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Vegetation dynamics and human activity in the Western Pyrenean Region during the Holocene

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ABSTRACT

The present paper summarises the evolution of the vegetation and the evidences of anthropisation in the Western Pyrenees (Northern Iberian Peninsula) during the Holocene. All the palynological studies published about this region, about both natural and archaeological deposits, have been compiled, and special attention is paid on the available radiocarbon dates. We also present new results of the palynological study of the peat bog of Atxuri (Navarre). The main results document the arboreal colonisation in the early Holocene; the first evidences of anthropisation associated with the Early Neolithic (*ca.* 5500–4500 cal BC); the consolidation of a productive economy (agriculture and pastoralism) in the Middle/Late Neolithic (*ca.* 4500–3200 cal BC) and above all in the Chalcolithic (*ca.* 3200–2200 cal BC); and the rise of complex urban societies in the Bronze Age (*ca.* 2200–900 cal BC) and Iron Age (*ca.* 900–200 cal BC) and their impact on the vegetation.

1. Introduction

The Western Pyrenees is a region whose climate, geology, biogeography and history have resulted in a great environmental heterogeneity and biological diversity, with a noteworthy wealth of species, biological communities and ecosystems. In addition, from the viewpoint of its geographical situation, it has been on the traditional route from central and southern Europe to the inner Iberian Peninsula, as shown by the large number of archaeological remains of different periods that have been found (Barandiarán-Maestu et al., 1998; Alday et al., 2006; Peñalver, 2008; Fernández-Eraso et al., 2009).

The current vegetation of this region has originated in different processes that have taken place over time and which have modified the structure of the forests significantly (Costa-Tenorio et al., 2005). These phenomena correspond, on one hand, to continuous environmental changes and, on the other, to the weight of a long heterogeneous human use of the territory. The latter factor, the impact of human communities on the environment, becomes particularly noticeable after *ca.* 5500 cal BC, mainly owing to the change in the ways of life of the prehistoric communities. After this time, farming practices spread across the Western Pyrenees, significantly modifying local ecosystems in both mountain and valley areas, within a process related to the Neolithisation dynamic in the Mediterranean basin (Galop et al., 2013).

To obtain an accurate picture of the phenomena involved in shaping the modern vegetation communities it is necessary to take into account all the available palaeobotanical records, especially palynological studies both from archaeological sediments and from natural deposits like peat bogs, lakes, estuaries, and so on. All these data together provide the essential information to address some issues of great interest and hot debated, such as the evolution of the main plant communities over time, the appearance/expansion/regression of some taxa of particular interest because of their rareness, climate change and its connection with the development of the vegetation, relationships between human communities and the environment, and aspects such as the anthropisation processes associated with the Neolithic (Dupré, 1988; Birks et al., 1988; Berglund, 1991; Galop, 1998; López-Sáez et al., 2000, 2003; Barbier et al., 2001; Davis et al., 2003; Carrión et al., 2010; Vannière et al., 2011; Nieto-Moreno et al., 2011; Galop et al., 2013; Sadori et al., 2013; among others).

The first palynological research in the region took place in the 1980s when this type of study began to be widely applied both to natural deposits (Peñalba, 1989) and to archaeological ones (López-

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García, 1982; Dupré, 1984; Boyer-Klein, 1985; García-Antón et al., 1987; Peñalba, 1987; Sánchez-Goñi, 1987). Since then, more than 40 new palynological sequences have been published both in Spanish journals (Iriarte, 2006, 2009b; Pérez-Díaz and López-Sáez, 2013) and International journals (Sanchez-Goñi, 1996; Iriarte, 2009a; Corella et al., 2013).

This paper focuses on the evolution of the vegetation over the last 9500 years, in order to evaluate the anthropic impact on the landscape by prehistoric groups that inhabited the Western Pyrenees. With this objective, all the available palynological studies from the Epipaleolithic-Mesolithic to the Iron Age, and a full series of 219 radiocarbon dates, have been taken into account.

2. Regional setting

The Western Pyrenees is quite rugged, with great climatic and geomorphologic variety. The relief is generally aligned east-west, and therefore the area consists of a series of mountain barriers, parallel to the coastline, which limits the spread of Atlantic flora southwards. From the biogeographic point of view, it can be divided into three areas: the Atlantic zone (coastal and inner valleys of the north of the Basque Country), the Pyrenees (north of Navarre), both belonging to the Eurosiberian region, and the Transition area (Sub-Atlantic and Sub-Mediterranean Valleys of Álava), belonging to the Mediterranean region (Fig. 1).

The Pyrenees is a large mountain range over 400 km long, separating the Aquitaine basin from the Ebro valley. Its main valleys in the north of Navarre run perpendicular to the range. The climate is generally cold and wet in winter, when snow and mist are common. In contrast, summer temperatures can be relatively high. It has large well-conserved forest masses with *Pinus sylvestris* L. (Scots pine), *Quercus robur* L. (Pendunculate oak), *Quercus faginea* Lam. (Portuguese oak), *Fagus sylvatica* L. (beech) and *Abies alba* Mill. (fir).

In northern Iberia, the Atlantic zone is a strip parallel to the coastline, directly influenced by the sea. It is characterised by undulating relief, with hills and wide valleys near the coast and more abrupt relief inland. The climate is very humid and temperate, with hardly any summer drought (Aseginolaza et al., 1996). The main elements in the vegetation today are anthropic, with farmlands, above all meadows, together with plantations of conifers. Stands of *Quercus ilex* L. (holm oak) are found in some limestone areas, and small dispersed woods with penduncular oak and other deciduous species (Aseginolaza et al., 1996).

Finally, the climate of the Transition area displays characteristics of both Atlantic and Mediterranean environments. In high mountain areas the climate is characterised by low temperatures and heavy precipitation, with frequent mist, and frost and snow except in summer. The climatic and geomorphologic conditions result in vegetation communities consisting of calcicolous beech woods on limestone hills, together with anthropic pastures used by livestock. In the valleys, the most important vegetation types are oak woods with penduncular oak, *Quercus pyrenaica* Willd. (Pyrenean oak) and small stands of Portuguese oak, together with areas of holm oak and Scots pine (Aseginolaza et al., 1996).

3. Materials and methods

All palynological studies published for the Holocene on the southern side of the Western Pyrenees have been examined. In total, these refer to 55 deposits, of which 7 are natural deposits and 48 are archaeological sites. They are all situated chronologically with a total of 219 absolute dates (Table 1).

Table 1
Holocene pollen sequences in the study area. Nature: AS (Archaeological Site) – Mg (Megalithic Monument), C (Cave), OA (Open Air Site), RS (Rock Shelter). ND (Natual Deposit) –M (Marsh), P (Peatbog), L (Lake). Radiocarbon dates have been calibrated with the Calib 7.0 programme at 2σ (95.4% probability) and are given in dates BP (in brackets cal BC or cal AD).

Number	Site	Location	Nature	Altitude	Age BP (Age cal BC/AD)	References
Atlantic area						
1	Aitxu	Ataun-Idiazabal	AS (Mg)	930	3530 ± 110 (2196–1566 cal BC)	Iriarte, 1997c
2	Amalda	Cestona	AS (C)	205	1740 ± 200 (185 cal BC–665 cal AD), 1460 ± 80 (415–762 cal AD)	Dupré, 1990
3	Arenaza I	Galdames	AS (C)	185	10,300 ± 180 (10,653–9419 cal BC), 9600 ± 180 (9446–8354 cal BC), 6040 ± 75 (5207–4779 cal BC) 5755 ± 65 (4767–4457 cal BC), 4965 ± 195 (4259–3346 cal BC), 4730 ± 110 (3760–3108 cal BC) 3835 ± 55 (2466–2141 cal BC), 3805 ± 70 (2465–2039 cal BC), 3580 ± 70 (2135–1746 cal BC)	Isturiz and Sanchez-Goñi, 1990
4	Berreaga	Mungia	AS (OA)	360	–	Iriarte, 1994a
5	Buruntza	Andoain	AS (OA)	439	3000 ± 60 (1401–1055 cal BC), 2810 ± 90 (1253–806 cal BC), 2475 ± 75 (779–408 cal BC) 2270 ± 80 (706–95 cal BC), 2180 ± 80 (394–46 cal BC)	Iriarte, 1997b
6	Ekain	Deba	AS (C)	90	9460 ± 185 (9249–8323 cal BC), 9540 ± 210 (9433–8295 cal BC), 9610 ± 85 (9247–8766 cal BC) 4960 ± 60 (3942–3641 cal BC), 5179 ± 170 (4338–3653 cal BC), 4680 ± 60 (3633–3358 cal BC) 4120 ± 50 (2876–2505 cal BC), 3820 ± 240 (2896–1658 cal BC), 3700 ± 40 (2202–1973 cal BC)	Dupré, 1984
7	Gastiburu	Arratzu	AS (OA)	340	3260 ± 60 (1681–1427 cal BC), 2455 ± 26 (753–412 cal BC), 2396 ± 27 (723–398 cal BC) 2270 ± 26 (398–211 cal BC), 2257 ± 29 (394–209 cal BC), 2233 ± 26 (386–205 cal BC) 2190 ± 26 (362–180 cal BC), 2157 ± 27 (357–106 cal BC), 2140 ± 60 (370–41 cal BC) 2076 ± 44 (201 cal BC–21 cal AD), 2060 ± 60 (345 cal BC–69 cal AD), 1759 ± 28 (176–383 cal AD)	Valdés, 2009