The territory and its resources

STUDIES ON THE RURAL WORLD IN THE ROMAN PERIOD 4

Wood in the ancient Mediterranean: forests, fuelwood and raw materials

Raquel Piqué
Department of Prehistory. Universitat Autònoma de Barcelona

ABSTRACT
Human communities have historically exploited the resources provided by the forests in order to satisfy some of their needs. Through the analysis of charcoal and wood remains recovered in diverse archaeological excavations it is studied the use of the wood and the most employed species in Roman settlements, either as fuelwood for domestic activities, as fuelwood for industrial activities –mainly to feed the metallurgical or ceramic kilns– or as raw materials to make various instruments.

KEYWORDS: wood, charcoal, fuelwood, raw materials.

RESUM
Les comunitats humanes han aprofitat històricament els recursos que els ofereixen els boscos per satisfer algunes de llurs necessitats. A través de l'anàlisi de restes de carbons i fustes recuperades en diverses excavacions arqueològiques s'estudia l'ús de la fusta i les espècies més emprades als assentaments romans, ja sigui com a combustible per a activitats de caire domèstic, com a combustible per a activitats de caire industrial –principalment per alimentar els forns metal·lúrgics i ceràmics– o com a matèria primera per elaborar instruments variats.

PARAULES CLAU: fusta, carbó, combustible, matèria primera.

Throughout history forests have provided human communities with a diverse range of products to satisfy their needs. Trees and shrubs have always been one of the Mediterranean forest's most versatile resources, providing firewood, wood for making furniture, houses and instruments, bark, tannin for treating leather, leaves for food for livestock, fruit, resin and fibres (Buxó/Piqué 2008). Obtaining these products did not depend upon opportunistic foraging but was probably a highly organised task, requiring the use of appropriate technology and specialist knowledge about forest environments. The principle means to develop practices to take full advantage of the forest were essentially knowledge of the properties of the anatomy of trees and bushes, their vegetative cycle and distribution, and familiarity with the tools needed to exploit these resources.

Forests are not natural environments detached from human activity, but rather are spaces shaped by a shared history, areas where human communities have actively intervened in their formation. Consequently, human activity has transformed the existing biodiversity of forests through the introduction of new species and by increasing or decreasing the areas occupied by others. Human intervention is sometimes deliberate and intended to create a specific environment, for example pastureland or meadows, and other times human activity unintentionally causes the spread of certain species as in the case of colonisers in degraded areas.

Greek and Roman writers testify to the huge variety of products obtained from plants and trees. Fruit, wood from trunks, branches and stumps and even leaves provided human communities with a wide range of products from food for livestock to wood to satisfy the needs of both rural and urban settlements. Various essays about agriculture and plants are principal sources of information about the different uses of wood in Roman society. One of the most thorough works is that of Theophrastus, while the texts of other authors such as Pliny, whose work was based on that of Theophrastus, and also Hesiod, Porcius Cato, Varro and Columella make reference to the wide and varied uses of this material. Classical texts bear witness to the ample knowledge ancient societies possessed about the properties of wood and how best to exploit it. These essays not only mention the types of wood used but also the different kinds of work related to the exploitation of trees. Furthermore, they demonstrate ancient peoples' expertise in fruit cultivation, grafting and different types of pruning, and provide insight into the techniques used to produce charcoal and advice about how best to exploit the land to obtain wood. These texts also reveal that both local wood and wood transported from elsewhere was used where necessary. There are many specific examples of preferences regarding the type of wood used to make furniture, glasses, bowls, coffins, ships, building parts, statuary and others. Even though these texts probably do not provide an exhaustive inventory of the types of wood used and the ends to which it was put, they still mention a huge number of species and the various uses of this raw material. These classical texts are certainly a principle source of information about the agroforestry practices implemented in the classical world.

One of the most important works about the exploitation of wood in the Ancient Mediterranean world is by Russell Meiggs (1985). His study gathers information from classical texts about the principle uses of wood in this period, namely making furniture and sculptures and providing the fleet, the army and cities with the raw material they needed. According to the author the exploitation of forests was critical to the expansion of the Empire and one of the main reasons for establishing industrial settlements.

As a result of their colonialist and imperialist policies both the Greeks

and the Romans introduced numerous economically valuable species to the Iberian Peninsula, some of which over time came to form part of the landscape. The arrival of these new species also brought about changes in the way land was managed as the fact that the species growing on the Peninsula were now familiar meant that new ways to exploit the natural environment could be successfully implemented.

The needs of the colonies and later those of the Empire had dramatic consequences for the Iberian landscape. The Empire required vast quantities of wood to satisfy both public and private needs, for construction, domestic consumption, the production of craftwork and for the naval fleet. The effect of this pressure on the natural environment is evident in pollinic diagrams of the north-east of the Iberian Peninsula, where the different phases of deforestation clearly coincide with the expansion of the Roman Empire (Riera/Mora 2006, Burjachs et al. 2005).

While classical authors have been widely studied and analysed (Meiggs *op. cit.*), little attention has been paid to the archaeological study of the uses of wood, especially in the Iberian Peninsula. Classical authors mentioned ideal models for the exploitation of forests, or those referring to specific sectors of the population that could pay for exotic wood to make furniture. However, little reference was made to the everyday use of this raw material in the colonies and provinces of the Empire.

Archaeological sites provide valuable information about how wood was used in different contexts and different periods. One of the most common types of remains found at these sites is charcoal, which normally corresponds to the residue of the fuel used there. These charcoal remains have been studied as a way of reconstructing the landscape as well as a means to analyse the economic practices employed (Piqué 1999; Allué 2002). Various Roman sites in the north-east of the Iberian Peninsula have provided an insight into both domestic fuel consumption and fuel consumed to produce craftwork. Far fewer sites have provided wooden artefacts, although there are some notable exceptions in terms of both the quantity and quality of the remains recovered. The location of the sites and the different landscapes characteristic of these areas undoubtedly influenced the range of species used, and the end to which the wood would be put certainly determined how it was managed. This paper does not attempt to provide an exhaustive inventory of sites, especially as many of the studies carried out at settlements from this period are unpublished, but a general overview of some of the more common uses of wood obtained from the analysis of remains from various sites is given.

1. DOMESTIC USE OF FUELWOOD

The sites with sequences from the end of the 1st millennium BC to the middle of the 1st millennium AD provide an insight into how Romanisation affected the use of fuelwood. These sites represent different urban and rural archaeological contexts. Each site is unique regarding the species used there for fuel. This choice was no doubt influenced by the different landscapes from which the fuelwood was collected, and it was probably also dependent upon the use to which this wood would be put. The results obtained from some of the more extensively studied areas of the north-east of the Iberian Peninsula are shown below.

The remains from the archaeological excavations carried out at the Roman city of Lleida, which cover the period from the 1st century BC to the 4th century AD, provide a good example of the fuelwood used in an urban context. The remains come from various excavations within the urban centre:

- Excavation 46, 1st century AD, 3rd-4th century AD
- Excavation 47, 1st century AD
- Excavation 48, 1st century BC

Ecology	**Taxa**	1st c. BC	1st c. AD	2ndc. AD	3rd -4th c. AD
Thermo and Meso-Mediterranean	Leguminosae	0.2	0	0	0
	Pinus halepensis	37.4	49.4	0.9	12.3
	Pistacia lentiscus	2.1	4.2	0	0.7
	Quercus sp evergreen	9.2	18.4	0	4.8
	Rosmarinus officinalis	0.8	0.3	17.7	1.4
	Rhamnus -Phillyrea	0.2	1.2	1.9	0
Supra-Mediterranean	Acer sp	2.5	0.3	0	0
	Buxus sempervirens	0.6	0	0	0
	Pinus sylvestris-nigra	8.9	0	75.7	8.9
	Quercus sp deciduous	11.4	6.3	0.9	2.7
Riparian	Alnus glutinosa	2.1	0	0	0
	Fraxinus sp	0.2	0	0	0
	Populus sp	0.6	0	0	66.4
	Salix sp	1.2	0	0	0
	Ulmus sp	5.4	0.9	1.9	0
Halophilous	Chenopodiaceae	0	0.3	0	0
	Tamarix sp	0.4	0	0	0
Domestic	cf. Celtis australis	0	9.3	0	0
	Ficus carica	3.1	0	0	0
	Juglans sp	6.1	0	0	0.7
	Olea europaea	1.9	0.3	0	0
	cf. Punica granatum	0.6	0	0	0
	Vitis vinifera	0.6	0	0	0
Indeterminate	Pomoideae	2.1	9.1	0.9	0
	Prunus sp	1.1	0	0	1.4
	Juniperus sp	0.4	0	0	0
	Pinus sp	0.8	0	0	0.7
Minimum number of species		24	11	7	9

Table 1- Summary of the relative frequencies (%) of taxa represented in the excavations of Roman Lleida.

Charcoal analysis indicates that fuelwood was gathered in various plant comunities (Table 1). Thermo and Meso-Mediterranean taxa typical of open shrub, or maquis, are represented: Aleppo pine (*Pinus halepensis*), rosemary (*Rosmarinus officinalis*), mastic (*Pistacia lentiscus*), buckthorn (*Rhamnus)*, Phillyrea (*Phillyrea*), and holm and kermes oaks (*Quercus ilex-coccifera*). Supra-Mediterranean species such as the deciduous oak (*Quercus* sp deciduous), maple (*Acer* sp), common boxwood (*Buxus sempervirens*) and Scots-Black pine (*Pinus sylvestris-nigra* type) were also gathered, all of which are usually found in shady places and in higher elevation areas. Pome fruit (*Pomoideae*) and stone fruit trees (*Prunus* sp) can also be included in this group. These species may also have been cultivated, although this cannot be determined from an analysis of the anatomy. Riparian species were also represented in almost all of the time periods, for example the elm (*Ulmus* sp) which was the most frequently occurring taxon. The remains of halophilous vegetation also appear in the individual samples taken from all of the time periods studied except for those from the 2nd and 3rd centuries AD. Lastly, fruit trees and other trees that may have been cultivated were used, including the common fig (*Ficus carica*), the walnut tree (*Juglans* sp), possibly the European nettle tree (Cf *Celtis australis*), the pomegranate

(*Punica granatum*), the olive tree (*Olea europaea*), the common grape vine (*Vitis vinifera*), and pome fruit and stone fruit trees. However, these taxa do not appear in all of the periods studied.

Only three taxa, *Pinus halepensis, Quercus sp* deciduous and *Rosmarinus officinalis*, were documented in all of the time periods studied, and only *Pinus halepensis* was consistently present in large quantities. Different species of pine, including Aleppo and Scots-Black pines, were also important in all the phases. Another noteworthy characteristic was the predominance of remains from trees as opposed to shrubs, the latter only becoming relatively important around the 1st -2nd century AD (Figure 1).

Various differences were observed throughout the sequence studied at the city of Lleida. Firstly, the number of different taxa decreased over the time period studied. Twenty-four species were identified in the earlier part of the phase, whereas only 9-10 species were observed in the later phase. Secondly, in the 2nd century AD and during the late antiquity there was a progressive increase in the number of riparian and supra-Mediterranean taxa used and a subsequent decrease in the variety of low Mediterranean and domestic species (Figure 2). This increase in the number of taxa from mountainous and riparian environments may have been due to the fact that the collection area for fuelwood had to be widened in order to satisfy an increasing demand and because the forested areas nearer the urban areas had been reduced in size.

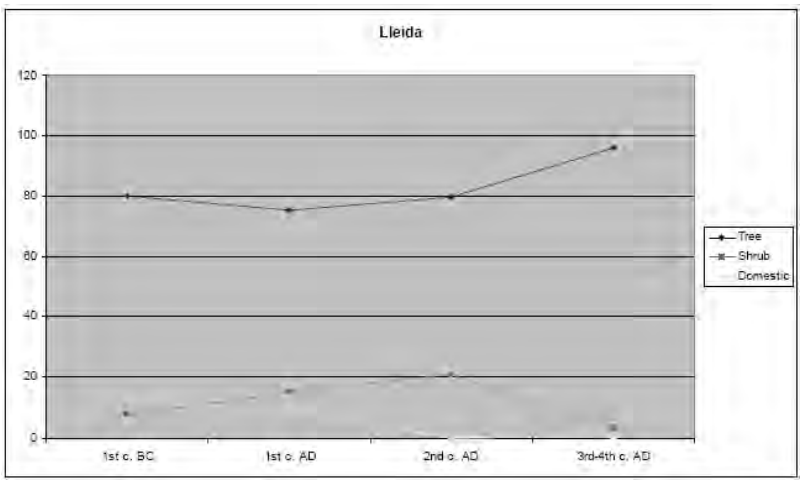

Figure 1. Graphic representation of the distribution of tree, shrub and domestic taxa in Roman Lleida, expressed in relative frequencies (%).

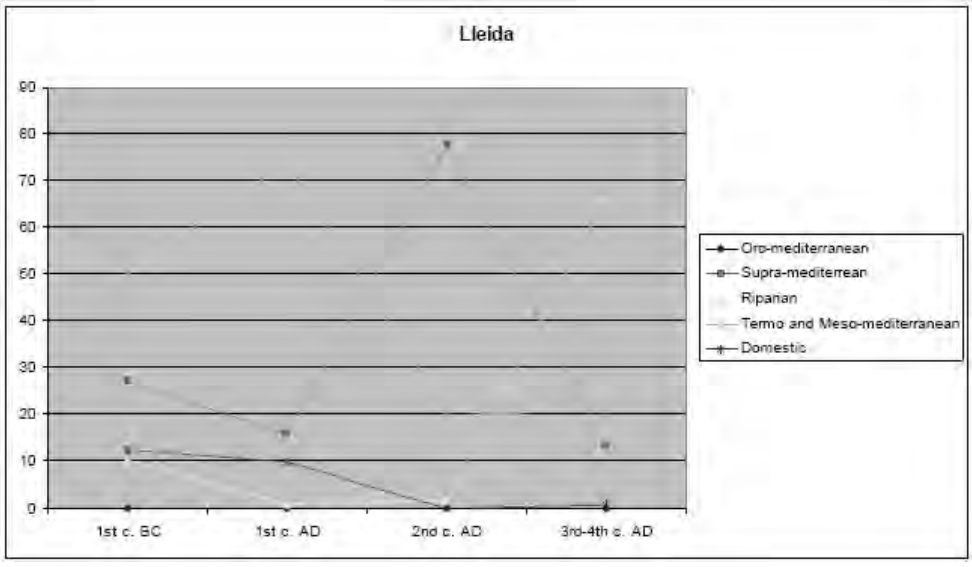

Figure 2. Graphic representation of the distribution of supra-Mediterranean, thermo and meso-Mediterranean and domestic taxa in Roman Lleida, expressed in relative frequencies (%).

The archaeological sites located in the district of Vallès Occidental also provide an opportunity to study trends in the use of fuelwood over a long time period. These Roman and late antiquity settlements, which were mainly rural and produced craftwork, cover the period from the 3rd century BC to the 8th century AD:

- Can Feu (Sabadell), 3rd century BC, 2nd century BC, 1st century BC, 1st century AD, 2nd century AD (Piqué *et al.* 2000)
- Can Roqueta-Torre Romeu (Sabadell), 6th-8th century AD
- Can Gambús (Sabadell), 6th-8th century AD

Ecology	**Taxa**	3rd c. BC	2nd c. BC	1st c. BC	1st c. AD	2nd c. AD	6th-8th c. AD
Meso-Mediterranean	*Arbutus unedo*	0	1.3	8.8	5.9	1.1	3.4
	Cistaceae	0	0	0	0	0	3.7
	Erica sp	10	4.6	5.3	5.1	1.5	8.9
	Leguminosae	0	0	0	0	0	1.3
	Pinus halepensis	0	0	1.7	0	6.1	0
	Pistacia lentiscus	0	0	5.3	4.6	0	4.2
	Quercus sp evergreen	10	41.2	26.3	32.1	1.5	35.4
	Rosmarinus officinalis	0	0	0	0	0	0.5
	Rhamnus -Phillyrea	0	2.6	0	0.4	0.5	5.3
Supra-Mediterranean	*Buxus sempervirens*	0	0	0	6.9	0	0
	Pinus sylvestris-nigra	0	1.3	1.7	0.9	14.3	0
	Quercus sp deciduous	10	44.4	24.5	22.5	70.7	19.6
Oro-Mediterranean	*Abies alba*	0	0	0	0.4	0	0
	Fagus sylvatica	0	0	0	0	0	0.5
Riparian	*Corylus avellana*	0	0	0	0.9	0	0
	Populus sp	0	0.6	1.7	0	0	0
	Salix sp	0	0	0	0	0	7.1
	Ulmus sp	0	1.9	3.5	4.1	2.5	1.1
Domestic	*Ficus carica*	0	0	0	0	0	0
	Olea europaea	0	0.6	0	1.4	0	0.5
	Vitis vinifera	0	0	0	10.1	1.5	5.9
Indeterminate	*Juniperus* sp	40	0	0	0	0	0
	Monocotiledonea	0	0	0	1.8	0	0
	Quercus sp	0	0	0	0	0	0
	Pomoideae	10	1.3	0	1.8	0	0.8
	Prunus sp	20	0	21.1	0.9	0	1.9
Minimum	number of species	6	10	10	16	10	16

Table 2. Summary of the relative frequencies (%) of taxa represented in the Vallès Occidental excavations.

In these settlements the fuelwood was collected mainly from evergreen and deciduous oak forests, natural environments where these two species are predominant (Table 2). Evergreen oaks and meso-Mediterranean species would have occupied the sunnier areas, together with deciduous oaks and other supra-Mediterranean species in the shady areas and hollows. The deciduous oak forests would have been found mainly in middle elevation areas and would have been enriched by species pertaining to evergreen oak forests in the sunnier spots. Riparian species like elm, common hazel (*Corylus avellana*), willow (*Salix* sp) and white poplar (*Populus* sp) were also used for fuelwood. The settlement also contained the remains of beech (*Fagus sylvatica*) and silver fir (*Abies alba*), species found in high elevation areas and which nowadays in the district of Vallès only grow in the massif of Montseny. Therefore, it would appear that these taxa were transported to this settlement from elsewhere. Lastly, domestic species were represented,

which would indicate that the wood obtained from pruning fruit trees was used as fuelwood. These taxa may have included the common vine and common fig, olive trees, and possibly pome fruit and stone fruit trees. Throughout the sequence the fuelwood was collected from the same forests but with varying intensity.

The deciduous oak and the kermes oak were the most frequently used species; they were found in all of the phases and most of the remains were from these taxa. The remains of other species such as heather (*Erica* sp), strawberry tree (*Arbutus unedo*) and elm were frequently represented, but in smaller quantities than the oak trees. The general preference for using trees for fuel as opposed to shrubs can be seen in Figure 3, although an increase in the use of the latter can be observed from around the 1st century BC to the 1st century AD.

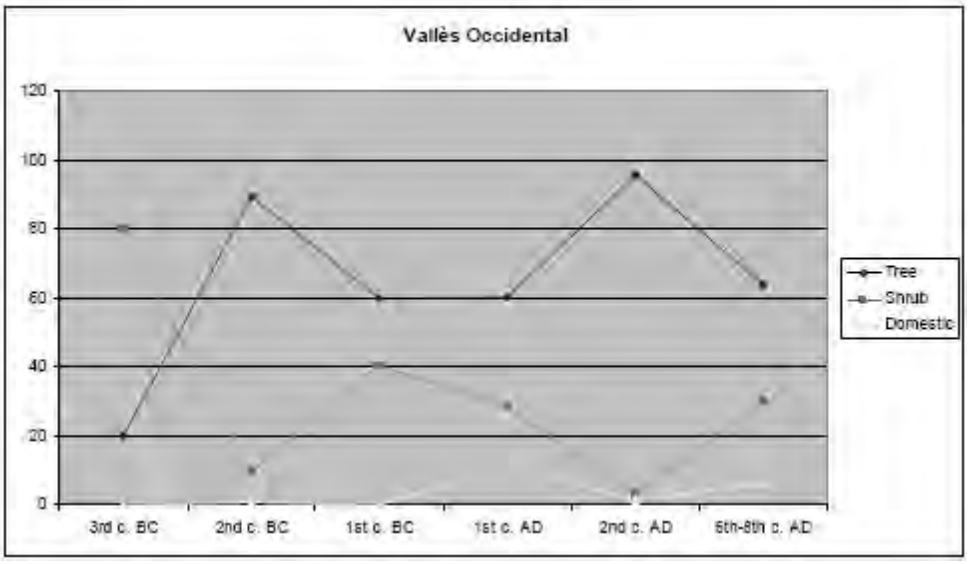

Figure 3. Graphic representation of the distribution of tree, shrub and domestic taxa in the sites of Vallès Occidental, expressed in relative frequencies (%).

Supra-Mediterranean vegetation was increasingly used for fuelwood from the 2nd century BC (Figure 4). This may have been the consequence of widening the collection area to include higher elevation zones due to the increasing anthropisation of the landscape. However, once again in the late antiquity shrubs and meso-Mediterranean taxa became more common and therefore were increasingly used for fuel.

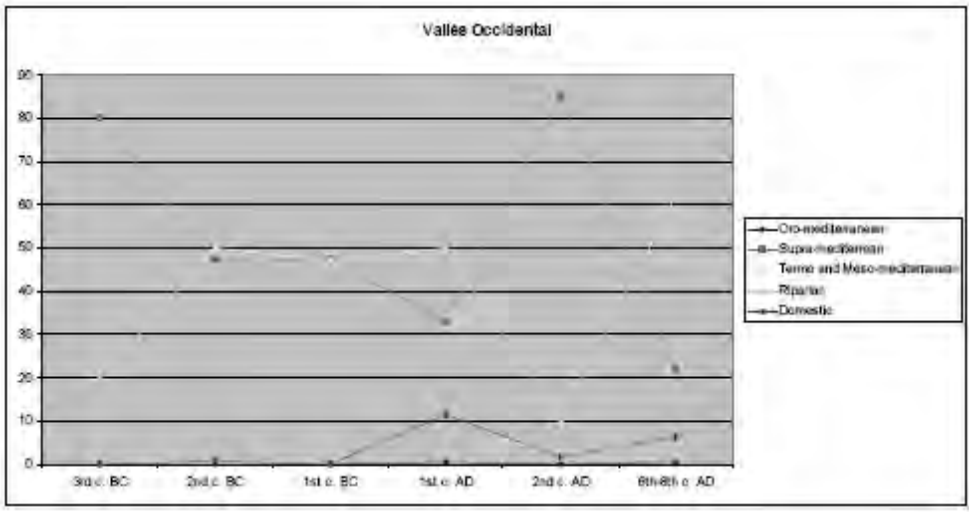

Figure 4. Graphic representation of the distribution of meso-, supra- and oro-Mediterranean taxa in the sites of the district of Vallès Occidental, expressed in relative frequencies (%).

In other districts studies have been less extensive or have been confined to a specific point in time which means that a diachronic analysis of the use of fuelwood in these districts cannot be made. However, the data from these studies are interesting in that they provide an insight into the differences in the use of fuelwood for domestic purposes and for specialised production processes. Furthermore, it is interesting to compare these data with those from other settlements. The site of Ca l'Estrada (Canovelles) in the district of Vallès Oriental provides information about the use of fuelwood in the 1st century BC and from the 6th-8th century AD. The most common taxa at this site during the 1st century BC were *Quercus* sp deciduous and *Quercus* sp evergreen (deciduous and evergreen oaks). At this time more trees were used than shrubs, but in the late antiquity shrubs were increasingly used as firewood (Figures 5 and 6). This meant an increase in the exploitation of species from meso-Mediterranean areas, which was similar to the trend observed in Vallès Occidental. Pollinic diagrams show that the most pronounced indicators of deforestation occurred during the late antiquity. According to Riera and Palet (2005) between 1550 cal BP and 1370 cal BP the frequent forest fires in the Vallès-Maresme area would have caused the formation of heather thickets and steppe communities.

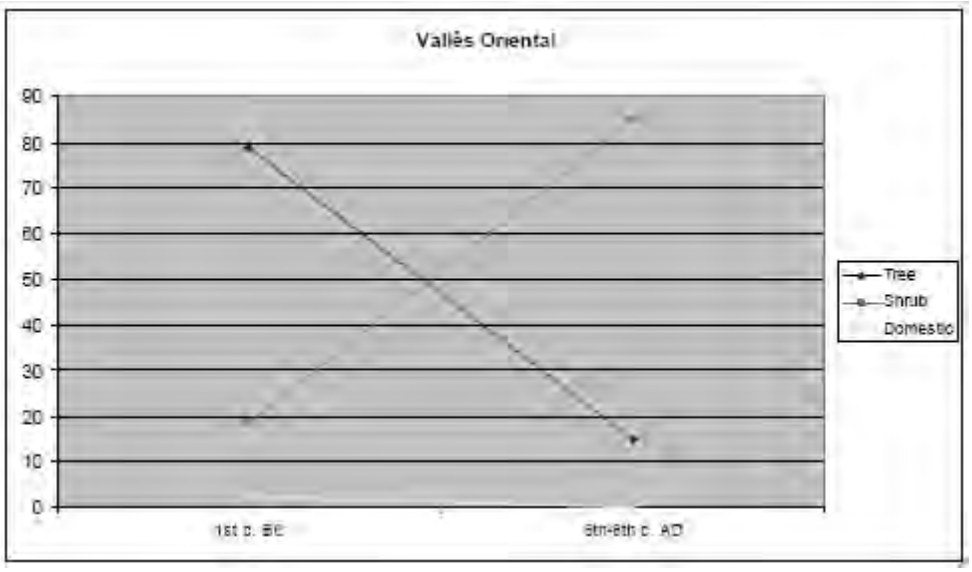

Figure 5. Graphic representation of the distribution of tree, shrub and domestic taxa at the site of Ca L'Estrada (Vallès Oriental), expressed in relative frequencies (%).

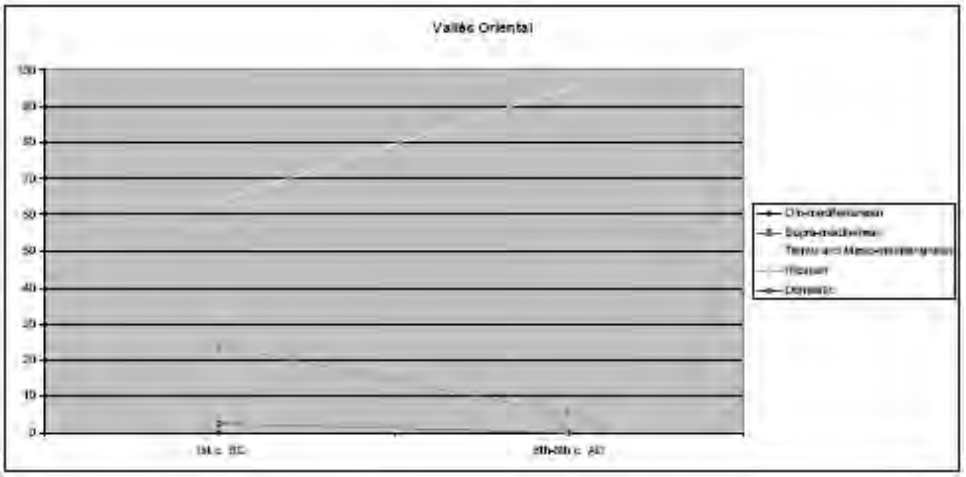

Figure 6. Graphic representation of the distribution of meso-, supra- and oro-Mediterranean and domestic taxa at the site of Ca L'Estrada (Vallès Oriental), expressed in relative frequencies (%).

The settlement in the city of Lleida and those in the district of Vallès share some characteristics regarding domestic fuel consumption, despite the first being an urban context and the second rural. In both areas tree taxa were used for fuelwood more than shrubs. However, there was an increase in the use of the latter around the 1st century AD and a subsequent widening of the collection area around the 2nd century AD. It would therefore seem that the area surrounding the settlements could no longer provide enough fuelwood to satisfy domestic demand, which created a need to exploit the shrub stratum more intensively and later the need to widen the collection area and use species less intensively exploited before. These new collection areas, including supra-Mediterranean forests, were increasingly far from the settlements and also difficult to access. Finally, the late antiquity saw a return to the use of meso-Mediterranean and riparian shrubs which could mean that once again fuelwood from areas closer to the settlements was being exploited.

Another important aspect is the large percentage of fruit tree branches in the fuelwood remains. From the anatomy it is impossible to determine whether these are the remains of cultivated trees, but what is certain is that these taxa were absent or uncommon at Iberian sites. The presence of fruit trees could indicate that the branches obtained from pruning were used for fuelwood and that fruit-bearing trees were cultivated at this time. Some of the species present, for example the common vine and the olive tree, could have been very valuable economically. Although these fruit tree remains were not present in very large quantities their use as fuelwood was recurrent throughout the time period studied which would indicate that arboriculture was an established practice.

2. INDUSTRIAL USE OF FUELWOOD

Some Roman settlements were used for specific production processes. Ceramic production and metallurgy are two industries which would have required huge quantities of fuelwood to transform raw materials. The study of the fuelwood used in some metallurgical and ceramic kilns reveals important differences between fuel consumption for production and for domestic purposes.

Charcoal from the sites of Can Notxa (Maresme), Ermedàs (Pla de l'Estany) and Can Feu (Vallès Occidental) provides information about the type of fuelwood used in the ceramic production process at these locations between the 1st and the 3rd century AD. The most notable finding after analysing the charcoal from these settlements was that only two to four taxa were identified. Table 3 shows that at all three sites mainly a single species was used for fuel: Aleppo pine in the case of Can Notxa and deciduous oak at Ermedàs and Can Feu. The different landscapes of the three sites no doubt influenced the choice of species used. However, the charcoal recovered from inside the kilns could have come from the last time they were used and would therefore be the remains of only the last fuelwood burnt there. The availability of different species in the surrounding area could have varied throughout the time period studied as a result of anthropic erosion. Aleppo pine, for example, is a colonising species that proliferates in degraded evergreen oak forests. The almost exclusive use of this taxon for fuelwood at Can Notxa could have been due to the anthropisation of the natural environment and the resulting transformation of the surrounding landscape. At Ermedàs and Can Feu, even though the surrounding area may have also been significantly degraded, there would still have been some evergreen oak and deciduous oak forests to provide fuelwood.

One of the most notable findings was the small number of species used

in these kilns compared to a much wider variety of taxa used as fuelwood in domestic contexts in the urban villas and settlements in the same geographic region, suggesting a more specialised use of fuelwood in production processes. Ceramic production in particular required huge amounts of fuel, which may have created the need for a more organised system of fuel supply. The exploitation of the more common tree taxa in the fuelwood collection area would therefore have been more organised and methodical and less indiscriminate and opportunistic than was the collection of other species.

Site	CAN NOTXA	ERMEDÀS	CAN FEU
Time period	1st-3rd c.	1st-2nd c.	1st-2nd c.
Erica sp	4.3	0	0
Juniperus sp	0	6.4	0
Pinus halepensis	95.7	0	0
Populus sp	0	0	0.7
Quercus sp deciduous	0	84.2	71.1
Quercus sp	0	0.5	0
Quercus sp evergreen	0	3.4	28.2
Total *Quercus*	0	88.1	99.3
Ulmus sp	0	5.5	0
Minimum number of species	2	4	3

Table 3. Taxa present at sites used for ceramic production.

Various studies about metallurgic production between the 2nd century BC and the 3rd century AD have been carried out in the region of the Pyrenees. Studies of the kilns of Goleró and Vall de l'Ingla in Andorra (Euba 2008) and the dolmen of La Font del Coms in Baiasca (Celma 2008), which was later used as a kiln, indicate that the most commonly used fuelwood in all the different stages of metal production was Scots pine (*Pinus* sp *sylvestris-nigra* type) and that at all the sites studied the fuelwood used came from the dominant species in the forests in the surrounding area. Charcoal analysis could not determine whether the fuelwood was gathered from the surrounding area or if it was charcoal produced from these same species specifically for use in the kilns. Charcoal is not only a better quality fuel but it also reaches a higher temperature and therefore is more efficient at transforming metal. Charcoal production technology was known to ancient societies, as demonstrated by the fact that Theophrastus (1988 edition) described the procedure for obtaining charcoal as early as the 3rd century BC. However, there is no evidence of charcoal kilns until the late Roman period (Pèlachs et al. 2006) in the Vallferrera area (Pallars), where these earliest facilities have been discovered.

3. THE USE OF WOOD IN THE PRODUCTION OF INSTRUMENTS

There are few archaeological sites from the Roman period in the Iberian Peninsula that afford the opportunity to analyse the raw materials used in the production of instruments. The site of Iesso (Guissona) in Catalonia is a notable exception. The wooden artefacts recovered from the phreatic level of two wells have provided information about the raw materials used as well as some technical aspects of instrument manufacture (Buxó et al. 2004). The remains of artefacts and some branches that probably came from the natural pruning of the trees in the immediate area were also recovered. Among the artefacts the remains of taxa which did not appear among the fallen branches were found, indicating that the species used may not have grown around the settlement and would therefore have needed to be

transported there from elsewhere. The taxa represented in this collection of artefacts all pertain to supra-Mediterranean oak forests (*Acer* sp, *Buxus sempervirens*, *Quercus* sp deciduous) and riparian forests (*Salix* sp), but at this site there is also some evidence of the use of oro-Mediterranean taxa such as the European silver fur, birch (*Betula* sp) and Scots-Black pine (*Pinus* sp *sylvestris-nigra* type) that would have been collected from longer distances.
Birch was used to make flat, thin pieces of wood with polished surfaces into which incisions were made, but the form and function of these wooden artefacts are unknown. The trunks of maple trees (*Acer* sp) were hollowed out to make recipients with polished surfaces. Boxwood (*Buxus sempervirens*) was used to make three pointed objects with polished surfaces, possibly awls or punches, and a cylindrical object whose function is unknown. Scots-Black pine was used to make long, flat pieces of wood and also a cylindrical artefact which may have been used as a lid. Deciduous oaks were used to make larger objects like planks, and the trunks of these trees were hollowed out and possibly used as pipes. Oak was also used to make a spatula shaped object. Lastly, basket parts were made from a species of willow (*Salix* sp). The study of the wooden artefacts recovered from the Iesso site provides valuable information about the diverse uses of the different species of wood in the ancient Mediterranean.

4. CONCLUSIONS

The study of charcoal and wood from the different sites in the north-east of the Iberian Peninsula provides information about the diverse uses of wood in the ancient Mediterranean, from fuelwood for domestic use to the raw material used to make instruments. The data obtained shows how the different types of wood were put to many different uses. A wide variety of species were used as fuelwood for domestic fires, whereas in production processes the use of different taxa for fuelwood was more specialised.
The differences between the landscapes at the different sites were reflected in the composition of the anthracological evidence from the domestic sites**.** However, a similar trend was observed in the two areas studied (Vallès and the city of Lleida). At both sites tree taxa were the principle source of fuelwood, and in both cases the collection area grew progressively wider as a probable consequence of the increasing anthropisation of the landscape nearer the settlements. In all cases fuelwood was gathered from different collection areas and branches pruned from fruit trees were also used.
Information about the production of instruments is scarcer. However, evidence suggests that various types of wood were used to make different instruments. The raw material came from different collection areas that included both local forests and higher elevation forests some distance from the settlements.

BIBLIOGRAPHY

- ALLUÉ, E. 2002, *Dinámica de la vegetación y explotación del combustible leñoso durante el Pleistoceno Superior y el Holoceno del Noreste de la Península Ibérica a partir del análisis antracológico*. Doctoral thesis, Department of History and Geography, Rovira i Virgili University, Tarragona. http://www.tdx.cesca.es/TDX-1103103-113135/

- BURJACHS, F., BACH, J., BUXÓ, R., LLÀCER, P., MCGLADE, J., PICAZO, M., PIQUÉ, R., ROS, M.T. 2005, El territori d'Emporion i les seves dades paleoambientals, *Empúries* 54, 25-32.

- BUXÓ, R., CANAL, D., GUITART, J., PERA, J., PIQUÉ, R. 2004, Excavació

de dos pous d'època romana a Guissona: L'explotació dels recursos vegetals a la ciutat romana de Iesso als segles I aC-II dC, *Arqueologia a Iesso (Guissona)* I, Miscel·lània, Guissona: Patronat d'Arqueologia de Guissona, 213-277.

- CELMA, M. 2008, *Paleoambient i explotació forestal del Dolmen de la Font dels Coms en època romana: Una aportació des de l'anàlisi antracològica.* Research work, Department of Prehistory, Universitat Autònoma de Barcelona.

- EUBA REMENTERIA, I. 2008, *Análisis antracológico de estructuras altimontanas en el Valle de la Vansa-Sierra del Cadi (Alt Urgell) y en el Valle del Madriu (Andorra): explotación de recursos forestales del neolítico a la época moderna*. Doctoral thesis, Department of History and Geography, Rovira i Virgili University, Tarragona. http://www.tdx.cat/TDX-1121108-124416.

- MEIGGS, R. 1985, *Trees and Timber in the Ancient Mediterranean World,* Oxford.

- PÈLACHS, A., SORIANO, J. M., ESTEBAN, A., PIQUÉ, R., MATAMALA, N. 2006, Antracología y palinología como herramientas complementarias para la caracterización de una perturbación en el Pirineo Central Catalán en época tardoromana. *III Congreso Español de Biogeografía/ Espainiako III. Biogeografia Biltzarra*, 134-138.

- PIQUÉ, R. 1999, *Producción y uso del combustible vegetal: una evaluación arqueológica*, Treballs d'etnoarqueologia 3, Universitat Autònoma de Barcelona, Consejo Superior de Investigaciones Científicas, Madrid.

- PIQUÉ, R., ROS, M.T., OLESTI, O. 2000, Análisis antracológicos y estudio territorial: primeros datos del período romano en Catalunya, T. ÑACO, O. OLESTI, A. PRIETO, (ed.) *Paleoenvironmental Analysis and Landscape Studies*, Barcelona: European Comisión, Cost Action G2, 87-100.

- RIERA MORA, S. 2006, Cambios vegetales holocenos en la región mediterránea de la Península Ibérica: ensayo de síntesis, *Ecosistemas* 15 (1), 17-30. http://www.revistaecosistemas.net

- RIERA, S., PALET, J.M. 2005, Aportaciones de la Palinología a la historia del paisaje mediterráneo: estudio de los sistemas de terrazas en las Sierras Litorales Catalanas desde la perspectiva de la Arqueología Ambiental y del Paisaje, S. RIERA, R. JULIÀ (eds.), *Transdisciplinary approach to a 8,000-yr history of land uses. 1st Workshop of Catalan Network for the Study of Cultural Landscapes and Environmental History*, Serie Monografías del SERP 5, 55-74.

- TEOFRASTO 1988, *Historia de las plantas,* Editorial Gredos, Madrid.