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BEYOND THE THEME

REVIEWS

Sabrina Bianco, Ethel Allué, Santiago Riera Mora,
Antoni Fernández, Mikel Soberón Rodríguez,
Carme Miró Alaix*

The evolution of wood fuel exploitation in the El Born Market site (Barcelona, Spain) during the 15th-18th centuries starting from charcoal analysis

Results from the wood charcoal analysis of a Medieval and Post-Medieval structure in the Barcelona city centre are presented. The anthracological assemblage reflects, plausibly, the fuel composition used in the site and informs us about the woodland exploitation during the period considered. Data reveal high percentages of oak species in almost all the sequence, except in the 16th century layers, which present shrubbier taxa. These evidences have been commented in the light of taxa ecology and available archival documents, which provide information about fuel imports and prices.
Keywords: anthracology, fuel supply, woodland exploitation, Early Modern period, Barcelona

Sono qui presentati i risultati dell'analisi antracologica di una struttura medievale e postmedievale rinvenuta nel centro di Barcellona. Il record antracologico riflette plausibilmente la composizione del combustibile usato nel sito e dà informazioni sullo sfruttamento delle risorse boschive nel periodo considerato. I dati riportano alte percentuali di specie di quercia in tutta la sequenza, ad eccezione degli strati di XVI secolo, che presentano tassoni più arbustivi. Queste evidenze sono commentate alla luce dell'ecologia e dei dati disponibili grazie alle fonti archivistiche, che danno informazioni sulle importazioni di combustibile e i relativi prezzi.
Parole chiave: *antracologia, fonti di combustibile, sfruttamento del bosco, prima età moderna, Barcellona*

1. Introduction

Woodlands for centuries played a central role in supplying human settlements for fuel and raw material for buildings, objects and tools. Hence, woodlands are considered essential for the development of all the societies before the 18th century. Fuelwood, above all, was the first woodland

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exploitation cause (Wing 2015, pp. 28-29), as it represented a basic human need for heating, cooking, melting or smoking material in domestic and manufacturing activities. As carbonization prevents the material degradation, charcoals are often very abundant in archaeological sites and they are a source of valuable information (Carrión 2005, p. 31). In detail, through anthracological analysis, it is possible to understand which trees were used in human settlements for different purposes. Moreover, the presence of one type of wood instead of another could subtend choices dictated by availability in the environment proximal to the site, qualities and convenience, and as well the socio-economic situation of the moment on both smaller and larger scale (Delhon 2018; Durand 2004).

Many anthracological studies on historical periods have been realized up today in the framework of multidisciplinary projects about historic landscapes, following the tradition of L. Fabre (1996), A. Durand (1998) and B. Davasse (2000), focusing, above all, on the charcoal kilns remains. These sites are of primary production of charcoal fuel, located either nearby or inside the woodland to be exploited (Montanari *et al.* 2002; Nelle 2003; Ludemann 2003; Euba 2009; Paradis-Grenouillet 2012, 2017; Deforce *et al.* 2013; Dupin *et al*. 2017, among others). However, investigations about fuel waste debris inside urban contexts during Medieval and Early Modern period are less abundant, at least in Catalonia (see among others Euba, Allué 2010; Vila Moreira, Piqué Huerta 2012 for Catalonia; Deforce 2017 for Belgium; cf. Mercuri *et al.* 2015 for Italy).

The site of the El Born Market (*Mercat del Born*), in the city centre of Barcelona, represents an excellent opportunity to develop anthracological studies on the 15th-18th centuries, very limited up to now, thanks to the particular attention given to the recovery of bioarchaeological remains during the last excavation campaigns (2016-2019). An urban context like this supposes a challenge for the interpretation of the anthracological diagram, due to the numerous agents that might have biased the record. In fact, in addition to the bias represented by the combustion and the depositional or post-depositional processes, the charcoal assemblage is particularly subjected to the "societal filter" (Théry-Parisot *et al.* 2010). Since an Early-Modern city requires most likely a systematic fuel management, the charcoal assemblage could have little paleoecological value, as it is the result of many selections that took place at the moment of cutting, trading, selling and finally buying the fuel inside the city (cf. Asouti, Austin 2005). The aim of this work is to discuss this idea through the study of the evolution of the fuel supply inside a house, located in the Born Market archaeological site. In detail, the composition in taxa of the anthracological assemblage and its variations will be presented and linked to which vegetation was exploited in the site. Subsequently, origins and prices of fuelwood will be analysed in the light of the information provided by the available archival sources.

2. Regional settings and site description

The site object of the study is located inside the city of Barcelona, which rises on the homonymous plain created, in its lower part, by the sedimentary action of the Besòs and Llobregat rivers during the Holocene (Riera Mora 1994; Julià Bruguès, Riera Mora 2014). According to Rivas Martínez *et al.* 2004, the region includes meso and thermo-Mediterranean environment.

Northward the Barcelona's plain, the Catalan Coastal Range follows the coast. This is delimited southward by the Garraf Massif, Collserola Mountain Range and Montnegre Mountain Range to the North-East, and it reaches the highest peak at 763 m.a.s.l. Vegetation of these ranges are dominated by *Quercetum ilicis galloprovinciale*, composed generally by *Quercus ilex* and a shrubby underwood of *Viburnum tinus*, *Rhamnus alaternus*, *Phillyrea latifolia*, *Arbutus unedo* and *Erica arborea*, among others. In this range it is possible to find sporadic associations of sub-mediterranean communities (*Violo-Quercetum fagineae* subass. *buxetosum* or *cerroidetosum)* (Bolòs 1962).

The southern part of Barcelona plain is characterized by calcareous substrates and the most common plant community is the *Querco-Lentiscetum,* composed by sclerophyllous shrubby species such as *Quercus coccifera, Olea europaea* var. *sylvestris*, *Pistacia lentiscus*, *Chamaerops humilis* and *Rhamnus lycioides.*

The Catalan Coastal Range is followed northward by the Catalan Pre-Coastal Depression and the Catalan Pre-Coastal Range, defined by the mountains of Montserrat, Sant Llorenç del Munt and Montseny. In the depression, it is common to find *Quercetum ilicis galloprovinciale*, whereas in the mountains semi-evergreen sclerophyllous woodland (*Quercetum rotundifoliae*) is prevalent, due to a more continental and drier climate. *Buxo-Quercetum pubescentis* and *Viburno-Quercetum ilicis* may also be present at this stage, the first composed mainly by *Quercus pubescens*, *Quercus ilex* ssp. *rotundifolia*, *Fagus sylvatica*, *Acer opalus*, *Pinus sylvestris*, *Buxus sempervirens*, *Prunus spinosa*, *Juniperus communis*, *Corylus avellana*, whereas the second, in less rainy areas, is formed by *Quercus faginea*, *Pinus nigra*, *Acer opalus*, *Pinus sylvestris* and *Buxus sempervirens* (fig. 1) (Bolòs 1962, 1957; Folch i Guillèn 1981; Riera Mora 1994; Allué 2002).

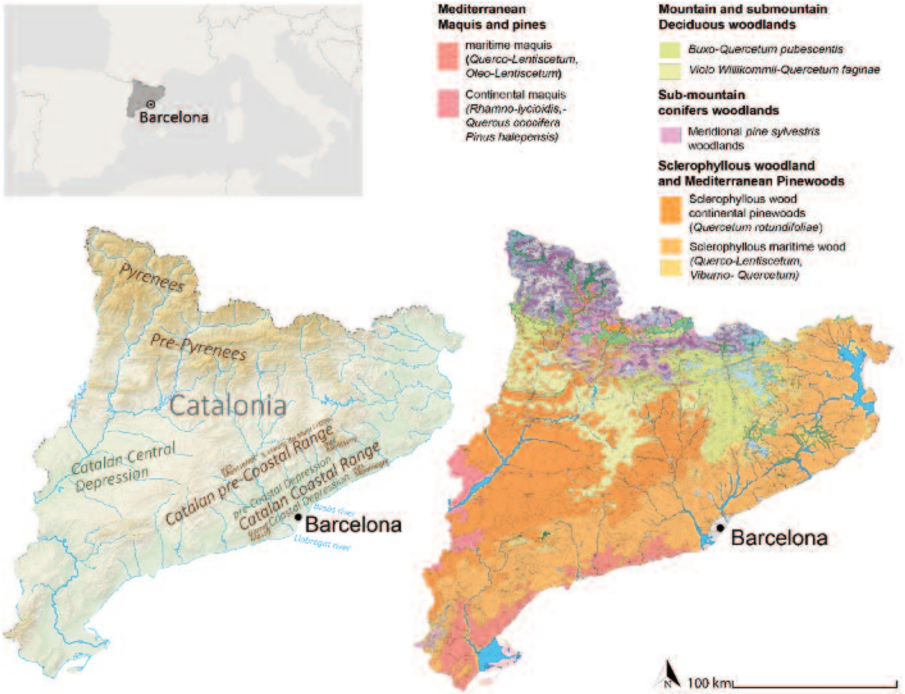

Fig. 1. Thematic maps of Catalonia. On the left, physical map with the main geomorphologic units (Institut Cartogràfic i Geològic de Catalunya, https://www.icgc.cat/, ri-elaborated by S. Bianco). On the right, map of the vegetation communities (from Bolòs *et al.* 2004, translated by S. Bianco).

Anyhow, in the area considered, these ecosystems are rarely in equilibrium and they are frequently affected by different factors such as fires, cutting, clearances or grazing. In Mediterranean woodlands, these disturbances often cause the retreat of the *Quercion* communities in favour of more sclerophyllous species which can both regenerate faster and adapt better in case of soil loss or prolonged droughts, as in the case of Mediterranean pines and shrubs like *Arbutus unedo* or *Erica arborea* (Folch i Guillèn 1981; Julià Bruguès, Riera Mora 2010).

El Born Market (*Mercat del Born*) site is located in the eastern part of the Old City (*Ciutat Vella*) district of Barcelona, in *La Ribera* neighbourhood (fig. 2). The archaeological site shows the evolution of this part of the city from the late Middle Ages to the Modern Period and is very peculiar for the "recent" chronology represented, the exceptional preservation and the large extension of the excavation.

Fig. 2. Barcelona city centre and localization of El Born Market site (Institut Cartogràfic i Geològic de Catalunya, https://www.icgc.cat/, ri-elaborated by S. Bianco).

This area was formed in Roman times due to an increase in the sedimentation rate of the Besòs river and since then, the coastline has changed considerably (Julià, Riera 2014). Up to the 13th century this part was still covered by littoral sands and used first by Christians, and then by Muslims as a necropolis (Beltrán de Heredia Bercero 2010, 2011). Subsequently, in the following century, urbanization began and continued as the sea receded, until this area became the new commercial and mercantile heart of Barcelona (Banks 1992; Guàrdia, Garcia Espuche 1992). The construction of an irrigation canal called *Rec Comtal* had a key role in the development of this part of the city. Besides being the engine of the mills and providing irrigation to the fields, it allowed to carry out many crafting activities which needed water, such as dyeing, tanning and forging metals (Guàrdia, Garcia Espuche 1992; Artigues Conesa, Fernández Espinosa 2014).

With the defeat of Barcelona at the end of the Spanish Succession War (1700-1714) and the Bourbons' rise of power, it was decided to build in the area of *La Ribera* neighbourhood a military fortress, called the Citadel (*La Ciutadella*) in 1717. The construction of a large pentagonal structure and an esplanade for military operations implied the demolition of about 1015 buildings for clearance, 17% of the total buildings of Barcelona at that time (García Espuche 2009) (fig. 3). To level off the topographical differences, in some depressed areas such as *El Born*, the

Fig. 3. Plan of Barcelona in 1717 with the area affected by the construction of the Citadel, a 17% of the city (from Artigues Conesa, Fernández Espinosa 2014).

walls of the buildings were maintained up to about 2 m of height and then they were covered with soil in order to flatten the area for the construction of the esplanade. Therefore, between 1718 and 1802, the area remained buried underground and nothing else was built above it, which allowed the preservation of the remains of the old structures. In 1869, the Citadel was demolished and replaced with a big park as well as a market, which remained functioning until 1971.

Extensive archaeological interventions have been carried out since 2001, under the iron structure of the old market, allowing to uncover around 8000 m^2 of the 18th century-Barcelona and, since 2013, the site has been accessible to the public as part of the current cultural centre *El Born Centre de Cultura i Memoria* (Artigues Conesa, Fernández Espinosa 2014) (fig. 4).

From 2015 up to the present, new archaeological interventions have been taking place inside the Born Market in order to investigate the stratigraphy under the 18th century layers for a better understanding of the neighbourhood's evolution through time (Fernández 2019).

In general, the last phases of the site are particularly well documented, thanks to the study of the archaeological remains, but also due to the very abundant written sources available for the Early Modern Period, i.e. notarial deeds, post-mortem inventories, marriage certificates, testaments, census, cadastres etc., that made possible the reconstruction of the economic, social and daily life of *El Born* neighbourhood's inhabitants (Garcia Espuche 2009).

Fig. 4. Current views of the archaeological site of El Born Market (S. Bianco).

The structure considered in this work, denominated Corrales's house, is located in the western part of the El Born Market site. This area was more dedicated to crafts and productive activities due to the possibility to exploit *Rec Comtal* water for different processes and to eliminate directly the waste (Garcia Espuche 2009; Artigues Conesa, Fernández Espinosa 2014) (fig. 5). Its name is due to the last owner of the parcel cited in the Bourbon cadastre of 1716, before the demolition of the neighbourhood. In detail, during the last phase of the site, the Corrales family owned 2 buildings in the block and, thanks to the retrospective analysis of the written sources, it is possible to obtain information about the tenants of the two houses from the beginning of the 17th century (García Espuche 2009). It is noteworthy that the building and more in general the block, was continuously owned or rented by members of the Viola strings producers (*Corders de Viola*) guild. From the second half of the 16th century, in fact, this profession was really popular and most of the products were exported, above all to England, passing by Cadis.

A *post-mortem* inventory, compiled in 1659, listed the instruments and tools to carry out this activity in the workshop on the ground floor of Corrales's house: two wood string tensors, two lathes to twist the strings and three jars for bleach (Garcia Espuche 2009, p. 175). However, these were only a few tools, because most of the work took place in *Casa dels Budells* (literally "The Guts house"), a space that was shared with other guild members near Rec Comtal and Llull square (Garcia Espuche 2009; Artigues Conesa, Fernández Espinosa 2014). Therefore, since only finishing works was supposed to take place in the house, the charcoal material studied in this work has been considered more as a result of domestic activities than as the viola strings manufacturing process (cf. Garcia Espuche *et al.* 2009).

Fig. 5. General plan of the ancient El Born neighbourhood with the position of Corrales's house highlighted in red (parcels n. 3 and n. 4); the rectangle represents El Born Market site (A. Fernández, S. Bianco).

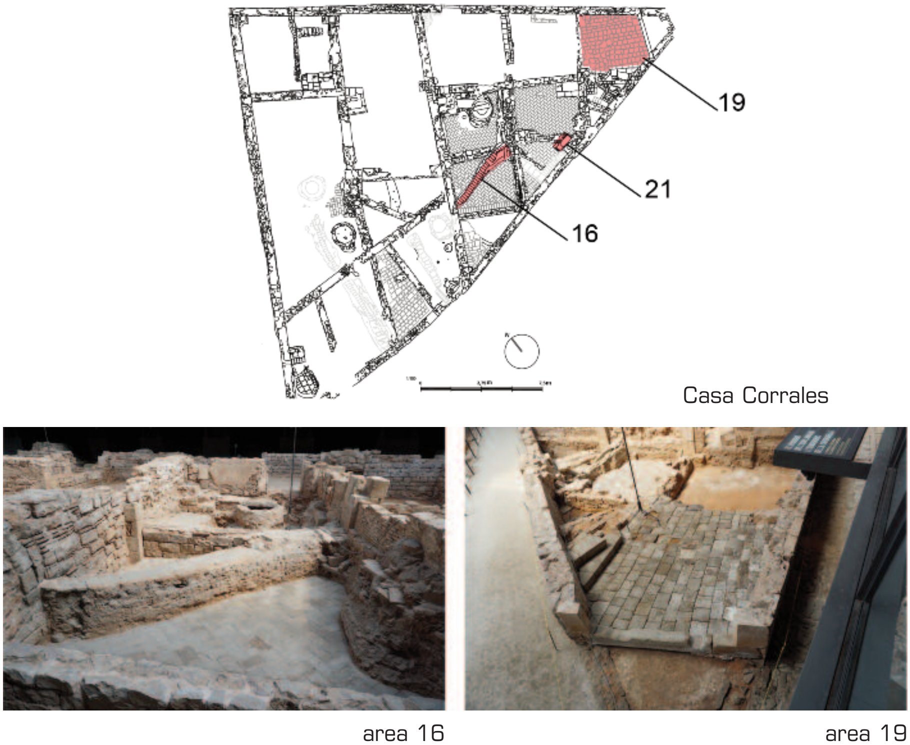

Fig. 6. Planimetry of Corrales's house with areas excavated during the archaeological intervention in 2016 highlighted in pink and photos of area 16 and 19 before the intervention (from Fernández 2019).

The building n. 4 was excavated in 2016 and the intervention focused on three rooms of the house, called area 16, 19 and 21 (fig. 6). In area 16, located in the south-west part of the plan, the excavation of 50 cm of stratigraphy was carried out at the base of two sewers that crossed the room diagonally, built in two different moments of the 17th century. The excavation reached the 14th century tile floor, partially exposed during the archaeological interventions in 2001-2002. In area 19, in the eastern part of the house, after disassembling the floor stone slabs of the 18th century, brought to light in 2001-2002, the excavation of 14 m^2 surface of the area was carried out and reached the base of the anthropic stratigraphy dated at the end of the 13th century. The only structures documented in this area were the remains of the staircase to reach the first floor, dated around the 1625, and the traces of a big coeval entrance door opened onto Na Rodés street. Area 21 is located in the southern part of the house, near area 16. The intervention here was only punctual and was limited to the excavation of the sediment that filled the sewer. This structure was in use until the 18th century and was related to the sewer in area 16; it allowed the outflow of the wastewaters in *Rec Comtal* (Fernández 2019).

3. Materials and methods

In Corrales's house, the recovery of charcoal and other archaeobotanical macroremains went through different phases. In the first place, a minimum of 40 litres of sediment for every Stratigraphic Unit (S.U.) was collected during fieldwork, when available. Subsequently, manual flotation was carried out to extract the bioarchaeological macroremains, pouring the less dense material on a column of sieves with mesh size of 2, 1, o,5 and 0,25 mm (Buxó, Piqué 2003). Once dried under environmental conditions, the samples were sorted with the help of a binocular loupe. Afterwards, due to the large amount of charcoal material collected, it was necessary to select a group of the most representative S.U. for the analysis. In the first place, material from dwelling surfaces was preferred, when present, and subsequently some levelling layers and sewer's fillings of different chronologies were chosen to complete the anthracological sequence. A total of fourteen S.U. were used in this work: five S.U. have been taken in consideration in the area 16 (S.U. 1961, 1964, 1988, 10007, 10014), eight S.U. in the area 19 (S.U. 1955, 1994, 10016, 10044, 10048, 10061, 10074, 10075) and one S.U. has been considered in the area 21 (S.U. 1972) (fig. 7). These units have been grouped in 8 chronological phases, according to the interpretations given in the intervention report and their chronology (Fernández 2019), as summarized in fig. 8. Almost all the S.U. considered contained dispersed charcoal fragments, which are supposed to be the result of a long-term accumulation of fuel waste. Dispersed charcoals are considered more representative for the anthracological analysis than concentred charcoals, which are normally associated to combustion structures and represent only the last burning events (Chabal *et al.* 1999). In the record analysed, none of the S.U. were associated to combustion structures (not present at all in Corrales's house), although S.U. 10044 and 10074 were composed principally by ashes and charred organic material.

Taxonomical identification was carried out by fragmenting by hand each charcoal in three sections (transverse, radial and tangential) and

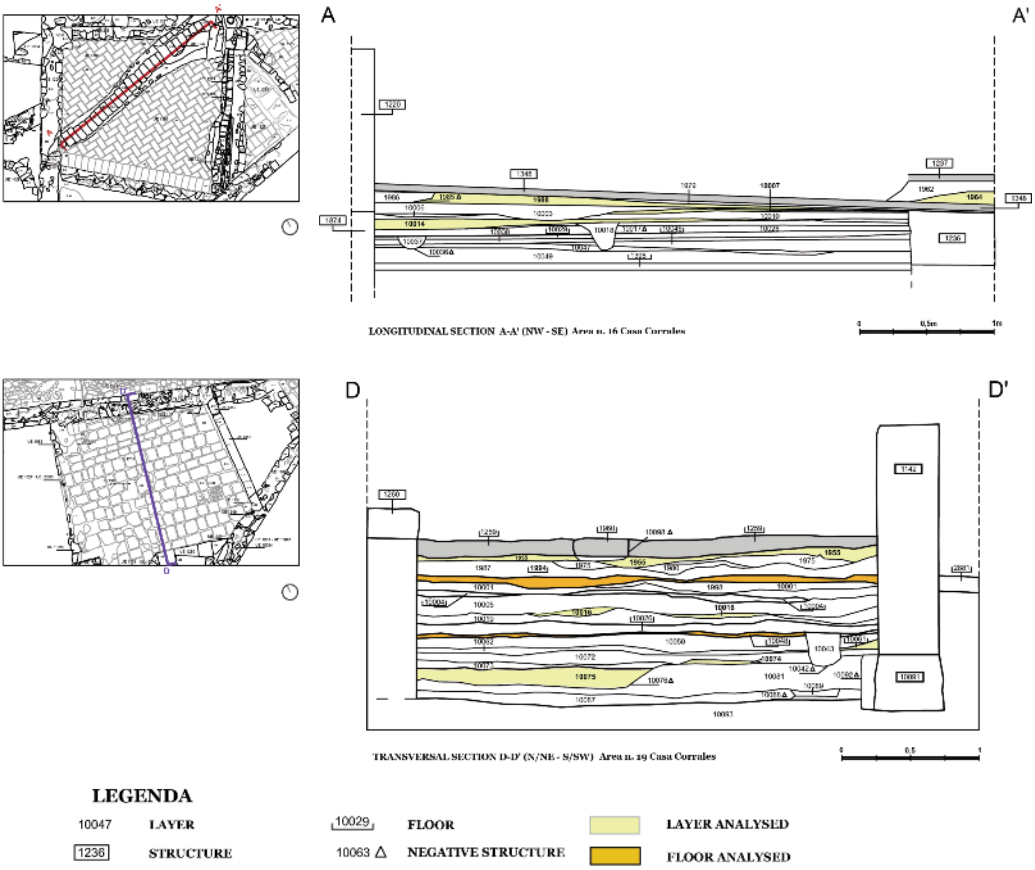

Fig. 7. Sections of area 16 (above) and area 19 (below) with the stratigraphic units (S.U.) analysed in this study highlighted in yellow and orange (from Fernández 2019, ri-elaborated by S. Bianco).

by observing the anatomical characteristics with the dark/bright field reflected light microscope Olympus BX41 at 50x, 200x, 500x magnifications. Moreover, the determination was supported with a reference collection, the wood anatomy atlas (Schweingruber 1990) and the InsideWood project database, available online (https://insidewood.lib.ncsu.edu).

In the charcoal analysis, most of the times, genus and family can be identified. However, it is less often possible to determine the species. It depends, among other reasons, on the species variability inside a genus or family, on the preservation of the material, its alteration status and

Stratigraphic Unit	Composition	Area	Interpretation	Chronology	Phase
10075	clayey texture with presence of mortar, ceramics, metals and a big quantity of charcoals.	19	floor	mid c. 15th	1
10074	charred organic material and ashes	19	levelling layer	mid c. 15th	
10061	brittle clayey texture with presence of mortar	19	floor	second half of c. 15th	2
10048	clayey texture with presence of mortar, constructive material, ceramic, charred organic materials and faunal remains	19	floor	second half of c. 15th	
10044	ashes	19	levelling layer	beginning of c. 16th	3
10014	brittle clayey texture with presence of charcoals, constructive materials, mortar, plaster, and ceramic materials	16	levelling layer	first half of the c. 16th	
10016	compact clayey texture with presence of charred organic material, ashes, faunal remains, constructive materials, ceramic and metals.	19	levelling layer	first half of the c. 16th	4
10007	compact clayey texture with presence of faunal remains, ceramic materials and charcoals	16	levelling layer	second half of c. 16th	5
1994	clayey texture and presence of faunal remains, lot of charred organic material, ashes, ceramic materials metals and mortar	19	floor	end of c. 16th	6
1988	compact clay texture, rich in ashes and charcoal. Presence of ceramic material	16	levelling layer	end of c. 16th	
1955	brittle clay-sandy texture, heterogeneous composition with presence of malacofaunal and faunal remains, charcoals, ceramic materials, a coin, other metal fragments and mortar	19	floor preparation layer	mid c. 17th	7
1964	brittle silty texture and presence of ceramic materials, one iron fragment, one coin, bones, malacofaunal and charcoal remains	16	filling layer of the sewer (S.U. 1348)	beginning of the c. 18th	8
1961	sandy brittle texture with presence of ceramic materials and charcoal	16	levelling layer	beginning of the c. 18th	
1972	sandy texture with presence of little stones, ceramic, constructive material, charcoals and faunal remains	21	filling layer of the sewer (S.U. 1385-1386)	beginning of the c. 18th	

Fig. 8. Table which summarizes the information about the selected stratigraphic units (S.U.) and their chronology. Phases have been arbitrarily decided for the aim of this work, based on stratigraphy and chronology.

on the size of the charcoal fragments. The results are then shown through different identification categories (family, genus, cf., type and, occasionally, species) (cf. Alcolea Gracia 2017) and quantification is based on the number of fragments (Chabal 1988; Chabal *et al.* 1999). In the case of oak, heath and pine, sometimes species or types were impossible to determine, and therefore they were treated separately. Due to the great preservation state of the record, only fragments larger than 4 mm have been considered and for each S.U., variable quantities of them have been studied, on the base of material availability and time. Finally, saturation curves have been built for each sample to verify the result reliability (Chabal 1988, 1992).

By contrast, wood anatomy alterations as vitrification, shrinkage cracks, attacks of fungi or xylophagous animals, as well as growth ring size and minimum diameter of the initial wood (cf. Castelletti 1990) have not been included in this article because further developments and a specific discussions on the topic are needed.

4. Results

The study of 2336 charcoal fragments from the selected S.U. has yielded 23 different taxa (fig. 9). In general, in terms of variability, it ranges between 6 to 11 taxa for S.U., independently from chronology and the area considered. In addition, 220 fragments have been excluded from the analysis because they did not present enough anatomical characteristics to allow a determination.

It is noteworthy that *Quercus* sp. evergreen resulted the most abundant taxon (51,3% of the total), followed by *Arbutus unedo* (strawberry tree) with 15,2%, *Quercus* sp. deciduous (*Q. humilis*, *Q. faginea*, *Q. petraea* and *Q. cerrioides,* according to Burriel *et al.* 2000) with 11,6%, *Pinus halepensis* (Aleppo pine) with 9,1% and by *Erica* type *arborea* (tree heath) with 7,4%. As showed in the fig. 10, these taxa are present in almost all the S.U. Other taxa are present only in some of the layers and appear generally with very low percentages, such as other Mediterranean pines (*Pinus* cf. *pinea*, *Pinus* cf. *pinaster*, *Pinus* type small pits), Mountain pines (*Pinus* type *sylvestris*), *Corylus avellana* (hazels), *Populus* (poplar), *Salix* (willow), *Alnus* (alder), *Fagus sylvatica* (beech), Liliaceae type *Smilax* (lily family), *Rhamus alaternus*/*Phillyrea* (buckthorn/privets) *Ficus carica* (fig tree), *Cistus* (rockroses), *Olea europaea* (Olive), Fabaceae (legumes), *Vitis vinifera* (vine), *Prunus* (plums), *Punica granatum* (pomegranate), Maloideae (pomes).

	Phase 8						Phase 7		Phase 6				Phase 5		Phase 4		Phase 3				Phase 2				Phase 1				
	S.U.1972		S.U.1961		S.U.1964		S.U.1955		S.U.1988		S.U.1994		S.U.10007		S.U.10016		S.U.10014		S.U.10044		S.U.10048		S.U.10061		S.U.10074		S.U.10075		Total
Taxa	N.	(%)	N.	(%)	N.	(%)	N.	(%)	N.	(%)	N.	(%)	N.	(%)	N.	(%)	N.	(%)	N.	(%)	N.	(%)	N.	(%)	N.	(%)	N.	(%)	N.
Alnus sp.			1	0,60													1	0,56							1	0,43			3
Arbutus unedo	2	1,72			16	6,64	12	12,37	41	17,30	27	11,79	6	11,76	15	6,49	89	50,28	66	30,84	20	9,76	21	21,43	25	10,68	16	41,03	356
Cistus sp.											2	0,87																	2
Corylus avellana																					4	1,95							4
Erica sp.					1	0,41	1	1,03			1	0,44	1	1,96															4
Erica type *arborea*	2	1,72	4	2,40	5	2,07	2	2,06	14	5,91	12	5,24	14	27,45	9	3,90	27	15,25	60	28,04	5	2,44	4	4,08	2	0,85	13	33,33	173
Fagus sylvatica									2	0,84																			2
Ficus carica													1	1,96															1
Fabaceae			1	0,60																									1
Liliaceae type *Smilax*																			1	0,47									1
Maloideae																											1	2,56	1
Olea europaea									5	2,11							1	0,56	1	0,47			1	1,02	1	0,43	1	2,56	10
Pinus cf. *pinaster*	1	0,86																											1
Pinus cf. *pinea*					2	0,83									3	1,30					1	0,49	1	1,02					7
Pinus halepensis	35	30,17	4	2,40	10	4,15	3	3,09	3	1,27	6	2,62			136	58,87	1	0,56	10	4,67	4	1,95					1	2,56	213
Pinus sp.							1	1,03							1	0,43			1	0,47									3
Pinus sp. type small pits					1	0,41			1	0,42	1	0,44			4	1,73	2	1,13	1	0,47									10
Pinus type *sylvestris*	5	4,31			1	0,41									1	0,43	1	0,56			1	0,49							9
Populus sp.	10						1	1,03									1	0,56											12
Prunus sp.																			1	0,47	2	0,98	1	1,02			1	2,56	5
Punica granatum																					1	0,49	1	1,02					2
Quercus sp.	4	3,45	6	3,59	2	0,83			1	0,42	2	0,87	3	5,88			3	1,69	1	0,47	1	0,49			6	2,56			32
Quercus sp. *deciduous*	7	6,03	5	2,99	48	19,92	12	12,37	13	5,49	26	11,35	6	11,76	8	3,46	8	4,52	4	1,87	43	20,98	30	30,61	60	25,64	1	2,56	271
Quercus sp. *evergreen*	49	42,24	146	87,43	155	64,32	65	67,01	156	65,82	152	66,38	19	37,25	50	21,65	43	24,29	63	29,44	119	58,05	39	39,80	139	59,40	3	7,69	1198
Rhamnus alaternus/Phillyrea									1	0,42			1	1,96					5	2,34	3	1,46					1	2,56	11
Salix sp.	1	0,86																			1	0,49					1	2,56	3
Vitis vinifera															1	0,43													1
Total	116		167		241		97		237		229		51		231		177		214		205		98		234		39		2336
Bark	3	2,50			2	0,80	2	1,98			9	3,60	2	3,39			7	3,33	1	0,45	4	1,60	2	1,96			1	2,27	33
Cf. *Arbutus unedo*									1	0,40																			1
Cf. *Erica* sp.																	1	0,48	1	0,45	1	0,40							3
Cf. *Punica granatum*																			1	0,45									1
Cf. *Quercus* sp.															1	0,40	1	0,48											2
Cf. *Quercus* sp. evergreen									1	0,40																			1
Undeterminable	1	0,83	30	14,85	4	1,60	2	1,98	10	4,02	11	4,40	5	8,47	14	5,65	20	9,52			37	14,80	2	1,96	14	5,60			150
Undeterminable type *Erica* sp.																									1	0,40			1
Undeterminable type *Laurus* sp.																	2	0,95											2
Undetermined			5	2,48	3	1,20					1	0,40	1	1,69	2	0,81	2	0,95	4	1,81	3	1,20			1	0,40	4	9,09	26
Subtotal	120		202		250		101		249		250		59		248		210		221		250		102		250		44		2556

4.1. Description of the anthracological phases

Phase 1 (1450 A.D.)

It groups the S.U. 10075 and S.U. 10074. In the first unit, *Arbutus unedo* (41,1%) and *Erica* type *arborea* (33,3%) are the most abundant taxa, followed by a scarcer presence of *Quercus* sp. *evergreen* (7,7%), whereas in S.U. 10074 *Quercus* sp. evergreen reaches the 59,4%, *Quercus* sp. deciduous the 25,6% and *Arbutus unedo* only the 10,7%.

Phase 2 (1450-1500 A.D.)

This phase includes the S.U. 10061 and 10048, which present roughly the same trend. In both units, in fact, *Quercus* sp. evergreen and *Quercus* sp. deciduous are the most frequent taxa, followed by *Arbutus unedo*.

Phase 3 (1500 A.D.)

This phase groups the S.U. 10044 and 10014. In the first layer, *Arbutus unedo* (30,8%), *Quercus* sp. evergreen (29,4%) and *Erica* type *arborea* (28%) are the most important taxa, followed by a littler presence of *Pinus halepensis* (4,7%). In the second S.U. *Arbutus unedo* is more abundant (50,3%) and *Erica* type *arborea* is scarcer (15,3%).

Phase 4 (1525-1550 A.D.)

It is represented by the S.U. 10016, which accounts a high presence of *Pinus halepensis* (58,9%), followed by littler percentages of *Quercus* sp. evergreen (21,7%) and *Arbutus unedo* (6,5%).

Phase 5 (1550-1600 A.D.)

It is characterized by the S.U. 10007, which shows a good presence of *Quercus* sp. evergreen (37,3%), *Erica* type *arborea* (27,4%) and the same quantity of *Arbutus unedo* and *Quercus* sp. deciduous (11,8%).

Phase 6 (1600 A.D.)

It is represented by the S.U. 1994 and 1988 which have similar trends. In the first unit, *Quercus* sp. evergreen's presence grows considerably (66,4%) compared to the previous phase, followed by *Arbutus unedo* (11,8%) and *Quercus* sp. deciduous (11,4%).

Fig. 9. Results of the charcoal analysis. Quantification of identified taxa are expressed in number of fragments (N.) and percentage (%) on the total identified charcoal in the S.U. (whereas the % of unidentified fragments are calculated on the total fragments considered in each S.U.).

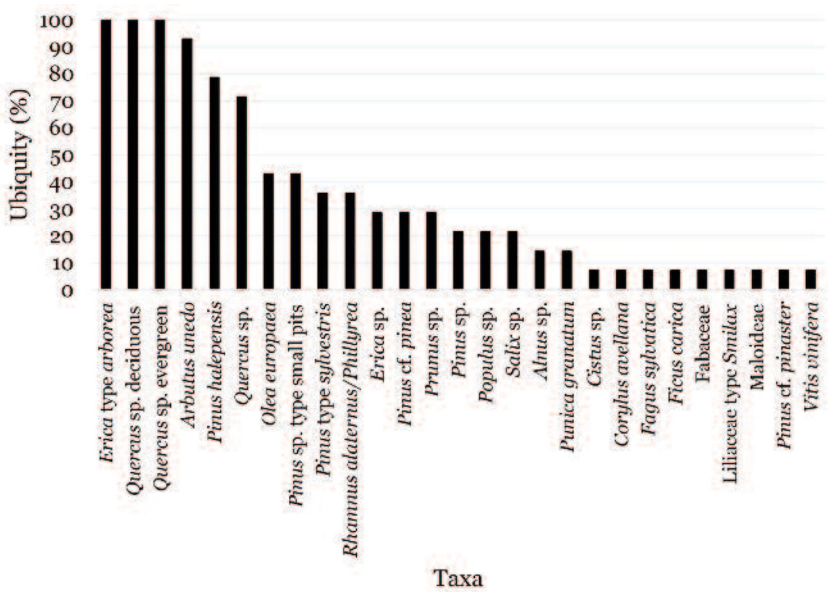

Fig. 10. Diagram of taxa ubiquity inside the record analysed (100% represents the presence of the taxon in all the 14 S.U.).

Phase 7 (1625-1655 A.D.)

Represented by the S.U. 1955, it shows again a great presence of *Quercus* sp. evergreen (67%), followed by the same percentage of *Quercus* sp. deciduous and *Arbutus unedo* (12,3%).

Phase 8 (1700-1717 A.D.)

This phase groups the S.U. 1964, 1961 and 1972, all dated to the last use period of the structure. S.U. 1964 and 1961 are characterized by a high presence of *Quercus* sp. evergreen (64% and 87%), whereas S.U. 1972 presents scarcer percentages of *Quercus* sp. evergreen (42,3%) and a higher presence of *Pinus halepensis* (30,8%). This unit presents also 8,6% of *Populus* and 4,3% of *Pinus* type *sylvestris*.

Overall, according to the fig. 11, in the first two phases *Quercus* sp. evergreen and deciduous are the most present taxa, except for S.U. 10075. Therefore, it seems that an important decrease of *Quercus* species percentages occurs for the phases 3-5, which cover the 16th century, in favour of shrubby taxa such as *Arbutus unedo* and *Erica* type *arborea*. Moreover, the only S.U. considered for the Phase 4 presents a very high presence of Aleppo pine charcoal fragments. Finally, in the

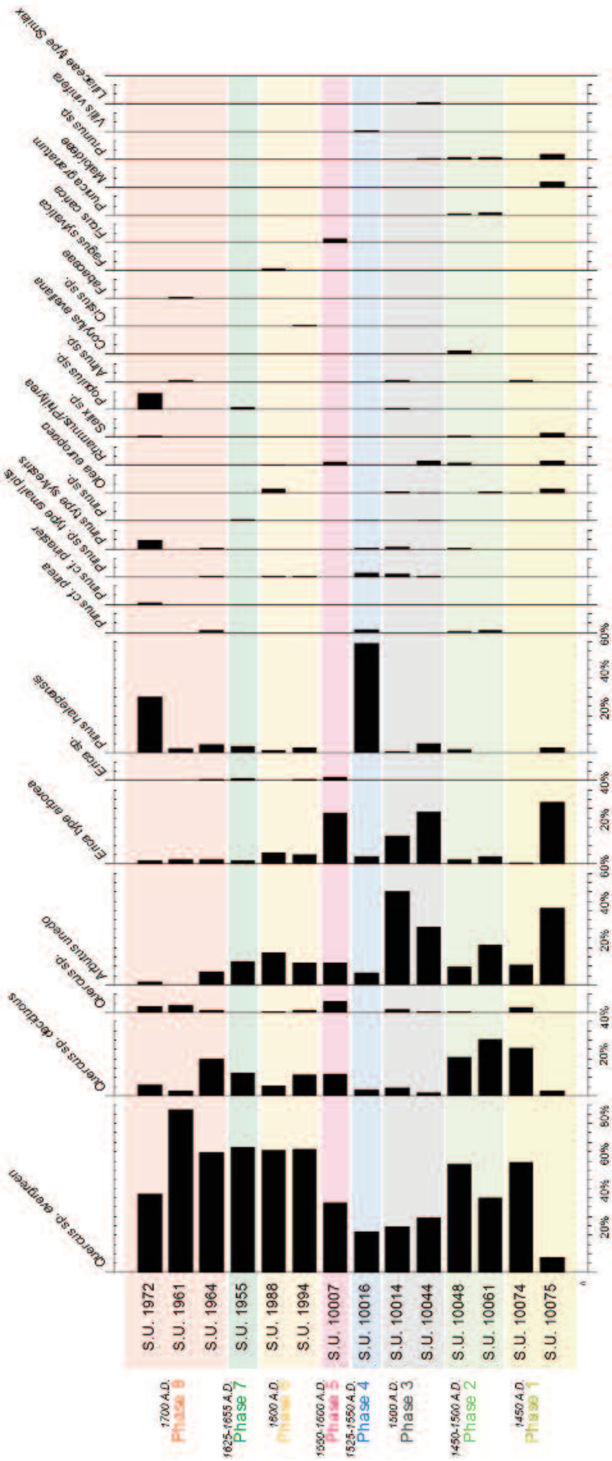

Fig. 11. Anthracological diagram of Corrales's house.

phases 6-8, *Quercus* sp. evergreen increases again (more than 60 %), *Arbutus unedo* decreases and *Erica* type *arborea* almost disappears from the record (above all in the last two phases). S.U. 1972 presents a slightly different trend, with a good proportion of *Pinus halepensis* fragments and less fragments of *Quercus* sp. evergreen than the other units of the same phase. However, it should be noted that S.U. 1972 comes from the filling of the sewer in the area 21, so probably it could have had different formation processes than the others S.U. from area 16.

5. Discussion

5.1. The vegetation types represented in the charcoal assemblage

The results obtained from the anthracological analysis suggest that in Corrales's house, during the period considered, people were exploiting different types of fuel coming mainly from sclerophyllous woodlands (*Quercetum ilicis galloprovinciale*). In fact, the taxa which refer to this type of vegetation in the record are mainly *Quercus* sp. evergreen, *Arbutus unedo*, *Erica* type arborea, *Pinus halepensis*, *Pinus* cf. *pinea*, *Pinus* cf. *pinaster, Pinus* sp. type small pits, *Cistus* and *Rhamnus alaternus/ Phillyrea*, which together represent 87% of the total fragments considered. *Querco-Lentiscetum* community does not appear reflected in the assemblage and in fact, *Olea europaea* is very scarce (0,43%) and *Pistacia lentiscus* is absolutely absent, although they were supposedly abundant species in the southern Garraf Massif areas (Folch 1981).

Other taxa identified are typical of middle-mountain deciduous woodland, such as *Quercus* sp. deciduous, *Fagus sylvatica*, *Corylus avellana* and *Prunus*. However, *Quercus* sp. deciduous, which is the most abundant taxa in this group, may also be found in mixed oak forests with *Quercus* sp. evergreen, *Erica* and *Arbutus* in shady and moist areas. Taxa such as *Alnus*, *Populus* and *Salix,* present in very low percentages, grow mostly in riparian woodlands, which are developed either near water courses or humid areas. *Pinus* type *sylvestris* (mountain pines) could be found in the mountain conifers woodlands, typical in inland regions and pre-Pyrenees, but as well in the pre-Coastal Range, between 400-700 m a.s.l., sharing space with oaks. Finally, the record presents a low presence of taxa which probably came from either orchards or cultivated areas, such as *Vitis vinifera*, *Punica granatum*, Maloideae, as well as *Corylus avellana*, *Ficus carica*, *Prunus* and *Olea europaea.* According to García Espuche (2008), in fact, it seems that the area at least in the

17th century was characterized by many orchards and gardens which exploited the *Rec Comtal* water. Moreover, there are documents from the Crown of Aragon Archive (Barcelona) indicating that, in addition, Corrales's house had also courtyard with trees[1]. It is reasonable that people occasionally exploited branches or pruning remains of these cultivated fruit trees as fuel.

5.2. The fuelwood in Corrales's house

In general, the dominance of *Quercus* sp. evergreen along the whole sequence, excluded the 16th century, is noteworthy, because it could indicate a high selection of the wood material at the time of cutting and purchasing the product inside the city. In fact, it is agreed that the evermore intense human activities in this area of Catalonia lead to a dramatic reduction of oak species, which were exploited for centuries either as fuel or building material. Woodland degradation processes were common since the Roman times and involved, beside the general reduction of the forest canopy, the increase of Aleppo pines and xerophilous shrubs at the expenses of oak woodlands (Riera Mora 1994; Riera Mora, Esteban Amat 1994; Julià Bruguès, Riera Mora 2010). Deforestation increased between the 7th-9th centuries with the conversion of many woodlands into pastures, proven by the high presence of charcoal, shrubs and pyrophytic taxa in pollen diagrams, but by the higher sedimentation rate of the Llobregat and Besòs rivers as well (Julià Bruguès, Riera Mora 2010; Riera Mora, Esteban Amat 1994). The growing demand of forest products is a *leitmotiv* for the Late Middle Ages and the Early Modern Period, to feed the numerous metal forges, domestic heating and other productive activities, as well as being exploited for navy and infrastructure construction (Costa *et al.* 2007, pp. 112-122; Wing 2015, pp. 1-25).

For these reasons, it is believed that the results of this charcoal analysis are not necessarily the reflection of the vegetation around the site but seem instead more the consequence of a targeted exploitation of different woodlands in order to obtain a specific firewood.

Regarding the last phases of fig. 12, our results agree with the anthracological study carried out in El Born in 2005 (Allué, Euba 2005). In fact, in this occasion 355 charcoal fragments from the 17th-18th centuries layers from different sectors were analysed, discovering that *Quercus* sp. evergreen was the dominant taxon in all the S.U. considered, followed by *Quercus* sp. deciduous and *Arbutus unedo*. Despite the

[1] ACA (*Arxiu de la Corona d'Aragó*), *Plets civils* 25192; p. 1.

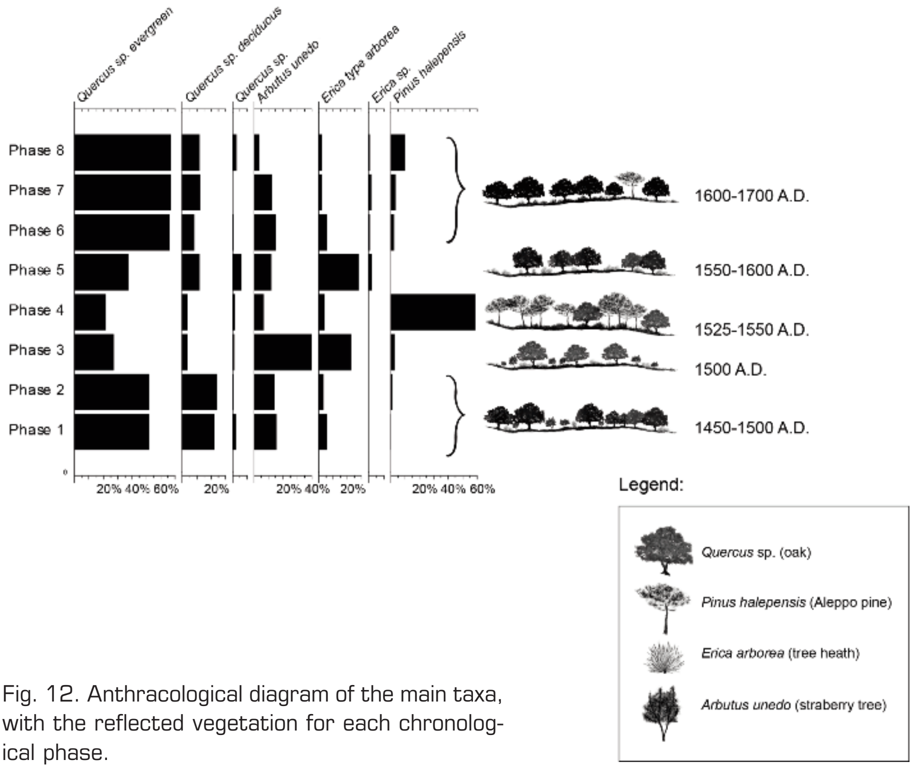

Fig. 12. Anthracological diagram of the main taxa, with the reflected vegetation for each chronological phase.

low number of fragments analysed in that occasion, it seems that during this period, the predominant use of oak fuel was common in the whole area of the El Born Market.

However, the scarce or statistical non-reliable anthracological analyses regarding this chronology which was carried out in other areas of Barcelona city, mostly unpublished (Caruso Fermé, Piqué Huerta 2012; López Bultó 2018 among others), do not allow us to make solid comparisons from a synchronic perspective.

The decrease in *Quercus* species usage during the 16th century (phases 3-5 in fig. 12), in favour of shrubbier taxa, represents a detachable change in the fuel type exploitation inside the house for different reasons which can be discussed. According to the archaeological interpretations, it is agreed that during this century the house suffered various structural modifications, which involved the construction of the sewer (Fernández 2019). Probably, this is the result of a change in the house tenants which could have affected the functionality of some spaces and therefore, the usage of a different kind fuel. Moreover, the anthracological diagram could be highlighting a period of more general changes in the wood trades, prices and economy of the city. In general, Barcelona showed the decrease of its importance in the European context in the 16th century, as well as a reduction in the urbanization rate, in comparison with the previous centuries (Guàrdia, Espuche 1992; Torres Sans 1992). Furthermore, two big plague infections (year 1530: ~6100 deaths, year 1589: ~11700 deaths on a population of around 32.000 people) caused demographic contraction that could have affected the quality of life and trades (Simon, Andreu 1992).

From another point of view, since the material analysed was not directly associated with any combustion structure and it was part of extended floors and levelling layers, it might also be plausible to consider that it came from outside instead of being produced directly inside Corrales's house. In fact, it was common, during these chronologies, to use charcoal waste as an insulator and often it was recycled material from metal forges, called *cagaferro* in Catalan (Garcia Espuche 2005, p. 30). However, only further anthracological analyses and comparisons in different structures of the El Born Market will help to shed a light on this aspect.

5.3. The contribution of written sources: fuelwood origins and prices

From the analysis of the written sources available, it is known that Barcelona was not self-sufficient in terms of forest products and strongly depended on trades with the surrounding areas in 15th century. Fuelwood and building material were transported to the city in large quantities by the sea, through cabotage navigation along the plain littoral (Ferrer i Mallol 1990; Soberón 2017). This is evidenced by the analysis of the registers of the "Port anchoring right" (*Dret d'ancoratge,* in Catalan), a tax in force since June 1439, on all ships and vessels that anchored the port, calculated proportionally to their cargo capacity. The registers, in different states of preservation depending on the year, reported daily, from 1439 to 1550, the types of boat that entered the port, registering the name of the owner, boat tonnage and the port of origin. Except for the first few months, the registers normally did not list the content of the boats, although it is now possible to identify those that transported fuelwood because they had a discount of 25% (reported in the register) on the tax (Soberón 2017). Therefore, this document is very valuable in order to understand the main fuel supply areas of the time and to quantify the incoming material. *De facto*, it has been calcu-

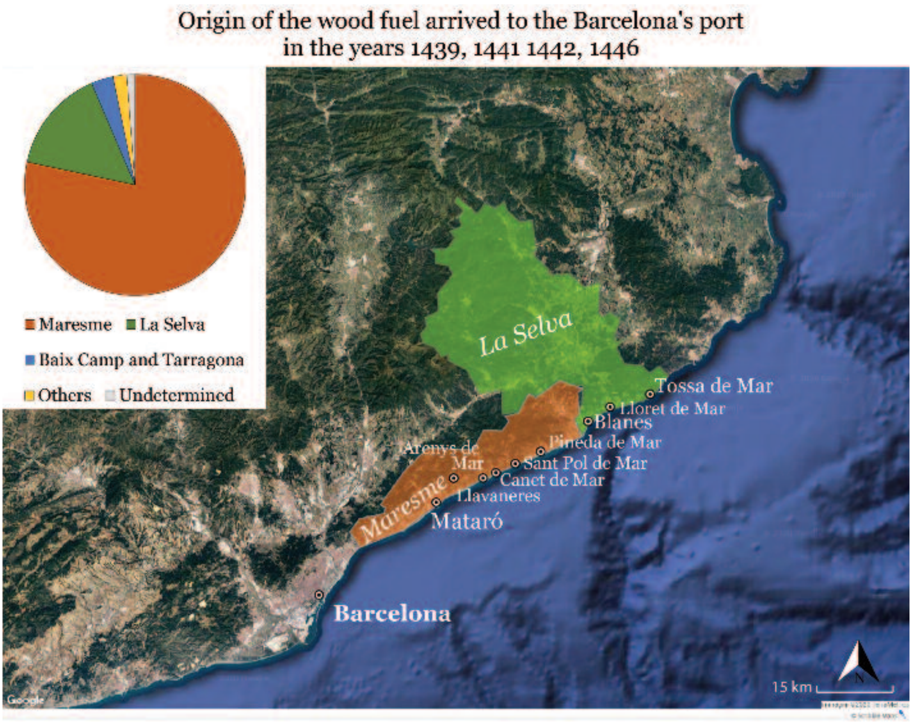

Fig. 13. Percentages of wood fuel that entered the Barcelona's port for supply area, calculated on the years 1439, 1441, 1442, 1446 (from Soberón 2017) and localization of the main wood fuel supply centres (Scribble Maps pro, https://www.scribblemaps.com/, elaborated by S. Bianco).

lated that, during the years 1429, 1441, 1442 and 1446, a 23% of the boats which entered the port were carrying woodfuel, which represented 20% of the whole unloaded materials (Soberón 2017). In particular, 75% of the whole fuel which entered the port in these four years came from the Maresme area, while the rest arrived from La Selva (15%), Baix Camp and Tarragona's area (3,22%) and in lower quantities from other or undetermined ports (fig. 13).

Maresme is the area between Turó de Montgat and Tordera, formed by about 20 supplying centres, out of which Mataró, Pineda, Arenys, Sant Pol, Canet and Llavaneres were the most important and productive ones; while the main centres in La Selva were Blanes, Lloret and Tossa.

Although the estimation is indicative, because it depends on the number of month-registers preserved for each year, the trend seems to be maintained also for the following years until at least 1520 (Soberón, pers. comm.).

Prices for year (*diners/quintar*)

FIREWOOD	1458[1]	1465[2]	1475[3]	1493[4]	1553[5]
Quercus sp. evergreen			10	11	18
Quercus sp. deciduous					18
Arbutus unedo	9		9	9	16
Pinus sp.		10			14
Erica arborea					14

CHARCOAL	1517[5]
Quercus sp. evergreen	20
Pinus sp.	7
Erica arborea	12

[1] *Despeses per una fogera a la plaja*, Obreria 1CXIV-6, 19v.
[2] *Compra de 40 quintars de llenya de pi per cremar quatre sodomites.* 33 s i 4 d. ACA, MR, Receptor d'emoluments, 1744, 19v.
[3] AHCB Reg delib, 1BII.22, 187v.
[4] AHCB Reg delib, 1BII.31, 122r.
[5] Bajet 1993, pp. 305, 311-312.

Fig. 14. Approximative prices expressed in *diners* for *quintar* of different firewood and charcoal types starting from various archival sources (ACA: *Arxiu de la Corona d'Aragó*; AHCB: *Arxiu Històric de la Ciutat de Barcelona*). Measures have been converted on the base of Riu 1996 (elaborated by M. Soberón Rodríguez and S. Bianco).

These areas are generally characterized by a sclerophyllous maritime woodland, with species typical of *Quercetum ilicis galloprovinciale* (dominated by *Quercus ilex)* (see fig. 1)*. Pinus pinea* is also widespread, whereas *Quercus suber* grows mainly on siliceous substrates in some areas of La Selva coast. Furthermore, although *Quercus petraea* nowadays is scarcely present in these areas, it was supposed to be more abundant in the past (Vilar i Sais 1987; Bolòs *et al.* 2004).

According to the *Libres de la Mostassafia* (version of the year 1560), a collection of laws and regulations on manufacturing, trades and services of the city, wood fuel was considered an essential good and the government guaranteed low prices and limited the resale. Charcoal was considered even more precious, and, from 1393, it was forbidden to export it or to take it out of the city (Bajet 1993, pp. 304-312). The prices of pine and heath charcoal, used in productive activities, were established by law to 10 *diners* for one *sarrio* of pine charcoal (the half of a *càrrega*, ~62,1 kg), and 2 *sous* for one *sac* of heath charcoal (i.e. 24 *diners* for ~85-90 kg) (Riu 1996; Bajet 1993, pp. 309-312). The price of evergreen oak charcoal was 20 *diners* for *quintar* (41,6 kg), almost twice as much as the price of heath charcoal (Riu 1996; Bajet 1993, pp. 305, 311-312). Moreover, the document lists the official prices of firewood at the 16th century: 18 *diners* for *quintar* for evergreen/deciduous oak and olive tree, 16 *diners* for *quintar* for strawberry tree, and 14 *diners* for *quintars* for pine wood (Bajet 1993, pp. 304-309). However, these values result inexplicably higher than the ones extrapolated from different archival sources concerning the previous century, as summarized in fig. 14.

The unloading and sale areas were strictly regulated as well. It is known that all the wood fuel that entered through the port was deposited near the *Torre Nova*, between Palau square and Marquès de l'Argentera street (Pujades *et al.* in press), at least from the 14th to the 16th century (Bajet 1993, pp. 304-309).

Wood transported by land was officially weighed at Llull square or near Boquería market along *La Rambla* and then sold in dedicated public squares. Moreover, wood which came from the sea had to be weighed and sold in the Ribera neighbourhood and sellers trading outside the official places had to impose a discount of 1 *diner* for *quintar* (Bajet 1993, pp. 304-309).

5.4. Firewood or charcoal?

Fuel was obtained both burning charcoal and firewood and these were considered different products with different prices, uses and often different areas of origin.

According to Soberón (2017), who studied the first registers of the anchoring right dated to 1439 (when some goods transported by boats were listed), the area of La Selva was mostly dedicated to the production and selling of charcoal as fuel; this seems confirmed also by the study of the Tossa export activity (Zucchitello 1991). Mainly two type of charcoal were produced here, one for domestic use, called *carbó de fum* or *carbó de foc* (smoke charcoal or fire charcoal), and another for industrial activities (above all metallurgy) called *carbó de ferrer* (blacksmith charcoal). For the first type, oak species were preferred, whereas the second was produced mostly using wood from pines or strawberry trees (Zucchitello 1991). In general, as this distinction implies different economic values and trades, it could be interesting to distinguish charcoal produced from charcoal burning, and charcoal generated from firewood. However, during anthracological analysis, this distinction is complicate to obtain. A viable way seems to be the observation of the vitrification degree of the charcoal fragments, as it could indicate that a second combustion has occurred or that the material was subjected to high temperatures (Fabre 1996; McParland *et al.* 2010). However, these do not seem to be the only factors that influence vitrification (Scheel-Ybert 1998) and so it will be better to combine it with other approaches. In this sense, the evaluation of trunk/branch calibre seems promising in order to understand if the material has been previously carbonized in charcoal kilns or not (Paradis-Grenouillet *et al.* 2015). The approximation of the wood initial diameter could be carried out through dentro-anthracological software (Dufraisse, García Martínez 2011; Paradis-Grenouillet 2012; Dufraisse *et al*. 2018, 2020).

Overall, in light of these considerations, it is assumed that highly selected fuel was used in Corrales's house. This is shown by the huge percentage of oak charcoal in the phases 1-2 and 5-8, considered by the written sources the domestic fuel par excellence and the most expensive. Probably, this material came mostly from Maresme and La Selva areas, ranging a maximum of 100 km north from Barcelona. During the 16th century, oak fuel use decreased in favour of heath tree, strawberry tree and Aleppo pine. These species can be a clue pointing to the exploitation of degraded maritime woodlands, but they are also good fuels used generally for productive activities with lower prices compared to oak fuel. This phenomenon could have been caused by specific internal house dynamics (change of tenants, different activities inside the house), depositional processes (taking charcoal debris for floor arrangements from different places), or external causes, such as the decline of Barcelona's trades and the shortage of oak fuelwood.

Furthermore, it will be essential in the future to elaborate an approach to distinguish charcoal from firewood starting from the anthracological record, in order to understand which specific product was used through time.

6. Conclusions

In this study, we have analysed the anthracological record of Corrales's house, a structure located in the Born Market archaeological site (*El Born CCM*), in the centre of Barcelona. This provides a first approximation of the fuel exploitation between the Late Medieval and Early Modern period (15th-18th centuries), in a neighbourhood that was the heart of the city's commercial life. In addition to a traditional charcoal analysis, results have been commented considering various archival sources (*Dret d'ancoratge* and *Llibres de la Mostassafia* above all), which allow us to understand the origins and prices of fuel at the time.

The anthracological record is mostly composed of species linked to the Mediterranean woodland and it seems that the exploitation of the environment and the fuel consumption were extremely selective. Forest products were imported above all from the area of Maresme and La Selva and transported by sea to Barcelona. Evergreen oak species dominate the anthracological sequence and, according to written sources, this was the fuel specifically produced for domestic use and, probably, the most expensive. During the 16th century, the consumption of oak fuel decreased in favour of shrubbier taxa, that were cheaper and mostly exploited for productive activities. This phenomenon could reflect a change (tenants, space functionality or activities) inside the house that lead to buy different kinds of fuel. It could also be a symptom of different trade dynamics of the city or a crisis period that caused shortages in some types of fuel.

In general, this study shows that, in an urban context, the charcoal assemblage could be the result of very different dynamics, which must be interpreted through a multidisciplinary approach, combining together charcoal and archival document analysis, in order to examine the socio-economical aspects of fuel supply. In the future, more anthracological studies in the urban archaeological contexts of Barcelona are necessary, in both a synchronic and diachronic sense, to confirm and compare the trend obtained in this study and to expand the understanding of the fuel exploitation in historic times.

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References

M. Alcolea Gracia 2017, *Paisaje vegetal y gestión de recursos leñosos durante la transición epipaleolítico-neolítico en el Valle del Ebro. Aportaciones desde la antracología*, Phd thesis, Universidad de Zaragoza.

E. Allué 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*, PhD thesis, Universitat Rovira i Virgili, Tarragona.

E. Allué, I. Euba 2005, *Informe de l'Anàlisi Antracològica del Born (Barcelona)*, Unpublished report, ArqueoCat sl.

P.L. Artigues Conesa, A. Fernández Espinosa 2014*, El jaciment arqueològic de l'antic Mercat del Born. La seva darrera fase d'us (1700-1717)*, "Quaderns d'Arqueologia i Història de la ciutat de Barcelona", Època II. n. 10, pp. 30-55.

E. Asouti, P. Austin 2005, *Reconstructing woodland vegetation and its exploitation by past societies, based on the analysis and interpretation of archaeological wood charcoal macro-remains*, "Environmental Archaeology", 10, pp. 1-18.

M. Bajet 1993, *Aspectes del comerç a Catalunya en el segle XVI segons els llibres dels mostassas*, PhD Thesis, Universitat de Lleida.

P. Banks 1992, *L'estructura urbana de Barcelona, 714-1300*, in J. Sobrequès (ed), *Història de Barcelona. La formació de la Barcelona medieval*, Vol. 2. Enciclopèdia Catalana, Barcelona, pp. 27-71.

J. Beltrán de Heredia Bercero 2010, *La cristianización del suburbium de Barcino*, in *Las áreas suburbanas en la ciudad histórica: topografía, usos y función*, Córdoba, pp. 363-396.

J. Beltrán de Heredia Bercero 2011, *Santa Maria del Mar, un enclave cultual de la antigüedad tardía en Barcino*, "Quaderns d'Arqueologia i Història de la Ciutat de Barcelona", Època II, n. 7, pp. 103-143.

O. Bolòs de 1957, *Les zones de vegetació de Catalunya*, Societat Catalana de Geografia, discurs de la sessió inaugural del curs 1955-56, Barcelona.

O. Bolòs de 1962, *El paisaje vegetal barcelonés*, Barcelona.

O. Bolòs de, J. Vigo, J. Carreras 2004, *Mapa de la vegetació potencial de Catalunya*, Barcelona.

J.A. Burriel, C. Gracia, J.J. Ibàñez, T. Mata, J. Vayreda 2000, *Inventari Ecològic i Forestal de Catalunya*, Regió Forestal V, CREAF-Ecological and Forestry Applications Research Center, Online in http://www.creaf.cat/.

R. Buxó, R. Piqué 2003, *La recogida de muestras en arqueobotánica: objetivos y propuestas metodológicas. La gestión de los recursos vegetales y la transformación del paleopaisaje en el Mediterráneo occidental*, Proceedings from "Encuentro del grupo de trabajo de arqueobotánica de la Península Ibérica Barcelona/Bellaterra" (29, 30 noviembre y 1 diciembre 2000), Museu d'Arqueología de Catalunya.

Y. Carrión 2005, *La vegetación mediterránea y atlántica de la Península Ibérica. Nuevas secuencias antracológicas*, Valencia.

L. Caruso Fermé, R. Piqué Huerta 2012, *Anàlisi de les fustes carbonitzades del jaciment Passeig de la Plaça Major (Passeig Manresa, Sabadell)*, unpublished report, Laboratori d'arqueobotanica Servei d'anàlisis arqueològiques, Universitat Autònoma de Barcelona.

L. Castelletti 1990, *Legni e carboni in archeologia*, in T. Mannoni, A. Molinari (eds), *Scienze in Archeologia, II ciclo di lezioni sulla Ricerca applicata in Archeologia* (Certosa di Pontignano (Siena), 7-19 novembre 1988), Firenze, pp. 321-394.

L. Chabal 1988, *Pourquoi et comment prélever les charbons de bois pour la période antique: les méthodes utilisées sur le site de Lattes (Hérault)*, "Lattara", 1, pp. 187-222.

L. Chabal 1992, *La représentativité paléo-écologique des charbons de bois archéologiques issus du bois de feu*, "Bulletin de la Société Botanique de France, Actualités Botaniques", n. 2/3/4, pp. 213-236.

L. Chabal, L. Fabre, J.F. Terral, I. Théry-Parisot 1999, *L'anthracologie*, in A. Ferdière (ed), *La botanique*, París, pp. 43-104.

V. Costa, F. Navarro, M. Aulet, J.M. Mijarra, L. Sánchez (eds) 2007, *La transformación histórica del paisaje forestal en Cataluña*, Tercer Inventario Forestal Nacional IFN3, Ministerio del Medio Ambiente.

B. Davasse 2000, *Forêts charbonniers et paysans dans les Pyrénées de l'Est du Moyen âge à nos jours: une approche géographique de l'histoire de l'environnement*, Toulouse.

K. Deforce 2017, *Wood use in a growing medieval city. The overexploitation of woody resources in Ghent (Belgium) between the 10th and 12th century AD*, "Quaternary International", 458, pp. 123-133.

K. Deforce, I. Boeren, S. Adriaenssens, J. Bastiaens, L. De Keersmaeker, H. Haneca, D. Tys, K. Vandekerkhove 2013, *Selective woodland exploitation for charcoal production. A detailed analysis of charcoal kiln remains (ca. 1300-1900 AD) from Zoersel (northern Belgium)*, "Journal of Archaeological Science", 40, pp. 681-689.

C. Dehlon 2018, *Is choice acceptable? How the anthracological paradigm may hinder the consideration of fuel gathering as a cultural behaviour*, "Environmental archaeology", pp. 1-9.

A. Dufraisse, M.S. García Martínez 2011, *Mesurer les diamètres du bois de feu en anthracologie. Outils dendrométriques et interprétation des données,* "Anthropobotanica", 2, pp. 1-18.

A. Dufraisse, S. Coubray, O. Girardclos, N. Nocus, M. Lemoine, G.L. Dupouey, D. Marguerie 2018, *Anthraco-typology as a key approach to past firewood exploitation and woodland management reconstructions. Dendrological reference dataset modelling with dendro-anthracological tools,* "Quaternary International", 463, Part B, pp. 232-249.

A. Dufraisse, J. Bardin, L. Picornell-Gelabert, S. Coubray, M.S. García-Martínez, M. Lemoine, S. Vila Moreiras 2020, *Pith location tool and wood diameter estimation: validity and limits tested on seven taxa to approach the length of the missing radius on archaeological wood and charcoal fragments*, "Journal of Archeological Sciences, Reports", 29: 102166.

A. Dupin, O. Girardclos, C. Fruchart, C. Laplaige, L. Nuninger, A. Dufraisse, E. Gauthier 2017, *Anthracology of charcoal kilns in the forest of Chailluz (France) as a tool to understand Franche-Comte forestry from the mid-15th to the early 20th century AD*, "Quaternary International", 458, pp. 200-213.

A. Durand 1998, *Les paysages médiévaux du Languedoc (Xe-XIIe s.)*, Toulouse.

A. Durand 2004, *Les milieux naturels autour de l'an Mil: approches paléoenvironnementales méditerranéennes*, in P. Bonnassie, P. Toubert (eds), *Hommes et sociétés dans l'Europe de l'an Mil*, Actes du colloque (Conques, 19-21 mai 2000), Toulouse, pp. 73-100.

I. Euba 2009, *Explotación de los recursos forestales desde el Neolítico hasta la época moderna en los valles de La Vansa-sierra del Cadí (Alt Urgell) y del Madriu (Andorra). Análisis antracológico de estructuras altimontanas*, Tarragona.

I. Euba, E. Allué 2010, *Paisajes y recursos forestales de Tarragona en el siglo XV a partir del registro antracológico*, "Arqueología y Territorio Medieval", 17, pp. 71-80.

L. Fabre 1996, *Le charbonnage historique de la chênaie à* Quercus ilex *L. (Lanugedoc, France): conséquences écologiques*, Phd Thesis, Université de Sciences et Techniques du Languedoc, Montpellier.

A. Fernández 2019, *Memòria de la intervenció arqueològica a l'antic mercat del Born de Barcelona. Excavació dels àmbits núm.16, núm.19 i núm.21 de la casa Corrales i actuació al carrer Gensana del conjunt arqueològic* (*Juny – Setembre de 2016),* unpublished report, Servei d'Arqueologia de l'Ajuntament de Barcelona.

M.T. Ferrer i Mallol 1990, *Boscos i deveses a la Corona catalanoaragonesa (segles XIV-XV)*, "Anuario de Estudios Medievales", 20, pp. 485-537.

R. Folch i Guillèn 1981, *Vegetació dels Països Catalans*, Barcelona.

A. Garcia Espuche 2005, *Barcelona entre dues guerres. Economia i vida quotidiana (1652-1714)*, Barcelona.

A. Garcia Espuche 2008, *Jardins, jardineria i botànica. Barcelona 1700*, Barcelona.

A. Garcia Espuche 2009, *La ciutat del Born. Economia i vida quotidiana a Barcelona (segles XIV a XVIII)*, Barcelona.

A. Garcia Espuche, J. Borràs i Roca, J. Pellisa Pujades, J. Dolcet, C. Mas i Gracia 2009, *Dansa i música. Barcelona 1700*, Barcelona.

M. Guàrdia, A. Garcia Espuche 1992, *Consolidació d'una estructura urbana: 1300-1516*, in J. Sobrequès (ed), *Història de Barcelona. La ciutat consolidada (segles XIV-XV)*, Vol. 3, Enciclopèdia Catalana, Barcelona, pp. 37-71.

R. Julià Brugués, S. Riera Mora 2010, *Usos del sòl i activitats productives a Barcelona a partir de l'anàlisi paleoambiental de la llacuna litoral medieval del Pla de Palau*, "Quaderns d'Arqueologia i Història de la ciutat de Barcelona", Època II, n. 6, pp. 164-177.

R. Julià Brugués, S. Riera Mora 2014, *Evolució geomorfològica del barri de la Ribera en èpoques històriques*, "Quaderns d'Arqueologia i Història de la ciutat de Barcelona", Època II n. 10, pp. 139-161.

O. López-Bultó 2018, *Informe de l'analisi antracològic del jaciment del Carrer Sotstinent Navarro (Barcelona)*, unpublished report, Universitat Autònoma de Barcelona.

T. Ludemann 2003, *Large-scale reconstruction of ancient forest vegetation by anthracology, a contribution from the Black Forest*, "Phytocoenologia", 33(4), pp. 645-666.

L.C. McParland, M.E. Collinson, A.C. Scott, G. Campbell, R. Veal 2010, *Is vitrification in charcoal a result of high temperature burning of wood?*, "Journal of Archaeological Science", 37, pp. 2679-2687.

A.M. Mercuri, E. Allevato, D. Arobba, M. Bandini Mazzanti, G. Bosi, R. Caramiello, E. Castiglioni, M.L. Carra, A. Celant, L. Costantini, G. Di Pasquale, G. Fiorentino, A. Florenzano, M. Guido, M. Marchesini, M. Mariotti Lippi, S. Marvelli, A. Miola, C. Montanari, R. Nisbet, L. Peña-Chocarro, R. Perego, C. Ravazzi, M. Rottoli, L. Sadori, M. Ucchesus, R. Rinaldi 2015, *Pollen and macroremains from Holocene archaeological sites: A dataset for the understanding of the biocultural diversity of the Italian landscape,* "Review of Palaeobotany and Palynology", 218, pp. 250-266.

C. Montanari, S. Scipioni, G. Calderoni, G. Leonardi, D. Moreno 2002, *Linking anthracology and historical ecology: suggestions from a post-medieval site in the Ligurian Apennines (northwest Italy)*, in S. Thiébault (ed), *Charcoal Analysis. Methodological Approaches, Palaeoecological Results and Wood Uses*, Proceedings of the Second International Meeting of Anthracology (Paris, September 2000), Oxford, pp. 235-241.

O. Nelle 2003, *Woodland history of the last 500 years revealed by anthracological studies of charcoal kiln sites in the Bavarian Forest*, *Germany*, "Phytocoenologia", 33, pp. 667-682.

S. Paradis-Grenouillet 2012, *Etudier les "forêts métallurgiques": analyses dendro-anthracologiques et approches géohistoriques. Exemple des forêts du mont Lozère et du Périgord-Limousin*, PhD Thesis, Université de Limoges, Limoges.

S. Paradis-Grenouillet, P. Allée, G. Servera Vives, A. Ploquin 2015, *Sustainable management of metallurgical forest on Mont Lozère (France) during the Early Middle Ages*, "Environmental Archaeology", 20(2), pp. 168-183.

S. Paradis-Grenouillet 2017, *Trasformazione e gestione dei paesaggi boschivi dei Colli Euganei*, in G.P. Brogiolo (ed), *Este, L'Adige e i Colli Euganei. Storie di paesaggi*, Mantova, pp. 187-200.

R. Pujades, M. Soberón, A. Cubeles (in press), *Entre el realisme i la idealització: la façana marítima de Barcelona i les vistes urbanes, 1450-1697*, IV Jornades d'Història de la Cartografia (Barcelona, 17 i 18 d'octubre 2018), Barcelona.

S. Riera Mora 1994, *Evolució del paisatge vegetal holocè al Pla de Barcelona, a partir de les dades pollíniques*, Phd Thesis, Universitat de Barcelona.

S. Riera Mora, A. Esteban Amat 1994, *Vegetation history and human activity during the last 6000 years on the central Catalan coast (northeastern Iberian Peninsula),* "Vegetation History and Archaeobotany", 3(1), pp. 7-23.

M. Riu 1996, *Pesos, mides i mesures a la Catalunya del segle XIII: aportació al seu estudi*, "Anuario de Estudios Medievales", 26, pp. 825-837.

S. Rivas Martínez, A. Penas, T.E. Díaz 2004, *Bioclimatic & Biogeographic Maps of Europe,* Universidad de León, online in http://www.globalbioclimatics.org.

R. Scheel Ybert 1998, *Stabilité de l'Écosystéme sur le Littoral Sud-Est du Brésil à l'Holocéne Supérieur (5500-1400 ans BP). Les Pêcheurs-Cueilleurs-Chasseurs et le Milieu Végétal: apports de l'Anthracologie*, PhD Thesis, Université de Montpellier II.

F.H. Schweingruber 1990, *Anatomy of European Woods. An Atlas for the Identification of European Trees, Shrubs and Dwarf Shrubs*, Bern-Stuttgart (2nd ed).

A. Simon, J. Andreau 1992, *Evolució demografica segles XVI-XVII*, in J. Sobrequès (ed), *Història de Barcelona. Barcelona dins la Catalunya Moderna (segles XVI-XVII)*, Vol. 4. Enciclopèdia Catalana, Barcelona, pp. 103-164.

M. Soberón 2017, *La relació marítima entre el Maresme i Barcelona a mitjan segle XV*, in *El segle XV, temps de canvis i incerteses*, Simposi in Maritima, 1r Simposi sobre història cultura i patrimoni del Maresme medieval, Vilassar del Dalt, pp. 79-99.

I. Théry-Parisot, L. Chabal, J. Chrzavzez 2010, *Anthracology and taphonomy, from wood gathering to charcoal analysis. A review of the taphonomic processes modifying charcoal assemblages, in archaeological contexts*, "Palaeogeography, Palaeoclimatology, Palaeoecology", 291, pp. 142-153.

X. Torres Sans 1992, *Activitats ecònomiques*, in J. Sobrequès (ed), *Història de Barcelona. Barcelona dins la Catalunya Moderna (segles XVI-XVII)*, Vol. 4. Enciclopèdia Catalana, Barcelona, pp. 213-256.

S. Vila Moreiras, R. Piqué Huerta 2012, *Paisatge vegetal i gestió del combustible a la plana occidental catalana entre el neolític i l'edat mitjana: estat de la qüestió des de l'anàlisi antracològica*, "Revista d'Arqueologia de Ponent", 22, pp. 9-36.

L. Vilar i Sais 1987, *Flora I vegetació de la Selva*, PhD Thesis, Universitat Autonoma de Barcelona.

J.T. Wing 2015, *Roots of Empire. Forests and State Power in Early Modern Spain, c. 1500-1750*, Leiden-Boston.

M. Zucchitello 1991, *Homes, vaixells i mercaderies de Tossa al Grau de València (1459-1703)*, Tossa del Mar.