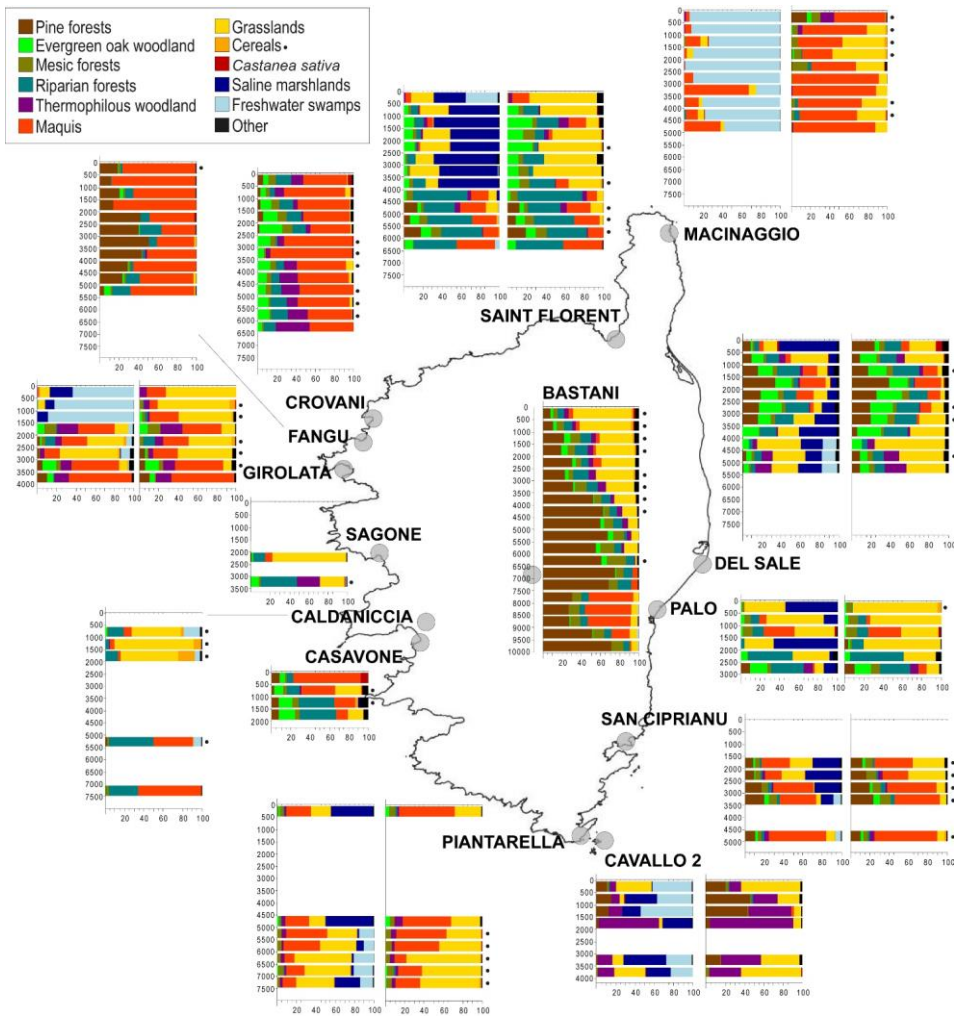
405 Local Vegetation Estimates (LOVE model) were generated individually for 15 pollen records (see detailed
 406 results in Suppl. Mat. 6). This analysis was run twice, the first including all taxa, the second, excluding local
 407 swamplands and marshlands herbs (Cyperaceae and Amaranthaceae). In some cases, the scarcity or absence
 408 of swamplands and marshlands provided similar or identical diagrams, but in some records, the picture of
 409 local vegetation changed significantly (Suppl. Mat. 6). PCA conducted on LOVE outputs highlights the
 410 significant influence of Amaranthaceae and Cyperaceae when all taxa are included. However, excluding these
 411 wetland and marshland taxa shifts the focus to broader vegetation patterns, with Poaceae and Ericaceae
 412 emerging as dominant contributors (Suppl. Mat. 7).

413 Figure 6 illustrates the predominance of swamps and marshlands in specific records, such as Macinaggio and
 414 Girolata (high Cyperaceae values), Saint Florent, Del Sale, Palo, and San Ciprianu (high Amaranthaceae
 415 values), and Piantarella and Cavallo 2 (high values of both taxa). When Cyperaceae and Amaranthaceae are
 416 excluded, the analysis reveals local landscape evolution beyond swamp and marsh influences. This includes
 417 the predominance of Ericaceae and Poaceae in records such as Macinaggio, Girolata, San Ciprianu, and
 418 Piantarella, a dominance of Poaceae in Palo and Saint Florent, and mosaic landscapes in Del Sale. Regional
 419 trends in coastal landscape evolution are evident: *Erica* maquis dominates in the northwest, alder forests
 420 appear in Saint Florent and Casavone, and grasslands emerge in the south from the middle Holocene onward.
 421 Piantarella shows extensive grasslands, while Cavallo Island features open *Pistacia* woodlands interspersed
 422 with grasslands.

423
 424 Local orography constitutes an important factor explaining local coastal vegetation derived from LOVE model
 425 estimates. The case of Caldaniccia and Casavone records is the most representative, as they are located at 2
 426 km of distance from each other, and they show different local vegetation dynamics. The local orography
 427 influence on the representation of forests at local scale, as Étang de Casavone is nearer (2 km) to low
 428 elevations (120-180 m asl.), while the area of Caldaniccia is 4 km away from mountains. This small difference
 429 explains important values of evergreen *Quercus* and the presence of deciduous *Quercus* and *Pinus* at local
 430 scale in Casavone, and the absence of these tree taxa in Caldaniccia LOVE model (Fig. 6). Although both
 431 REVEALS and LOVE models highlighted the predominant role of Ericaceae maquis and the limited role of
 432 *Quercus ilex*-type in Corsican lowlands, the representation at local scale in many records of mixed oak forests

433 is due to the steep topography of the island and the low distance of montane belts from the coast, as is the
434 case of Monte Sant'Angelo (354 m asl.) near Saint Florent, and peaks at 565 m asl. near Macinaggio in Cape
435 Corsica. This explains the important role of evergreen *Quercus* during the Late Holocene in the north around
436 Saint Florent, where *Quercus ilex*-type consisted of the predominant woody taxa after the decline of
437 Ericaceae maquis and *Alnus* forests in the lowlands. Finally, it is remarkable the limited presence of *Alnus*
438 spp. riparian forests in the NW compared with other Corsican areas, such as Saint Florent in the north, Del
439 Sale and Palo on the eastern coast and Sagone on the western coast (Fig. 6). This is explained by the important
440 role of coastal *Pinus pinaster* and *Pinus laricio* forests, favoured by the granitic substrate at low altitudes in
441 this area of Corsica. The record of Fangu is the most representative of the development of coastal pine
442 forests, reaching its optimum in 4.0-2.0 cal ka BP, before strong human exploitation reduced its presence in
443 these coastal lowlands.

444
445
446
447
448
449



450
 451 **Figure 6.** Synthesis diagram showing LOVE model reconstructions for 14 records. For records with high values of local
 452 herbs (*Cyperaceae* and *Amaranthaceae*), two diagrams are presented: the first (left) includes all taxa, while the second
 453 (right) excludes *Cyperaceae* and *Amaranthaceae*. In the case of sites where there is only one diagram shown, the diagram
 454 includes all taxa. Presence of Cereal cultivation is highlighted with a dot.

455
 456
 457
 458
 459
 460
 461

462

463 5. Discussion

464 5.1. Landscape patterns and regional vegetation evolution in Corsica during the Holocene.

465 The regional diversity of Corsican vegetation has deep roots, as confirmed by the REVEALS model based on
466 Holocene pollen records from coastal wetlands. Since the Middle Holocene, vegetation composition and
467 communities across the island have shown significant changes. During the early Mid-Holocene (7500–6000
468 cal yr BP), grasslands (Poaceae) dominated the south as Ericaceae maquis declined, while dense maquis and
469 riparian forests developed in western Corsica (Figure 7). By 6000 cal yr BP, Ericaceae maquis expanded across
470 southern, northwestern, and northern Corsica, peaking around 4500–4000 cal yr BP. Regional differences are
471 notable, such as riparian forests (*Alnus* spp.), which played a significant role in the north and west but were
472 scarce in the south, likely restricted to local wetlands and riverbanks. Evergreen (*Quercus ilex*) and deciduous
473 oaks (*Quercus deciduous*) developed at medium elevations inland but played a limited role in coastal
474 lowlands.

475 The key contribution of the new reconstructions is the suggestion that *Q. ilex* played a more limited role in
476 coastal lowlands than previously assumed. In contrast to earlier interpretations (e.g., Reille, 1992), our data
477 do not support a direct successional trajectory from Ericaceae to *Q. ilex* driven by Neolithic human impact.
478 Instead, human pressure on Ericaceae-dominated maquis may have promoted the expansion of more
479 disturbance-adapted taxa such as Cistaceae and Poaceae (see PCA results in Figure 3 and original pollen
480 percentages in Suppl. Mat. 3). Grasslands, degraded shrublands (e.g., Cistaceae), and even *Pinus* expanded
481 in certain regions (Figure 7). Although we do observe an expansion of *Q. ilex* during the Roman Climate
482 Optimum, this appears to be more closely linked to climatic factors than to early anthropogenic disturbance.

483 The expansion of Ericaceae around 9500 cal yr BP (Figure 5) is attributed to the Early Holocene Thermal
484 Optimum and frequent fires (Lestienne et al., 2020), with Ericaceae spreading to higher altitudes due to
485 climate and fire dynamics. Its predominance during the Middle Holocene reflects prolonged summer drought
486 favouring fire-adapted species like *Erica arborea* and *E. scoparia* (Di Rita et al., 2022a). Similar trends in
487 Sardinia during this period link to warmer, drier summers and cooler, moister winters (Beffa et al., 2016).
488 Pollen ratios (Fig. 8) suggest moister summers between 7000 and 6000 cal yr BP, especially in north Corsica,
489 linked to higher SSTs in the Minorca Sea (Català et al., 2019), followed by increased aridity and prolonged
490 summer drought from 5500 cal yr BP onwards, coinciding with the Bond 4 cooling event and global Rapid
491 Climate Change (RCC) around 6.0–5.0 cal ka BP (Mayewski et al., 2004). These conditions fostered
492 thermophilous woodlands (*Pistacia*, *Phillyrea*, *Juniperus*) with regional variations (Fig. 7), including their
493 prominence on the isle of Cavallo (Suppl. Mat. 5).

494 Climatic instability linked to Bond events 3 and 2 (4.2, 2.8 cal ka BP, Bond et al., 2001), RCC 2 (3.2 cal ka BP,
495 Mayewski et al., 2004), and the Homeric Minimum (2.75–2.55 cal ka BP, Martin-Puertas et al., 2012), caused
496 forest declines in the central and western Mediterranean due to increased aridity (Fletcher et al., 2013;
497 Magny et al., 2013; Di Rita et al., 2018a,b). However, Corsican vegetation showed resilience, with *Erica*
498 expanding in the South under heightened aridity and *Fagus* increasing in the North and East (4500–3500 cal
499 yr BP), suggesting localized humidity during the Mid-to-Late Holocene transition (Fig. 7). This contrasts with
500 drier conditions recorded in Tuscany's caves (Zanchetta et al., 2016; Isola et al., 2019) and cooler SST in the
501 Western Mediterranean (Català et al., 2019; Jalali et al., 2016; Fig. 8). Recent analyses point out that, despite
502 a general stability of the forest cover, a few sites of Corsica document an increase in the rate of floristic
503 change during the 4.2 cal ka BP (Michelangeli et al., 2025). All these findings highlight the complexity and
504 variability of the 4.2 ka event's impact (Bini et al., 2019; Di Rita and Magri, 2019; Di Rita et al., 2022b) and
505 Corsica's divergence from broader Mediterranean trends during the onset of the Late Holocene. This Corsican

506 pattern of ecological resilience aligns with other Mediterranean regions at similar latitudes that exhibited
507 stability in response to Mid and Late Holocene rapid climate fluctuations. A notable parallel can be drawn
508 with northeastern Iberia (Revelles et al., 2018) and northern Italy (Di Rita and Magri, 2019), where vegetation
509 communities adapted to climatic variability without experiencing severe ecological collapse. This suggests
510 that latitude, along with local environmental conditions and ecosystem adaptability, played a key role in
511 modulating responses to large-scale climate events, contributing to regional differences in vegetation
512 dynamics across the Mediterranean.

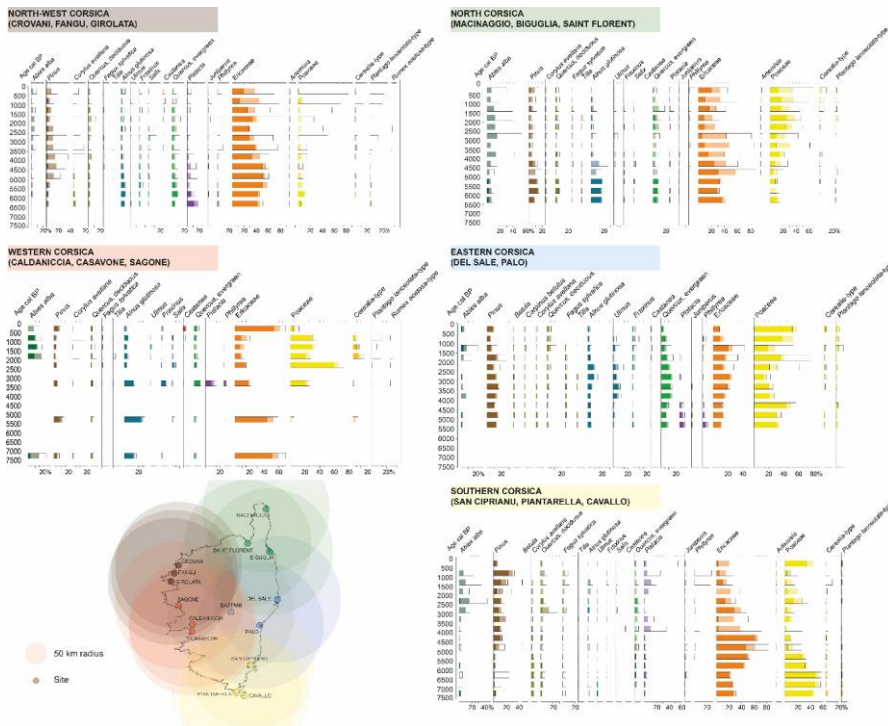
513 Wetter conditions from 3.5–2.8 cal ka BP marked a shift to moister summers, evidenced by the expansion of
514 *Quercus ilex* and mesophilous trees (*Quercus deciduous*, *Fagus*), and intense precipitation episodes
515 documented in sedimentological records, such as Crovani (Di Rita et al., 2022a); Girolata (Ghilardi et al., 2023)
516 and Canniccia (Ghilardi et al., 2017; Vella et al., 2019). These changes coincide with increased storm activity
517 in the Gulf of Lion (Sabatier et al., 2012) and alluviation in the Pyrenees and Rhone (Galop et al., 2007; Berger
518 et al., 2007). During the Roman Climate Optimum (ca. 2500-1500 cal BP), *Quercus ilex* forests reached their
519 maximum extent, particularly in upland and mid-elevation areas, although their presence in lowlands
520 remained more limited (Figs. 5 and 7). Persistent negative phases of the North Atlantic Oscillation (NAO) likely
521 enhanced winter precipitation across the western Mediterranean, increasing soil moisture and promoting
522 forest expansion, including *Q. ilex*. At the same time, declining summer insolation reduced
523 evapotranspiration, alleviating summer drought stress. Speleothem records from the Apuan Alps (Bini et al.,
524 2020) support this climatic pattern, documenting a marked increase in precipitation from the late 1st century
525 BC to the early 1st century AD, likely associated with a prolonged negative NAO phase. The combination of
526 wetter winters and reduced summer drought likely suppressed fire frequency and favored the development
527 of more continuous, closed-canopy vegetation, reflected in the decline of *Erica* and other pyrophytic taxa.

528 These more stable and humid environmental conditions would also have improved freshwater availability in
529 coastal wetlands, particularly along Corsica's western coast, creating favorable settings for settlement and
530 land use intensification during the Roman period (Ghilardi et al., 2023). The peak of *Q. ilex* forests and
531 associated human activity thus reflects a period of combined climatic and ecological stability that supported
532 the expansion of land-use across the island. Mesophilous trees primarily remained at higher elevations but
533 expanded slightly to lower areas during this time. Coastal pine forests had already expanded during the Mid-
534 to-Late Holocene transition (5000–3500 cal yr BP), reflecting a dynamic interplay of climate and vegetation.

535 The Late Antiquity Little Ice Age (LALIA, Fig. 8), also referred to as the Early Medieval Cooling episode or
536 Migration Period Cooling (1450–1050 cal yr BP; Ljungqvist, 2010), ended the Roman Climate Optimum and
537 brought significant environmental shifts. Evergreen oak declined, while *Erica* maquis and grasslands
538 expanded, reflecting increased aridity, summer drought and growing human impact. Human activities over
539 the last two millennia complicate the interpretation of pollen records solely as the result of the paleoclimate
540 forcing. Notably, cereals appear consistently in vegetation models from the Neolithic, peaking during Roman
541 times and the Middle Ages (Fig. 7). Additionally, the appearance of *Castanea* during the Middle Ages suggests
542 its cultivation, a traditional activity in Corsica with origins at least as far back as this period.

543 In summary, Corsican vegetation demonstrates broad trends, such as the dominance of *Erica* maquis from
544 the Early to Middle Holocene, the peak of *Quercus ilex* during the Roman Climate Optimum, and the
545 expansion of grasslands due to human impacts from the Middle Ages onward. Regional contrasts, however,
546 are clear. The South's arid conditions supported grasslands and limited mesophilous trees and riparian
547 vegetation (Fig. 7). The North maintained prominent riparian forests and arboreal vegetation during the Late
548 Holocene, while the eastern coast exhibited a patchy landscape with notable evergreen oak, pine forests,
549 and riparian vegetation, partly influenced by pollen input from central Corsica's highlands and even mainland
550 Italy, as seen in *Carpinus betulus*, a tree not native to Corsica (Reille, 1992).

551
 552
 553
 554
 555



556 **Figure 7.** REVEALS model for different Corsican regions: North-West, North, West, East and South.

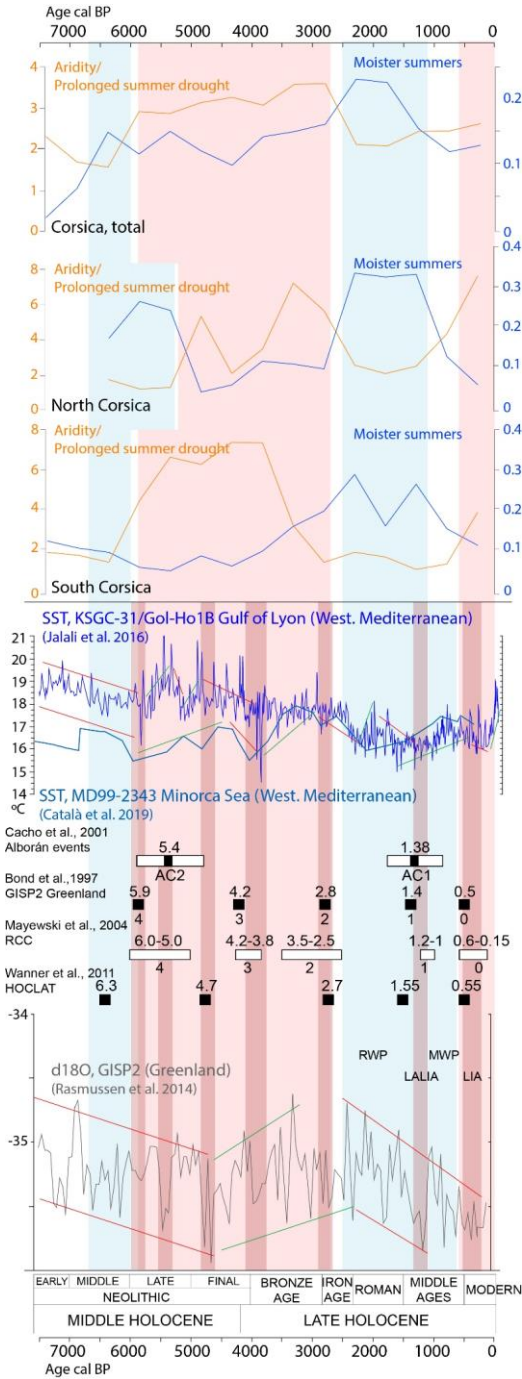


Figure 8. Pollen ratios calculated using REVEALS data, indicating aridity or prolonged summer drought (*Erica*/mesophilous trees (*Alnus* spp., *Quercus* deciduous, *Corylus*, *Fagus*, *Tilia*, *Ulmus*, *Fraxinus*, *Salix*)) and moister summers (*Quercus* evergreen/*Erica*), in relation to climate proxies, Sea Surface Temperatures (SST) from Minorca Sea (Català et al., 2019) and Gulf of Lyon (Jalali et al., 2016); and $\delta^{18}\text{O}$ from ice core records (GISP2, Greenland, Rasmussen et al., 2014).

570 **5.2. Local vegetation evolution in changing coastal landscapes.**

571 The evolution of Corsican coastal wetlands reflects a dynamic interplay between geomorphological
572 processes, climate shifts, and human activity. Marine transgression and deltaic progradation were primary
573 drivers of landscape change, leading to the transformation of lagoons and shallow marine environments into
574 marshlands and swamps. This process occurred in two main phases: first, during the marine transgression
575 (6.5–4.2 cal ka BP), when sea level rise influenced wetland formation; second, from 4.2 cal ka BP onwards,
576 deltaic progradation led to sediment accumulation and shallowing, expanding subaerial swamplands and
577 marshes. These environments exhibited varying degrees of salinity and humidity, with increasing dominance
578 of sedges and marsh vegetation (Cyperaceae, Amaranthaceae, and, in part, Poaceae) (Figure 6).

579 The development of coastal wetlands varied across Corsica due to local geomorphological and climatic
580 factors. In the West and North (Caldaniccia, Saint Florent), early wetland formation followed marine
581 transgression, with riparian forests (*Alnus glutinosa*, *Salix*, *Ulmus*) dominating coastal lowlands. In contrast,
582 southern and eastern sites (Piantarella, Del Sale) developed marshlands earlier (7.5–5.5 cal ka BP), likely in
583 response to drier conditions. As deltaic progradation advanced, Del Sale (East) and San Ciprianu (South)
584 experienced wetland expansion (6.0–4.0 cal ka BP), and in Piantarella, a new marshland phase replaced
585 earlier freshwater swamps (Figure 6).

586 From the early Bronze Age (4.2 cal ka BP onwards), intensified sedimentation advanced the coastline in Del
587 Sale, leading to the regression of swamps and marshlands (3.5–1.5 cal ka BP). These processes contributed
588 to the establishment of a mixed landscape of sclerophyllous forests (evergreen oak and pine woodlands),
589 maquis and riparian forests (Figure 6). Similarly, in Saint Florent (North), the transition from marine
590 environment to subaerial marshlands (from 4.2 cal ka BP) drove the expansion of Amaranthaceae and
591 grasslands (4.0–3.5 cal ka BP) due to both environmental changes and increasing human influence, as
592 evidenced by a local decline in Ericaceae maquis (Figure 6).

593 In contrast, the western coast followed a different trajectory. Only Girolata (Northwest) shows minor
594 marshland expansion in recent periods (1.5 cal ka BP–present), remaining dominated by freshwater or
595 brackish sedge swamps. Other western sites, including Caldaniccia, Sagone, and Fangu, as well as isolated
596 marine/brackish wetlands (Crovani, Casavone), show minimal marine influence throughout the Middle and
597 Late Holocene. Local factors, such as barrier formations (e.g., Crovani’s shingle bar), effectively prevented
598 marine incursions and salinity increases from the Middle Holocene onwards (Di Rita et al., 2022). In that
599 sense, local orography played a key role in vegetation patterns. In the North (Saint Florent) and East (Palo,
600 Macinaggio), proximity to mountainous areas allowed for the persistence of *Quercus ilex* and mixed oak
601 forests, even as coastal vegetation transformed. In contrast, the Northwest (Fangu, Girolata) saw the
602 dominance of coastal pine forests (*Pinus pinaster*, *P. nigra* subsp. *laricio*), driven by granitic substrates in the
603 lowlands.

604 This reconstruction of local landscape evolution highlights two key insights. First, Corsican coastal landscapes
605 exhibit remarkable diversity, shaped by a combination of geomorphological processes, local orographic
606 features and climatic conditions. The interplay between marine transgression, deltaic progradation, and
607 regional aridity created a complex mosaic of wetlands, marshes, and forested lowlands that evolved
608 differently across the island. Second, coastal landscapes—considering both vegetation development and
609 geomorphological evolution—demonstrate a high degree of sensitivity to climatic shifts, particularly during
610 the mid-to-late Holocene transition. Episodes such as the 4.2 cal ka BP event and subsequent climatic
611 oscillations (e.g., 3.2–2.8 cal ka BP) (Bond et al., 2001; Mayewski et al., 2004) triggered significant
612 environmental transformations, influencing sediment dynamics, wetland expansion or regression, and shifts
613 in vegetation communities.

614 Importantly, while Corsican vegetation showed resilience at the regional scale in response to these climatic
615 events, local vegetation dynamics were more sensitive, exhibiting pronounced shifts in composition and
616 spatial distribution. Coastal wetlands, in particular, responded to changes in sea level, hydrology and
617 sedimentation dynamics, with certain areas experiencing rapid transformations while others remained
618 relatively stable due to local geomorphological constraints. This highlights the need for a detailed perspective
619 when assessing past environmental changes—not only considering broader regional trends but also
620 recognizing the variability of local responses.

621 **5.3. Landscape transformation in coastal ecosystems by humans since the Neolithic.**

622 Coastal ecosystems have long been central to human activity, serving as migration routes, resource hubs,
623 and centres of cultural development (Erlandson, 2001). The Local Vegetation Estimates (LOVE) model
624 provides fine-scale insights into human-environment interactions, revealing patterns of early farming
625 activities, deforestation episodes, and long-term landscape transformations in Corsican coastal areas.

626 ***Neolithic and Bronze Age Agricultural Expansion and Decline.***

627 The lack of pre-7.5 cal ka BP sediments limits paleoecological insights into the Mesolithic–Neolithic transition
628 (8.0–7.8 cal ka BP; Lugliè, 2018), but Piantarella provides the earliest evidence of cereal cultivation (7.4 cal
629 ka BP; Fig. 6), coeval with Early Neolithic settlements in Bonifacio (Araguina Sennola, Longone; Lugliè, 2018)
630 and northeast Sardinia (Melis et al., 2018). The expansion of grasslands and decline of maquis between 6.5
631 and 6.0 cal ka BP may reflect local-scale landscape transformation influenced by early agricultural practices,
632 although other factors such as climatic variability or fire disturbance may also have contributed. During the
633 Recent Neolithic (6.0–5.0 cal ka BP), cereal agriculture expanded beyond the south, contributing to the
634 decline of Ericaceae in Saint Florent and thermophilous woodland clearance in Crovani (Fig. 6), while human
635 impact in Caldaniccia remained limited. Despite regional differences, a common pattern emerges: coastal
636 environments supported the establishment and expansion of agricultural societies in Corsica playing a crucial
637 role in Neolithic settlement dynamics, offering rich ecotones between marine and terrestrial ecosystems, as
638 well as between coastal wetlands and inland woodlands, together with freshwater resources and favourable
639 conditions for early farming.

640 The Late Neolithic–Chalcolithic (5.0–4.2 cal ka BP) saw farming expand to the eastern coast (Del Sale, San
641 Ciprianu, see Cerealia-type in Figs. 6 and 7), yet a decline in anthropogenic indicators (4.5–3.5 cal ka BP)
642 suggests reduced coastal occupation, likely due to shifts toward upland settlements. In that sense, alluvial
643 deposits (4.2 cal ka BP; Ghilardi, 2021) suggest erosion from upland deforestation and torrential rains. During
644 the Early Bronze Age (4.0–3.5 cal ka BP), agriculture persisted in the north (Saint Florent, Macinaggio), while
645 the Middle Bronze Age (3.5–2.5 cal ka BP) saw renewed transformation, particularly in Crovani (woodland
646 decline, grassland expansion; Fig. 6). In Girolata 2, evidence of farming and grassland expansion continues
647 from the Bronze Age into the Iron Age and Roman periods (3.5–2.0 cal ka BP).

648 ***Iron Age, Roman Intensification, and Spatial Specialization.***

649 By the Late Bronze Age and Iron Age (3.5–2.5 cal ka BP), land-use intensified in Del Sale and San Ciprianu (Fig.
650 6), while the Phocaeen colony of Alalia (565 cal yr BCE; 2.5 cal ka BP) appears to have had minimal
651 environmental impact. In this context, our data align with the lack of clear archaeological evidence for a
652 significant Greek presence in the area. Roman times (2.5–2.0 cal ka BP) saw grassland expansion, woodland
653 regression, and increased settlement across the north, northwest, and eastern coasts (Fig. 6). Historical
654 sources describe deforestation for timber (e.g., Laricio pine harvesting; Theophrastus, 371–288 BCE; Ghilardi
655 et al., 2023), likely contributing to pine forest decline in Girolata and Fangu (Fig. 6).

656 During the Roman Empire (2.0–1.5 cal ka BP), spatial specialization of land use emerges. Cereal farming
657 declined in the northwest (Girolata), replaced by thermophilous woodland recovery, while olive (*Olea*)

658 cultivation expanded (Crovani, Di Rita et al., 2022a; Girolata, Ghilardi et al., 2023), mirroring regional
659 economic strategies seen in North Africa (Leveau, 1990). Agricultural activity concentrated in Caldaniccia,
660 where the highest Cerealia-type pollen levels were recorded (Fig. 6), cereal agriculture expanded in Cape
661 Corsica (Macinaggio; Ghilardi et al., 2025) and both cereal and olive show peaks in San Ciprianu (Fig. 6; Suppl.
662 Mat.3). Degraded shrublands dominated by Cistaceae replaced dense Ericaceae maquis in Crovani,
663 highlighting shifts in vegetation dynamics. Future improvements to the LOVE model should incorporate
664 Cistaceae and *Olea* RPPs to refine Mediterranean landscape reconstructions.

665 **Medieval Transformations: Deforestation and Castanea Expansion.**

666 During the early Middle Ages (1.5–1.0 cal ka BP), the LOVE reconstruction indicates woodland recovery, with
667 increases in pine forests (northwest), maquis and oaks (Saint Florent), and riparian forests (Palo, Fig. 6), likely
668 following a period of reduced human pressure after Roman deforestation and political instability. From the
669 11th–16th centuries CE, Pisan and Genoese rule brought renewed deforestation. As observed in higher detail
670 in Ghilardi et al. (2023), Pisan colonization (1070–1284 CE) cleared land for farming, while under Genoese
671 dominance (from 1347 CE), forests declined, and grasslands expanded, marking the most intense
672 deforestation phase.

673 While lowland vegetation had been impacted since prehistory, upland oak forests remained intact until the
674 Genoese period (0.5 cal ka BP–present, Fig. 6). Strong deforestation also recorded in Fangu and Girolata,
675 where cereal cultivation first appears in the 16th century CE, coinciding with the construction of defensive
676 towers near the Fangu estuary. A major medieval novelty was the expansion of *Castanea* (chestnut
677 cultivation) across different altitudes, with pollen records in Crovani, Saint Florent, Girolata, Casavone, and
678 Lake Bastani. However, low values of *Castanea* pollen are present from the onset of the Late Holocene (3.5–
679 3.0 cal ka BP, Del Sale, Crovani), and it was likely in a wild state before active human management.

680 **6. Conclusions.**

681 This study has used quantitative paleoecological modeling to disentangle regional and local vegetation
682 dynamics, providing a detailed understanding of a major Mediterranean island (the Corsican coastal
683 landscapes) over the Holocene for the first time. The application of the REVEALS and LOVE models have
684 significantly improved the reconstruction of past land cover, going beyond conventional pollen analysis. This
685 approach offers a robust framework for assessing the interplay between climate variability,
686 geomorphological processes, and human activities at multiple spatial scales.

687 Our results demonstrate that Corsica's modern vegetation diversity has deep historical roots, shaped by long-
688 term climate and regional variable anthropogenic influences. The application of the REVEALS model
689 challenges previous hypotheses of an *Erica arborea*–*Quercus ilex* succession driven by Neolithic human
690 activity (Reille, 1992). Instead, our reconstruction shows that Ericaceae-dominated maquis prevailed in
691 coastal lowlands from at least 7500 cal yr BP, while *Quercus ilex* played a more limited role than previously
692 assumed. Rather than promoting oak expansion, early human pressure on Ericaceae maquis appears to have
693 facilitated the spread of grasslands and degraded maquis (Cistaceae).

694 Climate oscillations structured these vegetation patterns, with humid conditions during the Middle Neolithic
695 (7000–6000 cal yr BP), increasing aridity from the Late Neolithic to the Late Bronze Age (5500–2800 cal yr
696 BP), and a shift to reduced summer drought during the Iron Age and Roman Warm Period (2800–1500 cal yr
697 BP). Aridity intensified again with the Late Antiquity Little Ice Age (1450–1250 cal yr BP) and the Little Ice Age
698 (600–150 cal yr BP). These findings highlight the complexity of Holocene climate events and their regionally
699 diverse impacts on Corsican landscapes.

700

701 The combined application of REVEALS and LOVE models illustrates how coastal landscapes evolved in
702 response to marine transgression, deltaic progradation, and mid-to-late Holocene climate variability. Three
703 key pulses of sedimentary change reshaped coastal ecosystems: (1) the Early Bronze Age (~4200 cal yr BP),
704 linked to the 4.2 ka event, brought wetland expansion (Del Sale, Saint Florent) and dune formation (San
705 Ciprianu); (2) during the Iron Age (~2800 cal yr BP), increased alluviation impacted riparian forests (Sagone
706 Valley) and deltaic areas in the southeast, likely associated with the 2.8 ka RCC event; and (3) in the Medieval
707 period (~500 cal yr BP), intensified sedimentation in Del Sale, Palo, and San Ciprianu corresponded with
708 Genoese deforestation and Little Ice Age conditions. While regional vegetation remained broadly resilient,
709 these episodes underscore the high sensitivity of local environments—particularly wetlands—to sea-level
710 fluctuations, sedimentation dynamics, and hydrological shifts, reinforcing the importance of integrating local-
711 scale studies within regional paleoecological reconstructions.

712
713 The earliest signs of agriculture appear in southern Corsica around 7400 cal yr BP, expanding through the
714 Neolithic and intensifying during the Late Neolithic–Chalcolithic. A decline in human impact during the Early
715 Bronze Age (~4200–3700 cal yr BP) may reflect settlement shifts to upland areas. Land-use pressures
716 returned in the Middle and Late Bronze Age and intensified in the Iron Age, peaking under Roman
717 administration. This period shows clear evidence of specialized land-use, including olive cultivation (Crovani,
718 Girolata), cereal farming (Caldanaccia), and timber exploitation (Girolata, Fangu). From the Middle Ages,
719 deforestation expanded inland, with the Genoese period (from 1347 CE) marking the most intense and lasting
720 forest clearance.

721
722 This study demonstrates the potential of quantitative pollen-based approaches to reconstruct regional and
723 local-scale vegetation history in Mediterranean coastal landscapes. By applying the REVEALS and LOVE
724 models we: 1) refined regional vegetation estimates; 2) captured local vegetation dynamics, revealing spatial
725 specialization of land-use activities; and 3) enhanced interpretations of human–environment interactions,
726 highlighting differences between coastal swamps and marshlands, riparian forests, maquis, and upland
727 landscapes.

728 Future research should further improve quantitative reconstructions by developing and integrating new
729 Relative Pollen Productivity (RPP) estimates for key Mediterranean taxa. Cistaceae should be prioritized to
730 better model successional shifts from dense Ericaceae maquis to degraded maquis, while *Olea* would
731 enhance understanding of olive cultivation and management since Roman times. Additionally, new
732 sedimentary archives are needed to bridge gaps in the Mesolithic–Neolithic transition, providing a more
733 complete picture of early human–environment interactions in Corsica.

734 **Acknowledgments**

735 J.R. carried out this research under a Juan de la Cierva-Incorporación contract (IJC2020-045876-I) funded by
736 the Spanish Ministry of Science and Innovation (MCINN), within the research group GAPS ‘*Group of Analyses*
737 *on Socio-ecological Processes, Cultural Changes and Population dynamics during Prehistory*’ (2021 SGR
738 01237). This article is a contribution to the multi-disciplinary research programmes *Programme Collectif de*
739 *Recherche « Géoaarchéologie des basses vallées fluviales: la nécessaire prise en compte de l’évolution*
740 *paysagère au cours de l’Holocène (2013–2015) »* and *« Approche géoaarchéologique des paysages de Corse à*
741 *l’Holocène, entre mer et intérieur des terres Trà Mare è Monti – (2018–2020) »* directed by Matthieu Ghilardi
742 (CNRS- CEREGE) and funded by the French Ministry of Culture and Communication (Direction Régionale des
743 Affaires Culturelles de Corse, Ajaccio). It also forms part of the MISTRALS-PALEOMEX (2010-2020)
744 programme of the CNRS (INEE-INSU scientific departments), and was funded by the ARCHEOMED workshop
745 (Dir. Laurent Lespez). Additionally, this paper is also a contribution from the Sapienza University project

746 'HumAN and climAtic iMplicatioNs of palaeoecological changeS in large iSlands in the central Mediterranean
747 (ANAMNESIS)'. Code: RM1221816B963D12, CUP: B83C22008590005.

748 **Author contributions:** Conceptualization: JR and RF; Data curation: JR and RF; Formal analysis: JR and RF;
749 Funding acquisition: MG; Investigation: JR, RF, MG and FDR; Methodology: JR and RF; Software: JR and RF;
750 Contribution of palynological data: JR, FDR and AC; Writing original draft: JR, RF, MG, FDR.

751 References

752 Beffa, G., Pedrotta, T., Colombaroli, D., Henne, P. D., van Leeuwen, J. F., Sússtrunk, P., ... & Tinner, W. (2016).
753 Vegetation and fire history of coastal north-eastern Sardinia (Italy) under changing Holocene climates and
754 land use. *Vegetation History and Archaeobotany*, 25, 271-289.

755 Berger JF, Brochier JL, Vital J et al. (2007) Nouveau regard sur la dynamique des paysages et l'occupation
756 humaine à l'Âge du bronze en moyenne vallée du Rhône. In: Mordant C, Richard H and Magny M (eds)
757 *Environnements et cultures à l'âge du Bronze en Europe occidentale. Actes du 129e colloque du CTHS,*
758 *Besançon*, avril 2004, Editions du CTHS, Documents Préhistoriques, vol. 21. pp.260–283.

759 Bini, M., Zanchetta, G., Regattieri, E., Isola, I., Drysdale, R. N., Fabiani, F., ... Hellstrom, J. C. 2020. Hydrological
760 changes during the Roman Climatic Optimum in northern Tuscany (Central Italy) as evidenced by speleothem
761 records and archaeological data. *Journal of Quaternary Science*, 35(6), 791-802.

762 Bini, M., Zanchetta, G., Perşoiu, A., Cartier, R., Català, A., Cacho, I., ... & Brisset, E. (2019). The 4.2 ka BP Event
763 in the Mediterranean region: an overview. *Climate of the Past*, 15(2), 555-577.

764 Bond, G., Kromer, B., Beer, J., Muscheler, R., Evans, M. N., Showers, W., ... & Bonani, G. (2001). Persistent
765 solar influence on North Atlantic climate during the Holocene. *Science*, 294(5549), 2130-2136.

766 Broström, A., Nielsen, A. B., Gaillard, M. J., Hjelle, K., Mazier, F., Binney, H., ... & Sugita, S. (2008). Pollen
767 productivity estimates of key European plant taxa for quantitative reconstruction of past vegetation: a
768 review. *Vegetation history and archaeobotany*, 17, 461-478.

769 Català, A., Cacho, I., Frigola, J., Pena, L. D., & Lirer, F. (2019). Holocene hydrography evolution in the Alboran
770 Sea: a multi-record and multi-proxy comparison. *Climate of the Past*, 15(3), 927-942.

771 Currás, A., Ghilardi, M., Peche-Quilichini, K., Fagel, N., Vacchi, M., Delanghe, D., ... & Ottaviani, J. C. (2017).
772 Reconstructing past landscapes of the eastern plain of Corsica (NW Mediterranean) during the last 6000 years
773 based on molluscan, sedimentological and palynological analyses. *Journal of Archaeological Science:*
774 *Reports*, 12, 755-769.

775 Di Rita, F., & Magri, D. (2019). The 4.2 ka event in the vegetation record of the central Mediterranean. *Climate*
776 *of the Past*, 15(1), 237-251.

777 Di Rita, F., & Magri, D. (2012). An overview of the Holocene vegetation history from the central
778 Mediterranean coasts. *Journal of Mediterranean Earth Sciences*, 4.

779 Di Rita, F., Lirer, F., Bonomo, S., Cascella, A., Ferraro, L., Florindo, F., ... & Magri, D. (2018a). Late Holocene
780 forest dynamics in the Gulf of Gaeta (central Mediterranean) in relation to NAO variability and human
781 impact. *Quaternary Science Reviews*, 179, 137-152.

782 Di Rita, F., Fletcher, W. J., Aranbarri, J., Margaritelli, G., Lirer, F., & Magri, D. (2018b). Holocene forest
783 dynamics in central and western Mediterranean: Periodicity, spatio-temporal patterns and climate
784 influence. *Scientific Reports*, 8(1), 8929.

785 Di Rita, F., Ghilardi, M., Fagel, N., Vacchi, M., Warichet, F., Delanghe, D., ... & Robresco, S. (2022a). Natural
786 and anthropogenic dynamics of the coastal environment in northwestern Corsica (western Mediterranean)
787 over the past six millennia. *Quaternary Science Reviews*, 278, 107372.

788 Di Rita, F., Michelangeli, F., Celant, A., & Magri, D. (2022b). Sign-switching ecological changes in the
789 Mediterranean Basin at 4.2 ka BP. *Global and Planetary Change*, 208, 103713.

790 Erlandson, J. M. (2001). The archaeology of aquatic adaptations: paradigms for a new millennium. *Journal of*
791 *Archaeological Research*, 9, 287-350.

792 Fletcher, W. J., Debret, M., & Goñi, M. F. S. (2013). Mid-Holocene emergence of a low-frequency millennial
793 oscillation in western Mediterranean climate: Implications for past dynamics of the North Atlantic
794 atmospheric westerlies. *The Holocene*, 23(2), 153-166.

795 Fyfe, R. M., Twiddle, C., Sugita, S., Gaillard, M. J., Barratt, P., Caseldine, C. J., ... & Waller, M. (2013). The
796 Holocene vegetation cover of Britain and Ireland: overcoming problems of scale and discerning patterns of
797 openness. *Quaternary Science Reviews*, 73, 132-148.

798 Fyfe, R. M., Woodbridge, J., & Roberts, C. N. (2018). Trajectories of change in Mediterranean Holocene
799 vegetation through classification of pollen data. *Vegetation History and Archaeobotany*, 27, 351-364.

800 Fyfe, R. M., Woodbridge, J., Palmisano, A., Bevan, A., Shennan, S., Burjachs, F., ... & Roberts, C. N. (2019).
801 Prehistoric palaeodemographics and regional land cover change in eastern Iberia. *The Holocene*, 29(5), 799-
802 815.

803 Galop D, Carozza L, Marembert F et al. (2007) Activités agropastorales et climat durant l'Âge du Bronze dans
804 les Pyrénées : l'état de la question à la lumière des données environnementales et archéologiques. In:
805 Mordant C, Richard H and Magny M (eds) *Environnements et cultures à l'âge du Bronze en Europe occidentale*.
806 *Actes du 129e colloque du CTHS, Besançon*, avril 2004, Editions du CTHS, Documents Préhistoriques, vol. 21.
807 pp.107–119.

808 Gamisans, J. (1999). *La végétation de la Corse*. Edisud.

809 Ghilardi M (2020) *Lagunes et marais littoraux de Corse. De la Préhistoire à nos jours*. Collec. Orma : la Corse
810 archéologique, Editions ARAC, 5 , p.105.

811 Ghilardi, M. (2021). Geoarchaeology: Where geosciences meet the humanities to reconstruct past human-
812 environment interactions. An Application to the Coastal Areas of the Largest Mediterranean Islands. *Applied*
813 *Sciences*, 11(10), 4480.

814 Ghilardi M, Istria D, Curras A et al. (2017) Reconstructing the landscape evolution and the human occupation
815 of the Lower Sagone River (Western Corsica, France) from the Bronze Age to the Medieval period. *Journal of*
816 *Archaeological Science Reports* 12: 741–754.

817 Ghilardi, M., Revelles, J., Mary, J. B., Rita, F. D., Delhon, C., Delanghe, D., & Robresco, S. (2023). Mid-to Late-
818 Holocene coastal morphological evolution, vegetation history and land-use changes of the Porto Gulf
819 UNESCO World Heritage site and its surroundings (NW Corsica Island, Western Mediterranean). *The*
820 *Holocene*, 33(9), 1023-1044.

821 Ghilardi, M., Revelles, J., Fagel, N., Schmidt, S., & Delanghe, D. (2025). Reconstructing the Mid-to Late
822 Holocene human-environments interactions in Cape Corsica (Corsica Island, Western Mediterranean) based
823 on sedimentology, pollen analyses and geochemistry. *Journal of Archaeological Science: Reports*, 62, 104985.

824 Gillson, L., Whitlock, C., & Humphrey, G. (2019). Resilience and fire management in the
825 Anthropocene. *Ecology and Society*, 24(3).

826 Githumbi, E., Fyfe, R., Gaillard, M.-J., Trondman, A.K., Mazier, F., Nielsen, A.-B., Poska, A., Sugita, S.,
827 Woodbridge, J., Azuara, J., Feurdean, A., Grindean, R., Lebreton, V., Marquer, L., Nebout-Combourieu, N.,
828 Stancikaite, M., Tantau, I., Tonkov, S., Shumilovskikh, L., LandClimII data contributors, 2022. European pollen-
829 based REVEALS land cover reconstructions for the Holocene: methodology, mapping and potentials. *Earth*
830 *Syst. Sci. Data* 14, 1581-1619. <https://doi.org/10.5194/essd-14-1581-2022>

831 Isola, I., Zanchetta, G., Drysdale, R. N., Regattieri, E., Bini, M., Bajo, P., ... & Greig, A. (2019). The 4.2 ka event
832 in the central Mediterranean: new data from a Corchia speleothem (Apuan Alps, central Italy). *Climate of the*
833 *Past*, 15(1), 135-151.

834 Jalali, B., Sicre, M. A., Bassetti, M. A., & Kallel, N. (2016). Holocene climate variability in the north-western
835 Mediterranean Sea (gulf of lions). *Climate of the Past*, 12(1), 91-101.

836 Juggins, S. (2015). *Rioja: analysis of quaternary science data, R package*.

837 Lestienne, M., Jouffroy-Bapicot, I., Leyssenne, D., Sabatier, P., Debret, M., Albertini, P. J., ... & Vanni re, B.
838 (2020). Fires and human activities as key factors in the high diversity of Corsican vegetation. *The*
839 *Holocene*, 30(2), 244-257.

840 Leveau, P. (1990). L'organisation de l'espace agricole en Afrique   l' poque romaine. *Publications de l' cole*
841 *Fran aise de Rome*, 134(1), 129-141.

842 Ljungqvist, F. C. (2010). A regional approach to the medieval warm period and the little ice age. *Climate*
843 *Change and Variability*, 1-25.

844 Lorenzoni, C., Muracciole, M., Paradis, G., 1995.  tude de la v g tation du Marais del Sale (Est de la Corse,
845 France). Modifications depuis la fin du 19e si cle. Colloques Phytosociologiques, XXIV. pp. 707-726.

846 Lugli , C., 2018. Your path led trough the sea ... the emergence of Neolithic in Sardinia and Corsica. *Quat. Int.*
847 470 (B), 285-300.

848 Magny, M., Combourieu Nebout, N., de Beaulieu, J.L., Bout-Roumazeilles, V., Colombaroli, D., Desprat, S.,
849 Francke, A., Joannin, S., Peyron, O., Revel, M., Sadori, L., Siani, G., Sicre, M.A., Samartin, S., Simonneau, A.,
850 Tinner, W., Vanni re, B., Wagner, B., Zanchetta, G., Anselmetti, F., Brugiapaglia, E., Chapron, E., Debret, M.,
851 Desmet, M., Didier, J., Essallami, L., Galop, D., Gilli, A., Haas, J.N., Kallel, N., Millet, L., Stock, A., Turon, J.L.,
852 Wirth, S., 2013. North-south palaeohydrological contrasts in the central Mediterranean during the Holocene:
853 tentative synthesis and working hypotheses. *Climate of the Past*, 9(5), 2043-2071

854 Magny, M., Miramont, C., Sivan, O. 2002. Assessment of the impact of climate and anthropogenic factors on
855 Holocene Mediterranean vegetation in Europe on the basis of palaeohydrological records. *Palaeogeography,*
856 *Palaeoclimatology, Palaeoecology*, 186(1-2), 47-59.

857 Martin-Puertas, C., Matthes, K., Brauer, A., Muscheler, R., Hansen, F., Petrick, C., ... & Van Geel, B. (2012).
858 Regional atmospheric circulation shifts induced by a grand solar minimum. *Nature Geoscience*, 5(6), 397-401.

859 Mayewski, P. A., Rohling, E. E., Stager, J. C., Karlén, W., Maasch, K. A., Meeker, L. D., ... & Steig, E. J. (2004).
860 Holocene climate variability. *Quaternary research*, 62(3), 243-255.

861 Melis, R.T., Di Rita, F., French, C., Marriner, N., Montis, F., Serreli, G., Sulas, F., Vacchi, M., 2018. 8000 years
862 of coastal changes on a western Mediterranean island: a multiproxy approach from the Posada plain of
863 Sardinia. *Mar. Geol.* 403, 93–108.

864 Michelangeli, F., De Luca, E., Magri, D., De Santis, S., Celant, A., Ghilardi, M., Vacchi, M., Revelles, J., Melis, R.
865 T., Ochando, J., Carrión, J., Pini, R., Servera-Vives, G., Di Rita, F. (2025). Holocene Forest Dynamics in Western
866 Mediterranean Islands: Rates, Periodicity, and Trends. *Forests*, 16(5), 808.
867 <https://doi.org/10.3390/f16050808>

868 Oksanen, J., Blanchet, F. G., Kindt, R., Legendre, P., Minchin, P. R., O'hara, R. B., ... & Oksanen, M. J. (2013).
869 Package 'vegan'. *Community ecology package, version*, 2(9), 1-295.

870 Perrin, T., Vigne, J.D., Picavet, R., 2022. Récents acquis sur les premiers peuplements de l'île. In: Leandri, C.,
871 Leandri, F. (Eds.), *Archéologie en Corse. Vingt années de recherches*. Ed. Errance, Arles, France, pp. 18–27.

872 Poher, Y., Ponel, P., Médail, F., Andrieu-Ponel, V., & Guiter, F. (2017). Holocene environmental history of a
873 small Mediterranean island in response to sea-level changes, climate and human impact. *Palaeogeography,*
874 *Palaeoclimatology, Palaeoecology*, 465, 247-263.

875 Rasmussen, S. O., Bigler, M., Blockley, S. P., Blunier, T., Buchardt, S. L., Clausen, H. B., ... & Winstrup, M.
876 (2014). A stratigraphic framework for abrupt climatic changes during the Last Glacial period based on three
877 synchronized Greenland ice-core records: refining and extending the INTIMATE event
878 stratigraphy. *Quaternary science reviews*, 106, 14-28.

879 Reille, M., 1984. Origine de la végétation actuelle de la Corse sud-orientale; analyse pollinique de cinq marais
880 côtiers. *Pollen Spores* 1 XXVI, 43-60.

881 Reille, M., 1992. New pollen-analytical researches in Corsica: The problem of *Quercus ilex* L. and *Erica arborea*
882 L., the origin of *Pinus halepensis* Miller forests. *New Phytol.* 122, 359–378.

883 Revelles J, Ghilardi M, Rossi V et al. (2019) Coastal landscape evolution of Corsica island (W. Mediterranean):
884 Palaeoenvironments, vegetation history and human impacts since the Early Neolithic period. *Quaternary*
885 *Science Reviews* 225: 105993.

886 Revelles, J., Burjachs, F., Palomo, A., Piqué, R., Iriarte, E., Pérez-Obiol, R., & Terradas, X. (2018). Human-
887 environment interaction during the Mesolithic-Neolithic transition in the NE Iberian Peninsula. *Vegetation*
888 *history, climate change and human impact during the Early-Middle Holocene in the Eastern Pre-*
889 *Pyrenees. Quaternary Science Reviews*, 184, 183-200.

890 Roberts, C. N., Woodbridge, J., Palmisano, A., Bevan, A., Fyfe, R., & Shennan, S. (2019). Mediterranean
891 landscape change during the Holocene: Synthesis, comparison and regional trends in population, land cover
892 and climate. *The Holocene*, 29(5), 923-937.

893 Sabatier, P., Dezileau, L., Colin, C., Briquieu, L., Bouchette, F., Martinez, P., ... & Von Grafenstein, U. (2012).
894 7000 years of paleostorm activity in the NW Mediterranean Sea in response to Holocene climate
895 events. *Quaternary Research*, 77(1), 1-11.

896 Sugita, S. (2007a). Theory of quantitative reconstruction of vegetation I: Pollen from large sites. *The*
897 *Holocene*, 17(2), 229–241.

898 Sugita, S. (2007b). Theory of quantitative reconstruction of vegetation II: Pollen from small sites. *The*
899 *Holocene*, 17(2), 242–257.

900 Sugita, S., Gaillard, M. J., & Broström, A. (1999). Landscape openness and pollen records: a simulation
901 approach. *The Holocene*, 9(4), 409-421.

902 Sugita, S., Parshall, T., Calcote, R., & Walker, K. (2010). Testing the Landscape Reconstruction Algorithm for
903 spatially explicit reconstruction of vegetation in northern Michigan and Wisconsin. *Quaternary*
904 *research*, 74(2), 289-300.

905 Trondman, A. K., Gaillard, M. J., Sugita, S., Björkman, L., Greisman, A., Hultberg, T.,
906 ... & Mazier, F. (2016). Are pollen records from small sites appropriate for REVEALS model-based
907 quantitative reconstructions of past regional vegetation? An empirical test in southern Sweden. *Vegetation*
history and archaeobotany, 25, 131-151.

908 Trondman, A. K., Gaillard, M. J., Mazier, F., Sugita, S., Fyfe, R., Nielsen, A. B., ... & Wick, L. (2015). Pollen-based
909 quantitative reconstructions of Holocene regional vegetation cover (plant-functional types and land-cover
910 types) in Europe suitable for climate modelling. *Global change biology*, 21(2), 676-697.

911 Vacchi M, Ghilardi M, Melis RT et al. (2018) New relative sealevel insights into the isostatic history of the
912 Western Mediterranean. *Quaternary Science Reviews* 201: 396–408.

913 Vacchi, M., Joyse, K. M., Kopp, R. E., Marriner, N., Kaniewski, D., & Rovere, A. (2021). Climate pacing of
914 millennial sea-level change variability in the central and western Mediterranean. *Nature*
915 *communications*, 12(1), 4013.

916 Vella, M. A., Andrieu-Ponel, V., Cesari, J., Leandri, F., Pêche-Quilichini, K., Reille, M., ... & Ottaviani-Spella, M.
917 M. (2019). Early impact of agropastoral activities and climate on the littoral landscape of Corsica since mid-
918 Holocene. *PLoS One*, 14(12), e0226358.

919 Zanchetta, G., Regattieri, E., Isola, I., Drysdale, R. N., Banerjee, I., & Hellstrom, J. C. (2016). The so-called “4.2
920 event” in the central Mediterranean and its climatic teleconnections. *Alpine and Mediterranean*
921 *quaternary*, 29(1), 5-17.

922

923