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ORIGINAL ARTICLE

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# Middle/Late Bronze Age plant communities and their exploitation in the Cávado Basin (NW Portugal) as shown by charcoal analysis: the significance and co-occurrence of *Quercus* (deciduous) – Fabaceae

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**Abstract** Plant communities and their possible exploitation during Late Prehistory are studied based on charcoal data from four archaeological sites. Settlement location in the area appears to have been chosen on the basis of easy access to rivers and good arable land. *Quercus* (deciduous) and Fabaceae appear to have been the main source of wood; this is in agreement with previous data from north-western Portugal. The abundance of Fabaceae, which thrive in open well-lit areas, is seen as a direct consequence of woodland clearance. The co-occurrence of *Quercus* (deciduous) and Fabaceae appears as a distinctive feature in north-western Portugal during Late Prehistory and Protohistory. Fabaceae have remained a familiar component of the vegetation cover ever since. *Pinus pinaster* is present as isolated individuals, in contrast to its present-day abundance.

**Keywords** Cávado Basin · North-western Portugal · Charcoal analysis · Palaeoenvironment · Land-use · Middle/Late Bronze Age · Iron Age

## Introduction

Charcoal analysis is currently used as a tool to illustrate and elucidate the development of local and regional plant communities and flora. It provides evidence for ancient woodlands, their composition and structure, and identifies patterns of cultural development. The analysis of archaeological charcoal is particularly useful when studying past human interactions with the plant environment.

In north-western Portugal the study of the wealth of archaeological charcoal remains also compensates for the relative paucity of information from other palaeoenvironmental disciplines (pollen, fruit and seeds, fauna). The evidence from pollen analysis is still fragmentary since there are few suitable deposits in the lowlands; as a result the overall picture of the succession of plant communities in northern Portugal has so far been indicated by pollen profiles from highland lake sediments (Coudé-Gaussen and Denèfle 1980; Ramil Rego et al. 1996, 1998; Janssen and Woldringh 1981; Brink and Janssen 1985; van der Knapp and van Leeuwen 1994, 1995, 1997). However, important as these data are, environmental conditions and vegetation should be further studied to elucidate historical man-environment relationships at a local scale.

The study of archaeological sites located in constrained areas and within the same ecological contexts is believed to provide levels of detail and precision that would not be obtained otherwise. This is clearly the case for the Cávado Basin (north-western Portugal), where work has focussed in particular on the period from the Middle Bronze Age to the transition Bronze/Iron Age. This period of cultural development appears to have taken place during a relatively cold episode, identified in a Galician core between 975 and 250 B.C. (Desprat et al. 2003). This episode encompasses the northern Europe Sub-Atlantic cold and humid period 850/760–450 B.C. (van Geel et al. 1996). It is therefore of interest to understand the possible role of climate in the process of cultural change, hence the undertaking of an interdisciplinary research project (supervised by A. Bettencourt) combining the study of both artefacts and ecofacts.

Data obtained by charcoal analysis will be summarised here and compared with those provided by other palaeoenvironmental disciplines.

## Present day ecology

The archaeological sites studied (Santinha, Sola, S. Julião and S. João do Rei) are situated in north-western Portugal, in the Cávado Basin (in the province Entre Douro e Minho) (Fig. 1), 40–50 km from the coast, where the

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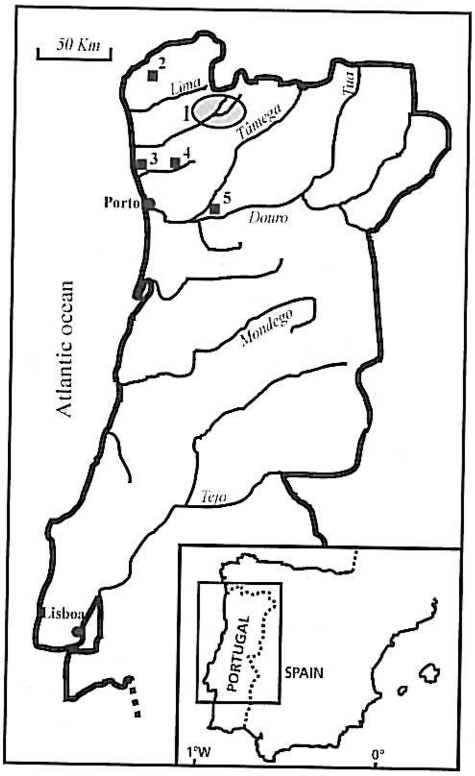


**Fig. 1** Location of the Cávado Basin (*1*) in northwestern Portugal, where the four sites (Sola, Santinha, S. Julião, São João do Rei) are situated. Locations of other archaeological sites mentioned in the text are also shown: (*2*) Romarigães, Cristelo, (*3*) Castro de Terroso, (*4*) Castro das Ermidas, Castro de Penices, (*5*) Bouça do Frade, Castelo de Matos, Lavra

Atlantic influence is strong. The climate is characterised by a narrow temperature range; during the summer, north-north-westerly winds reduce the ambient temperature while, during the winter, mild temperatures and abundant rain are brought by depressions from the northwest. Annual rainfall is 1200–2000 mm (80 to 200 mm during the summer) (Daveau et al. 1977). From the geological point of view this area is included in the Central-Iberian zone, which is the most westerly point of the Hesperic Massif, comprised of schist and greywacke with extensive granite intrusions (Ferreira 1981). In terms of mineral resources the Cávado Basin belongs to the ante-Hercinian or Hercinian Province, rich in tin, iron, gold and tungsten (Teixeira et al. 1973).

The distribution of present-day plant communities results from intensive human pressure. The local potential vegetation declined considerably in the last century and now few pockets of natural plant communities continue to survive. According to a recent biogeographical map (Costa et al. 1998) this area is included in the Eurosiberian region, province 'Cantabro-Atlantica', super-district 'Miniense Litoral' characterised by the meso- and thermo-temperate oaks (Rusco aculeati-Quercetum roboris quercetosum suberis) and scrubland plants (Ulici latebracteati-Cytisetum striati, Ulicetum latebracteatominoris, Erico umbellatae-Ulicetum latebracteati). However the artificial expansion of *Pinus pinaster* (cluster pine), the introduction of *Eucalyptus* and *Robinia* and the very strong human impact (agriculture, industry, urbanisation) have profoundly changed the environment.

Land around the sites is currently classified as arable in the valleys and low slopes, and non-arable in plateau areas (Carta de Capacidade de Uso do Solo da Comissão Nacional do Ambiente 1982).

## Archaeological context

The information presented in this paper is based mainly on data obtained by excavation work, undertaken between 1989 and 1996. However, information from other sites is also used.

The Middle/Late Bronze Age in north-western Portugal covers the period from the late 3rd to the middle 1st millennium B.C. Little is known about the Middle Bronze Age in the Cávado Basin, and in northern Portugal in general; the period is frequently considered to be a time of economic recession due to the scarcity of archaeological remains. However this assumption is probably a consequence of both methodological problems (Bettencourt and Sanches 1998; Bettencourt 1999, 2003) and the obscurity of the archaeological record from this period (Fabregas Valcarce 2001; Fabregas Valcarce et al. 2003). According to Fabregas Valcarce (2001) the middle of the second millennium may have witnessed a "velvet" or "silent revolution" (Fabregas Valcarce et al. 2003), which paved the way to the more noticeable Late Bronze Age developments.

Recent archaeological work in the Cávado Basin has revealed certain characteristics. Firstly, the different types of contexts identified (settlements, graves, deposits) are all located in areas directly or indirectly linked with valleys, i.e. situated in the middle of alluvial plains or in their margins, with easy access to rivers. Secondly, the majority of archaeological finds are also situated very close to good arable land (less than 30 m away).

The settlement of Sola is a good example of this. It is located on the top ridge of a low hill with good visibility, controlling the surrounding landscape and with easy access to the valleys around the Cávado Basin. Two occupation phases dating back to the 2nd millennium B.C. (Table 1) have been distinguished. The strategic setting of this site, in the middle of a natural passageway suitable for both plant and animal husbandry and rich in minerals, and its dimensions (mostly during the second period of occupation, phase II), together with its well-defined internal organization and storage areas, suggest that Sola may have been an important settlement in the area (Bettencourt 1999, 2000b, 2001)

In northern Portugal, the Late Bronze Age is better documented, mainly by excavation of "so-called" settlements (where domestic and ritual cannot be separated). In the Cávado Basin, two main types of space occupation have been distinguished: long-term and short/middle-term sites. The occupation of long-term settlements is not re-

**Table 1** Chronology of sites. $^{14}C$ dates based on charcoal fragments sampled from different occupation periods (phases). At Sola, phases IA and B correspond to the Middle Bronze Age; the occupation of Santinha occurred during the Late Bronze Age, while that at S. João do Rei covers the transition to the Iron Age. At S. Julião, phases IA-C belong to the Late Bronze Age, while phase ID (+ end) corresponds to the transition Late Bronze Age/ Iron Age

| Site | Phase | Lab. ref. | Date | Mean date | Date (calibrated, B.C.) | |
|---|---|---|---|---|---|---|
| | | | (B.P.) | (B.P.) | (1 sigma) | (2sigma) (B) |
| Sola | IIa | CSIC - 1139 | 3450 ± 37 | | 1859–1847 (0.11) | 1879–1831 (0.19) |
| | | | | | 1772–1731 (0.43) | 1827–1673 (0.81) |
| | | | | | 1728–1686 (0.46) | |
| | IIb | CSIC - 1186 | 3338 ± 33 | 3334 ± 20 | 1671–1665 (0.05) | 1673–1651 (0.11) |
| | | UtC - 5657 | 3343 ± 30 | | 1635–1596 (0.47) | 1648–1591 (0.44) |
| | | ICEN - 1274 | 3310 ± 110 | | 1570–1529 (0.47) | 1589–1527 (0.45) |
| | | UtC - 4785 | 3315 ± 40 | | | |
| Santinha | I | CSIC - 1145 | 2800 ± 33 | 2810 ± 19 | 997–988 (0.14) | 1001–906 (100) |
| | | CSIC - 1084 | 2793 ± 53 | | 975–966 (0.15) | |
| | | CSIC - 1315 | 2837 ± 27 | | 963–922 (0.71) | |
| | | CSIC - 1085 | 2761 ± 50 | | | |
| S. João de Rei | I | CSIC - 1150 | 2357 ± 30 | 2409 ± 19 | 487–442 (0.65) | 513–430 (0.71) |
| | | CSCI - 1149 | 2435 ± 30 | | 424–402 (0.35) | 430–402 (0.29) |
| | | UtC - 5659 | 2443 ± 35 | | | |
| S. Julião | 1 | CSIC- 734 | 2900 ± 50 | 2901 ± 14 | 1113–1094 (0.61) | 1202–1171 (0.4) |
| | | GIF - 6993 | 2840 ± 80 | | 1094–1079 (0.39) | 1169–980 (93) |
| | | ICEN - 28 | 2820 ± 40 | | | 962–938 (0.03) |
| | | UtC - 5609 | 2900 ± 36 | | | |
| | Ib | CSIC - 1086 | 2688 ± 61 | 2702 ± 10 | 837–820 (100) | 894–879 (07) |
| | | ICEN - 23 | 2700 ± 40 | | | 849–810 (93) |
| | | ICEN - 1277 | 2780 ± 50 | | | |
| | | UtC - 5655 | 2625 ± 35 | | | |
| | Ic | CSIC - 1020 | 2570 ± 25 | 2544 ± 18 | 793–762 (0.75) | 796–758 (0.56) |
| | | ICEN - 830 | 2530 ± 45 | | 621–600 (0.25) | 678–656 (0.06) |
| | | CSIC - 1022 | 2520 ± 25 | | | 639–552 (0.39) |
| | Id | CSIC - 1184 | 2548 ± 22 | | | |
| | | CSIC - 1140 | 2457 ± 36 | | | |
| | | ICEN - 1021 | 2530 ± 130 | | | |
| | end | CSIC - 1141 | 2316 ± 17 | | 395–383 (100) | 399–374 (100) |

stricted to the Late Bronze Age but lasts well into the Iron Age. They are located at the margins of large valleys, at junction points between the valley and the hills; the short/ middle term settlements lay at the top of low hills, hill slopes and ridges close to valleys, and show no subsequent occupation during later periods.

The data obtained allow us to suggest that site location diversity during this phase corresponds to a hierarchic settlement system. This comprised short/middle term occupation sites, such as Santinha and S.João do Rei I, closely related to valleys and dependant upon farming activities, as shown by the presence of storage pits and cereal grains. Long-term settlements, such as S. Julião, situated on high ground, may have functioned either as spatial and ideological boundaries or symbolic power centres of emerging socio-political entities (Bettencourt 1999, 2000a).

Several occupation periods (phases) have been distinguished at Santinha (127m a.s.l.) during the Late Bronze Age. The first occupation took place during the $10^{th}$ century B.C. (Santinha I, Table 1), spreading from the acropolis area to the southern slope, as shown by the structures and artefacts uncovered. The acropolis may have been used as a storage area, as suggested by the existence of several storage pits, the abundance of plant remains, the profusion of coarse vases (large and medium capacity) and fragments of manual grindstones. Structures and artefacts uncovered in the southern slope also testify to a different organisation of space and activities. Storage pits are also identified in the slopes (Bettencourt 2001).

The archaeological remains show that during the $10^{th}$ century B.C. human communities settled here for a considerable length of time, probably because of the easy access to the alluvial soils of the Cávado valley and to a great diversity of riverside and mountain resources. That they also relied on regional trade is shown by the presence of bronze implements (which imply the transport of copper and tin) and glassy beads.

The lack of continuity between the first and second effective occupations of Santinha (Santinha I and II) is clearly revealed by the stratigraphy. Remains from the second occupation (still during the Late Bronze Age) have been significantly damaged by erosion. Storage pits with plant remains have been identified. The settlement was later abandoned for a long period of time, being probably used again during the Roman period.

Although archaeological remains uncovered here are not particularly extraordinary, Santinha may be considered as a key site for the study of settlement patterns in the Late Bronze Age; it provides evidence of a new type of land occupation - the use of low hill tops adjacent to fluvial basins, i.e. inserted in a valley environment.

The settlement of S. João do Rei is located on a low ridge (202m), in an area with easy access to the Cávado valley. Several discontinuous occupation phases from the Late Bronze Age/Iron Age transition to the Roman period are recorded. The Late Bronze Age/Iron Age transition occupation is dated to the beginning of 6th - end 5th century B.C. (Table 1). The archaeological structures identified as well as the artefacts and ecofacts suggest that this was a short to middle term settlement, relying largely on agriculture for its survival (Bettencourt 2000c).

The site of S. Julião, perched on a granite outcrop adjacent to the river Homem valley, provides an important stratigraphic sequence (Table 1). The earliest occupation dates back to the Chalcolithic (end 4th – middle 3rd millennium), followed by a second phase during the Late Bronze Age (11th century B.C.). After a hiatus, but still during the Late Bronze Age (9th century B.C.), a third long-term occupation took place lasting well into the Iron Age. S. Julião was also occupied during the Roman period (at least up to the 3rd century A.D.) and in the Middle Ages (probably 15th century). The first monumental stone walls (in the acropolis and on the western slope) were built from the 9th century onwards, allowing subsequent internal subdivision of space. The presence of these unique walls reflects the efficient use and control of manpower, exceptional in the Late Bronze Age of the region. Human societies appear to have permanently established themselves, extending their control over a specific territory and effectively ensuring their political, social, economical and ideological survival and supremacy. Traces of several huts have been identified in the acropolis area. The western sector may be interpreted as a ritual area (Bettencourt 2000c).

The presence of new forms of pottery, glass beads and weaving remains, the first iron artefacts (of southern origin) and moulds for the making of bronze artefacts, testifies to both the importance of extra regional contacts and Phoenician influence.

## Materials and methods

The results are based on an analysis of 5308 charcoal fragments recovered by dry-sieving during excavation work. Fragments were found both as scattered and concentrated charcoal throughout the archaeological layers. Sampling included occupation horizons, *in situ* burnt huts, pits, postholes and fireplaces, as well as other structures believed to be linked with ritual practices. Significant differences in terms of abundance of charcoal fragments and taxa identified were noted, both between sites and between structures within sites. The settlement of S. Julião produced the highest density of charcoal fragments, followed by Santinha (Table 2). Charcoal fragments from S. Julião are also relatively large in size (>5 mm). In the laboratory specimens were fractured manually along the three planes of observation (transversal, longitudinal tangential, longitudinal radial) and analysed with a compound microscope equipped with reflected light. Taxonomic identification was achieved by comparison with a reference collection of modern species and by the use of atlases of wood anatomy (Schweingruber

**Table 2** Presence / absence of taxa. Taxa are assembled according to their expected plant association: 1 - mixed oak forest, 2 - wasteland vegetation, 3 - riparian vegetation, 4 - "late arrivals". * = present, ** = abundant, *** = very abundant

| | Taxa | | Santinha | Sola | S. Julião | S.J. Rei |
|---|---|---|---|---|---|---|
| | Latin name | Common name | | | | |
| 1 | *Quercus (deciduous)* | Oak (deciduous) | *** | ** | *** | ** |
| | *Corylus avellana* | Hazel | * | * | * | * |
| | *Ilex aquifolium* | Holly | | | * | |
| | *Buxus sempervirens* | Box-tree | * | | | |
| | Rosaceae Maloidea | Rosacea | * | * | * | |
| | Ros. Mal. type Crataegus | Ros. type Hawthorn | | * | * | |
| | Ros. Mal. type Pyrus | Ros. type Pear tree | * | * | * | |
| | *Rubus sp.* | Bramble | * | | | |
| | *Quercus suber* | Cork oak | * | * | * | * |
| | *Quercus (evergreen)* | Cork oak / Holm oak | | | * | * |
| 2 | Fabaceae | Legumes | *** | ** | *** | * |
| | *Erica* | Heather | * | * | | |
| | Cistaceae | | * | | | |
| | *Pteridium aquilinum* | Bracken | * | | | |
| 3 | *Alnus glutinosa* | Alder | ** | | * | |
| | *Acer sp.* | Maple | | * | | |
| | *Clematis sp.* | Clematis | * | | | |
| | *Fraxinus cf. angustifolia* | Ash | * | * | * | * |
| | *Frangula alnus* | Blackthorne | * | | * | |
| | *Hedera helix* | Ivy | | * | | |
| | Monocotyledonous | | | | * | |
| | *Salix sp.* | Rowan / Willow | * | * | * | * |
| | *Sambucus nigra* | Elder | * | * | * | |
| | *Ulmus cf. minor* | Elm | | | * | |
| 4 | *Castanea sativa* | Chestnut-tree | | ? | * | |
| | *Juglans regia* | Walnut tree | * | | | |
| | *Pinus pinaster* | Cluster pine | * | * | * | |
| | *Prunus type domestica—spinosa* | Plum tree / Blackthorn | | * | | |
| | Number of fragments studied: | | 1371 | 566 | 3005 | 366 |

1990; Greguss 1955, 1959; Grosser 1977 among others). As a large amount of material was available from S. Julião only some of the samples taken were later analysed.

Assessment of relationship charcoal record—plant cover

The importance of charcoal analysis as a palaeoecological and palaeoethnological discipline has long been recognized. However, while the ethnobotanical approach is never questioned, the relationship between the charcoal record and past plant cover has been vigorously discussed among authors favouring qualitative or quantitative approaches (Smart and Hoffman 1988; Neumann 1992; Chabal 1997; Chabal et al. 1999). In fact, as noted by Dimbleby (1978, p12) "... it is sometimes easier to identify the material than interpret the identifications".

Arguments for or against quantification have been discussed previously (Figueiral and Willcox 1999), and will not be repeated here. However we believe that controversy could easily be avoided provided that 'numbers' are not considered as a precise expression of vegetation composition; Quantitative analyses simply offer a means to (1) observe ecological trends in chronological sequences, (2) estimate the degree of local plant cover, (3) compare samples and (4) identify variables, in order to obtain an image which may be considered a reasonable approximation to reality. It is in this perspective that quantitative data of dispersed charcoal agree with present-day ecological patterns (Godron et al. 1971). It is also in this perspective that quantification is used here, along with presence/absence and ubiquity (no. of times a taxon is present/no. of times a taxon is absent) of taxa.

## Results

Site results will not be discussed in great detail, as they have been included in archaeological reports (Figueiral 2000a, 2000b, 2000c, 2001a). Presence/absence of main taxa (including dispersed and concentrated charcoal assemblages) in the four sites is presented in Table 2. The taxonomic spectrum comprises plants characterising diverse biotopes: (1) the mixed oak forest, (2) wasteland vegetation and (3) the riparian forest. Some taxa have been considered as 'late arrivals'(4) in the sense of being slow to become established, either because they are largely connected to man (cultivation) or because they had to compete with the well established original woodland. Only when this original woodland was cut could the 'late arrivals' settle and spread. Our interpretation is derived from modern plant ecology taking into account the ecological requirements of plant species. The great adaptability of certain plants to different habitats is also considered.

The results suggest a patchwork of plant communities exploited by the local inhabitants since the Middle Bronze Age. Two elements appear as the most ubiquitous and abundant at all sites, *Quercus* (deciduous) and Fabaceae, as shown in Tables 3, 4, 5.

It is possible that the abundance of deciduous oak in our record reflects its real importance in woodland areas. This assumption of abundance is based mostly on (1) frequencies from dispersed charcoal from the site of Santinha (Table 4), which we believe are the most significant from an ecological point of view, and (2) presence/ absence and ubiquity of taxa in samples from all sites (Tables 2, 3). This is also supported by data from previous studies in the region (Figueiral 1993, 1995a).

**Table 3** Ubiquity of taxa in samples available from all four sites. *Quercus* (deciduous) and Fabaceae are the most ubiquitous taxa

| Ubiquity of taxa | Santinha | Sola | S. Julião | S.J. Rei |
|---|---|---|---|---|
| N° samples studied | 34 | 29 | 33 | 9 |
| Fabaceae | 33 | 23 | 30 | 7 |
| *Quercus (deciduous)* | 33 | 22 | 33 | 9 |
| *Acer sp.* | | 1 | | |
| *Alnus glutinosa* | 9 | | 7 | 1 |
| *Alnus—Corylus* | | 1 | | |
| *Buxus sempervirens* | 1 | | | |
| *Castanea sativa* | | | 1 | |
| *Castanea—Quercus* | | 2 | | |
| Cistaceae | 8 | | | |
| Cistaceae—Ericaceae | 1 | | | |
| cf Clematis sp. | 2 | | | |
| *Corylus avellana* | 8 | 3 | 8 | 6 |
| *Erica* | 2 | 2 | | 1 |
| *Frangula alnus* | 6 | | | |
| *Fraxinus* | 13 | 1 | 6 | 2 |
| *Hedera helix* | | 1 | | |
| *Ilex aquifolium* | | | 2 | |
| *Juglans regia* | 1 | | | |
| Monocotyledoneae | | | 2 | |
| *Pinus pinaster* | 3 | 2 | 1 | |
| *Prunus type domestica—spinosa* | | 1 | | |
| *Pteridium aquilinum* | 2 | | | |
| *Quercus (evergreen)* | | | 5 | 1 |
| *Quercus suber* | 9 | 3 | 16 | 3 |
| Rosaceae Maloideae | 11 | 7 | 8 | |
| *Rubus sp.* | 1 | | | |
| *Salix sp.* | 14 | 7 | 8 | 1 |
| Salicaceae indet. | 1 | | | 1 |
| *Sambucus nigra* | 6 | 1 | 6 | |
| *Ulmus cf. minor* | | | 1 | |
| Indetermined | 2 | | | 1 |
| Cork | | 1 | | |

On the basis of both wood anatomy features (vessel size) and on ecological grounds, it is possible that we are dealing mostly here with *Quercus robur*. However *Quercus pyrenaica* may also be sporadically represented. Both species grow at present in north-western Portugal, as part of the alliance Quercion occidentale (Braun Blanquet et al. 1956) in association with *Quercus suber*, also identified at all four sites. *Quercus robur* usually grows at lower altitudes (up to 500–600 m) while higher ground (from 500–600m to 1400–1500 m) favours the development of *Quercus pyrenaica*. Strictly speaking, *Quercus pyrenaica* belongs to the group of intermediate oaks which keep their dried leaves during the winter, growing well on the fringes of the Atlantic and Mediterranean zones (Costa Tenorio et al. 1998).

Other plants probably forming this mixed woodland include *Corylus* (present in all sites), Rosaceae (in 3 sites), *Ilex*, *Rubus* and *Buxus* (all identified in one single site). The identification of *Buxus* is important. In Portugal, *Buxus sempervirens* is usually considered as a subspontaneous/ornamental plant and, to our knowledge, it has been recorded only once through pollen analysis in

**Table 4** Santinha: Absolute and relative frequencies of taxa based on analysis of scattered charcoal fragments from layer 2 (left hand side). Absolute frequencies of concentrated charcoal found in different structures are also presented. Occurrence and abundance of *Quercus* (deciduous) and Fabaceae are highlighted. There is a notable presence of pine remains in association with a vase

| | dispersed charcoal | | concentrated charcoal | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Santinha | Zone 1 | | Zone 1 | | | | | | Zone 3 | |
| Layer 2 | | | Pits 2 | 3 | 4 | 5 | 6 | Posthole | Posthole 1 | Ass. with vase |
| Taxa | Nb | % | Nb | Nb | Nb | Nb | Nb | Nb | Nb | Nb |
| *Alnus glutinosa* | 48 | 9.2 | | | | | | | | |
| *Buxus sempervirens* | 1 | 0.2 | | | | | | | | |
| Cistaceae | 5 | 1 | 12 | | 10 | | 1 | | 1 | |
| Cistaceae / Ericaceae | 2 | 0.4 | | | | | | | | |
| cf Clematis sp. | 1 | 0.2 | 3 | | | | | | | |
| *Corylus avellana* | 17 | 3.2 | 3 | | | | | | | |
| *Erica sp.* | | | | | 1 | | | | | |
| *Frangula alnus* | 11 | 2.1 | | | 1 | | | | | |
| *Fraxinus cf. angustifolia* | 10 | 1.9 | | | | | 2 | | 2 | 1 |
| Gymnosperm (indet.) | 1 | 0.2 | | | | | | | 1 | 3 |
| Fabaceae | 151 | 28.9 | 55 | 34 | 34 | 5 | 1 | 1 | 15 | 12 |
| *Pinus pinaster* | 2 | 0.4 | | | | 14 | | | | |
| *Pinus sp.* | | | | | | | | | | 2 |
| *Pinus sp. (needles)* | | | | | | | | | | 17 |
| *Pinus sp. (short shoot)* | | | | | | | | | | 1 |
| *Pteridium aquilinum* | | | 2 | | | 1 | | | | |
| *Quercus (deciduous)* | 224 | 42.8 | 55 | 4 | 1 | 12 | 2 | 51 | 9 | 17 |
| *Quercus suber* | 7 | 1.3 | 2 | 1 | | | 17 | | 6 | |
| *Quercus sp.* | 3 | 0.6 | 3 | | | | 1 | | 2 | 1 |
| Rosaceae Maloideae | 2 | 0.4 | 4 | | | | | | | |
| Ros. Mal. type Crataegus sp. | | | 1 | | | | | | | |
| Ros. Mal. type Pyrus sp. | 11 | 2.1 | 2 | | | | | 1 | | |
| *Rubus sp.* | | | | | | | | | 1 | |
| *Salix sp.* | 9 | 1.7 | 2 | | | | | 2 | 1 | |
| Salicaceae indet. | 1 | 0.2 | | | | | | | | |
| *Sambucus nigra* | 4 | 0.7 | 1 | | | | | | | |
| acorn fragment | 3 | 0.6 | 15 | | | | | | | |
| Indetermined | 1 | 0.2 | | | | | | | 1 | 1 |
| Indeterminable | 9 | 1.7 | 7 | 1 | 1 | 1 | 3 | | 2 | 3 |
| Total | 523 | | 167 | 41 | 48 | 33 | 27 | 55 | 41 | 58 |

northern Portugal during the Holocene (Elhai 1964). However *Buxus* has been identified by charcoal analysis both at Late Bronze Age (Santinha, Bouça do Frade) and Iron Age sites (Crastoeiro) (Figueiral 1993, 2001a). Two explanations are possible: (1) *Buxus* is a rare spontaneously-occurring plant in north-western Portugal, whose pollen has a low dispersal capacity; (2) the charcoal fragments come from traded objects accidentally burnt, and have therefore no palaeoecological significance. More work has yet to be done to clarify this problem.

In our record the wasteland vegetation is clearly dominated by Fabaceae (identified in 93 out of 105 samples – all sites combined, Table 3). These include at least two different genera, *Cytisus* and *Ulex*. A third genus (*Adenocarpus*) may also be present. Furthermore, based on ray features, some specimens of *Cytisus* have been identified to species level as *Cytisus scoparius*. These plants are clear indicators of an oceanic climate. Other colonisers of open ground, identified more sporadically, include *Pteridium aquilinum*, *Erica* and Cistaceae. The survival of ferns, non-woody and therefore fragile plants, should be noted. This however is not without precedent as *Pteridium* has been previously identified at other archaeological sites (Figueiral 1993).

The riverside woodland is represented by taxa such as alder (*Alnus glutinosa*), sallow/willow (*Salix*), ash (*Fraxinus*), maple (*Acer*) and elm (*Ulmus*), which appear more sporadically. *Fraxinus* is the most frequent of the riverine taxa. Other elements, such as alder buckthorn (*Frangula alnus*), elder (*Sambucus nigra*), *Clematis* and ivy (*Hedera helix*), as well as deciduous oak, hazel, heathers and monocotyledons could also have been present along the river banks, but these taxa are also frequent in non-fluvial habitats.

Other taxa such as chestnut (*Castanea*) and walnut (*Juglans*), are usually considered as closely associated with man. However, the pollen record has shown that *Juglans* was sporadically present in the Iberian Peninsula since the Early Würm. The identifications of *Castanea* during the same period must be re-assessed (Sanchez Goñi 1988, 1993; Carrión and Sánchez-Gómez 1992; Garcia Antón et al. 1990). The later expansion of both genera is a direct result of arboriculture.

*Pinus pinaster* is identified as already at three of the four sites during the Middle Bronze Age. The very low number of fragments identified as pine contrasts with the present-day artificial distribution of this species. These data support a previous hypothesis (Figueiral 1995b) that for a considerable period in north-western Portugal *Pinus pinaster* failed to become established in significant numbers because of the well established deciduous vegetation. The taxonomic spectrum obtained in the four sites may be considered as relatively reduced. Two hypotheses may be presented to explain this; (1) the restricted amount

**Table 5** S. Julião: the reduced taxonomic spectrum and the abundance of Fabaceae and *Quercus* (deciduous) are clearly shown by the data provided

| S. Julião | dispersed charcoal | | | concentrated charcoal | | | |
|---|---|---|---|---|---|---|---|
| Area 3A | Layer 3 | | | | | | |
| | | | | destruction of hut | | in vase | fire- place |
| Context | 0001 | | 0006 | 0005 | | 0007 | 0008 |
| Location | C1 | D5 | B3 | C1 | D4 | D3 | B4/B5 |
| Taxa | | | | | | | |
| *Alnus glutinosa* | | | | | | | 1 |
| *Corylus avellana* | 3 | | | | | | |
| Fabaceae | 118 | 93 | 112 | 60 | 11 | 63 | 177 |
| *Frangula alnus* | 1 | | | | | | |
| *Fraxinus cf. angustifolia* | | | 2 | | | | |
| *Quercus (deciduous)* | 75 | 21 | 40 | 34 | 39 | 13 | 22 |
| *Quercus* (evergreen) | | | | 1 | | 2 | |
| *Quercus suber* | 6 | 2 | 2 | 1 | | 1 | |
| *Quercus sp.* | 7 | | | | | | |
| Ros. Maloideae type *Pyrus* sp. | 2 | | 2 | | | | |
| *Salix sp.* | 1 | | 1 | 2 | | | |
| *Sambucus nigra* | | 4 | 5 | 1 | | | |
| Indeterminable | 2 | | 1 | | | 2 | |
| Total | 215 | 120 | 165 | 100 | 50 | 81 | 200 |

of material available from Sola and S. João do Rei (Table 2), and (2) the abundance of samples from concentrated charcoal at S. Julião. In fact concentrated charcoal may be a sign of the short-term selection of preferred material.

## The co-occurrence of *Quercus* (deciduous) and Fabaceae in north-western Portugal

*Quercus* (deciduous) and Fabaceae are consistently associated in large quantities in the samples from the four archaeological sites. Relatively significant frequencies of *Quercus* (deciduous) are noted from Santinha, while Fabaceae are especially abundant at S. Julião. They outnumber the deciduous oak in several contexts (Table 5).

Pollen and charcoal evidence suggest that deciduous oaks, in our case *Quercus robur* and possibly *Quercus pyrenaica*, were the major component of natural wildwoods in north-western Portugal during the Early Holocene (Janssen and Woldringh 1981; Brink and Janssen 1985; Knapp and Leeuwen 1994, 1995, 1997; Figueiral 1993, 1995a, 1996; Vernet and Figueiral 1993).

The expansion of legumes (Fabaceae), as shown in the charcoal record, can be interpreted as a side effect of woodland clearance. In fact, cleared and/or abandoned ground is rapidly colonised by these pioneer shrubs. They protect exposed soil from erosion and enhance its fertility via root nodules containing nitrogen – fixing bacteria thus favouring woodland recovery (Heywood 1978). The fact that these are considered as shrubs does not imply that we are dealing always here with a low-scrub vegetation. At present, in "undisturbed" areas, *Cytisus* species may grow up to 2–2.5m high, forming a relatively dense plant cover.

Available charcoal data clearly show that these communities were already well established during the Late Neolithic (Vernet and Figueiral 1993). The critical questions are: Why did Fabaceae prosper so significantly? Why was their importance maintained through time? To answer these questions we have first to answer another: What are the antecedents of the Late Neolithic vegetation in north-western Portugal? The answer must be looked for mostly in the pollen data as, for the moment, few charcoal remains are available from the region. The problem is that Fabaceae are entomophilous and do not produce much pollen and are therefore under-represented in pollen diagrams (Burjachs i Casas 1985).

Fabaceae are very sporadically recorded in the pollen diagram obtained from the Douro estuary (Naughton 2002) where the period 9500–5780 B.P. is dominated by arboreal pollen (*Pinus*, *Quercus* (deciduous), *Alnus*, *Quercus ilex*, *Quercus suber*, *Corylus*, *Betula* and *Fraxinus*). Non-arboreal pollen is dominated by Ericaceae. Also in the post-Glacial diagram obtained by Elhai (1964) from the mouth of the river Leça, near Oporto, Fabaceae are recorded only in the topmost part.

In pollen diagrams from Galicia, shrubby legumes (*Ulex* type) are only very sporadically recorded, except at Lagoa de Lucenza (Muñoz Sobrino et al. 2001) where they are well represented since ca. 13330 ± 280 B.P. (their curve, however is not continuous). According to pollen analysis (Ramil Rego 1993, Ramil Rego and Fernandez Rodriguez 1996) North western Iberia was covered with thick woodland from 8000 to ca. 5000 B.P. with *Quercus* (deciduous) and *Corylus avellana* predominating. The pollen record also includes *Alnus*, *Ulmus*, *Castanea*, *Frangula*, *Ilex*, *Betula*, *Pinus*, *Abies* and *Taxus*. *Quercus suber* and *Arbutus unedo* developed in coastal areas. Human impact was very limited and restricted to the immediate surroundings of human camps and settlements.

Pollen diagrams from Serra da Estrela (central Portugal) record more or less continuous low frequencies of *Genista* type pollen during the Late Glacial and early

**Table 6** Summary of relative frequencies of *Quercus* (deciduous) and Fabaceae in archaeological sites from north-west Portugal (Bronze Age – Iron Age)

| Sites | Phases | Hab. Str. | Layers | *Quercus* (deciduous) (%) | Fabaceae (%) | Total fragments studied |
|---|---|---|---|---|---|---|
| Lavra | II | | 2 | 61.6 | 15.6 | 1298 |
| B. Frade | | | 2 | 56.7 | 22.5 | 474 |
| C. Matos | I | | 3 | 63.8 | 14.4 | 1875 |
| C. Terroso | | St. 6 | 2 | 41.5 | 44.7 | 94 |
| | | | 3 | 40.9 | 42.1 | 247 |
| | | St. 7 | 5 | 31.8 | 44.9 | 176 |
| | | | 6 | 49.5 | 32.6 | 95 |
| | | | 7 | 54.7 | 24.5 | 159 |
| C. Penices | III | | 1 | 36 | 16.1 | 150 |
| | | | 5 | 43.6 | 17.3 | 627 |
| | II | | 11 | 45.2 | 15 | 595 |
| | | | 15 | 43.7 | 18.8 | 510 |
| | | | 25 | 36.3 | 16.9 | 466 |
| | I | | 43 | 50.5 | 23 | 200 |
| | | | 49 | 26.6 | 35.4 | 158 |
| | | | 27 | 42.1 | 25.7 | 479 |
| | | | 30 | 34.5 | 38.5 | 200 |
| C. Ermidas | | | 1 | 47 | 29.8 | 670 |
| | | | 4 | 51.1 | 28.6 | 654 |
| | | | 40 | 39.7 | 38.7 | 483 |
| Romarigães | | St. 1 | 2 | 74 | 7.6 | 211 |
| | | | 3 - int | 62.7 | 6.9 | 260 |
| | | | 3 - ext. | 48.5 | 21.7 | 161 |
| Cristelo | | St. 1 | 3 | 20.8 | 70.2 | 356 |
| | | | 4 | 89.1 | 9.3 | 129 |
| | | St. 3 | 3 | 76.9 | 17.9 | 156 |

Holocene. *Ulex* type pollen is recorded more sporadically (van der Knapp and van Leeuwen 1994, 1995, 1997).

As referred to above, most of the earlier data are provided by pollen. However, charcoal sampled in a geological profile from the Alto Paiva region (northern Portugal) clearly testifies to the presence of Fabaceae growing in association with *Pinus sylvestris* before ca. 11000 B.P. (Figueiral 2001b). Unpublished data concerning archaeological material also document the existence of legumes during the Chalcolithic.

It is obvious that Fabaceae were present in north-western Iberia during the beginning of the Holocene. These ground colonisers must have spread very rapidly to attain the importance recorded already by the Late Neolithic and later. How fast they spread must remain a matter of speculation.

The Fabaceae wasteland might have been of significant economic importance providing fuel, fodder, stable-litter, and agricultural fertilizer as well as building materials. Their exploitation in Portugal has had a long-standing tradition as is shown still by their present use by farmers (mostly as stable litter and agricultural fertilizer). The genus *Ulex*, represented in Portugal by 19 different species (Ribeiro 1986), might have also played a special role in the Iberian Peninsula. Pliny was probably referring to *Ulex* when he mentioned that a spiky plant similar to *Rosmarinus* was used in the interior of wells to recover gold particles disseminated in the water (Schulten 1958–1961).

At S. Julião the very marked representation of Fabaceae and deciduous oak, as well as the low taxonomic diversity in the majority of the samples studied (both concentrated and dispersed charcoal) is problematic. We believe that, in this particular case, the majority of archaeological contexts may have been deposited very rapidly, therefore representing short-term specific uses of woody material easily available in the immediate neighbourhood. Part of the samples may be related to construction, the legumes probably being used mostly as light roofing material.

The constant use of Fabaceae plants has been noticed in other settlements in north-western Portugal (Fig. 1). Table 6 summarises data on the presence of *Quercus* (deciduous) and Fabaceae in Late Bronze Age – Iron Age/Roman sites already studied (Figueiral 1993; 1995a). They suggest (1) a real importance of these two elements in the surrounding environment of human settlements and (2) comparable plant exploitation by different communities using a similar variety of wood resources. The constant exploitation of scrubland may be largely responsible for the regeneration and maintenance of the plants, which otherwise would have contracted greatly (having a short life = 20 years). Our data testify to the long history of present-day 'lande' communities in north-western Portugal.

## The sporadic representation of cluster pine (*Pinus pinaster*)

At our four sites the scarcity of charcoal fragments identified as *Pinus pinaster* contrasts with the present-day abundance of this species resulting from deliberate governmental and private policies. The species was planted in large areas of the country mostly at the beginning of the 20$^{th}$ century (Fabião 1987).

Previous charcoal analyses testify to the early presence (and relative abundance) of *Pinus pinaster* in the Portuguese Estremadura since the Upper Palaeolithic and in north-eastern areas since the Neolithic (Figueiral 1991, 1992; Figueiral and Sanches 2003). In north-western Portugal the occurrence of this species is remarkably sporadic (although present at least since the Middle Bronze Age as shown by data from Sola). Of the 15 sites studied so far, only 5 yielded remains of this pine and even in these the number of charcoal fragments recovered is sparse considering the amount of material available. For example, at the S. Julião site, of the 3005 fragments studied only 1 has been assigned to this species; at Santinha (Table 4) of the 523 dispersed fragments observed in zone 1, only 2 belong to this species. It is possible that in the north-west the well-established deciduous oak forest made it difficult for cluster pine to settle and spread. At least *Pinus pinaster* was not abundant enough to be used regularly by human populations. Furthermore, it is interesting to note that, as seen at Santinha, its presence might be linked to 'ritual' practices, these playing an important role in any human society. However, material evidence is difficult to identify and interpret when written documents are not available. Ritual practices related to death (burials) are more apparent than those included in day-to-day life. Consequently, the word 'ritual' is too readily used, mainly when we are faced with situations we are unable to interpret. This may be precisely the case at Santinha where very few remains of *Pinus pinaster* have been identified (2 fragments in dispersed material as stated above + 14 fragments concentrated in a pit). A deposit of pine needles (+ charcoal fragments and a short-shoot) in association with a vase appears therefore as particularly striking. The use of pine in rituals has been recorded previously (Dimbleby cited in Ashbee 1958; Ciaraldi and Richardson 2000; Robinson 2002; Zach 2002)

## Comparison with other palaeoenvironmental data

Further local palaeoenvironmental data are provided by the analysis of pollen, seeds, fruits and faunal remains. Pollen diagrams are available from Sola (Middle Bronze Age), S. Julião (Late Bronze/transition Iron Age) and S. João de Rei (transition Bronze/Iron Age) (Aira Rodriguez and Ramil Rego 1995; Diaz-Fierros Viqueira et al. 1992/1994).

The most striking feature in the diagrams from Sola, S. Julião and in the earlier levels from S. João do Rei is the clear dominance of a non-arboreal pollen assemblage, with features described by Ramil Rego (1992) as "Cultural steppe". Furthermore, the very low frequencies of *Quercus* and Fabaceae are in opposition to the charcoal record. With respect to Fabaceae this may be easily understood as already explained above. The pollen diagrams suggest the existence of a much reduced woodland cover since the Middle Bronze Age while the charcoal evidence appears to indicate otherwise. Of course, important woodland clearance is also suggested by charcoal frequencies of Fabaceae; also growth ring features observed in the oak fragments appear to indicate that plants collected were not growing in a closed environment (there being a near absence of trees with narrow growth rings at all four sites). However, we believe it would be wrong to describe woodland as a minor component of the ground cover at any of the sites. Data from regional pollen diagrams appear to support our interpretation (Brink and Janssen 1985; Muñoz-Sobrino et al. 2001).

The abundance of *Castanea* (at Sola and S. Julião) was unexpected, as was the presence of *Olea* since the Middle Bronze Age (Subboreal). In the case of *Olea,* pollen could have been transported some distance, as its presence in an area where conditions are usually very humid, rather than just humid, appears ecologically unlikely. The wild variety of *Olea* is characteristic of the thermophilous Mediterranean association Oleo-lentiscetum and it seems unreasonable to expect this species to settle naturally in this area.

The pollen identified here could come from both southern and north-eastern areas. For example, in Galicia, the Sierras de la Lastra, de Ancares and Caurel act as a barrier to oceanic influence creating a Mediterranean enclave within the Eurosiberian region (Rodriguez Guitian et al. 1996). In the south, *Olea* survived the cold conditions of the Tardiglacial period in refuge areas, such as the Serra de Sicó (Portuguese Estremadura) (Figueiral and Terral 2002).

In north-western Portugal, the presence of charcoal identified as *Olea* has been recorded only in more recent contexts—Castro das Ermidas and Castro do Cruito (Roman period). However, two olive stones have been recovered from Cossourado, Paredes de Coura, (Early Iron Age), (Figueiral unpublished report) and Castro das Ermidas, V.N. Famalicão (1$^{st}$ century A.D.) (Ede, in Queiroga 1992). The possibility that these finds are a consequence of trade must be considered. We recall that recent studies suggest that the pre-domestication of the olive tree in eastern Spain and southern France started during the Neolithic and increased during the Bronze Age (Terral 2000).

At S. Julião, *Castanea* is the most important arboreal taxon through the sequence, while at Sola it replaces *Quercus* towards the top of the diagram. Based on the charcoal data from these and other regional sites, the pollen data from S. João do Rei, as well as on our knowledge of present-day ecology, we believe that *Castanea* is largely over-represented in the pollen diagrams.

Additional information concerning anthropogenic markers is obtained through the occurrence of cereal pollen testifying to its cultivation nearby (Aira Rodriguez and Ramil Rego 1995). This is supported by the identification of cereal grains of *Panicum miliaceum* at Sola in association with *Hordeum vulgare* and *Triticum* at Santinha,

**Table 7** Possible day-to-day uses of plant taxa identified. B = bark, L = leaf, S = seed., F= fruit, Ro = root, Re = resin, Fl = flower

| **Possible plant uses** | Fuel | Human Food | Heavy building material | Light building material | Handcraft | Tanning- dyes | Illumination | Soil fertilizer | Animal fodder-litter | Medicine |
|---|---|---|---|---|---|---|---|---|---|---|
| *Quercus* (deciduous) | ■ | ■ | ■ | | | ■ | | | | B |
| *Corylus avellana* | ■ | ■ | | ■ | ■ | | | | | |
| *Ilex aquifolium* | ■ | | | | | | | | | L |
| *Buxus sempervirens* | ■ | | | | ■ | | | | | L, S |
| Rosaceae Maloideae | ■ | | | | ■ | | | | | |
| Ros. Mal. type *Crataegus* | ■ | ■ | | | ■ | | | | | L,F |
| Ros. Mal. type *Pyrus* | ■ | ■ | | | ■ | | | | | |
| *Rubus sp.* | ■ | ■ | | | | | | | | Ro, L |
| *Quercus suber* | ■ | | ■ | | | | | | | |
| *Quercus* (evergreen) | ■ | ■ | ■ | | | | | | | |
| Fabaceae | ■ | | | ■ | ■ | ■ | | ■ | ■ | |
| *Erica* | ■ | | | ■ | ■ | | ■ | | ■ | Fl, L |
| Cistaceae | ■ | | | ■ | | | | | | Re |
| *Pteridium aquilinum* | ■ | ■ | | ■ | | | | | | |
| *Alnus glutinosa* | ■ | | | | | ■ | | | | B |
| *Acer* sp. | ■ | | | | ■ | | | | | |
| *Clematis* | ■ | | | | ■ | | | | | |
| *Fraxinus* cf. *angustifolia* | ■ | | | | | | | | ■ | B, L |
| *Frangula alnus* | ■ | | | | | ■ | | | | B |
| *Hedera helix* | ■ | | | | | | | | | |
| Monocotyledonous | ■ | | | | | | | | | |
| *Salix* sp. | ■ | | | ■ | ■ | ■ | | | | B, L |
| *Sambucus nigra* | ■ | ■ | | | | ■ | | | | L, Fl, F |
| *Ulmus* cf. *minor* | ■ | | | | | | | | ■ | Sap |
| *Castanea sativa* | ■ | ■ | | | | | | | | |
| *Juglans regia* | ■ | ■ | | | | | | | | L |
| *Pinus pinaster* | ■ | ? | ■ | | | | ■ | | | |
| *Prunus* type *domestica -spinosa* | ■ | ■ | | | | | | | | L, F |

and S. Julião (Dopazo Martinez 1996). Other food plants include *Vicia faba*, *Brassica* and *Pisum sativum* which occur in the Late Bronze Age. These plants have also been identified in other Late Bronze Age contexts in the region. A summary of these finds has been presented by Bettencourt (1999). During the Middle Bronze Age foraging was also practiced as shown by the remains of acorns (*Quercus* sp.), hazel (*Corylus avellana*), *Pyrus* and *Vitis vinifera* (at Sola) (Aira Rodriguez and Ramil Rego 1995); this activity was also carried out during the Late Bronze Age (acorns at Santinha and S. Julião) and transition to the Iron Age (S. Julião and S. João de Rei).

Our interpretation of past living conditions does not rest solely upon artefact and plant evidence. Animal bones have also been recovered and provide complementary data. The vegetable diet could have been complemented by the consumption of beef, pork and lamb, as recorded at S. Julião (Antunes 1991/1992). However, the number of fauna remains available is too small (poor preservation in acid soil conditions) and they are therefore of relatively little value in the interpretation of site economy.

Potential uses of plants

Woody plants used as fuel (for cooking, heating, illumination, metalworking and pottery kilns) and as construction material are more likely to be preserved, recovered and recognised as such. Other uses of the same plants are less likely to be recognised. For example, deciduous oak wood is an excellent fuel and also particularly suitable for building and was widely used by man for such purposes. In fact, according to Vitruvius long narrow strips of *Quercus robur* were used as thatching in Gaule, Hispania and Lusitania (Schulten 1958–1961). Little attention is paid to the other possible uses of this tree as we lack explicit evidence. Its bark, leaves and wood could be used both in the curing of animal skins and for medicinal purposes (Polunin and Erverard 1983; Dimbleby 1978). Ash was still used recently for laundry (white linen) (Fontes 1992).

Table 7 summarises some of the possible uses of plant taxa identified in our sites. As we can see several of the plant taxa identified possess pigments and tannins, which might be isolated and used. For example, the use of plant tannins in curing animal skins is recorded since at least 1500 B.C. (Simpson and Conner-Ogorzaly 1986). Tannin stabilises the protein molecules of animal skin making cured leather resistant to degradation. In Europe, oak was the main source of tannin up to the 15th century when it was replaced by sumac (*Rhus* spp.) (Dimbleby 1978). The term 'tannin' is applied to a large spectrum of water-soluble polyphenolic substances found in all vascular plants, divided into hydrolysable tannins (restricted to dicotyledonous plants) and condensed tannins (more widely distributed in higher plants) (Wiltshire 1995).

The bark of *Sambucus*, the berries of *Frangula* and the bark, flowers and young shoots of *Ulex* can be used as textile dyes (Dimbleby 1978). The cork of *Quercus suber* was used as thatching material in Spain by the Roman armies in their winter quarters (Schulten 1958–1961).

Animal fodder must also have been collected. Leaves of plants such as *Salix*, *Ulmus*, *Fraxinus*, Fabaceae and *Erica* could have been used as feed, while the stems were used as domestic fuel. In Portugal different species of *Erica* and Fabaceae are still used as animal fodder. *Ulmus* was also frequently used (sometimes mixed with ground cereal chaff) until its recent disappearance as a result of the Dutch elm disease.

Plants with secondary metabolic compounds are frequently used in traditional medicine. In our case, these include *Quercus* (deciduous), *Salix*, *Cistus*, *Ilex*, *Fraxinus* (Cotton 1998; Polunin and Everard 1983). Other plants have been used in Portugal as home-made medicines; a syrup prepared with *Sambucus nigra* treats infections of the respiratory system, while tea made out of *Cytisus multiflorus* prevents cardiac and rheumatoid problems (Carvalho et al. 2001).

Heather and Fabaceae may be used to make brooms (house and oven brooms). After removal of the bark, heather has been used until recently to make spills (Fontes 1992). They were also particularly prized for charcoal making, while *Cytisus* has been regularly used during the winter as kindling (Fontes 1992).

The importance of wood in the making of home implements for everyday life should not be forgotten. Unfortunately these usually only survive in waterlogged deposits, which are very rare in our region. Until very recently *Salix* and young stems of *Cytisus multiflorus* (periderm removed) were used in basketry in small inland villages. Home implements (mostly for the kitchen) and furniture were made out of *Alnus*, *Fraxinus*, *Ulmus* and *Populus nigra* (Carvalho et al. 2001).

Human food could also be provided by species such as *Corylus avellana*, *Juglans regia*, *Castanea sativa*, Rosaceae, *Quercus*, *Rubus*, *Sorbus* and even *Pteridium* and *Sambucus*. The potential role of *Pteridium* rhizomes as a staple for humans during Prehistory has been discussed by Clarke (1976), Rowley-Conwy (1986) and Göransson (1987). The importance of acorns as a staple food for local populations before the Roman conquest has been described by classical authors. Although Strabo clearly mentions the use of acorns only when bread was in short supply (Schulten 1958–1961), it is possible that acorns played a more than supporting role in a strategic system of resource exploitation and subsistence (Vasquez Varela and Pombo Mosquera 1991). Further work is needed to understand their role in pre-historic and proto-historic economy.

## Conclusions

The Middle Bronze Age in the Cávado Basin sees the intensification of a process of 'land domestication' (Bettencourt 1999, 2000a, 2000d), when the more demanding use of natural woodland (mainly deciduous oaks) leads to the spread of otherwise minor plant communities (Fabaceae), and thus contributes to a new cycle in the history of local / regional vegetation, as already suggested by data from more recent sites (Figueiral, 1993, 1995a). The current study of earlier settlements in this same area will provide additional evidence and a clear picture of the local environmental changes.

So far, the causes of the modern extensive areas of scrubland (Fabaceae, *Erica*, Cistaceae) appear to lie mainly in the anthropogenic exploitation of natural woods. However, short term climatic changes may also have played a role in the maintenance of vegetation changes.

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