



HAL
open science

Macchia or forest? Toward the reconstruction of Ericaceae formations in Corsica (NW Mediterranean) during the Holocene using a quantitative wood anatomy analysis

Thomas Camagny, Sarah Ivorra, Jean-Frédéric Terral, Pauline Garberi, Alain Carré, Hélène Paolini-Saez, Thomas Perrin, Laurent Bouby, Claire Delhon

► To cite this version:

Thomas Camagny, Sarah Ivorra, Jean-Frédéric Terral, Pauline Garberi, Alain Carré, et al.. Macchia or forest? Toward the reconstruction of Ericaceae formations in Corsica (NW Mediterranean) during the Holocene using a quantitative wood anatomy analysis. *Journal of Archaeological Science: Reports*, 2025, 62, pp.105014. 10.1016/j.jasrep.2025.105014 . hal-04941194

HAL Id: hal-04941194

<https://hal.science/hal-04941194v1>

Submitted on 11 Feb 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.



Distributed under a Creative Commons Attribution - NonCommercial 4.0 International License



Macchia or forest? Toward the reconstruction of Ericaceae formations in Corsica (NW Mediterranean) during the Holocene using a quantitative wood anatomy analysis[☆]

Thomas Camagny^{a,b,*}, Sarah Ivorra^b, Jean-Frédéric Terral^b, Pauline Garberi^a, Alain Carré^a, Hélène Paolini-Saez^{c,d}, Thomas Perrin^c, Laurent Bouby^b, Claire Delhon^a

^a Université Côte d'Azur, CNRS, CEPAM, Nice, France

^b ISEM, Université de Montpellier, CNRS, IRD, EPHE, Montpellier, France

^c TRACES, UMR 5608, CNRS, Université Toulouse Jean Jaurès, EHESS, Toulouse, France

^d Laboratoire régional d'archéologie, Ajaccio, France

ARTICLE INFO

Keywords:

Quantitative wood anatomy
Arbutus unedo L.
 Macchia
 Palaeoenvironment
 Palaeoecology
 Corsica
 Neolithic
 Bronze Age
 Iron Age

ABSTRACT

Arbutus unedo L. is very abundant in pre- and protohistoric anthracological assemblages of Corsica (north-western Mediterranean). In the present day, it is a dominant species, along with *Erica arborea* L., of the macchia, a shrubland ecosystem that covers a major part of the island. The current state of the macchia is characterised by a low and more or less dense shrubby stage, maintained by frequent disturbances. However, rare preserved plots demonstrate the capacity of *Arbutus unedo* to evolve into a tree up to 10 m high, forming high, nearly forested macchia.

A traditional anthracological approach documents the floristic composition of past woodland but it does not allow us to specify the growth habit of the trees. Consequently, the physiognomy and structure of the Holocene Ericaceae formations remain unknown, despite their abundance in the landscape and their potential for exploitation in pre- and protohistoric human activities. To address this issue, we have developed a quantitative eco-anatomical approach for the characterisation of size patterns of *Arbutus unedo*. This method is based on the measurement and quantification of wood structural and vascular elements whose abundance and size are influenced by natural or anthropogenic ecological parameters. Modern wood samples are used to build a predictive model that can be applied to archaeological specimens.

Results from statistical analyses indicate that tree height and branch size are recorded by eco-anatomical features. Moreover, it has been shown that tree height is correlated with anatomical features such as ray size and vessel density. Applied to archaeological samples of *Arbutus*, the eco-anatomical analysis highlights the presence of tall *Arbutus* trees during the early Neolithic period, while low macchia appears to be the dominant vegetation type during the Bronze and Iron Ages. These results confirm hypotheses previously formulated from pollen and charcoal data and provide further insight into the impact of human activities on the landscapes.

1. Introduction

Arbutus unedo L. (strawberry tree) is an evergreen shrub or small tree of the Ericaceae family, native to the Mediterranean basin (Quézel and Médail, 2003; Almeida et al., 2022). It can be found from the coast to the hinterland in the Circum-Mediterranean regions and in some Atlantic areas, such as Portugal, south-western France and a few places in Brittany and in western Ireland, where its indigenesness is a matter of

debate (Torres et al., 2002; Santiso et al., 2016; Skeffington and Scott, 2021; De Santis et al., 2023).

Together with another Ericaceae, *Erica arborea* (tree heather), *Arbutus unedo* is particularly common in Corsica, an island in the north-western Mediterranean Sea (Fig. 1a, b). Corsica has a Mediterranean climate with subtropical, temperate and alpine affinities (Mouillot et al., 2008). These climatic conditions, the presence of high mountains, the contrasting topography and the rocky, often crystalline, soils allow the

[☆] This article is part of a special issue entitled: 'ANTHRACO' published in Journal of Archaeological Science: Reports.

* Corresponding author.

E-mail address: thomas.camagny@gmail.com (T. Camagny).

development of a wide variety of landscapes. The vegetation at low and medium altitudes up to 1000 m a.s.l. is dominated by evergreen and sclerophyllous formations, such as *Quercus ilex* forests and Mediterranean macchia (also known as *matorral* or *maquis*) (Gamisans, 1999). The latter is more or less dense scrubland that grows preferentially on crystalline soils, with drought-resistant species adapted to anthropogenic pressures such as logging, fire-setting, and grazing (Lacoste and Salanon, 1999). Usually considered as a regressive phase within the *Quercus ilex* series (*Quercetea ilicis*) (Lacoste and Salanon, 1999; Quézel and Médail, 2003), it is characterised in Corsica by the co-dominance of *Arbutus unedo* and *Erica arborea*, forming a specific plant association, namely the *Erica-Arbutetum* (Allier and Lacoste, 1980; Gamisans, 1999). It shows variations in its floristic composition and physiognomy, depending on biotic and abiotic factors. Several types of macchia are identified by ecologists and foresters depending on the height of the upper layer: low macchia (≤ 3 m), high macchia ($3 \text{ m} < x \leq 6 \text{ m}$) and “forest” macchia ($> 6 \text{ m}$) (Fig. 1c, 1d, 1e). *Arbutus unedo* and *Erica arborea* usually grow as shrubs in the present vegetation, but the existence of exceptionally tall individuals shows that they have the biological potential to form real trees (Fig. 1f) (Mesléard, 1987; Mesléard and Lepart, 1989).

Pollen and charcoal data indicate that *Erica arborea* and *Arbutus unedo*, together with sclerophyllous species, underwent a significant expansion from sea level up to the mountains after the postglacial warming, while mesophilous forests with deciduous *Quercus* and *Taxus baccata* initially remained restricted to small areas with thick soils (Reille, 1984, 1992). *Quercus ilex*, currently associated with the Ericaceae, seems to have been rare in the vegetation of Corsica before the 3rd millennium BCE (Reille, 1992; Poher et al., 2017; Revelles et al., 2019; Ghilardi, 2020). Anthracological data show that *Erica arborea* and *Arbutus unedo* provided firewood to the human populations since at least the Neolithic in the lowlands (Gilabert et al., 2011; Vaschalde, 2019; Vernet, 1988; Camagny et al., in press; Delhon, 2022; Figueiral, 2011). *Quercus ilex* forests gradually replaced the original Ericaceae formations, probably as a result of the intensification of human activities (Reille, 1992; Carcaillet et al., 1997; Revelles et al., 2019), leading several authors to consider the evergreen oak forest, now widespread on the island, as a paraclimax (Reille, 1992; Gamisans, 1999; Panaïotis, 2001). The question of the past existence, in a context of lower anthropogenic pressure, of tall forests with a floristic composition close to that of the current macchia, but with a different physiognomy, has been raised since the 1980's in Corsica (Reille, 1992; Reille et al., 1999; Poher et al.,

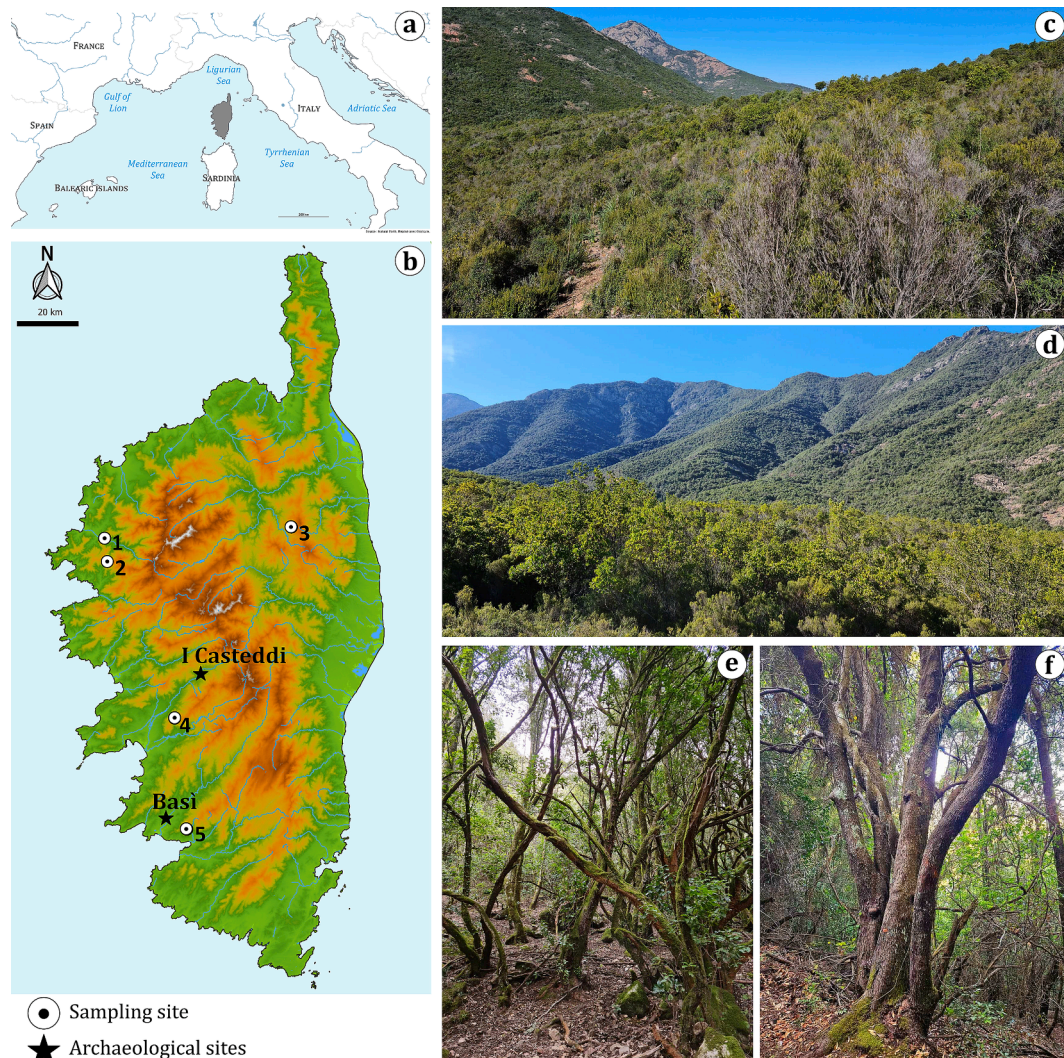


Fig. 1. Location of the study area (grey) (a), archaeological sites included in the study (black stars) (b) and sampling sites of *Arbutus* wood samples (white rings). 1: Filisorma forest, 2: Melza Pass, 3: San Petru pass, 4: Miluccia forest, 5: Penta road. Different type of macchia: low, i.e. trees ≤ 3 m (c), high, i.e. trees $3 \text{ m} < x \leq 6 \text{ m}$ (d) and “forest” macchia, i.e. trees $> 6 \text{ m}$ (e). Example of a large *Arbutus unedo* tree in a “forest” macchia (f) – photo. T. Camagny & I. Camagny.

2017) and more recently in Sardinia (Beffa et al., 2016). These forests would be impossible to distinguish from the macchia using standard palaeoenvironmental approaches (palynology, charcoal analysis) based on the reconstruction of the floristic composition of the vegetation. The reconstruction of the height and the physiognomy of Ericaceae formations in the past would improve both our knowledge of palaeovegetation types, including their position in the ecosystem dynamics (pristine, secondary, post-pioneer?), and the reconstruction of the landscapes inhabited by past Corsican communities (macchia or forest?), allowing us to assess their role in the shaping of the current macchia.

Anthracology allows us to obtain floristic lists (Chabal, 1997; Pernaud and Thiebault, 2002), but not to document precisely the physiognomy of vegetation such as macchia, because of the floristic similarities between the different forms it can take (low, high macchia or forest). In recent years, palaeoenvironmental studies have advanced through the development of semi-quantitative methods using wood morphology and anatomical features, including tree-ring measurements, which has been employed to estimate wood diameter and to assess past forestry practices and their impact on the landscape (Dufraisse and Garcia Martinez, 2011; Paradis-Grenouillet et al., 2013; Girardclos et al., 2018; Dufraisse et al., 2018). Quantitative wood anatomy has been developed in bioarchaeology to answer specific issues related to plant structure and management histories. This approach involves measuring and counting vascular and structural anatomical features of modern wood to identify variations in relation to abiotic (soil, climate, altitude...), biotic (human management) and intrinsic factors (individual size, branch diameter...) and then using these results to assign archaeological charred wood fragments to tree categories (Terral et al., 2009; Marguerie et al., 2010). The method has already been successfully used on the olive tree (*Olea europaea*) (Terral and Arnold-Simard, 1996; Heinz et al., 2004) and the grapevine (Terral, 2002; Limier et al., 2018) to distinguish wild from cultivated forms, and more recently on the argan tree (*Argania spinosa*) (Ros et al., 2021) to identify exploitation practices during the Middle Ages. Based on these pre-existing studies, we have developed a quantitative wood anatomy approach applied to *Arbutus unedo*. The aim was to characterise anatomical variations based on the tree's morphological traits, such as tree height and growth habit (tree or shrub), in order to improve our understanding of past Ericaceae formations in Corsica.

This paper presents the methodological and analytical processes used to build the eco-anatomical model based on *Arbutus unedo* wood collected from Corsican trees whose characteristics are known (size, habits, growth conditions, etc.). As a second step, we test the workability and relevance of the analytical procedure for archaeological charcoal, which is sometimes small in size and not optimally preserved. For this purpose, we use previously studied charcoal from two archaeological sites in south-western Corsica, Basi and I Casteddi.

2. Material

2.1. Modern reference material: Collection and preparation

Arbutus trees were sampled in spring 2022 in five different locations in four natural regions of Corsica: the Fangu, Gravona and Taravu valleys, and the mountainous region of Castagniccia (Fig. 1b). During fieldwork, carried out in collaboration with the Office National des Forêts (ONF) and the Parc Naturel Régional (PNR), no trees were felled and their health was carefully evaluated before sampling so as to minimise disturbance to local vegetation and preserve remarkable trees.

Eighty samples were obtained from tree-like and shrubby *Arbutus* growing in diverse vegetation types, including low and high macchia, evergreen oak forest and chestnut grove (Table 1). This referential material was intended to represent a variety of biotic and abiotic conditions (land use, soil type, water resources, climate). In these regions, the landscape bears witness to recent human activities through the remains of old roads, abandoned hamlets, ancient cultivation terraces and charcoal pits. Most of the regions surveyed are located in the crystalline part of Corsica. Castagniccia stand apart as it is characterised by metamorphic soils (schist, ophiolite, serpentine) rather than granitic soils. It also benefits from more abundant rainfall, which limits *Arbutus* to the warmest areas where the forest is least developed (Gamisans et al., 1983; Gamisans, 1999). In the Fangu valley (NW Corsica), 20 samples were collected along riverbanks and forest edges (Filosorma forest), as well as on the ridges to the south of the valley (Melza pass). In the Gravona valley (SW Corsica), 18 samples were taken from more or less open scrubland near a pass (San Petru pass). In the Taravu valley (SW Corsica), 22 samples were collected from densely wooded areas with natural or human-made clearings (Millucia forest), located above modern villages, where large *Arbutus* trees can be found. Finally, in Castagniccia (NE Corsica), 20 branches were sampled from *Arbutus* trees growing on land used for chestnut production near villages (Penta road). Morphological traits (tree height, growth habit, trunk diameter for trees characterised by a single trunk, diameter of sampled branches) were recorded in the field and are detailed in Appendix A.

Only branches were sampled so as not to cause any damage to the trunks. This strategy targeted the parts of the tree most likely to be dominant in archaeological domestic contexts, as collecting branches requires less effort than felling trees. From each selected *Arbutus* tree, four samples were sawn at heights ranging from 0.5 to 2.5 m above ground level. The branches were carefully chosen to minimise the presence of tension wood, which could impact on the measurements. Two samples were collected from primary branches and two from secondary branches, with cuts made 5 to 10 cm from the stem base (junction with trunk or with larger branch) to avoid wood knots.

Wood samples were charred in a muffle furnace at 300° for 30 min in order to obtain charcoals comparable to those found on archaeological sites.

Table 1

Location, ecological context and number of *Arbutus* wood samples included in the quantitative wood anatomical model.

Region	Station	Plant community	Location	Elevation (m)	Number of samples
Fangu	Filosorma forest	Low macchia	N42°23'45", E8°43'18"	100	8
		High macchia	N42°23'45", E8°43'18"	100	4
	Melza pass	"Forest" macchia	N42°20'32", E8°43'29"	800	8
Gravona	San Petru pass	Low macchia	N41°58'27", E8°53'44"	540	12
		High macchia	N41°58'30", E8°53'44"	540	6
Taravu	Miluccia forest	<i>Quercus ilex</i> forest	N41°43'9", E8°54'26"	650	16
		Low macchia	N41°43'12", E8°54'20"	700	6
Castagniccia	Penta road	<i>Quercus ilex</i> forest	N42°23'20", E9°17'53"	830	12
		<i>Castanea sativa</i> area	N42°23'22", E9°17'49"	780	8
		Total			

2.2. Archaeological charcoals

I Casteddi and Basì are archaeological sites in south-western Corsica, located respectively in the Gravona and the Taravu valleys. Ongoing archaeobotanical studies are providing a wealth of *Arbutus* charcoal and have raised questions about ancient landscapes and their evolution. These sites cover periods of time during which the vegetation experienced a sharp increase in anthropogenic pressure: Human impact is low for the Early Neolithic period in Basì (6th millennium BCE), and then rises with increasing agropastoral practices during the Bronze and Iron Ages in I Casteddi (2nd/1st millennium BCE). Charcoal fragments from these sites identified as *Arbutus unedo* could therefore come from trees growing in vegetation as close as possible to the original early Holocene Ericaceae formation (Basì), as well as in landscapes that were more intensely anthropised (I Casteddi). Fifty archaeological *Arbutus* charcoal samples, originating from diffuse deposits within seven domestic units, were selected.

Basì is known for its Neolithic (*Basien*) and Bronze Age occupations (Hasler et al., 2012), but the site was also previously inhabited by Mesolithic hunter-gatherers (8th millennium BCE), and by the first agropastoralist communities in the Early Neolithic period (6th millennium BCE) (Perrin et al., 2022). Few Ericaceae charcoal fragments, none of which are *Arbutus*, have been found so far in the Mesolithic layers (ongoing excavations and analyses), but they are abundant, despite being small, from the Early Neolithic onwards (Perrin, 2022). Ten fragments from the 6th millennium BCE units were large enough to be measured, including the oldest charcoal evidence to date of *Arbutus unedo* in Corsica (Table 2). The fragments come from 4 different stratigraphic units and were sampled at different depths in each unit, thus minimising the chances of them being from the same tree.

I Casteddi, perched on a rocky spur, was occupied from the Middle Bronze Age to the end of the Iron Age (2nd and 1st millennia BCE) (Paolini-Saez et al., 2019). Previous charcoal analysis showed that the large Ericaceae, *Erica arborea* and *Arbutus unedo*, provided most of the firewood throughout the occupation of the site (Camagny et al., in press). However, *Arbutus unedo* percentages decline over time while *Erica arborea* seems to maintain itself, raising questions about the impact of agro-sylvo-pastoral activities on the local plant cover. Forty charcoals of sufficient size were randomly selected in 3 different stratigraphic units for quantitative eco-anatomical analysis: 20 from the Middle Bronze Age units and 20 from the Second Iron Age unit (Table 2).

3. Methods

The quantitative wood anatomy approach is based on the interrelationships between anatomical features of the wood and the taxonomic, ecological or morphological characteristics of the plant. This study specifically examines the relationships between anatomical wood features and morphological characteristics of *Arbutus unedo*, with a particular focus on its height and tree habit. By measuring and quantifying anatomical elements in wood samples, it is possible to assess their functional and biological implications through statistical analysis and to

Table 2

Archaeological charcoal analysed in this study. N₁: Total number of *Arbutus* fragments identified at each archaeological sites. N₂: Number of *Arbutus* fragments selected for quantitative wood anatomy analysis.

Cultural Period	Age (BCE)	Site	SU	N ₁	N ₂	Excavation supervisor
Early Neolithic (Cardial)	6th millennium	Basì	1624	24	3	T. Perrin
			1241	7	2	
			1242	3	2	
Early-Middle Neolithic Middle Bronze Age	6-5th millennium 2nd millenium	I Casteddi	1013	29	3	H. Paolini-Saez
			387	54	10	
Second Iron Age	1st millenium		305	165	10	
			303	145	20	
Total				427	50	

develop a predictive model. The model is then used to classify archaeological charcoal analysed using the same measurement protocol, thereby allowing us to infer the morphological traits of ancient trees.

3.1. *Arbutus unedo* wood anatomy

As we intend to study the growth habits of the trees, we have focused on anatomical elements related primarily to sap conduction (vessels), nutrient storage (rays) and to mechanical properties of the trees (rays). *Arbutus unedo* displays considerable anatomical variability, as described in multiple atlases of wood anatomy (Queiroz and Van Der Burgh, 1989; Schweingruber, 1990; Vernet et al., 2001). In transverse section, *Arbutus unedo* wood is characterised by a diffuse- to semi-diffuse-porous structure, with many solitary or radially clustered vessels. The diameter of the vessels decreases from the initial (35–50 µm) to the final wood (20 µm). Growth rings are distinct, sometimes marked by a row of pores, but false rings are frequent. Both libriform fibres and tracheids occur. There is a continuum between small vessels and tracheids that sometimes makes it difficult to differentiate between them in transverse section. Rays can be short and uniseriate, but primarily multiseriate. Multiseriate rays are spindle-shaped and exhibit significant variability, ranging in size from 2 to 6 parenchyma cells in width and up to 40 cells in height. The perforation plates are usually simple, rarely scalariform with one to four bars in some of the smallest vessels. Spiral thickenings are abundant, thick, and tight, which is a very typical feature of the species.

3.2. Quantitative wood anatomy protocol

In order to refresh the sections of interest, charred reference samples were manually broken, in accordance with the standard methodological protocol for the study of archaeological charcoal (Chabal et al., 1999). Samples were then examined at × 200 magnification under a reflected-light microscope connected to a digital camera and image measurement software (Leica Application Suite software). Measurements were taken in the last rings formed in the years preceding sampling. In order to take advantage of ray size variability, which we hypothesized could have an eco-anatomical significance, and in contrast to usual quantitative wood anatomy protocols that deal exclusively with the transverse section of wood, we investigated both transverse and longitudinal-tangential sections. The processing of the transverse section necessitates taking photos, whereas anatomical features in the longitudinal-tangential section are quantified directly. The processing of a single sample takes an hour to an hour and a half to complete. This timeframe includes taking cross-section photos, measuring anatomical elements of the wood and quantifying anatomical features in longitudinal-tangential section.

3.3. Anatomical features measured

Six anatomical features were considered (Fig. 2):

- the vessel density (VD, N/mm²) is estimated in transverse section by counting the number of vessels in a 0.25 mm² surface area. It is

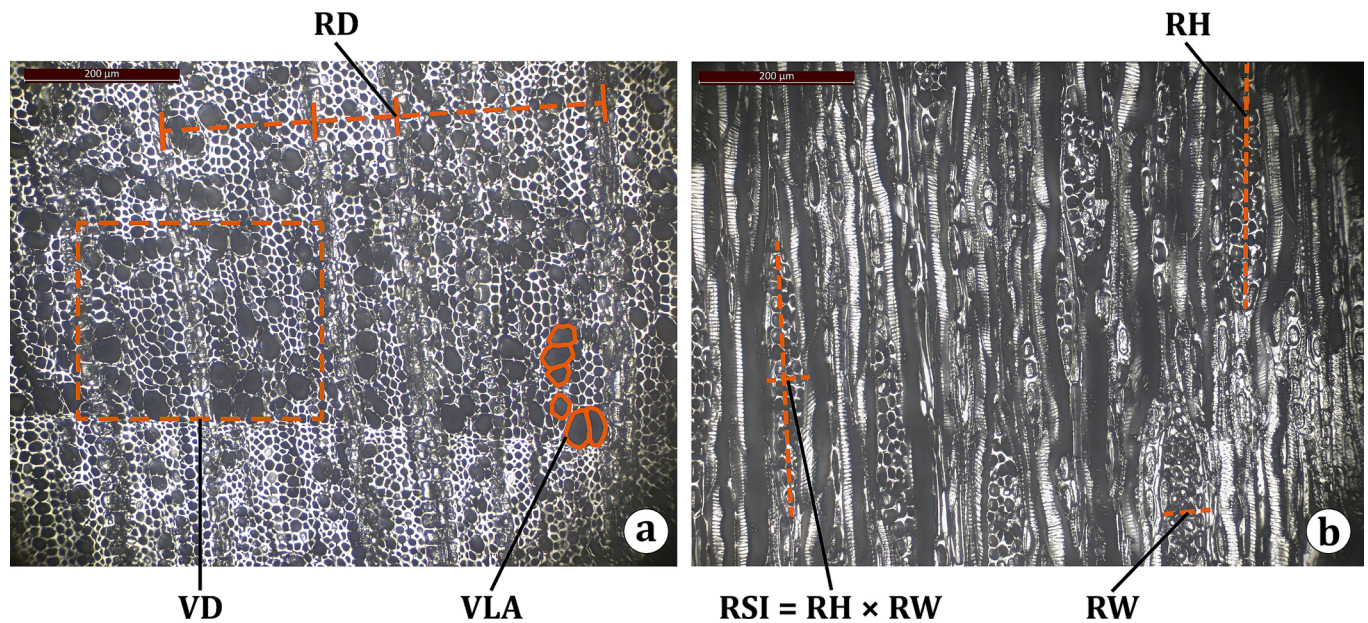


Fig. 2. A. *unedo* wood transverse (a) and longitudinal-tangential sections (b), showing the considered anatomical features (in orange): vessel density (VD, N/mm²), vessel lumen area (VLA, μm²), ray density (RD, N/mm), ray width (RW, N), ray height (RH, N) and ray surface index (RSI, N).

recommended that the covered areas extend across the entire width of a ring, using rays as edges, and that they do not overlap so as to avoid counting the same vessels twice.

- the vessel lumen area (VLA, μm²) is automatically measured on the transverse section after manually outlining the pores. The measurement must be made on an area covering at least one full ring from early to late wood, focusing on radially or obliquely clustered vessels
- the ray density (RD, N/mm) corresponds to the number of multi-seriate rays crossing a tangential line of a known length drawn on the transverse section, divided by the length of the line. The drawn line must cross at least 3 rays for the data to be valid.
- in longitudinal-tangential section, ray width (RW, N) and ray height (RH, N) are defined as the number of parenchyma cells in the horizontal and vertical directions, respectively (on multiseriate rays only).
- the ray surface index (RSI, N) is defined as the product of RW by RH (RW*RH). This additional variable is proposed to better express the total volume occupied by rays in the xylem. It is used together with the two previous variables, RW and RH, which are needed to consider the morphology of the rays (wide/short, wide/high, narrow/short, narrow/high).

3.4. Number of measurements required to characterise anatomical traits and measurement reproducibility

The number of measurements required to obtain representative values was tested on 4 samples by using cumulative average curves (Appendix B). To carry out these measurements correctly, charcoal fragments must be well-preserved and large enough. With the equipment used in this study and at × 200 magnification, it involves taking at least 15 photos of each fragment in transverse section. Ideally, a surface area of approximately 2.5 mm² is required in the transverse section and a slightly smaller size may be sufficient in the longitudinal-tangential section. Fragments close to a knot or areas with shrinkage cracks should be avoided.

Taking measurements on charred wood from a highly variable Mediterranean taxon such as *Arbutus unedo* requires a little time to adapt, in order to be able, for example, to differentiate the smallest vessels from the tracheids in transverse section. To assess the feasibility of the measurements and the reproducibility and the representativeness

of the results, three samples of the reference material were initially analysed. Measurements were made twice by the same operator (TC) on different days, and once more by a second operator (CD). Homogeneity of variances of the different groups was evaluated using ANOVA tests. The p-values obtained (> 0.05) indicate that there are no significant differences for one single operator or between two operators (Appendix C). It can therefore be assumed that the eco-anatomical protocol can be replicated on charred *Arbutus* wood.

3.5. Statistical analyses

The eco-anatomical model was built using the measurements data obtained from 80 samples of the reference material. The link between specific traits such as tree height and branch diameter and the anatomical features was evaluated by means of linear correlation coefficients.

Principal Component Analysis (PCA) was undertaken using 6 anatomical variables (active variables: VD, VLA, RD, RW, RH and RSI) and 2 tree descriptive variables (passive variables: branch diameter and tree height). The objectives were to examine the relationships between wood anatomical features and supplementary qualitative variables, which were collected during the field mission. These variables included the location (station), branch type (main, secondary), growth habit (tree/shrub) and tree height groups (using categories compatible with those commonly used by ecologists and foresters to describe the Corsican macchia: ≤ 3 m for low macchia, 3 m < x ≤ 6 m for high macchia, > 6 m for “forest” macchia).

A Linear Discriminant Analysis (LDA) was carried out in order to test the discrimination of tree-height groups based on eco-anatomical variables. This method requires the data to be distributed as closely as possible to normal distributions. A Shapiro-Wilk test on the modern material revealed that 4 variables (VD, RD, RW and RIS) did not verify the normality hypothesis (p-value < 0.05). Consequently, all data was log-transformed (base exponent), which makes it suitable for the construction of a predictive model using the LDA method. LDA is a clustering method that divides the data space linearly according to a target variable. In the present study, tree height data from the modern reference material was used to build the model. The samples were grouped according to the height of the originating trees (≤ 3 m, 3 m < x ≤ 6 m, > 6 m). In order to predict the height of ancient *Arbutus* trees, the

archaeological charcoals were projected into the predictive LDA as additional individuals.

In order to obtain the most robust prediction model possible, we used 2 statistical tools:

- The LDA model was constructed using the most significant variables, employing the function `greedy.wilks` from the `klAR` R package. This function enables the testing of multiple LDAs built from several combinations of variables, to identify the most efficient model for the prediction of additional individuals.
- Given the unbalanced size of the groups, data were standardised by matching them to the smaller-sized group (> 6 m, $N = 14$) (Evin et al., 2013; Bonhomme et al., 2021): 14 items were randomly selected from the larger groups (≤ 3 m, $N = 26$ and $3 \text{ m} < x \leq 6$ m, $N = 40$). The performance of the model was systematically evaluated, using leave-one-out cross-validation (LOOCV) (James et al., 2013, p. 193). This process was repeated until 1,000 LDA predictions had been generated with a 70 % training success rate, in order to ensure the robustness of the results.

The prediction rate for each archaeological charcoal in each tree-height group is calculated by summing all the allocation rates and then dividing by 1000.

When the allocation rate for a given group exceeded 0.66, we attributed the charcoal to this group. In the event that allocation rates for the 3 groups were equivalent or close, the charcoal was not allocated. When 2 groups presented close rates and the third a significantly lower one (< 0.20), these 2 groups were almost always contiguous (≤ 3 m and $3 \text{ m} < x \leq 6$ m or $3 \text{ m} < x \leq 6$ m and > 6 m). Subsequently, the charcoal was allocated to an extended group, spanning over 2 predefined categories: ≤ 6 m or > 6 m. In only two cases were the allocation rates close in the two extreme categories and much lower in the median one. These charcoals were considered as not allocated.

4. Results

4.1. Number of measurements required to characterize anatomical traits

The stabilization of the curves (plateau) for the 6 anatomical features determined that the required number of measurements on each charcoal was 15 for vessel density (VD), 45 for vessel lumen area (VLA) and 10 for ray density (RD), ray width (RW) and ray height (RH) (Appendix B).

4.2. Anatomical variation of modern *Arbutus unedo* wood

4.2.1. Correlation between wood anatomical features and morphological features

Ray height, ray width and ray surface index are positively correlated

to branch size (c.c. 0.50, 0.61 and 0.64, p -value < 0.05). All the ray parameters (ray density, ray width, ray height and ray surface index), and to lesser extent, vessel density, are also correlated to tree height (c.c. -0.44 , 0.35, 0.41, 0.43 and 0.37, p -value < 0.05) (Fig. 3). Vessel lumen area is slightly correlated to branch diameter. The p -values of correlation coefficients are detailed for each of the above variables in a table in the appendix (Appendix D).

4.2.2. Eco-anatomical variation in *Arbutus unedo* wood

The first axis of the PCA (DIM1, 45.5 % of variance) carried out on the reference material explains variations of anatomical features such as ray width (RW), ray height (RH) and ray surface index (RSI) (Fig. 4a). Branch diameter, as a supplementary variable, is also linked to DIM1. The variables correlated to the second axis (DIM2, 24.8 % of variance) are vessel density (VD), ray density (RD) and, to a lesser extent, vessel lumen area (VLA). Correlation between this axis and tree height appears to be significant.

The PCA does not allow shrubby individuals to be distinguished from arborescent ones on the basis of the anatomy of their wood (Fig. 4b). The first PCA biplot show differentiation trends between low (< 3 m), high ($3 \text{ m} < x \leq 6$ m) and very high (> 6 m) individuals (Fig. 4c), as well as between main and secondary branches (Fig. 4d). Finally, environmental parameters appear to influence *Arbutus unedo* wood anatomy, as can be seen from the differences between the samples from the five stations surveyed (Appendix E). However, there is a wide overlap and the factors responsible for the variations are not yet understood.

4.2.3. Differentiation of height classes according to anatomical features

LDA analysis allows us to discriminate height classes of *Arbutus* trees (≤ 3 m, $3 \text{ m} < x \leq 6$ m, > 6 m) a successful discrimination rate of more than 70 % ($\lambda = 0.44$, $F = 7.5$, $p < 0.0001$). The successful discrimination rate per group is variable (≤ 3 m: 80.17 %, $3 \text{ m} < x \leq 6$ m: 70.97 %, > 6 m: 73.31 %).

Variables that contribute the most to the LDA model are ray density (RD) ($\lambda = 0.716$, $F = 15.26$, $p < 0.0001$), vessel density (VD) ($\lambda = 0.616$, $F = 10.42$, $p < 0.0001$), ray surface index (RSI) ($\lambda = 0.490$, $F = 10.71$, $p < 0.0001$) and vessel lumen area ($\lambda = 0.449$, $F = 9.09$, $p < 0.0001$).

4.3. Inferring the height of archaeological *Arbutus unedo*

Fifty archaeological *Arbutus* fragments were integrated into the LDA model as additional individuals, allowing them to be allocated to one of the three predefined height groups (Fig. 5). The model classified 30 archaeological charcoal fragments to a predefined tree height group with a prediction rate more than 0.66: 25 to ≤ 3 m, two to $3 \text{ m} < x \leq 6$ m, and three to > 6 m. A review of the prediction rate indicates that 12 additional fragments can be assigned to "extended" groups: 10 to ≤ 6 m and two to > 3 m (Fig. 6, Appendix F).

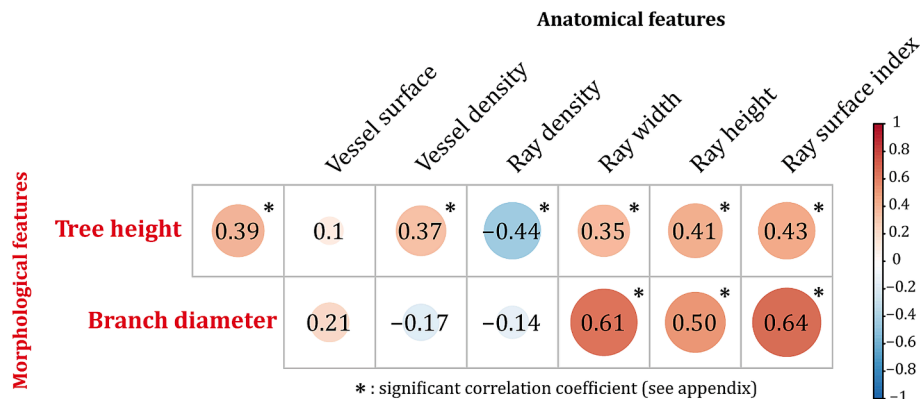


Fig. 3. Correlation coefficient between the quantitative variables. Blue dots indicate negative correlation, red dots positive correlation. The size of the dot and the colour intensity indicate the strength of the correlation.

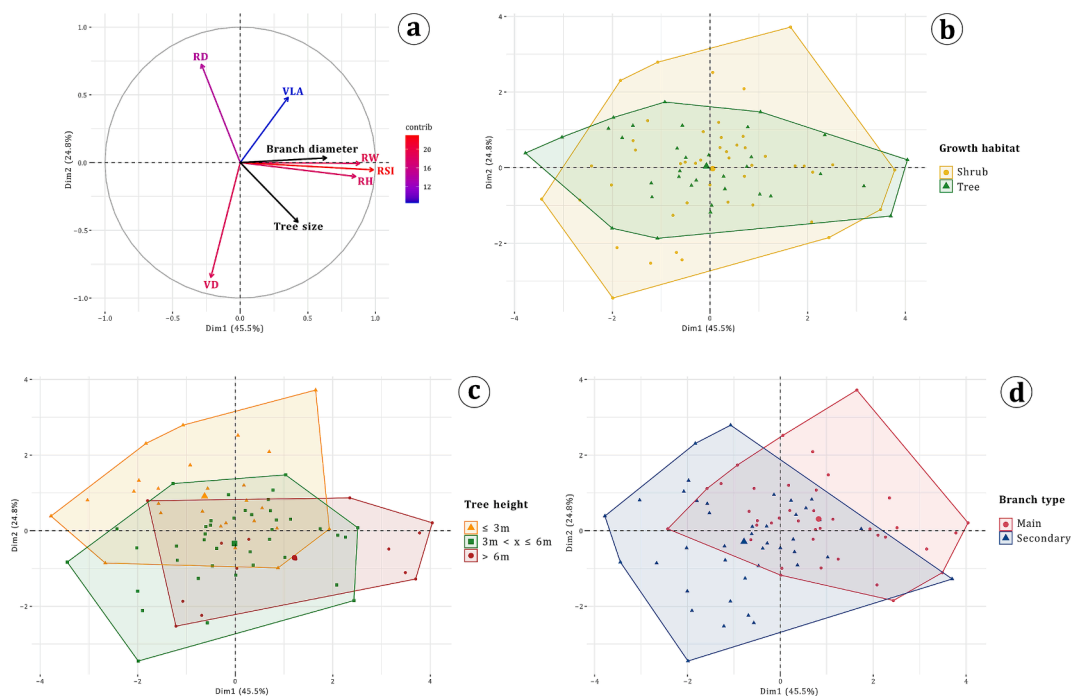


Fig. 4. Results from PCA carried out on 80 individuals (modern charcoal samples) and 8 variables (6 are active and 2 are passive, tree height and branch diameter): correlation circle (a) and PCA biplot 1–2 (70.3% of variance) of the distribution of the individuals depending on their growth habit (b), tree height (c) and branch type (d).

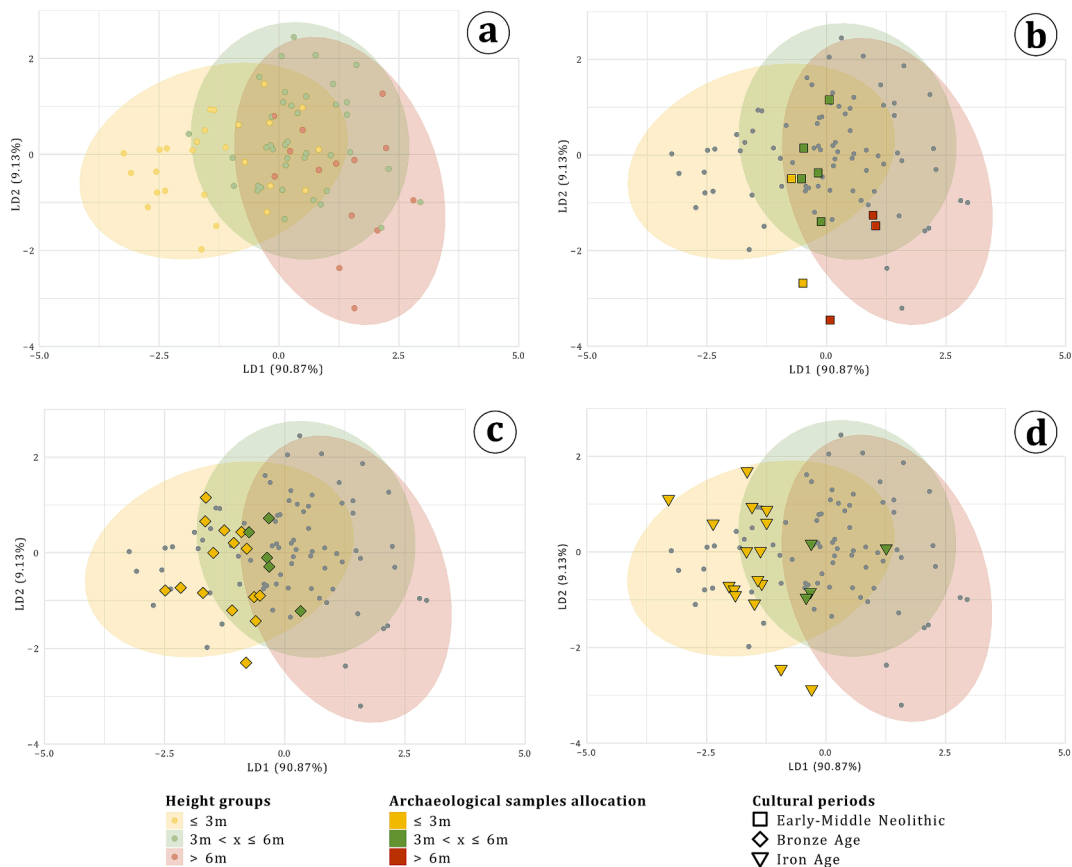


Fig. 5. LDA biplot showing the 3 height groups (yellow for $\leq 3\text{ m}$, green for $3\text{ m} < x \leq 6\text{ m}$, red for $> 6\text{ m}$) based on the reference material (dots, a). Archaeological samples are projected as additional individuals and coded according to their age: Early-Middle Neolithic (b), Bronze Age (c) and Iron Age (d).



Fig. 6. Prediction percentages of each archaeological charcoal in the predefined height groups (yellow: ≤ 3 m, green: $3 \text{ m} < x \leq 6 \text{ m}$, red: $> 6 \text{ m}$) using the LDA model (a). Number of charcoals attributed to each height class for each chrono-cultural period, with the highest probability of attribution considered (b). Charcoals attributed to two adjacent groups with close allocation rates were assigned to an extended group spanning both height intervals (light blue: $\leq 6 \text{ m}$, dark blue: $> 3 \text{ m}$) and those with similar allocation rates in all three groups or in the two extreme groups were not allocated (grey).

Three out of 10 archaeological charcoals from the Early Neolithic of Basi have been assigned to individuals whose height is greater than 6 m (#1, #2, #3). One charcoal is assigned to the $3 \text{ m} < x \leq 6 \text{ m}$ group (#4) and the other four charcoals are attributed to individuals less than 6 m in height (#5-#8). Two charcoals could not be allocated (#9, #10).

The majority of charcoals from I Casteddi are attributed to small *Arbutus* trees, with a height of less than 3 m. No *Arbutus* fragments could be clearly attributed to trees measuring more than 6 m in height. At the most two charcoals, one from the Bronze Age level (#27) and one from the Iron Age level (#47), are attributed to the $> 3 \text{ m}$ group (they could be between 3 and 6 m or more than 6 m with equivalent probability). Among the Bronze Age charcoals, 10 are allocated to the $\leq 3 \text{ m}$ group (#11-#20), five to the $\leq 6 \text{ m}$ group (#21-#25) and one to the $3 \text{ m} < x \leq 6 \text{ m}$ group (#26). Fifteen *Arbutus* fragments from the Iron Age are allocated to the $\leq 3 \text{ m}$ group (#31-#45) and one to the $\leq 6 \text{ m}$ group (#46). Three charcoals from the Bronze Age and three from the Iron Age could not be allocated (#28-#30 and #48-#50).

Not only were more *Arbutus* charcoals from the Iron Age attributed to the $\leq 3 \text{ m}$ group, but they also show higher allocation rates than those from the Bronze Age: 11 of them are assigned to the $\leq 3 \text{ m}$ group with an allocation rate higher than 0.80. Within the Bronze Age corpus, only 7 charcoals are predicted as low trees with such confidence (Appendix F).

5. Discussion

5.1. *Arbutus unedo* anatomical developmental and environmental plasticity in relation to tree size

The quantitative eco-anatomical study of *Arbutus unedo* wood highlights the correlation between morphological traits of the trees –branch type (main, secondary) and tree height – and anatomical features, such as ray parameters (ray density, ray width, ray height and ray surface index) and vessel density. Correlation coefficients show that small-diameter branches have smaller rays compared to large-diameter branches, suggesting a relationship between ray size and stem age, and therefore branch diameter. A less pronounced correlation exists between the vessel lumen area and the branch diameter. This has already been demonstrated in other quantitative wood anatomy studies (Kassout et al., 2021; Ros et al., 2021), in line with results regarding the

correlation between hydraulic conduit diameter and the distance from the base stem (Martínez-Vilalta et al., 2002; Anfodillo et al., 2013; Petit and Crivellaro, 2014). Moreover, it is observed that small *Arbutus* trees have more rays (higher ray density in transverse section) and that these rays are small-sized, whereas large individuals tend to have less rays, but of much larger dimensions. These large individuals also show more vessels than the small ones. These variations within the xylem can be linked to functional traits of the tree and growth conditions, which are influenced by environmental factors that are not yet well understood. We sampled trees in different vegetation types, at different elevations and in different regions within Corsica. However, despite these differences, the trees were ultimately sampled from the same island and in the same global biogeographical context. The two most distant stations, Castagniccia and Taravu, are only 80 km apart. It was not possible from this corpus to differentiate between shrub and tree-like *Arbutus*. The sampling strategy focused on branches rather than tree trunks, which might suggest a lack of information. However, this approach ensured the homogeneity of the corpus and facilitated its comparison with pre- and protohistoric charcoal from archaeological sites, which are most likely to come from branches, especially in the domestic context.

The following section will examine the potential relationships between the observed variations in wood anatomical features and the functions of sap conduction, nutrient storage and mechanical support of the *Arbutus* tree.

Sap and nutrient conduction: The low density of vessels observed in small *Arbutus* specimens is likely indicative of a moderate need for water resources in the early development stages of the stem. In mature and wider stems, sap conduction is actively promoted by increasing the number of vessels, rather than expanding their surface area. This trend is confirmed by the size of the rays, which are also involved in nutrient conduction and storage functions, as well as providing mechanical support (Carlquist, 1988; Burgert et al., 1999; Pfautsch et al., 2015a; Stupianek et al., 2021). To a certain extent the modulation of cambial functioning helps to ensure resilience against vessel conduction rupture caused by drought and to optimize tree growth and development (Pfautsch et al., 2015b).

Nutrient storage: parenchyma cells in rays stock carbohydrates and nutrients (Sauter and Neumann, 1994). In *Arbutus unedo*, as is also the case for other Ericaceae and other Mediterranean trees, rays are

particularly abundant in the lignotubers, located at the stem base (Mesléard and Lepart, 1989). This organ plays an important role in the development of *Arbutus* trees and in their capacity to respond to disturbances through varying degrees of intense resprouting (Montenegro et al., 1983; Canadell and López-Soria, 1998; Paula et al., 2016).

Mechanical support: The development of the tree implies mechanical constraints as a consequence of its growth. Rays are regarded as key elements in maintaining the stem's structure (Ślupianek et al., 2021). The presence of large rays in angiosperm species such as *Fagus sylvatica* provides greater resistance to the mechanical stresses to which wood is subjected, thereby increasing its rigidity (Burgert et al., 1999; Burgert and Eckstein, 2001). Indeed, both radial and tangential tensile strengths of wood appear to increase with the volume of rays (Beery et al., 1983; Reiterer et al., 2002). These observations are particularly noteworthy when compared with our results on *Arbutus unedo*. After 25 years without disturbance, *Arbutus unedo* stems stop sprouting from the lignotubers, and the development of the trunk is prioritized (Mesléard and Lepart, 1989). The increase in ray size observed in the *Arbutus* referential, correlated to branch diameter and tree height, may be attributed to changes in the functional needs of the tree as it develops.

5.2. New perspectives on Ericaceae formation physiognomy and anthropogenic impact during prehistoric times in Corsica

Anatomical features of the archaeological charcoals suggest differences in the height of *Arbutus* trees between the two sites and the three different periods. In Basi, during the Early Neolithic, *Arbutus* trees were probably over 3 m, and even quite often over 6 m high. This period is characterized by a low anthropogenic impact on the environment, related to a low population density when the first Neolithic farmers settled on the island at the beginning of the 6th millennium BCE, in an environment previously devoid of any human activity (Lugliè, 2018; Perrin et al., 2022). Although limited by the small number of archaeological samples studied, our data suggest the presence of tall sclerophyllous formations near the site at that time, which tends to support the archaeological observation.

At I Casteddi, during the Bronze Age and Iron Age, *Arbutus* trees used for firewood primarily came from low formations where trees did not exceed 3 m high. However, *Arbutus* trees over 3 m tall could have developed in quite high macchia, or in *Q. ilex* forest nearby, as holm oak has also been identified in the charcoal assemblage. During these periods, the density of the settlements increased, probably in response to demographic growth in the Gravona valley (Paolini-Saez et al., 2019, 2022, 2023). As a consequence, pastoral and agricultural activities were probably increasingly impacting the forests around the sites. Charcoal data from I Casteddi already suggests that human activities may have affected Ericaceae formations. Indeed, during the transition from the Bronze Age to the Iron Age, *Arbutus* frequencies decreased while *Erica* remained steady (Camagny et al., in press). Repeated degradation tends to favour *Erica* and other shrubs rather than *Arbutus* (Allier and Lacoste, 1981; Mesléard, 1987; Mesléard and Lepart, 1991). The coexistence of low macchia and high macchia, as evidenced by the anthracological spectrum and the relatively small size of *Arbutus* trees indicated by our quantitative wood anatomy data, suggests the presence of a mosaic landscape reminiscent of the current situation in Corsica.

6. Conclusion and perspectives

A quantitative wood anatomy approach applied to *Arbutus unedo* has demonstrated promising potential for classifying trees by height classes through the analysis of various wood anatomical features. A specific focus on ray size proved to be effective and may be useful for the estimation of branch diameter, which could be relevant for investigating

resource management issues. However, further research is needed to fully understand the relationships between wood anatomy and tree morphological traits. Expanding the reference material framework by sampling more trees of different heights and growth habits will be essential to improve the performance and reliability of the prediction model. Although this study focused on the Corsican macchia, the approach could potentially be extended to other regions in the Mediterranean and beyond, where Ericaceae species such as *Arbutus unedo* play a significant ecological role. Collecting additional wood samples from a wider range of regions, including both Mediterranean and Atlantic areas, might allow us to explore the potential abiotic influences on *Arbutus* wood anatomy across a broader ecological spectrum. Nonetheless, further studies would be required to verify these possibilities and fully assess the method's applicability in different contexts.

As part of the AI-WOOD ANR project (ANR-23-CE38-0013), Ericaceae will be sampled and analysed to evaluate the potential of artificial intelligence for taxonomic identification in anthracology. The potential for AI to reduce the time required for analysis, potentially through the automation of tasks such as quantifying anatomical features, will undoubtedly be acknowledged. Furthermore, developing a similar protocol for the *Erica* genus represents an intriguing prospect for future research.

The archaeological case study of Basi and I Casteddi has provided valuable insights for reconstructing the physiognomy of past Ericaceae formations. Quantitative eco-anatomy shows great potential for shedding light on woody vegetation from the past, particularly when present-day analogues are lacking. This approach could therefore provide a better understanding of the expansion and physiognomy of *Arbutus unedo* and the plant communities of which it forms part throughout the Holocene, allowing us to rethink their role in the economy of human societies, including firewood supply strategies, wood selection for construction and craft work but also land uses in relation to agropastoral activities.

CRedit authorship contribution statement

Thomas Camagny: Writing – original draft, Visualization, Resources, Methodology, Formal analysis, Data curation. **Sarah Ivorra:** Writing – review & editing, Validation, Supervision, Methodology, Formal analysis. **Jean-Frédéric Terral:** Writing – review & editing, Validation, Supervision, Methodology. **Pauline Garberi:** Writing – review & editing, Visualization, Software, Formal analysis. **Alain Carré:** Writing – review & editing, Resources. **Hélène Paolini-Saez:** Writing – review & editing, Resources. **Thomas Perrin:** Writing – original draft, Visualization, Resources, Methodology, Formal analysis, Data curation. **Laurent Boubry:** Writing – review & editing, Validation, Supervision, Methodology. **Claire Delhon:** Writing – review & editing, Visualization, Validation, Supervision, Methodology, Data curation.

Acknowledgements

This research was supported by the Collectivité de Corse/Cullettività di Corsica, France. We would like to acknowledge the Parc Naturel Régional de Corse for the information it provided. We thank the Office National des Forêts for its involvement and help on the field, in particular: Alain Chavenon, Alexandre Honoré-Giacomoni, Philippe Hazeman and Achille Sanroma. Special thanks to Stephane Negroni for his assistance in the Castagniccia region. We are also grateful to Antoine Pasqualini and Carla-Maria Poggi for their help with map creation and coordinates input. The authors would like to thank the two reviewers for their constructive comments, as well as Jérôme Ros, Bertrand Limier and Benoît Brossier (ISEM, CNRS, Montpellier) for their remarks. Finally, we express our thanks to the excavation teams from Basi and I Casteddi for their work on the field.

Appendix A

Modern Arbutus wood sample details.

Station	Tree	Tree habit	Tree height (m)	Size class	Sample	Branch type	Diameter (cm)
Filosorma forest	FANG01	Tree	3.9	$3 < x \leq 6 m$	FANG01-1	M	3.8
					FANG01-2	M	8.85
					FANG01-3	S	3.6
					FANG01-4	S	2.4
	FANG02	Tree	4.5	$3 < x \leq 6 m$	FANG02-5	M	5.7
					FANG02-6	M	5.25
					FANG02-7	S	3.1
					FANG02-8	S	2.1
	FANG03	Shrub	4	$3 < x \leq 6 m$	FANG03-9	M	3.5
					FANG03-10	M	9.5
					FANG03-11	S	2.4
					FANG03-12	S	2
Melza pass	FANG06	Shrub	6.5	$> 6 m$	FANG06-13	M	15.75
					FANG06-14	M	9.75
					FANG06-15	S	2.05
	FANG07	Tree	7	$> 6 m$	FANG06-16	S	2.1
					FANG07-17	M	6.45
					FANG07-18	M	5.35
San Petru pass	GRAV02	Shrub	2.5	$\leq 3 m$	FANG07-19	S	2.85
					FANG07-20	S	2.35
					GRAV02-21	M	3.15
					GRAV02-22	M	3.75
	GRAV09	Shrub	2	$\leq 3 m$	GRAV02-23	S	2
					GRAV02-24	S	1.75
					GRAV09-25	M	5
					GRAV09-26	M	4.75
	GRAV10	Shrub	1.5	$\leq 3 m$	GRAV09-27	S	2.85
					GRAV09-28	S	2.5
					GRAV10-29	M	3.35
					GRAV10-30	M	2.55
GRAV11	Shrub	3.8	$3 < x \leq 6 m$	GRAV10-31	S	1.9	
				GRAV10-32	S	1.95	
				GRAV11-33	M	5.9	
				GRAV11-34	M	4.9	
GRAV12	Shrub	5.5	$3 < x \leq 6 m$	GRAV11-35	S	2.1	
				GRAV11-36	S	1.8	
				GRAV12-37	M	4.25	
				GRAV12-38	M	7.75	
Miluccia forest	TAR01	Tree	9	$> 6 m$	TAR01-39	S	2.6
					TAR01-40	S	2.75
					TAR01-41	M	10.75
					TAR01-42	M	6.35
	TAR02	Tree	7	$> 6 m$	TAR02-43	S	2.3
	TAR03	Shrub	5	$3 < x \leq 6 m$	TAR02-44	S	2.55
					TAR03-45	M	5
					TAR03-46	M	3.35
					TAR03-47	S	2.2
	TAR04	Tree	6	$3 < x \leq 6 m$	TAR03-48	S	1.95
					TAR04-49	M	8.75
	TAR05	Tree	6	$3 < x \leq 6 m$	TAR04-50	S	2.6
TAR05-51					M	8.1	
TAR08	Tree	2	$\leq 3 m$	TAR05-52	S	2.45	
				TAR08-53	M	3.25	
TAR09	Tree	2.5	$\leq 3 m$	TAR08-54	S	1.65	
				TAR09-55	M	3.95	
TAR10	Shrub	2.5	$\leq 3 m$	TAR09-56	S	1.8	
				TAR10-57	M	2.7	
				TAR10-58	S	2	
				TAR17-59	M	2.65	
Penta road	CAST01	Tree	2	$\leq 3 m$	TAR17-60	S	2.6
					CAST01-61	M	2.25
					CAST01-62	M	1.9
					CAST01-63	S	1.95
					CAST01-64	S	1.35

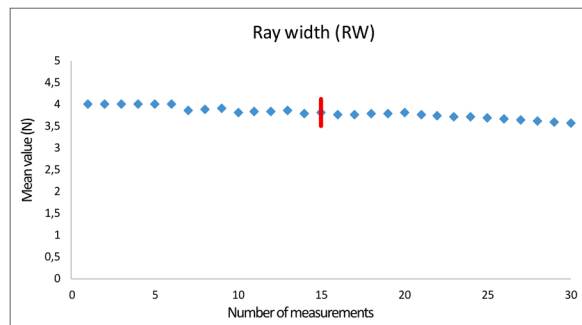
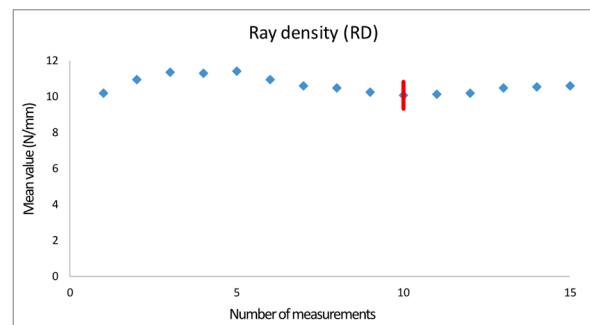
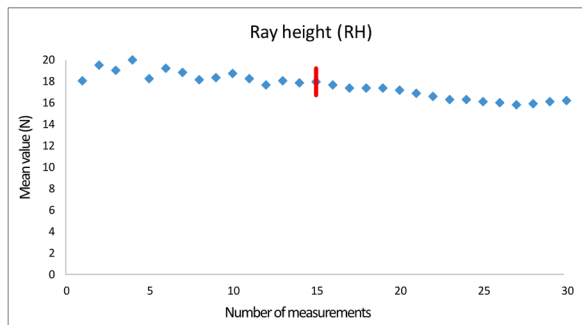
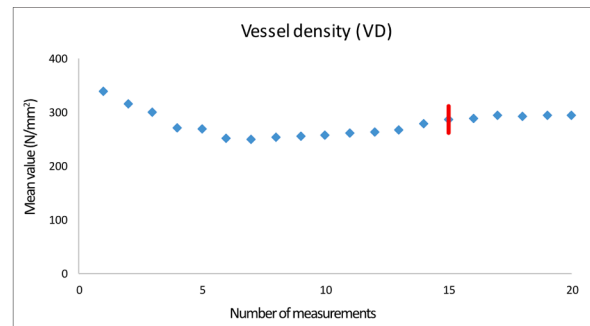
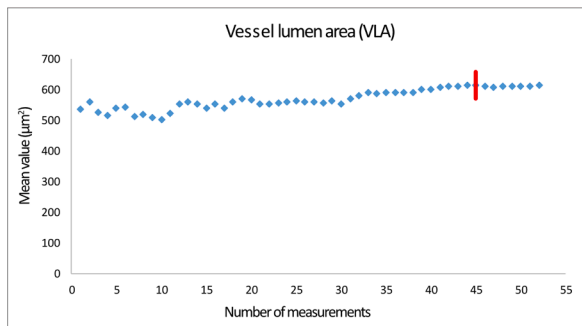
(continued on next page)

(continued)

Station	Tree	Tree habit	Tree height (m)	Size class	Sample	Branch type	Diameter (cm)
CAST02		Shrub	3.5	$3 < x \leq 6 m$	CAST02-65	M	6.5
					CAST02-66	M	5
					CAST02-67	S	2.45
					CAST02-68	S	1.55
CAST03	Tree	2.6	$\leq 3 m$	CAST03-69	M	4.35	
				CAST03-70	M	2.9	
				CAST03-71	S	1.95	
				CAST03-72	S	1.8	
CAST04	Shrub	4	$3 < x \leq 6 m$	CAST04-73	M	3.05	
				CAST04-74	M	2.65	
				CAST04-75	S	2.15	
				CAST04-76	S	2.1	
CAST05	Tree	4	$3 < x \leq 6 m$	CAST05-77	M	6.4	
				CAST05-78	M	4.65	
				CAST05-79	S	2.15	
				CAST05-80	S	1.9	

Appendix B

Cumulative average curves to determine the minimum number of measurements required to obtain representative values for each anatomical feature measured (red marks).



Appendix C

Variance homogeneity results (Anova test) for 2 sessions carried out by the same operator (TC) on 3 modern samples, and by two different operators (TC and CD) on one modern sample. If P-values > 0.05, then the homogeneity is verified.

Modern individual measured	Anatomical features	Same operator (TC)	Two different operators (TC and CD)
		P-values	P-values
TARARB01-1/4	VLA	0.67	0.12
	VD	0.848	0.17
	RD	0.378	0.151
	RW	0.667	0.644
	RH	0.592	0.124
TARARB02-1/4	VLA	0.336	
	VD	0.170	
	RD	0.631	
	RW	0.391	
TARARB02-4/4	RH	0.817	
	VLA	0.089	
	VD	0.564	
	RD	0.052	
	RW	0.097	
	RH	0.402	

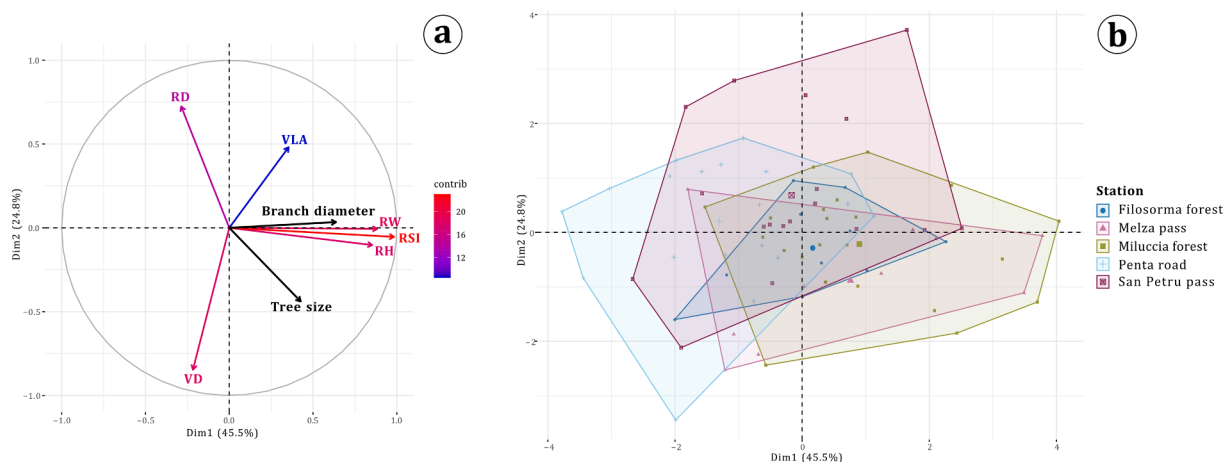
Appendix D

P-value of the correlation coefficients between anatomical feature variables and morphological traits variables. Significant p-values are symbolized with (*).

	Vessel lumen area	Vessel density	Ray density	Ray width	Ray height	Ray surface index
Tree height	0.334107989	0.0006378884*	0.00003661627	0.001247907	0.0001885330*	0.00008311085*
Branch diameter	0.063875173	0.1383853124	0.2150391	0.0000000001875404*	0.000002589277*	0.0000000002463609*

Appendix E

Results from PCA carried out on 80 individuals (modern charcoal samples) and 8 variables (6 are active and 2 are passive, tree height and branch diameter): Correlation circle (a) and PCA biplot 1–2 (70.3 % of variance) of the distribution of the individuals depending on their region of origin (station).



Appendix F

Total sum of all predictions obtained for each archaeological sample belonging to each predefined group according to LDA models (divided by 1000).

Site	Cultural period	Archaeological samples	Charcoal ID	P(≤ 3 m)	P(3 m < x ≤ 6 m)	P(> 6 m)	Allocation		
Basi	Early Neolithic	BASI21 1624 02	1	0.15	0.09	0.76	> 6 m		
		BASI21 1624 03	2	0.02	0.20	0.78	> 6 m		
		BASI22 1241 08	3	0.02	0.23	0.75	> 6 m		
	Early-Middle Neolithic	BASI17 1013 D3 06	4	0.11	0.75	0.14	3 m < x ≤ 6 m		
		BASI17 1013 D1 07	5	0.58	0.33	0.09	≤ 6 m		
		BASI17 1013 D3 05	6	0.43	0.39	0.18	≤ 6 m		
	Early Neolithic	BASI22 1241 09	7	0.35	0.52	0.13	≤ 6 m		
		BASI21 1242 D1 11	8	0.26	0.55	0.19	≤ 6 m		
		Basi21 1242 D1 10	9	0.26	0.36	0.38	Not allocated		
		BASI21 1624 04	10	0.53	0.17	0.30	Not allocated		
I Casteddi	Bronze Age	TAV19 387 241	11	0.99	0.01	0.00	≤ 3 m		
		TAV19 387 256	12	0.98	0.02	0.00	≤ 3 m		
		TAV17 305-2 233	13	0.95	0.05	0.00	≤ 3 m		
		TAV17 305 28	14	0.88	0.12	0.00	≤ 3 m		
		TAV17 305 241	15	0.87	0.12	0.01	≤ 3 m		
		TAV19 387 54	16	0.86	0.13	0.01	≤ 3 m		
		TAV17 305 323	17	0.82	0.13	0.05	≤ 3 m		
		TAV17 305 380	18	0.73	0.25	0.02	≤ 3 m		
		TAV19 387 334	19	0.72	0.25	0.03	≤ 3 m		
		TAV17 305 327	20	0.70	0.13	0.17	≤ 3 m		
		TAV19 387 221	21	0.58	0.37	0.05	≤ 6 m		
		TAV17 305 279	22	0.58	0.37	0.05	≤ 6 m		
		TAV19 387 291	23	0.55	0.40	0.05	≤ 6 m		
		TAV19 387 286	24	0.58	0.27	0.15	≤ 6 m		
		TAV19 387 17	25	0.34	0.48	0.18	≤ 6 m		
		TAV17 305 282	26	0.25	0.64	0.11	3 m < x ≤ 6 m		
		TAV19 387 293	27	0.08	0.31	0.61	> 3 m		
		TAV17 305 366	28	0.53	0.24	0.23	Not allocated		
		TAV17 305 104	29	0.49	0.28	0.23	Not allocated		
		TAV19 387 139	30	0.32	0.45	0.23	Not allocated		
		I Casteddi	Iron Age	TAV16 303 99	31	0.99	0.01	0	≤ 3 m
				TAV17 303 333	32	0.97	0.03	0	≤ 3 m
				TAV16 303 94	33	0.97	0.03	0	≤ 3 m
				TAV16 303 105	34	0.97	0.03	0	≤ 3 m
				TAV16 303 167	35	0.96	0.04	0	≤ 3 m
				TAV16 303 91	36	0.91	0.07	0.02	≤ 3 m
				TAV16 303 93	37	0.91	0.08	0.01	≤ 3 m
				TAV16 303 169	38	0.90	0.09	0.01	≤ 3 m
TAV16 303 135	39			0.84	0.13	0.03	≤ 3 m		
TAV16 303 108	40			0.84	0.15	0.01	≤ 3 m		
TAV16 303 78	41			0.8	0.19	0.01	≤ 3 m		
TAV16 303 142	42			0.76	0.24	0.00	≤ 3 m		
TAV17 303 71	43			0.72	0.26	0.02	≤ 3 m		
TAV16 303 159	44			0.72	0.11	0.17	≤ 3 m		
TAV16 303 102	45			0.70	0.30	0.00	≤ 3 m		
TAV16 303 98	46			0.29	0.56	0.15	≤ 6 m		
TAV17 303 99	47			0.01	0.41	0.58	> 3 m		
TAV16 303 156	48			0.42	0.31	0.27	Not allocated		
TAV16 303 92	49			0.35	0.40	0.25	Not allocated		
TAV16 303 158	50			0.34	0.14	0.52	Not allocated		

Data availability

Data will be made available on request.

References

- Allier, C., Lacoste, A., 1980. Maquis et groupements végétaux de la série du chêne vert dans le bassin du Fango (Corse). *Ecologie Méditerranéenne* 5, 59–82. <https://doi.org/10.3406/ecmed.1979.954>.
- Allier, C., Lacoste, A., 1981. Processus dynamiques de reconstitution dans la série du Quercus ilex en Corse. In: Poissonet, P., Romane, F., Austin, M.A., Van Der Maarel, E., Schmidt, W. (Eds.), *Vegetation Dynamics in Grasslands, Heathlands and Mediterranean Ligneous Formations*. Springer, Netherlands, Dordrecht, pp. 83–91. https://doi.org/10.1007/978-94-009-7991-8_8.
- Almeida, A.M., Martins, M.J., Campagnolo, M.L., Fernandez, P., Albuquerque, T., Gerassiss, S., Gonçalves, J.C., Ribeiro, M.M., 2022. Prediction scenarios of past, present, and future environmental suitability for the Mediterranean species *Arbutus unedo* L. *Sci Rep* 12, 84. <https://doi.org/10.1038/s41598-021-03996-0>.
- Anfodillo, T., Petit, G., Crivellaro, A., 2013. Axial conduit widening in woody species: a still neglected anatomical pattern. *IAWA J* 34 (4), 352–364. <https://doi.org/10.1163/22941932-00000030>.
- Beery, W.H., Ifju, G., McLain, T.E., 1983. Quantitative wood anatomy - relating anatomy to transverse tensile strength. *Wood Fiber Sci.* 15 (4), 395–407.
- Beffa, G., Pedrotta, T., Colombaroli, D., Henne, P.D., van Leeuwen, J.F.N., Süsstrunk, P., Kaltenrieder, P., Adolf, C., Vogel, H., Pasta, S., Anselmetti, F.S., Gobet, E., Tinner, W., 2016. Vegetation and fire history of coastal north-eastern Sardinia (Italy) under changing Holocene climates and land use. *Veget Hist Archaeobot* 25, 271–289. <https://doi.org/10.1007/s00334-015-0548-5>.
- Bonhomme, V., Ivorra, S., Lacombe, T., Evin, A., Figueiral, I., Maghradze, D., Marchal, C., Pagnoux, C., Pastor, T., Pomarèdes, H., Bacilieri, R., Terral, J.-F., Bouby, L., 2021. Pip shape echoes grapevine domestication history. *Sci. Rep.* 11 (1), 21381.

- Burgert, I., Bernasconi, A., Eckstein, D., 1999. Evidence for the strength function of rays in living trees. *Holz Roh Werkst.* 57, 397–399. <https://doi.org/10.1007/s001070050367>.
- Burgert, I., Eckstein, D., 2001. The tensile strength of isolated wood rays of beech (*Fagus sylvatica* L.) and its significance for the biomechanics of living trees. *Trees* 15, 168–170. <https://doi.org/10.1007/s004680000086>.
- Camagny, T., Arobba, D., Delhon, C., Paolini-Saez, H., Bouby, L., in press. Paléoenvironnement et interactions sociétés-milieux en Corse d'après l'archéobotanique : l'exemple de la vallée de la Gravona aux âges des Métaux, in: H. Paolini-Saez, E. Pereira, K. Peche-Quilichini (Eds.), *Six millénaire en Alta Rocca : archéologie-histoire-architecture-toponymie-géologie*, 5e Colloque Du Laboratoire Régional d'archéologie, Livia.
- Canadell, J., López-Soria, L., 1998. Lignotuber reserves support regrowth following clipping of two Mediterranean shrubs. *Funct. Ecol.* 12, 31–38. <https://doi.org/10.1046/j.1365-2435.1998.00154.x>.
- Carcaillet, C., Barakat, H.N., Panaïotis, C., Loisel, R., 1997. Fire and late-holocene expansion of *quercus ilex* and *pinus pinaster* on corsica. *J. Veg. Sci.* 8, 85–94. <https://doi.org/10.2307/3237246>.
- Carlquist, S., 1988. Rays. In: *Comparative wood anatomy: systematic, ecological, and evolutionary aspects of dicotyledon wood*. Springer, Berlin, Heidelberg, pp. 174–215. https://doi.org/10.1007/978-3-662-21714-6_6.
- Chabal, L., 1997. Forêts et sociétés en Languedoc (Néolithique final, Antiquité tardive) : l'anthracologie, méthode et paléocologie. *Doc. Archeol. Fr.* 63, Ed. De la Maison des Sciences de l'Homme, Paris.
- Chabal, L., Fabre, L., Terral, J.-F., Thery-Parisot, I., 1999. L'Anthracologie. In: Bourquin-Mignot, C., Brochier, J.-E., Chabal, L., Crozat, S., Fabre, L., Guibal, F., Marinval, P., Richard, H., Terral, J.-F., Thery-Parisot, I. (Eds.), *La Botanique, Coll. Archéologiques*. Editions Errance, pp. 43–104.
- De Santis, S., Spada, F., Magri, D., 2023. Geographic range vs. occurrence records in plant distribution mapping: the case of *arbutus* in the old world. *Forests* 14 (5), 1010. <https://doi.org/10.3390/f14051010>.
- Delhon, C., 2022. *Basi (Serra-di-Ferro, Corse du Sud) : analyse anthracologique*. In: Perrin, T. (Ed.), *Basi 2022, Rapport final d'opération programmée triennale*. CNRS, Toulouse, pp. 139–148.
- Dufraisse, A., Garcia Martínez, M.S., 2011. Mesurer les diamètres du bois de feu en anthracologie. *Anthropobotanica* 2, 1–18.
- Dufraisse, A., Coubray, S., Girardclos, O., Dupin, A., Lemoine, M., 2018. Contribution of tyloses quantification in earlywood oak vessels to archaeological charcoal analyses: Estimation of a minimum age and influences of physiological and environmental factors. *Quat. Int.* 463 (part B), 250–257. <https://doi.org/10.1016/j.quaint.2017.03.070>.
- Evin, A., Cucchi, T., Cardini, A., Strand, V.U., Larson, G., Dobney, K., 2013. The long and winding road : identifying pig domestication through molar size and shape. *J. Archaeol. Sci.* 40 (1), 735–743. <https://doi.org/10.1016/j.jas.2012.08.005>.
- Figueiral, I., 2011. Résultats archéologiques, in: Vidal L. (Ed.), Caselle, création d'un parc photovoltaïque. FA08009501, INRAP Méditerranée, Nîmes, 27–33.
- Gamisans, J., 1999. *La végétation de la Corse*. Edisud, Aix-en-Provence.
- Gamisans, J., Grüber, M., Quézel, P., 1983. Les forêts de *Castanea sativa*, *Alnus cordata* et *Ostrya carpinifolia* du massif de San Petrone (Corse). *Ecologia Mediterranea* 9 (1), 89–99. <https://doi.org/10.3406/ecmed.1983.1020>.
- Ghilardi, M., 2020. *Lagunes et marais littoraux de Corse, de la Préhistoire à nos jours*. Coll. Orma : la Corse archéologie, Ed. ARAC, 5.
- Gilabert, C., Leandri, F., Jorda, C., Assous-Plunian, M., Demouche, F., Bellot-Gurlet, L., Bressy-Leandri, C., Chabal, L., Errera, M., Bourdonnec, F.-X.L., Muller, S., Federzoni, N., Giannesi, G., Saez, H.P., Poupeau, G., Spella, M.M., Vella, M.-A., Watte, J., 2011. Le site du Monte Revincu : nouvelles données sur un village néolithique moyen du nord de la Corse. In: Sénépart, I., Perrin, T., Thirault, E., Bonnardin, S. (Eds.), *Marges, frontières et transgressions : Actualité de la recherche. Actes des 8e Rencontres Méridionales de Préhistoire Récente, 7-8 novembre 2008, Marseille*. Archives d'Ecologie Préhistorique, Toulouse, pp. 283–297.
- Girardclos, O., Dufraisse, A., Dupouey, J.-L., Coubray, S., Ruelle, J., Rathgeber, C.B.K., 2018. Improving identification of coppiced and seeded trees in past woodland management by comparing growth and wood anatomy of living sessile oaks (*Quercus petraea*). *Quat. Int.* 463 (Part B), 219–231. <https://doi.org/10.1016/j.quaint.2017.04.015>.
- Hasler, A., Tramoni, P., Sargiano, J.-P., Peche-Quilichini, K., Lancelot, S., Lefèvre-Gonzalez, L., Lelièvre, V., Piskorz, M., Sarazin, P., 2012. Nouvelle intervention archéologique sur le site de Basi (Serra-di-Ferro, Corse-du-Sud). In: Sénépart, I., Leandri, F., Cauliez, J., Perrin, T., Thirault, E. (Eds.), *Chronologie de la Préhistoire récente dans le Sud de la France. Actualités de la recherche, Actes des 10e Rencontres méridionales de Préhistoire récente, 18-20 octobre 2012, Porticcio*. Archives d'Ecologie Préhistorique, Toulouse, pp. 289–307.
- Heinz, C., Figueira, I., Terral, J.-F., Claustre, F., 2004. Holocene vegetation changes in the northwestern Mediterranean: new palaeoecological data from charcoal analysis and quantitative eco-anatomy. *The Holocene* 14 (4), 621–627.
- James, G., Witten, D., Hastie, T., Tibshirani, R., 2013. *An introduction to statistical learning: with applications in R*, 2nd Ed., Springer, Springer texts in Statistics, New York.
- Kassout, J., Ater, M., Ivorra, S., Barbara, H., Limier, B., Ros, J., Girard, V., Paradis, L., Terral, J.-F., 2021. Resisting aridification: adaptation of sap conduction performance in moroccan wild olive subspecies distributed over an aridity gradient. *Front. Plant Sci.* 12, 663721. <https://doi.org/10.3389/fpls.2021.663721>.
- Lacoste, A., Salanon, R., 1999. *Éléments de biogéographie et d'écologie*. Nathan, Paris.
- Limier, B., Ivorra, S., Bouby, L., Figueiral, I., Chabal, L., Cabanis, M., Ater, M., Lacombe, T., Ros, J., Brémont, L., Terral, J.-F., 2018. Documenting the history of the grapevine and viticulture: A quantitative eco-anatomical perspective applied to modern and archaeological charcoal. *J. Archaeol. Sci.* 100, 45–61.
- Lugliè, C., 2018. Your path led through the sea... the emergence of Neolithic in Sardinia and Corsica. *Quat. Int.* 470 (Part B), 285–300. <https://doi.org/10.1016/j.quaint.2017.12.032>.
- Marguerie, D., Bernard, V., Begin, Y., Terral, J.F., 2010. *Anthracologie et dendrologie*. In: Payette, S., Filion, L. (Eds.), *La dendroécologie : principes, méthodes et applications*. Presses de l'Université Laval, pp. 311–350.
- Martínez-Vilalta, J., Prat, E., Oliveras, I., Piñol, J., 2002. Xylem hydraulic properties of roots and stems of nine Mediterranean woody species. *Oecologia* 133, 19–29. <https://doi.org/10.1007/s00442-002-1009-2>.
- Mesléard, F., 1987. *Dynamique, après perturbations, de peuplements de deux Ericacées (Arbutus unedo L. et Erica arborea L.) en Corse*. Thèse de doctorat, Académie de Montpellier. Université des Sciences et Techniques du Languedoc, Montpellier.
- Mesléard, F., Lepart, J., 1989. Continuous basal sprouting from a lignotuber: *arbutus unedo* L. and *Erica arborea* L., as woody Mediterranean examples. *Oecologia* 80 (1), 127–131. <https://doi.org/10.1007/BF00789941>.
- Mesléard, F., Lepart, J., 1991. Germination and seedling dynamics of *Arbutus unedo* and *Erica arborea* on Corsica. *J. Veg. Sci.* 2, 155–164. <https://doi.org/10.2307/3235947>.
- Montenegro, G., Avila, G., Schatte, P., 1983. Presence and development of lignotubers in shrubs of the Chilean matorral. *Canadian Journal of Botanique* 61 (6), 1804–1808. <https://doi.org/10.1139/b83-189>.
- Mouillot, F., Paradis, G., Andrei-Ruiz, M.-C., Quilichini, A., 2008. Corsica. In: Vogiatzakis, I., Pungetti, G., Mannion, A.M. (Eds.), *Mediterranean Island Landscapes: Natural and Cultural Approaches*, Landscape Series, Springer, Netherlands, Dordrecht, pp. 220–244. https://doi.org/10.1007/978-1-4020-5064-0_10.
- Panaïotis, C., 2001. Place du maquis haut dans la dynamique naturelle des forêts de chênes verts (Réserve MAB du Fango - Corse). In: Lorenzi, L. (Ed.), *Le Maquis Corse. D'après Les Textes Anciens et Modernes*. L'Harmattan, Paris.
- Paolini-Saez, H., Villat, X., Jamaï-Chipon, A., Marcel, M., Arobba, D., Lambert, M., 2019. Les habitats protohistoriques d'I Casteddi (Tavera, Corse-du-Sud). In: Sicurani, J. (Ed.), *L'habitat Pré- et Protohistorique, Acte du premier colloque de l'Association de Recherches Préhistoriques et Protohistoriques Corses (ARPPC)*, 28-30 avril 2017, Calvi. Imprimerie Signature, Calvi, pp. 269–286.
- Paolini-Saez, H., Camagny, T., Graziani, J., 2022. Les occupations sur éperon au second âge de Fer dans la vallée de la Gravona: de l'espace géographique au territoire anthropique. In: Paolini-Saez, H., Pereira, E. (Eds.), *Six Millénaires En Centre Corse : Archeologia, Storia, Architettura, Tupunimia, Geulugia, Actes du 4e colloque du Laboratoire Régional d'Archéologie, 15-17 novembre 2019, Corte*. Éditions Alain Piazzola, Ajaccio, pp. 387–409.
- Paolini-Saez, H., Gratuze, B., Le Bourdonnec, F.-X., Leck, A., Le Flecher, T., 2023. Le territoire du site perché d'I casteddi à Tavera, Corse-du-Sud : premières réflexions. In: Peche-Quilichini, K., Paolini-Saez, H., Blitte, H., Lachenal, T., Leandri, F., Lehoërf, A., Quilliec, B. (Eds.), *Age du Bronze, Âge de Fer ? Violence organisée et expressions de la force au Ile millénaire av. J.-C., 14-17 octobre, Ajaccio-Porticcio*. Supplément n°12 au Bulletin de l'APRAB, pp. 73–85.
- Paradis-Grenouillet, S., Dufraisse, A., Allée, P., 2013. Radius of curvature measurements and wood diameter: a comparison of different image analysis techniques. *British Archaeological Report* 173–182.
- Paula, S., Naulin, P.I., Arce, C., Galaz, C., Pausas, J.G., 2016. Lignotubers in Mediterranean basin plants. *Plant Ecol* 217, 661–676. <https://doi.org/10.1007/s11258-015-0538-9>.
- Pernaud, J.-M., Thiebault, S., 2002. *L'anthracologie*. In: Miskovsky, J.-C. (Ed.), *Géologie de La Préhistoire : Méthodes, Techniques, Applications*. Presses universitaires de Perpignan, Paris, pp. 705–714.
- Perrin, T., 2022. *Basi 2022, Rapport final d'opération programmée triennale 2020-2022*. CNRS, Toulouse.
- Perrin, T., Vigne, J.-D., Picavet, R., 2022. Récents acquis sur les premiers peuplements de l'île. In: Leandri, F., Leandri, C. (Eds.), *Archéologie En Corse, Vingt Années de Recherche*. Ed. Errance, Arles, pp. 18–27.
- Petit, G., Crivellaro, A., 2014. Comparative axial widening of phloem and xylem conduits in small woody plants. *Trees* 28, 915–921. <https://doi.org/10.1007/s00468-014-1006-1>.
- Pfautsch, S., Hölttä, T., Mencuccini, M., 2015a. Hydraulic functioning of tree stems - fusing ray anatomy, radial transfer and capacitance. *Tree Physiol.* 35 (7), 706–722. <https://doi.org/10.1093/treephys/tpv058>.
- Pfautsch, S., Renard, J., Tjoelker, M.G., Salih, A., 2015b. Phloem as capacitor: radial transfer of water into xylem of tree stems occurs via symplastic transport in ray parenchyma. *Plant Physiol.* 167 (3), 963–971. <https://doi.org/10.1104/114.254581>.
- Poher, Y., Ponel, P., Médail, F., Andrieu-Ponel, V., Guitier, F., 2017. Holocene environmental history of a small Mediterranean island in response to sea-level changes, climate and human impact. *Palaeogeogr. Palaeoclimatol. Palaeoecol.* 465, 247–263. <https://doi.org/10.1016/j.palaeo.2016.10.037>.
- Queiroz, P.F., Van Der Burgh, J., 1989. Wood anatomy of iberian ericales. *Revista de Biologia* 14, 95–134.
- Quézel, P., Médail, F., 2003. *Écologie et biogéographie des forêts méditerranéennes*. Elsevier (Collection Environnement), Paris.
- Reille, M., 1984. Origine de la végétation actuelle de la Corse sud-orientale; analyse pollinique de cinq marais côtiers. *Pollen Spores* 26 (1), 43–60.
- Reille, M., 1992. New pollen-analytical researches in Corsica: the problem of *Quercus ilex* L. and *Erica arborea* L., the origin of *Pinus halepensis* Miller forests. *New Phytol.* 122 (2), 359–378. <https://doi.org/10.1111/j.1469-8137.1992.tb04241.x>.

- Reille, M., Gamisans, J., Andrieu-Ponel, V., de Beaulieu, J.-L., 1999. The Holocene at Lac de Creno, Corsica, France: a key site for the whole island. *New Phytol.* 141 (2), 291–307. <https://doi.org/10.1046/j.1469-8137.1999.00343.x>.
- Reiterer, A., Burgert, I., Sinn, G., Tschegg, S., 2002. The radial reinforcement of the wood structure and its implication on mechanical and fracture mechanical properties - A comparison between two tree species. *J. Mater. Sci.* 37, 935–940. <https://doi.org/10.1023/A:1014339612423>.
- Revelles, J., Ghilardi, M., Rossi, V., Currás, A., López-Bultó, O., Brkojewitsch, G., Vacchi, M., 2019. Coastal landscape evolution of Corsica island (W. Mediterranean): palaeoenvironments, vegetation history and human impacts since the early Neolithic period. *Quat. Sci. Rev.* 225, 105993. <https://doi.org/10.1016/j.quascirev.2019.105993>.
- Ros, J., Terral, J.-F., Ruas, M.-P., Ivorra, S., Limier, B., Ater, M., Paradis, L., Ettahiri, A.S., Fili, A., Van Staëvel, J.-P., 2021. Understanding anatomical plasticity of Argan wood features at local geographical scale in ecological and archaeobotanical perspectives. *Sci. Rep.* 11, 10830. <https://doi.org/10.1038/s41598-021-90286-4>.
- Santiso, X., Lopez, L., Retuerto, R., Barreiro, R., 2016. Population structure of a widespread species under balancing selection: the case of *arbutus unedo* L. *Front. Plant Sci.* 6, 1264. <https://doi.org/10.3389/fpls.2015.01264>.
- Sauter, J.J., Neumann, U., 1994. The accumulation of storage material in ray cells of poplar wood (*Populus x canadensis robusta*): effect of ringing and defoliation. *Journal of Plant Physiology* 143, 21–26.
- Schweingruber, F.H., 1990. *Anatomy of european woods*. Paul Haupt, Bern Stuttgart.
- Skeffington, M.S., Scott, N., 2021. Is the Strawberry Tree, *Arbutus unedo* (Ericaceae), native to Ireland, or was it brought by the first copper miners? *British & Irish Botany* 3 (4), 385–418. <https://doi.org/10.33928/bib.2021.03.385>.
- Slupianek, A., Dolzblasz, A., Sokotowska, K., 2021. Xylem parenchyma - role and relevance in wood functioning in trees. *Plants* 10, 1247. <https://doi.org/10.3390/plants10061247>.
- Terral, J.F., Arnold-Simard, G., 1996. Beginnings of olive cultivation in eastern Spain in relation to Holocene bioclimatic changes. *Quat. Res.* 46 (2), 176–185. <https://doi.org/10.1006/qres.1996.0057>.
- Terral, J.-F., 2002. Quantitative anatomical criteria for discriminating wild grapevine (*Vitis vinifera* ssp. *sylvestris*) from cultivated vines (*Vitis vinifera* ssp. *Vinifera*). In: Thiébaud, S. (Ed.), *Charcoal Analysis. Methodological Approaches, Palaeoecological Results and Wood Uses*, British Archaeological Reports 1063, pp. 59–64.
- Terral, J.-F., Durand, A., Newton, C., Ivorra, S., 2009. Archéo-biologie de la domestication de l'olivier en Méditerranée occidentale : de la remise en cause d'une histoire dogmatique à la révélation de son irrigation médiévale. *Études Héraultaises* 233, 13–25.
- Torres, J.A., Vallé, F., Pinto, C., García-Fuentes, A., Salazar, C., Cano, E., 2002. *Arbutus unedo* L. communities in southern Iberian Peninsula mountains. *Plant Ecol.* 160, 207–223. <https://doi.org/10.1023/A:1015864821706>.
- Vaschalde, C., 2019. Etude anthracologique des contextes domestiques et artisanaux de l'Antiquité et de l'Antiquité tardive. In: Guillaume, D. (Ed.), *Vico (Corse-du-Sud), A Sullana - Sant'Appianu. Agglomération littorale et nécropole tardo-antiques*, Arkemine, Beaumont-lès-Valence, pp. 341–353.
- Vernet, J.-L., 1988. Analyse anthracologique du gisement Chalcolithique de Terrina IV à Aleria (Corse). In: Camps, G. (Ed.), *Terrina et le terrinien. Recherche sur le chalcolithique de la Corse*, Ecole française de Rome, Roma, pp. 257–261.
- Vernet, J.-L., Ogereau, P., Figueiral, I., Machado Yanes, C., Uzquiano, P., 2001. Guide d'identification des charbons de bois préhistoriques et récents: sud-ouest de l'Europe: France, péninsule ibérique, et îles Canaries, ED. CNRS.