# COOKING WITH PLANTS IN ANCIENT EUROPE AND BEYOND

## *Interdisciplinary approaches to the archaeology of plant foods*

SOULTANA MARIA VALAMOTI, ANASTASIA DIMOULA
AND MARIA NTINOU (EDS)

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# Contents

Chapter 12

# Cooked and raw. Fruits and seeds in the Iberian Palaeolithic

Ernestina Badal, Carmen M. Martínez Varea

> [Man] *has discovered the art of making fire, by which hard and stringy roots can be rendered digestible, and poisonous roots or herbs innocuous.*
> Darwin 1871: 278

## Abstract

Fruits, seeds, leaves and underground storage organs were all consumed by human groups during the Palaeolithic. These plant foodstuffs provided humans with minerals, vitamins and nutrients essential for optimal health. In this sense, fire control was a crucial human achievement since cooking allowed the physical and chemical modification of these elements by eliminating toxins, enhancing the digestion of foodstuffs and increasing their energy value. The use of fire during plant processing increases the potential preservation of archaeobotanical remains, as well. Based on the preserved plant elements and their characteristics, the *chaîne opératoire* of plant consumption can be reconstructed.

In this chapter we focus on the gathering and processing of fruits and seeds of three plant species during the Palaeolithic in the Iberian Peninsula. We stress the role of fire as a processing tool and as a preservation agent. The plants in question are *Pinus pinea* L. (stone pine), *Corispermum gallicum* Iljin (bugseed), and *Corema album* (L.) D. Don ex Steudel (Portuguese crowberry). The archaeobotanical remains preserved in the three sites discussed here, namely Figueira Brava (Setúbal, Portugal), Cueva de Nerja (Málaga, Spain) and Cova de les Cendres (Alicante, Spain) prove that Neanderthals and modern humans had similar skills regarding the control of fire during all stages of the combustion process, and demonstrate the implementation of multi-step processing, especially at the end of the Upper Palaeolithic. By avoiding cutting down the species that provided food, these Palaeolithic groups carried out sustainable vegetation management, as well.

***Keywords:*** *Palaeolithic, food processing, pine nuts, berries, seeds, fire*

## 12.1 Introduction

Throughout history, humans have had an omnivorous diet, although some foodstuffs are frequently "missing" from the archaeological record, such as plant foods. The documentation of the consumption of plants during the Palaeolithic is not easy due to the scarce generated waste and their perishable nature. Nevertheless, recent developments concerning the analysis of macro- and micro- archaeobotanical remains from Palaeolithic

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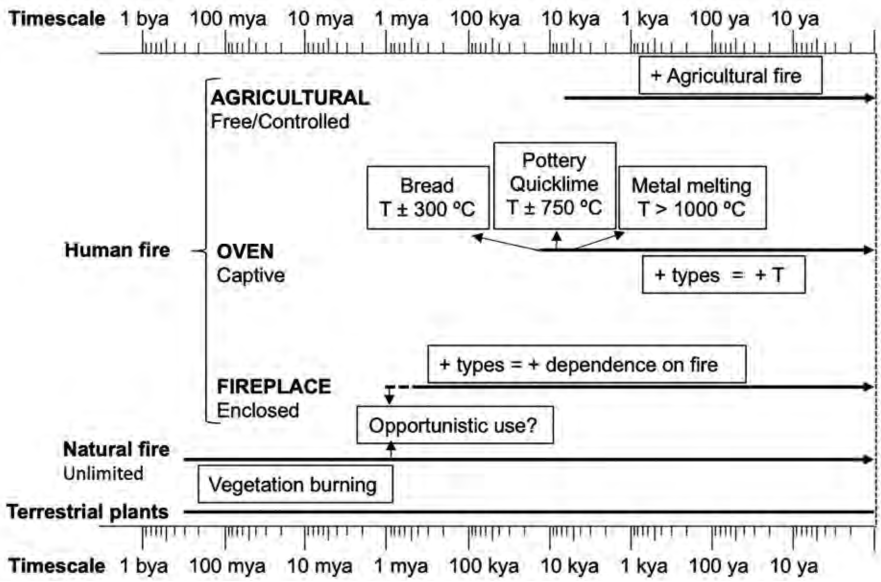


Fig. 12.1 Time scale of natural and human fire. As time goes by, types of combustion structures diversify and the reached temperatures increase.

sites are providing valuable evidence on plant food gathering and processing among hunter-gatherer groups (Asouti et al 2018; Henry et al 2014; Mariotti Lippi et al 2015; Martínez-Varea 2020; Miras et al 2020; Riehl et al 2015), filling gaps in the hitherto limited knowledge about plant use during this period.

Fruits, seeds, leaves, stems and underground storage organs of wild plants can be ingested raw or somehow processed to eliminate toxins or to ease digestion. In this sense, the domestication of fire was an inflection point in the use of plants (Stahl 1984).

In this chapter we focus on the gathering and processing of pine nuts (*Pinus pinea*), bugseeds (*Corispermum* cf. *gallicum*) and Portuguese crowberries (*Corema album*) during the Middle and Upper Palaeolithic in the Iberian Peninsula, as remains of these plants have been recovered in some archaeological sites. The significant amount of archaeobotanical remains suggests that these plants played an important role in human diet. We also examine the potential role of fire as a processing tool and as a preservation agent.

## 12.2 Fire as a key ally for humankind

Fire is a powerful natural force, unlimited and of great destructive power and, as such, it has had a crucial influence in the evolution of living beings, and of humankind in particular. The production, control and use of fire are exclusively human achievements, which break the equality relations with the other living organisms (Goudsblom 1992). In order to control fire, it is essential to understand its behaviour, namely how it is produced, how it spreads and what its consequences are; in this respect fire control is a result of learning and transmission which requires the development of some abilities among hominids, and specifically of their "powers of observation, memory, curiosity, imagination, and reason", as pointed out by Darwin (1871, 278). The ability to manage fire is a universal human milestone, but the date of this achievement is still debated (Alperson-Afil 2008; Roebroeks and Villa 2011). Throughout the history of humankind, climatic changes, the history of fire and cultural changes are somehow related. In each evolutionary phase, humans have diversified the uses of fire -heat, light, transformative tool, etc-, have generated more energy via the development of new combustion structures (e.g. domestic and industrial ovens), new fuels (e.g. coal, petroleum or gas), and have increased its destructive power (Fig. 12.1).

The domestication of fire implies the capacity to limit it within a combustion area. In dwellings, human fire is always bounded, and its action is reduced and centered in the combustion structure, namely the hearth, where the input of fuel is limited and controlled. In agriculture, human fire is generally limited to crop fields, although it can become uncontrolled and cause larger fires (Fig. 12.1). Even so, the products of human fire are the same as those of natural fires: wood charcoal, ashes and others (Perlès 1977).

Some researchers link the first consumption of plant food to the development of fire control since it allowed the elimination of toxins present in some plants (Leopold and Ardrey 1972). However, even before the control of fire, hominids could still minimize the intake of toxins through a diversified spectrum of ingested plants, along with other processing techniques developed in the course of the emergence of the genus *Homo* (Hillman and Wollstonecroft 2014; Stahl 1984). Cooking, that is processing of food ingredients by fire, alters the texture and taste of foodstuffs, rendering them more digestible and increasing their energetic content, thus enabling increase in brain and body size (Carmody and Wrangham 2009; Wollstonecroft

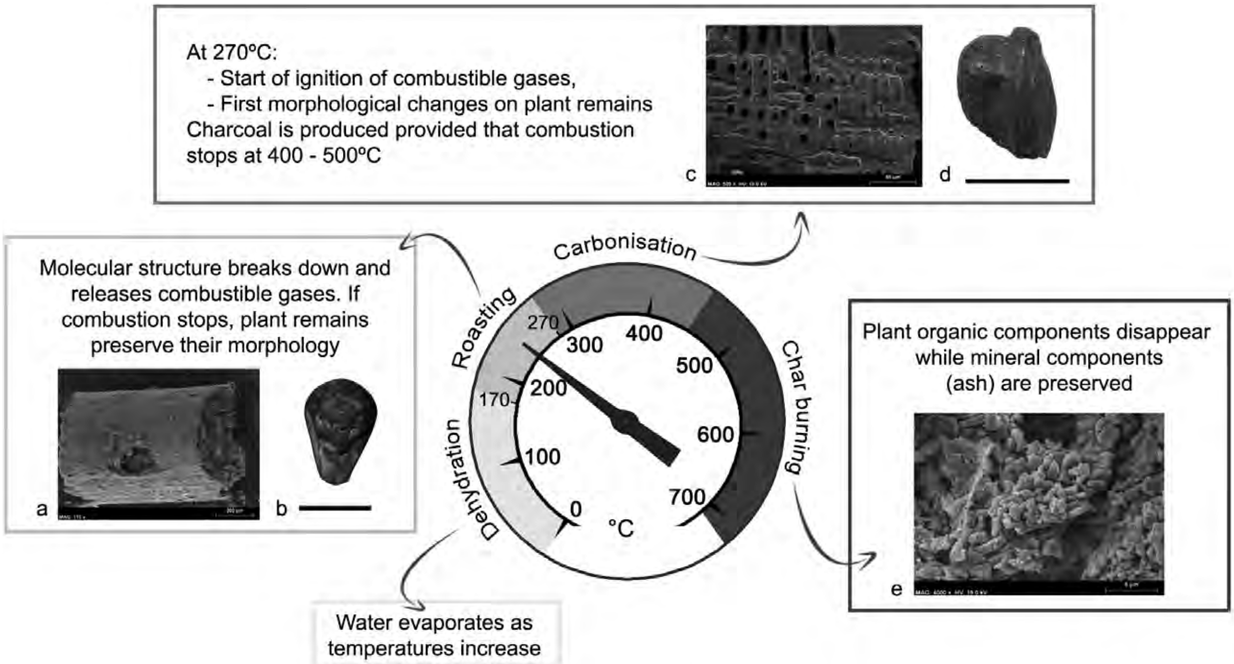


Fig. 12.2 Fire combustion process and generated plant residues: a *Pinus* sp. needle from Figueira Brava; b pine scale from Cueva de Nerja; c *Pinus pinea* wood charcoal from Cueva de Nerja; d altered *Corispermum* cf. *gallicum* seed from Cova de les Cendres; e ashes from Cova de les Cendres.

et al 2012). Physiological consequences of adaptation to the ingestion of cooked foodstuffs are first observed among *Homo erectus* some 1,8 m years ago (Wrangham and Carmody 2010). Therefore, "through food processing, hominins had an active role in their own evolution" (Butterworth et al 2016, 45). In this respect, Parker et al's (2016) pyrophilic primate hypothesis is quite intriguing: first hominids were aware of the benefits of recurrent natural fires in the savannah, as they generated open spaces where gathering was easier, thanks to the increased visibility and to the presence of "cooked" foodstuffs. Hominids, then, started to spread these natural fires, understanding quite early the benefits of cooking, leading to evolutionary adaptation. In any case, if we accept that *Homo erectus* were the first hominids to exhibit clear physiological adaptation to a cooked diet, we can hypothesize that they could occasionally have used fire with different aims, originally as active pyrophilics and then by acquiring the necessary experience and knowledge in order to control and produce it (Attwell et al 2015). We do not know the exact details of this learning process, but the benefits of fire as an evolutionary success are undeniable (Darwin 1871; Wrangham 2009).

In the Iberian Peninsula, evidence of possible use of fire appears in as early as the Lower Palaeolithic (MIS 11, ca 400 ky), while the ability of Neanderthals to produce and control it in all the combustion phases, same as modern humans, is beyond doubt (Sanz et al 2020; Vidal-Matutano et al 2019; Zilhão et al 2020).

## 12.3 Fire as a key ally to Archaeobotany

Fire is also considered an ally to Archaeobotany because carbonisation is the main preservation agent of plant remains in archaeological deposits; fire could also be considered as a destructive agent (Wilson 1984) since it causes preservation biases depending on the characteristics of the plant remains and the combustion conditions (Wright 2003).

The combustion process consists of four different phases: dehydration, roasting, carbonisation or pyrolysis and char burning (Chabal et al 1999). The generated remains differ according to which stage the firing stops, and they can demonstrate the use of fire during plant processing (Fig. 12.2). Carbonisation, according to Wright, is "the process by which incomplete combustion of tissues leaves a carbon residue that is black in colour" (2003, 578), the physical and chemical properties of which vary depending on heating variables (Braadbaart and Poole 2008).

## 12.4 From gathering to consumption

The *chaîne opératoire* of plant use during the Palaeolithic consists of six steps: gathering, transport, storage, processing, consumption and discard. The presence or absence of archaeobotanical remains in the archaeological deposits and their frequency allow us to more or less accurately detect these human actions (Berihuete 2016) (Fig. 12.3), although other factors (e.g. taphonomic

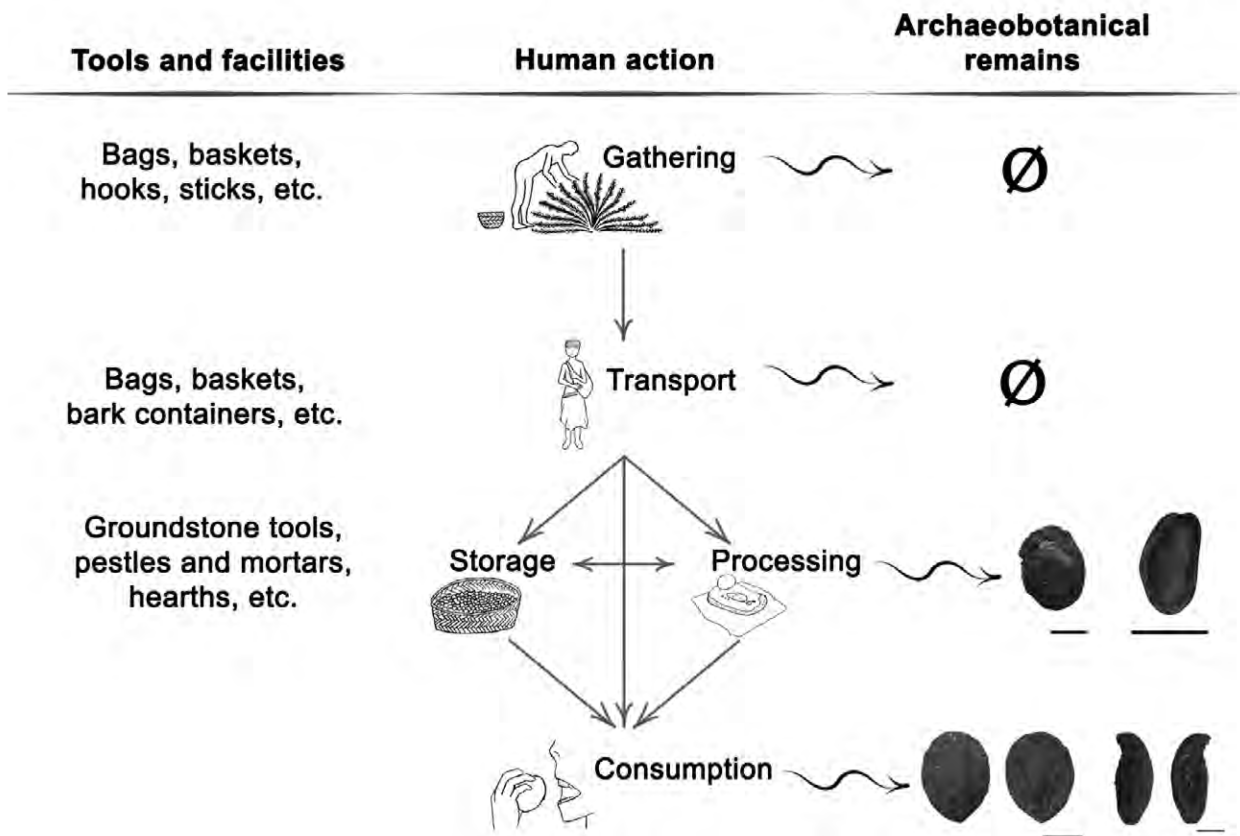


Fig. 12.3 *Chaîne opératoire* of plant food processing during the Palaeolithic.

alterations) must be considered when assessing the composition of archaeobotanical assemblages (Wright 2003).

Given the ease and the reduced risk involved in plant gathering, usually all members of Palaeolithic groups could participate in the gathering of some plant food resources, such as Portuguese crowberries, wild strawberries, etc regardless of gender or age (Fig. 12.4). However, gathering other fruits requires some skills and entails some risks, so it was probably carried out by trained members of the group; this is the case of the cones of the stone pine. In any case, gathering fruits and seeds is less dangerous than hunting, although both activities require specific skills and knowledge since the consumption of a toxic fruit could cause death.

Gathering itself does not leave any archaeological evidence. In fact, some of the collected foods could be consumed outside the habitat, in the very place of gathering, especially in the case of fruits that could be eaten raw. Regarding gathering tools, use-wear analyses that could shed some light on this subject are, unfortunately, not frequent (Pyżewicz and Nerudová 2020), while implements involved in it -baskets, bags, digging sticks or hooks- were made on perishable materials, and are, thus, rarely preserved (Aranguren et al 2018; Aura et al 2020). Concerning catchment area size, it varied according to the biodiversity of the territory, usually covering an area ranging from the immediate surroundings of the sites to as far as a 10 km radius (Martínez-Varea 2020) around them.

A post-harvesting process is carried out in order to remove the non-edible parts, to eliminate toxins and other components, to ensure preservation, to improve taste and texture, and to facilitate access to some nutrients (Stahl 1989). This process varies according to the characteristics of each fruit or seed: some fruits, like wild strawberries, could be consumed immediately because they can be eaten raw or because they cannot be stored; other fruits, like cones, acorns or hazelnuts, can be stored for months. In this case, some processing is needed to access the edible seeds or to ensure their preservation -for instance through roasting- as has been documented for hazelnuts in some Mesolithic sites (Bishop et al 2014). Other plant foods, like legumes (Valamoti et al 2011) or Chenopodiaceae (López et al 2011), require some processing before their consumption. The use of fire during this process or the removal of the discarded parts increases the possibilities of preservation of archaeobotanical remains and allows the reconstruction of the *chaîne opératoire* and of plant

Fig. 12.4 Reconstruction of gathering of *Corema album* berries in the surroundings of Cova de les Cendres. Illustration by Sara Pastrana Herrero.

diet during the Palaeolithic. In fact, as Dennell pointed out, "it is certainly a disturbing possibility that much of our archaeobotanical evidence might provide a more accurate indication of what was thrown away than of what was actually eaten" (1976, 232).

## 12.5 Fruits and seeds in the Iberian Peninsula during the Palaeolithic

Among the spectrum of plant foods available during the Palaeolithic in the Iberian Peninsula, gathering and consumption of pine nuts (*Pinus pinea*), bugseeds (*Corispermum* cf. *gallicum*) and Portuguese crowberries (*Corema album*) have been detected in Figueira Brava, Gorham's and Vanguard Cave, Cueva de Nerja, and Cova de les Cendres, thanks to the use of fire at some point during their processing.

### *12.5.1 Stone pine (Pinus pinea L.)*

*Pinus pinea* nowadays grows on coastal and continental areas, especially on sandy soils, where it forms dense masses (Fig. 12.5). In the Iberian Peninsula, stone pines grow at altitudes ranging from sea level to 1000 masl, with a mean annual temperature tolerance from 13ºC to 19ºC. They can thrive in areas with a mean annual precipitation of 250-1000 mm, withstanding summer droughts (Montoya 1990).

Flowering occurs in spring and maturation of cones takes three years. In the third year ripening occurs, and cones reach their final size (8-14 cm). Therefore, during the third autumn, cones are mature and closed, and during the next spring, as heat dilates their resin, they open, and the stones are dispersed by gravity.

Pine nuts have a thick woody shell (Fig. 12.7) that protects the edible seed, which can be eaten raw, roasted or boiled. Their nutritional value is outstanding, because of their high content in monounsaturated fat, omega-3 fatty acids and vitamin E (Moreiras et al 2016). Unsaturated fat reaches 89% of the lipids, with a predominance of polyunsaturated fatty acids (60%) over the monounsaturated (29%). Pine nuts are also

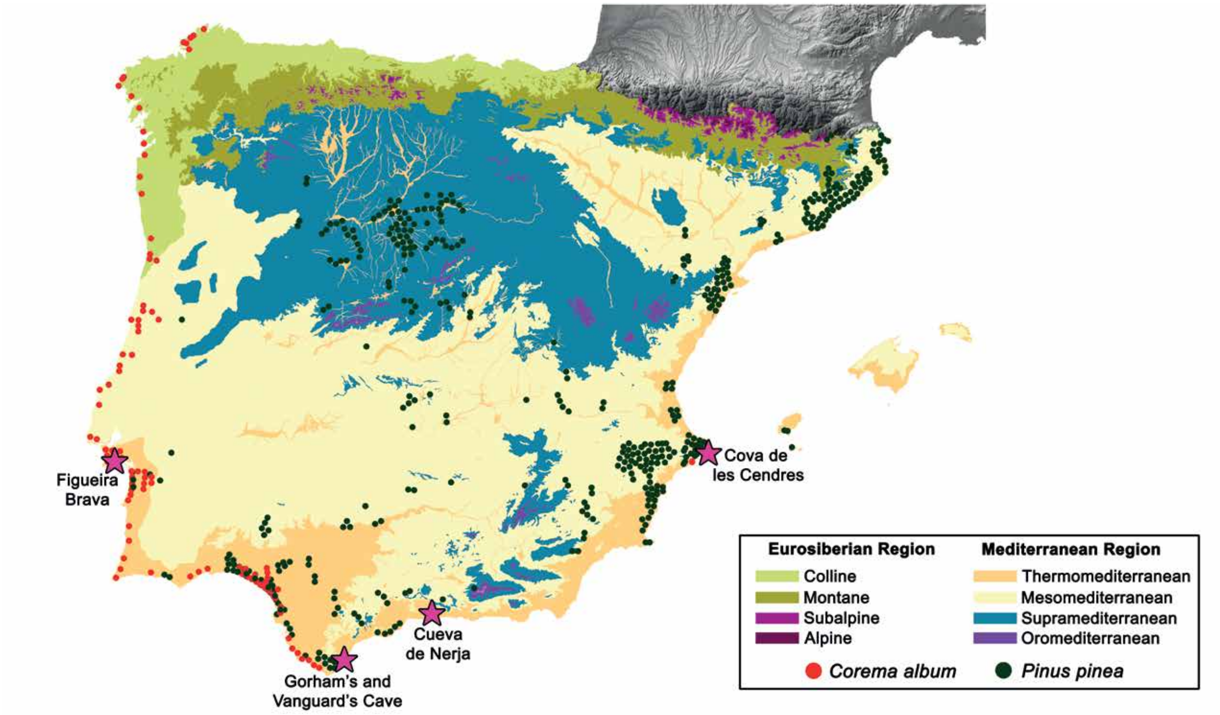


Fig. 12.5 Current distribution of *Pinus pinea* and *Corema album* populations in the Iberian Peninsula (based on www.anthos.es) (*Corispermum gallicum* is no longer present) and location of the main archaeological sites mentioned in the text. Map of bioclimatic belts based on Rivas-Martínez 1987.

high in phosphorus, magnesium, calcium, zinc, iron and other minerals essential for a healthy circulatory and nervous system (Nergiz and Dönmez 2004). In the Iberian Peninsula leaves, wood, bark and fruits of stone pine have traditionally been used (Rivera and Obón 1991).

Some researchers place the origins of *Pinus pinea* in the Eastern Mediterranean and date its introduction to the western part of the basin in historical times (Ceballos and Ruiz de la Torre 1979). Archaeobotanical data, however, prove that the stone pine was present in the Iberian Peninsula at least since the Middle Palaeolithic (Badal 1990; Metcalf 1964). Excavations in Figueira Brava (Setúbal, Portugal), Gorham's and Vanguard Cave (Gibraltar) and Cueva de Nerja (Málaga, Spain) have provided abundant remains of stone pine (Fig. 12.5).

Gruta da Figueira Brava is on the coast of the Serra da Arrábida (Setúbal), on the mouth of the estuary of the Sado River (Fig. 12.5). The cave opens onto a beachrock-covered regularised platform that lies at ~5 masl and corresponds to the Last Interglacial marine terrace. Four Middle Palaeolithic phases with remains of Neanderthal occupations have been identified in this sequence. The first three phases (FB1, FB2 and FB3) are dated to MIS 5c, while phase FB4 to MIS 5b (Zilhão et al 2020). Here we present the archaeobotanical data from phases FB2, FB3 and FB4.

Gorham's Cave and Vanguard Cave (Gibraltar), located close to the current marine shore (Fig. 12.5), provide, through their thick Middle Palaeolithic sequence, evidence of Neanderthal occupations, along with archaeobotanical remains. *Pinus pinea* remains, although documented, are scarce in Vanguard Cave. The archaeobotanical sequence of Gorham's Cave, on the other hand, is more complete. Here we focus on the results from the Middle Palaeolithic layer SSLm(Usm).2, whose chronology should be similar to that of Figueira Brava, as recently argued (Zilhao et al 2020, 74 S.I.), and on those from the Early Gravettian layer CHm5 published by Ward et al (2012a and b).

Cueva de Nerja is located on the south side of the Almijara Mountain (Nerja, Spain), at an altitude of 158 masl and approximately 1 km away from the nearest coastline (Fig. 12.5). The archaeological deposits in the Vestíbulo area cover the Upper Palaeolithic and partially the Mesolithic and Neolithic (ca 24000-4000 BP) (Aura et al 2002; Badal 1998).

All four sites are placed near the current coastline, in the warmest bioclimatic region of Europe, that is the thermomediterranean bioclimatic belt, with a mean annual temperature of 17ºC-19ºC (Fig. 12.5). Here thrive typical Mediterranean sclerophyll forests with *Quercus*, *Olea*, *Pistacia*, etc and thermophilous pine forests, where *Pinus pinea* is always present.

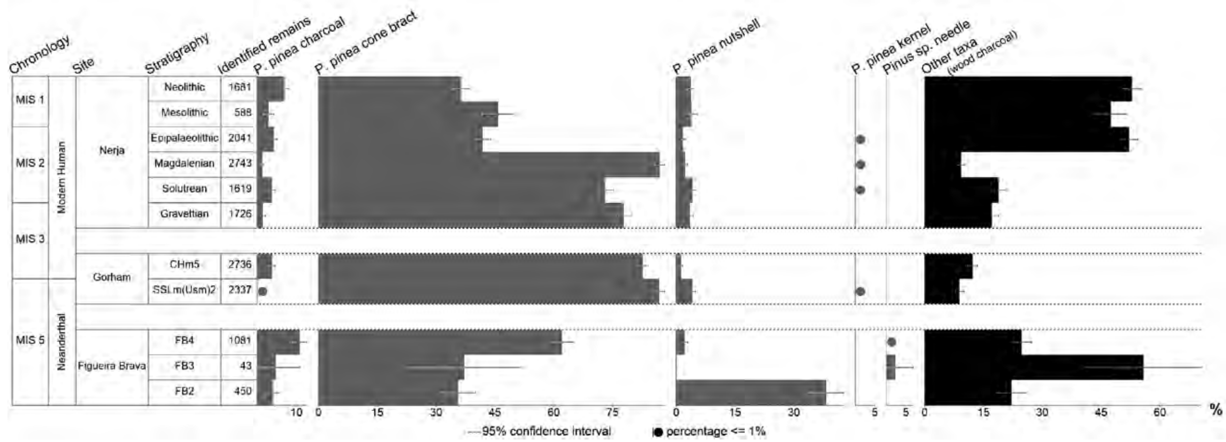


Fig. 12.6 Frequency of *Pinus pinea* remains and other taxa wood charcoal in Figueira Brava, Gorham's Cave and Cueva de Nerja. Data from Zilhão et al 2020, Ward et al 2012b and Badal 1990.

Table 12.1 *Pinus pinea* remains and other taxa wood charcoal from Figueira Brava (Setúbal, Portugal), Gorham's Cave (Gibraltar) and Cueva de Nerja (Málaga, Spain). Data from Zilhão et al 2020, Ward et al 2012b and Badal 1990.

| Chronology | | Site | Stratigraphy | **Identified remains** | *P. pinea* wood charcoal | *P. pinea* cone bract | *P. pinea* nutshell | *Pinus* sp. needle | *P. pinea* kernel | Other taxa (wood charcoal) |
|---|---|---|---|---|---|---|---|---|---|---|
| MIS 1 | Modern Human | Nerja | Neolithic | **1681** | 117 | 611 | 64 | 0 | 0 | 889 |
| | | | Mesolithic | **588** | 17 | 269 | 23 | 0 | 0 | 279 |
| MIS 2 | | | Epipalaeolithic | **2041** | 85 | 854 | 36 | 0 | 2 | 1064 |
| | | | Magdalenian | **2743** | 35 | 2386 | 65 | 0 | 2 | 255 |
| | | | Solutrean | **1619** | 60 | 1184 | 68 | 0 | 1 | 306 |
| MIS 3 | | | Gravettian | **1726** | 26 | 1345 | 60 | 0 | 0 | 295 |
| | | | | | | | | | | |
| | | Gorham | CHm.5 | **2736** | 105 | 2262 | 34 | 0 | 0 | 335 |
| MIS 5 | Neanderthal | | SSLm(Usm).2 | **2337** | 1 | 2031 | 96 | 0 | 1 | 208 |
| | | | | | | | | | | |
| | | Figueira Brava | FB4 | **1081** | 117 | 672 | 23 | 2 | 0 | 267 |
| | | | FB3 | **43** | 2 | 16 | 0 | 1 | 0 | 24 |
| | | | FB2 | **450** | 18 | 160 | 172 | 0 | 0 | 100 |

Table 12.2 Radiocarbon dating on *Pinus pinea* remains from Cueva de Nerja (Málaga, Spain).

| **Material** | **Years BP** | **Yrs cal BP** | **Laboratory** | **Reference** |
|---|---|---|---|---|
| *Pinus pinea* L. cone bract | 24730±250 | 30400 – 29160 | Gif A-102023 | Jordá and Aura 2008 |
| *Pinus pinea* L. cone bract | 24200±200 | 29730 – 28410 | Beta-189080 | Jordá and Aura 2008 |
| *Pinus pinea* L. cone bract | 21140±190 | 26000 – 24720 | Gif A-102021 | Jordá and Aura 2008 |
| *Pinus pinea* L. charcoal | 18490±70 | 22280 – 22030 | Beta-362535 | Unpublished |
| *Pinus pinea* L. nutshell | 12360±60 | 15370 – 14590 | Beta-189081 | Jordá and Aura 2008 |

*Pinus pinea* remains are extremely abundant throughout the sequences of these sites (except for Vanguard Cave) (Fig. 12.6, Table 12.1), especially in Cueva de Nerja, where 7,330 out of 10,398 identified archaeobotanical remains from the entire sequence were classified as *Pinus pinea* (including wood charcoal, cone bracts, nutshells and kernels) (Table 12.1). Some radiocarbon dates were obtained on macroremains of this taxon (Table 12.2), as well.

The proportion of the reproductive remains of stone pine is noteworthy in all four sites (Fig. 12.6, Table 12.1), especially concerning the cone scales whose presence varies from 35.6% of the analysed charred remains in the Middle Palaeolithic of Figueira Brava 2 to 87% during the Magdalenian of Cueva de Nerja (Fig. 12.6). Nutshells were documented in all analysed levels, but their percentages are lower to those of the cone scales, ranging normally

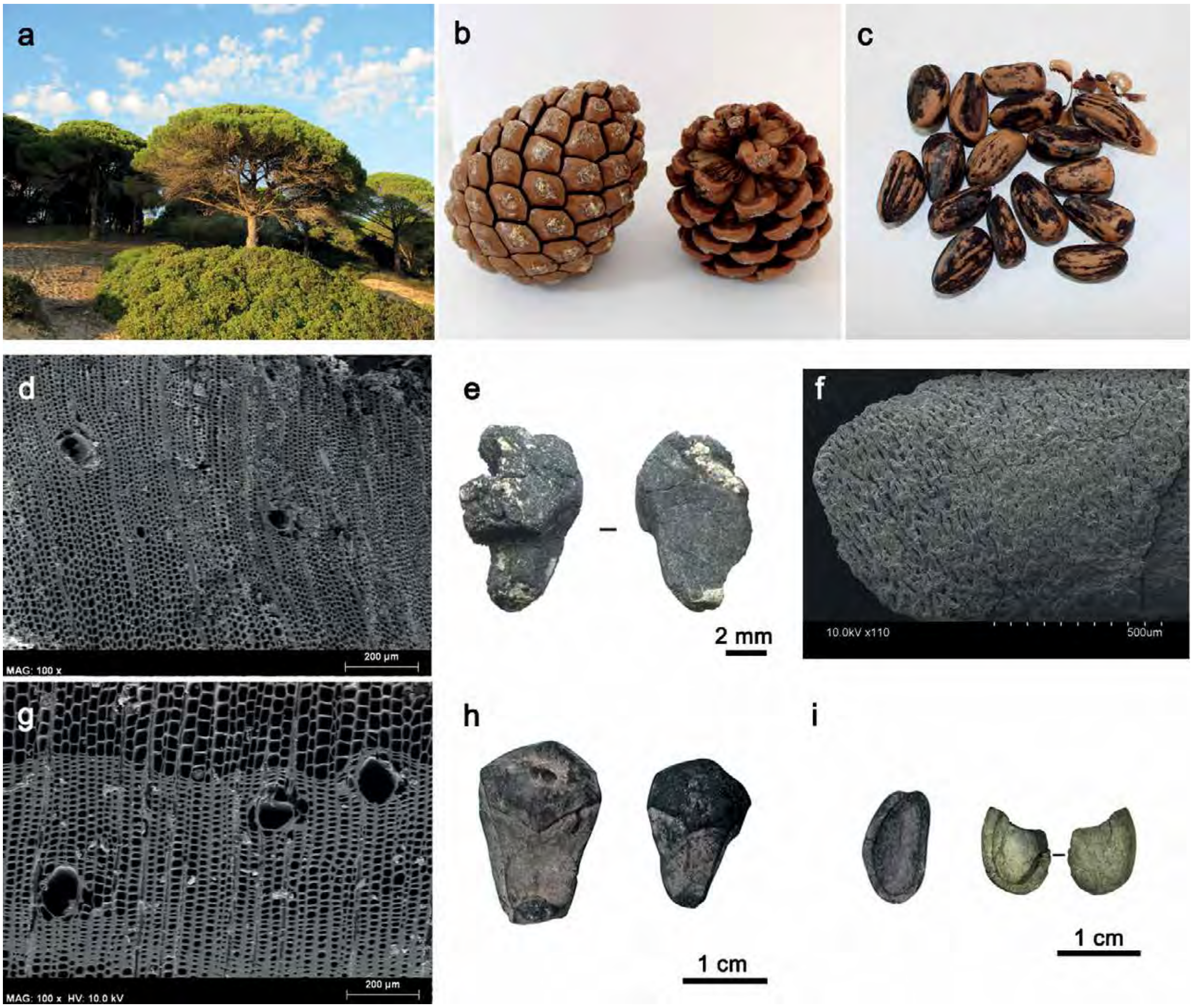


Fig. 12.7 a Current *Pinus pinea* forests; b cones; c pine nuts; d, e, f *Pinus pinea* remains from Figueira Brava; g, h, i *Pinus pinea* remains from Cueva de Nerja (d, g charred wood – transverse section; e, h cone bract; f, i nutshells).

between 1% and 5%, except for Figueira Brava 2 (FB2), where they represent 38.2% of the assemblage. On the contrary, seeds are almost absent: one specimen was documented in layer SSLm(Usm).2 from Gorham's Cave and five in Cueva de Nerja (Table 12.1).

In the case of the stone pine vegetative remains, some needles were documented in Figueira Brava, while wood charcoal was preserved in all sites. However, the proportions of the latter stand out when compared to other woody taxa charcoal: *Pinus pinea* wood charcoal is always lower than 10% of the charred wood, while that of other taxa (conifers and angiosperms) is dominant in all cultural phases – even in the Neolithic of Cueva de Nerja (Fig. 12.6). This suggests that human groups selected for firewood species that did not provide them with fruits since the proportion of the reproductive remains of stone pine at the four sites indicates management focused on nut consumption. These data suggest sustainable management of stone pine resources during both the Middle and the Upper Palaeolithic.

Wood charcoal fragments from Figueira Brava and Cueva de Nerja do not preserve their external morphology because combustion stopped during the carbonisation phase (T > 280-300ºC), but they do preserve the wood anatomy. Stone pine needles, cone scales and nutshells, on the contrary, preserve their morphology, because roasting stopped before ignition (T < 280ºC) (Fig. 12.7). Had they been gathered as fuel, their proportion would have been similar to other taxa (i.e. other conifer and angiosperm) present in the Mousterian, Upper Palaeolithic and Neolithic levels (Fig. 12.6) and they would have rarely preserved their external morphology; due to their high content in resin, a volatile and flammable substance, the cones are extremely susceptible to turn to ashes when combustion starts. Their

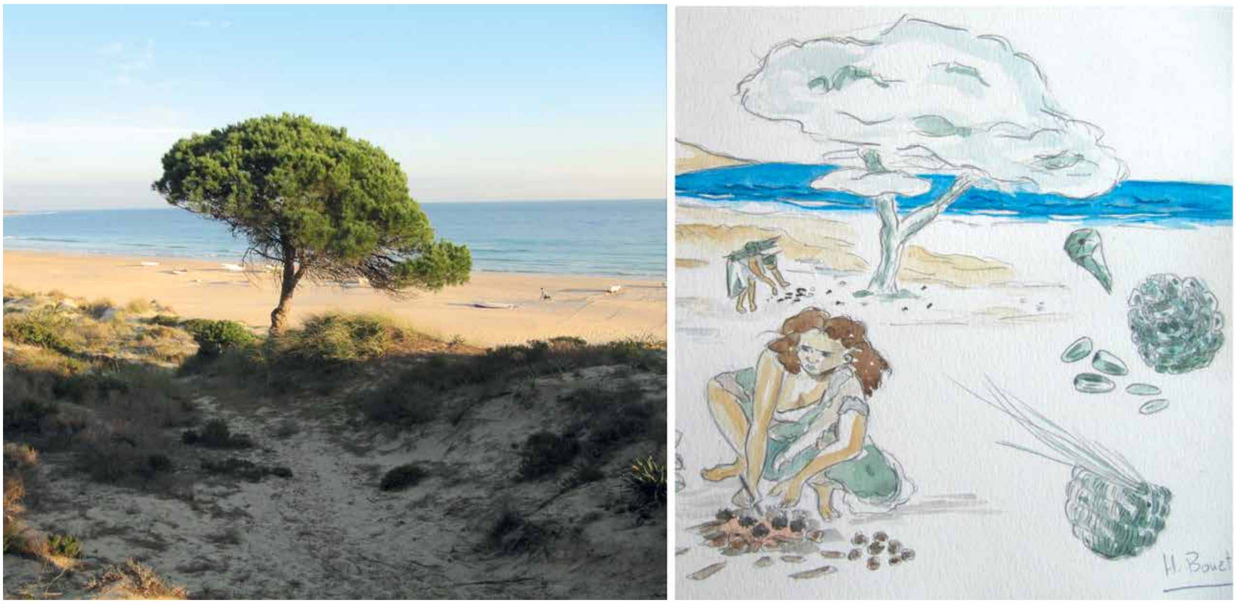


Fig. 12.8 *Pinus pinea* in Bolonia's dunes (Cádiz, Spain) and reconstruction of the gathering and processing of stone pine cones during the Palaeolithic. Illustration by Helena Bonet.

presence could, therefore, be probably related to food gathering and not to fuel collection. The presence of *Pinus pinea* wood charcoal is probably the result of the burning of the small fragments of branches still attached to the gathered cones.

The composition of the archaeobotanical assemblage of Figueira Brava, Vanguard and Gorham's Cave and Cueva de Nerja, is the result of selective human action, as in the case of marine and terrestrial animal resources (Aura et al 2002; Barton et al 2012, Colonese et al 2011; Zilhão et al 2020).

Bearing in mind the edaphological requirements of *Pinus pinea*, the abundance of its remains sustains the hypothesis of the existence of pine forests in the dune system in front of the studied caves, when sea level was lower than currently, during MIS 5 and MIS 3-2 (Barton et al 2012; Jordá et al 2011; Zilhão et al 2020). Both Neanderthals and modern humans visited these coastal areas in order to obtain firewood and food.

The high presence of cone bracts in the archaeological sites suggests that Neanderthals and modern humans probably gathered the cones when they were mature but closed, that is during the autumn or winter of the third year after fecundation, as currently performed in Iberia (Montoya 1990) (Fig. 12.8), thus avoiding the loss of nuts. They transported the cones to the caves, where they could expose them to the nearly extinguished embers or place them around the hearths. As heat dilated the resin, the cones would open, and about 100 pine nuts for each cone (Montoya 1990) could be released by simply hitting the cones. This process could have been performed in all the analysed archaeological sites, from the Middle Palaeolithic to the Neolithic, and it has also been documented for *Pinus halepensis* in the Capsian site of El Mekta (Tunisia) (Morales et al 2015). Pine nuts were then probably broken with a hammerstone to obtain the seeds. Nutshell fragments from Figueira Brava are too small to carry out an analysis of their processing. However, some of the remains recovered in Cueva de Nerja bear notches caused by hammering, although we cannot dismiss that they could have been opened by warming as in the case of the cones. Once obtained, pine stone seeds are completely edible, and in fact their intake could explain their scarcity in the assemblages (6 seeds among the 17045 analysed remains).

Obtaining pine nuts requires experience and great control of fire to avoid the complete carbonisation of the cones, skills that characterized both Neanderthals (Figueira Brava and layer SSLm(Usm).2 from Gorham's Cave) and modern humans (Cueva de Nerja and layer CHm5 of Gorham's Cave) alike.

### *12.5.2 Bugseed (Corispermum gallicum Iljin)*

Bugseed or *Corisperme à fruits ailés* is an annual herbaceous plant that nowadays grows on sandy coastal soils in the south of France, in the Camargue region. Although this species is no longer present in the Iberian Peninsula, it grew on the coast near Tarragona during the second half of the 19th c (Wilkomm 1893, 63).

*Corispermum* is taxonomically one of the most problematic genera of the Chenopodiaceae (Sukhorukov 2007), and its origin is a conundrum: its native range is South Siberia, although the subspecies *C. pallasii* subsp.

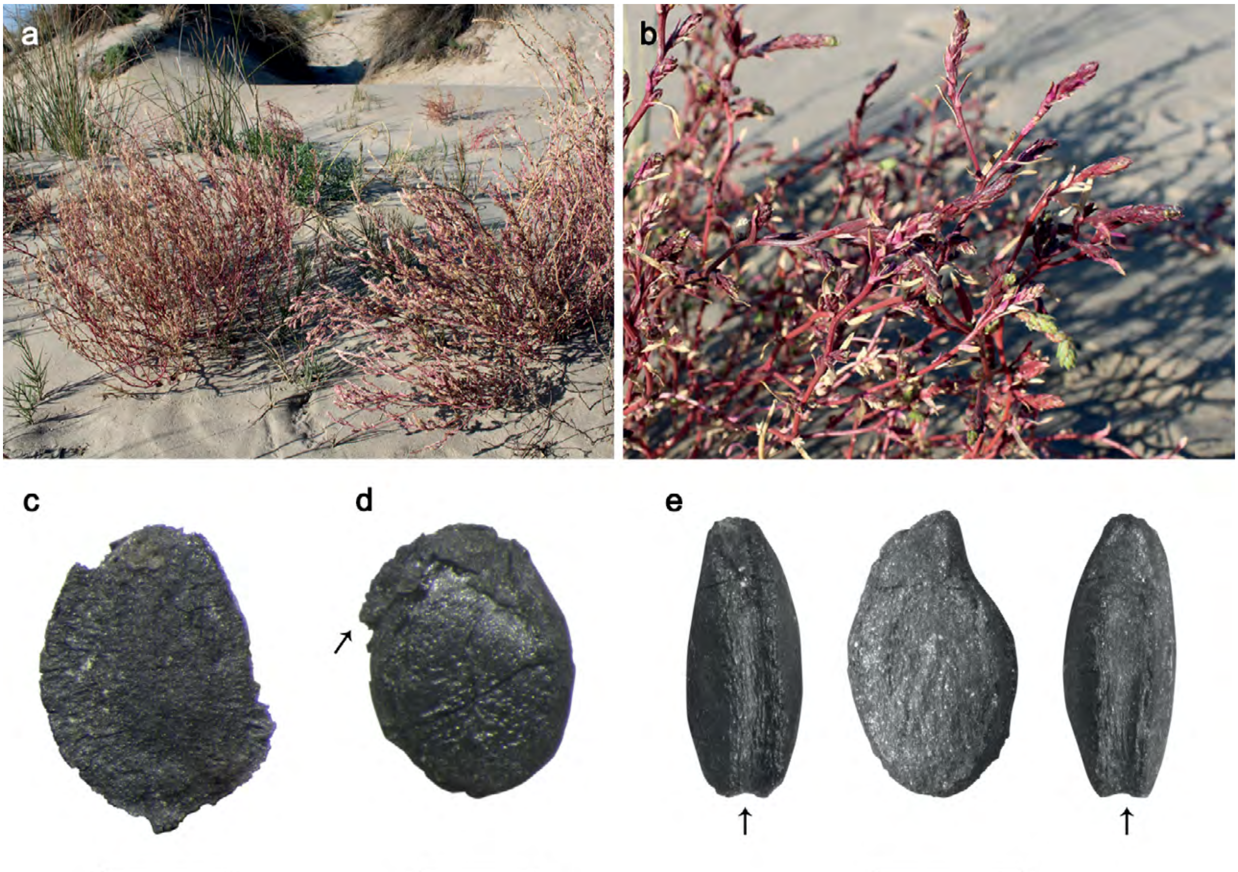

Fig. 12.9 *Corispermum gallicum*. a plant; b infructescence detail; c, d, e archaeobotanical remains from Cova de les Cendres: morphological changes derived from their processing (marked with an arrow and explained in the text). Scale bar 1 mm.

*membranaceum* is considered native to Eastern and Central Europe (POWO), and *C. gallicum* is considered native to France (Tison et al 2014, 1203).

The plant rises to 60 cm height and ramifies from the base. Its inflorescences are usually compact and dense (Fig. 12.9a-b). The bugseed produces obovate or obovate-oblong, strongly compressed, winged achenes (Aellen 1964). It blooms from June to September (www.pladias.cz) and seeds are ripe from July to September.

Some genera in the Chenopodiaceae family provide two types of food: greens and seeds. Leaves of *Atriplex hortensis* and *Chenopodium album*, for instance, can be ingested cooked or raw. The seeds of *Chenopodium album* were transformed into flour in Europe during periods of shortage (Font Quer 1999, 152-157), and those of *Atriplex halimus* are ingested boiled by the Tuareg (Rivera and Obón 1991, 361-362). No information on the uses of *Corispermum gallicum* has been found, but another species of this genus, *Corispermum dilutum*, whose characteristics are similar to those of *C. gallicum*, produces seeds that are gathered by the Mongol tribe Arhorchin. They consume them as a grain substitute cooked by dry roasting (Huai and Pei 2000). Like other Chenopodiaceae, *Corispermum* spp. grains are a source of proteins and fatty acids.

Some taxa included in the Chenopodiaceae family are present in Palaeolithic and Mesolithic sites, such as Kebara (Lev et al 2005), Halsskov (Kubiak-Martens 2002), Tybrind Vig (Kubiak-Martens 1999) or Ohalo II, where the abundant seeds and fruits of *Atriplex rosea/leucoclada* found near a grinding stone were considered as food remains (Weiss et al 2008). The contribution of *Chenopodium album* to the diet of the first farming communities in central Poland has been suggested by Mueller-Bieniek et al (2019), and the consumption of this species has been directly documented for the Iron Age with the intestinal contents of the bog bodies (Behre 2008).

*Corispermum* cf. *gallicum* has been identified among the plentiful archaeobotanical assemblage of Cova de les Cendres, a site located on the cliffs of the Moraira headland (Teulada-Moraira, Spain), at an altitude of 60 masl right on the modern coast. Inside this wide cave, a long Upper Palaeolithic archaeological sequence has been documented (Villaverde et al 2019); its archaeobotanical assemblage has provided exceptional data for the

|  | Level XVIA (Gv) | Level XV (Gv) | Level XIII (Sl) | Level XII (MM) | Level XI (UM) | Total |
|---|---|---|---|---|---|---|
| *Corispermum* cf. *gallicum* | 75 | 33 | 6 | 262 | 9 | **385** |
| Reproductive remains | 27192 | 5110 | 370 | 1043 | 1729 | **35444** |

Table 12.3 *Corispermum* cf. *gallicum* remains recovered in the Gravettian (Gv), Solutrean (Sl), Middle Magdalenian (MM) and Upper Magdalenian (UM) of Cova de les Cendres.

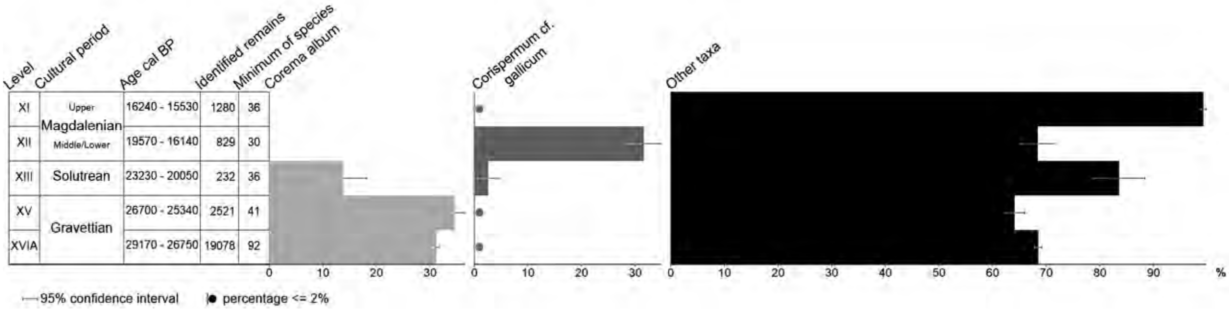


Fig. 12.10 Frequency of *Corispermum* cf. *gallicum*, *Corema album* and other taxa seeds and fruits in Cova de les Cendres.

reconstruction of the use of plants by Palaeolithic hunter-gatherers (Martínez-Varea 2020).

Different taxa of the Chenopodiaceae family -among others- have been documented throughout the Upper Palaeolithic sequence of the cave, but the presence of *Corispermum* cf. *gallicum* stands out. Seeds of bugseed are present at all the analysed levels, from the Gravettian to the Upper Magdalenian, although their presence is especially remarkable during the Middle Magdalenian when it represents more than 25% of the 1043 plant reproductive remains (Table 12.3, Fig. 12.10). As far as we know, this is the only archaeological record of this taxon in the Iberian Peninsula.

The grains of *Corispermum* cf. *gallicum* as well as those of other Chenopodiaceae, Fabaceae and Poaceae documented in Cendres, could be eaten as whole seed or ground. As previously pointed out, we found no ethnographic information about the processing of *Corispermum gallicum* grains, but we can take into account first the processing of *Corispermum dilutum* by the Arhorchin (Huai and Pei 2000) who dry roast the grains, and second the traditional processing of *Chenopodium quinoa* var. *quinoa* Willd. in Bolivia (López et al 2011) which is of special reference here. In Bolivia the processing of the grains varies depending on the type of meal (either as whole seed, in soups or as flour). After harvesting and threshing, the grains are parched, trodden upon, winnowed, rinsed and rubbed, with different intensities and at different times, depending on the final preparation. Once the process is finished, the grains are ready for storing or cooking. During these enchained steps, seeds lose their pericarp and frequently their embryo, which would remain attached if the seeds were carbonized before their processing. In this sense, it is noteworthy that most of the documented *Corispermum* cf. *gallicum* seeds have lost both the pericarp and the embryo, so the edge of the seed presents a groove, except for the apex (Fig. 12.9e). Based on these characteristics, we hypothesize that the seeds of *C.* cf. *gallicum* were processed similarly to *Chenopodium quinoa*. Just 17 of the 385 remains preserve the pericarp and/or the embryo (Fig. 12.9c-d), so they could have fallen into the fire during the processing, probably during the parching. The fact that the majority of the remains lack the pericarp or/and the embryo suggests that they could have accidentally fallen into the fire during cooking before consumption, and after this processing had been completed (Fig. 12.9e). Moreover, 53% of the remains presents thermoalterations most of which are linked to high warming ratios, like swelling and protrusions, an observation that also supports our hypothesis that some type of processing with fire, such as parching or roasting, had taken place. Unfortunately, no tools related to plant processing have been documented in the site.

According to Power and Williams (2018), food processing becomes more frequent and intense in the course of the Upper Palaeolithic. This evolution is evident in the sequence of Cova de les Cendres, where the more abundant edible plant during the Magdalenian is a member of the Chenopodiaceae family that requires a complex process before consumption. In contrast, in the previous periods, the most frequent plant foodstuff was a fleshy fruit that can be consumed raw, that is the *Corema album* (L.) D. Don ex Steudel.

### *12.5.3 Portuguese crowberry (Corema album (L.) D. Don ex Steudel)*

*Corema album* grows on sandy soils and coastal dunes of the Atlantic coast of the Iberian Peninsula. Moreover, a small and extreme disjunct population, consisting of 11 individuals, was documented in 1996 on the relict fossil dunes of the coastal cliffs of Serra Gelada (Benidorm, Alicante) (Fig. 12.5), and is evaluated as Critically Endangered based on the IUCN criterion D2 (Aguilella et al 2009). Hence, this species grows on areas from the thermomediterranean to the mesomediterranean bioclimatic belts and thermotemperate thermotypes, under dry-subhumid to hyper-humid ombrotypes (550 to 1600 mm annual rainfall), although in its Mediterranean location, annual rainfall is around 300 mm.

The Portuguese crowberry is a dioecious perennial erect shrub, densely ramified, up to 1 meter in height. Its whorled leaves are subpetiolate, linear, with a deep and narrow groove on the abaxial surface. Fruits are berry-like round drupes, 5-8 mm in diameter, white or pale pink, glossy, containing 1 to 3 pyrenes or stones with a thick woody endocarp (Villar 1993) (Fig. 12.11). Flowering occurs from March to April and fruiting from April to September.

The Portuguese crowberry has been considered a useful plant among the local people of the Atlantic coast of the Iberian Peninsula. Its slightly acid fruits are edible, and can be ingested raw or transformed into lemonades, liquors even jams (Gil-López 2011). They are a source of water, fibres and sugars, as well as of vitamin C, potassium and magnesium (Martínez-Varea et al 2019). Both leaves and fruit contain polyphenols and phenolic acids, and have medicinal properties as vermifugal, febrifugal, chemotoxic for carcinomas and neuroprotective against Parkinson's disease (Andrade et al 2017; León-González et al 2013).

In the Iberian Peninsula, *Corema album* remains have been identified in Early Neolithic, Chalcolithic, Phoenician, Medieval and Modern sites (López-Dóriga 2018), while the earliest evidence for its use comes from the Palaeolithic levels of Cova de les Cendres (Martínez-Varea et al 2019).

Throughout the Gravettian and Solutrean sequence of Cova de les Cendres various types of remains of *Corema album* have been recovered: mineralized and charred leaves, seeds and pyrenes (Fig. 12.11), accounting for 6839 remains, being charred pyrenes especially abundant in the Gravettian sequence (Fig. 12.10). At least, 3579 fruits were brought to the cave during the Gravettian, and just 16 during the Solutrean. On the contrary, no fragment of wood charcoal of Portuguese crowberry was identified among the anthracological assemblage.

Fruits of *Corema album* are available during summer, so they are predictable and easily gathered since no specialized tools are required: they can easily be knocked down into a container (Fig. 12.4). As previously pointed out, these fruits can be eaten raw, so they do not need any processing. This type of consumption, together with their simple harvesting, reduces the possibilities of generating archaeological evidence. However, their presence can be traced in the archaeological record, thanks to their woody pyrene, which must be thrown away during consumption. Hunter-gatherers could also have prepared some kind of beverage, with the pyrenes being probable by-products and thrown into the fire. In fact, some indigenous peoples of North America, as the Inuit, Inupiat, Cree or Ojibwa, consume the fruits of *Empetrum nigrum*, a species closely related to *Corema album*, fresh or cooked with animal fat (Anderson 1939; Porsild 1953, 21) or mixed with other berries to make pies and jelly (http://naeb.brit.org). *Corema album* berries could have provided the Palaeolithic hunter-gatherers of Cendres with vitamin C, as *Hippophae rhamnoides* L. did at Theopetra Cave (Kotzamani 2009) or at Balma de l'Auberador (Vaquer and Ruas 2009). At this point, however, we have to acknowledge that these are mere hypotheses, as we cannot prove the mode of consumption of the Portuguese crowberry berries in Cova de les Cendres, although human gathering is undeniable, considering that their natural habitat was 10 km away from the cave and that their presence varies along with other archaeological remains.

## 12.6 Conclusions

A diversified diet, including the ingestion of different types of foodstuffs -meat, fish, plant foods- is crucial in order to ensure the intake of all the essential nutrients at a sufficient level and to guarantee optimal human health (Lindeberg 2009). During the Palaeolithic a more or less diversified diet would have characterised hunter-gatherers; this diet would have included plant foods, as documented in different archaeological sites, like the Iberian ones presented here. These plant food resources would have provided them with fatty acids, vitamin C, minerals and proteins.

Complete control and management of fire was a "watershed moment" in hominid diet, as it opened opportunities of accessing, processing and consuming plant foods. The preservation of roasted pine cone bracts and nutshells with their original morphology provide evidence for an expert control of fire since resin is extraordinarily flammable and cones can quickly burn down. This ability to handle fire and to manage wild plant food resources is documented both among Neanderthals and modern humans since the by-products of Figueira Brava, Gorham's Cave and Cueva de Nerja are identical, thus indicating similar behaviour. Modern humans also applied this technique in the processing of other plant resources, as in the case of the seeds of *Corispermum* cf. *gallicum*.

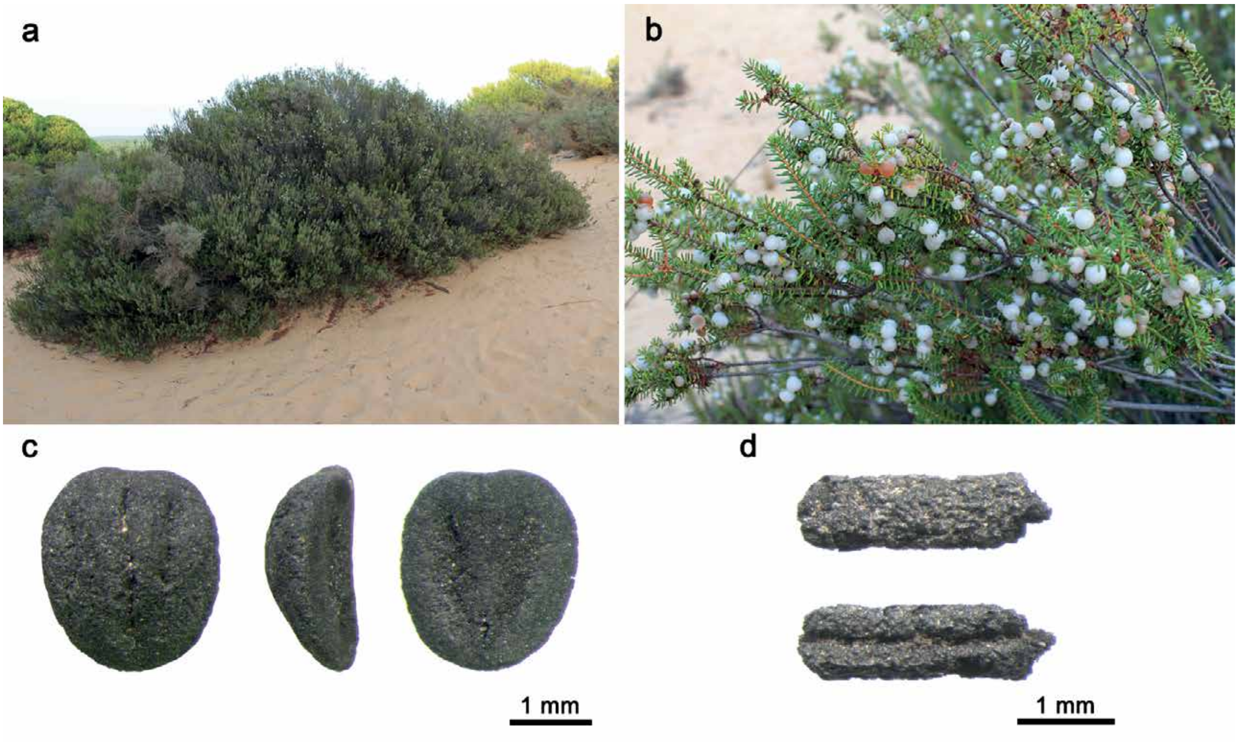


Fig. 12.11 *Corema album.* a plant; b fruit and leaves detail; c, d remains from Cova de les Cendres (c pyrene; d leaf).

In this regard, the presence of different types of remains and their characteristics shed light on the *chaîne opératoire* of plant food processing. Ethnographic and ethnobotanical information is essential in understanding the formation of archaeobotanical assemblages, together with experimentation, which is one of our future intentions.

The interrelation with plants and their exploitation led Palaeolithic groups to perform some kind of sustainable management of the fruit trees: they avoided the use as firewood of those species that provided food, despite the high calorific power of some of them; these are the cases of *Pinus pinea*, *Corema album* and *Corispermum* cf. *gallicum* presented in this work, as well as those of other taxa identified in Cova de les Cendres.

Coastal areas are extremely plentiful in resources, as they usually combine different biotopes. This biodiversity did not go unnoticed during the Palaeolithic (Real et al 2022; Will et al 2019) since several Middle and Upper Palaeolithic sites, like the ones presented here, are situated in such areas. In the Iberian sites in question, human groups would have made use of a diverse range of resources -shellfish, fish, mammals and plants-, like *Corema album*, *Pinus pinea* and *Corispermum* cf. *gallicum* that are discussed in the present paper. Experience provided Palaeolithic groups with thorough knowledge of their territory, of the life cycle of the useful plants and with the know-how that would have been transmitted from generation to generation.

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# COOKING WITH PLANTS
## IN ANCIENT EUROPE AND BEYOND

Plants have constituted the basis of human subsistence. This volume focuses on plant food ingredients that were consumed by the members of past societies and on the ways these ingredients were transformed into food. The thirty chapters of this book unfold the story of culinary transformation of cereals, pulses as well as of a wide range of wild and cultivated edible plants.

Regional syntheses provide insights on plant species choices and changes over time and fragments of recipes locked inside amorphous charred masses. Grinding equipment, cooking installations and cooking pots are used to reveal the ancient cooking steps in order to pull together the pieces of a culinary puzzle of the past. From the big picture of spatiotemporal patterns and changes to the micro-imaging of usewear on grinding tool surfaces, the book attempts for the first time a comprehensive and systematic approach to ancient plant food culinary transformation.

Focusing mainly on Europe and the Mediterranean world in prehistory, the book expands to other regions such as South Asia and Latin America and covers a time span from the Palaeolithic to the historic periods. Several of the contributions stem from original research conducted in the context of ERC project PlantCult: Investigating the Plant Food Cultures of Ancient Europe. The book's exploration into ancient cuisines culminates with an investigation of the significance of ethnoarchaeology towards a better understanding of past foodways as well as of the impact of archaeology in shaping modern culinary and consumer trends.

The book will be of interest to archaeologists, food historians, agronomists, botanists as well as the wider public with an interest in ancient cooking.

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